

# Wastewater Master Plan Investment Package I: Surabaya

## Final Master Plan

August 2011

Indonesia Infrastructure Initiative

Australia Indonesia Partnership

Kemitraan Australia Indonesia

Mott MacDonald

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Indonesia Infrastructure Initiative

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# Issue and revision record

| Revision | Date | Originator | Checker | Approver | Description |
|---|---|---|---|---|---|
| A | 22 August 2011 | Alasdair Cook<br>Frank Bell<br>Jan Spit<br>Sambas<br>Ristina | Ciaran Willcocks<br>Clive Sorhaindo | Enni Soetanto | English Version: Final Issue<br><br>Note: Appendicies in Stand Alone Document |



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***Note:*** *Appendices in Stand Alone Document for Ease of Reference*

# Glossary and Acronyms

| | |
|---|---|
| ABR | Anaerobic Baffle Reactor |
| ADB | Asian Development Bank |
| APBD | Anggaran Pendapatan Belanja Daerah (Regional Revenue Expenditure Budget) |
| APBN | Anggaran Pendapatan Belanja Nasional (National Revenue Expenditure Budget) |
| AusAid | Australian Agency for International Development |
| BAPEPAM | Badan Pengawas Pasar Modal (Capital Market Regulatory Official) |
| Bappeko | Badan Perencanaan Pembangunan Kota |
| Bappenas | Badan Perencanaan Pembangunan Nasional (National Development Planning Agency) |
| BLH | Badan Lingkungan Hidup (Environmental Agency) |
| BOD | Biochemical Oxygen Demand |
| BORDA | Bremen Overseas Research and Development Association |
| BOT | Built Operate Transfer |
| BPHTB | Bea Perolehan Hak atas Tanah dan Bangunan (land and buildings property transfer tax) |
| CBD | Central Business or Commercial District |
| CD | Covered Drains |
| CKTR | Cipta Karya dan Tata Ruang |
| COD | Chemical Oxygen Demand |
| CSS | City Sanitation Strategy |
| CT | Communal Treatment |
| DAK | Dana Alokasi Khusus |
| DED | Detailed Engineering Design |
| DEWATS | Decentralized Wastewater System |
| DGHS | Directorate General of Health Service |
| DGT | Directorate General of Taxation |
| DJCK | Direktorat Jenderal Cipta Karya |
| DKI | Daerah Khusus Ibukota (Special Capita District) |
| DKP | Dinas Kebersihan dan Pertamanan (Department of Hygiene and Gardening) |
| DPRD | Dewan Perwakilan Rakyat Daerah |
| EHRA | Environmental Health Risk Assessment |
| ESP | Environmental Service Program |
| FAP | Facultative Anaerobic Pond |
| FOPIP | Financial and Operational Performance Improvement Plan |
| GAPENSI | Gabungan Pelaksana Konstruksi Nasional Indonesia (The Indonesia Constructors Association) |
| GDP | Gross Domestic Product |
| GoA | Government of Australia |
| GoI | Government of Indonesia |
| GPS | Global Positioning System |
| IBRD | International Bank for Reconstruction and Development |
| ICD | Interceptors (leaching pit which has been made watertight or septic tank) and discharge of the effluent in adapted covered stormwater drains |
| IPLT | Instalasi Pengolahan Limbah Tinja |
| ITS | Institut Teknologi Surabaya |
| IUIDP | Integrated Urban Infrastructure Development Program |
| LIDAP | Local Institutional Development Action Plans |
| LKPP | Lembaga Kebijakan Pengadaan Pemerintah (Government Institution on Procurement Policy) |
| LP | Leaching Pit |

| | |
|---|---|
| LP+ | Improved Leaching Pit |
| MCK | Community toilet and washing facility (Mandi Cuci Kakus) |
| MDB | Multilateral Development Banks |
| MDG | Millennium Development Goals |
| MMI | Mott MacDonald Indonesia |
| MOF | Ministry of Finance |
| MPW | Ministry of Public Works |
| MSMHP | Metropolitan Sanitation Management and Health Project |
| NGO | Non Governmental Organization |
| NJOP | Nilai Jual Obyek Pajak (property valuation) |
| NMCP | NGO Management Certificate Program |
| O&M | Operation & Maintenance |
| OBA | Output Based Aid |
| OD | Open Defecation |
| ODF | Open Defecation Free |
| PAMSIMAS | Penyediaan Air Minum dan Sanitasi berbaSis Masyarakat |
| PBB | Pajak Bumi dan Bangunan (Property Tax) |
| PD | Perusahaan Daerah (Government Owned Company) |
| PDAM | Perusahaan Daerah Air Minum (Local Drinking Water Corporation) |
| PERDA | Peraturan Daerah |
| Perpres | Peraturan Presiden (Presidential Decree) |
| PKL | Pedagang Kaki Lima (Food Stalls) |
| PLN | Perusahaan Listrik Negara (National Electricity Company) |
| PMK | Peraturan Menteri Keuangan (Ministry Of Finance Regulation) |
| POKJA | Kelompok Kerja (Work Group) |
| PP | Peraturan Pemerintah (Government Regulation) |
| PPN | Pajak Pertambahan Nilai |
| PPSP | Percepatan Pembangunan Sanitasi Pemukiman (settlement sanitation development acceleration) |
| PSO | Public Service Obligation |
| PSP | Private Sector Participation |
| Puskesmas | Pusat Kesehatan Masyarakat |
| RBC | Rotating Biological Contactor |
| RISPK | Rencana Induk Sanitasi Perkotaan Kota Surabaya |
| RO | Reverse Osmosis |
| Rp. | Indonesian Rupiah |
| RPJMD | Rencana Pembangunan Jangka Menengah Daerah |
| RPJMN | Rencana Pembangunan Jangka Menengah Nasional |
| Rukan | Perumahan dan Perkantoran |
| Ruko | Rumah Toko |
| Sanimas | Sanitasi Masyarakat (community Based Sanitation) |
| SBS | Small Bore Sewerage |
| SDS | Sewer Discharge Station |
| SIER | Surabaya Industrial Estate Rungkut |
| SMS | Septage Management System |
| SOSEC | Social Economic |
| SPAL | Saluran Pembuangan Air Limbah |
| SS | Shallow Sewerage |
| SSDP | Sewerage and Sanitation Development Program |
| ST | Septic Tank |

| | |
|---|---|
| ST/AUF | Septic Tank with Anaerobic Upflow Filter |
| STei | Septic Tank effluent infiltration |
| STP | Sewage Treatment Plant |
| SUSENAS | Survei Sosial Ekonomi Nasional |
| TG1 | Task Group 1 |
| TG2 | Task Group 2 |
| TG3 | Task Group 3 |
| TG4 | Task Group 4 |
| TLP | Twin Leaching Pit |
| TPA | Tempat Pembuangan Akhir |
| TPS | Tempat Pembuangan Sementara |
| TUPOKSI | Tugas Pokok dan Fungsi (Main Task and function) |
| UASB | Upflow Anaerobic Sludge Blanket |
| UASBR | Upflow Anaerobic Sludge Blanket Reactor |
| Unair | Universitas Airlangga |
| UPTD | Unit Pelaksana Teknis Dinas |
| USAID | United States Agency for International Development |
| USRI | Urban Sanitation and Rural Infrastructures |
| WIP | Wastewater Investment Plans |
| WSI | Water and Sanitation Initiative |
| WTP | Willingness to Pay |
| WWTP | Waste Water Treatment Plant |

# Executive Summary

Surabaya is Indonesia's second largest city and the capital of the Province of East Java. Surabaya presently has almost 3 million inhabitants and it is expected that this number will grow to around 4 million by the end of the planning period for this Wastewater[1] Masterplan; 2030. By then, one quarter of the population will live in areas with a population density of more than 300 people per hectare. The increase in population will compound the present, and ever growing environmental problems related to wastewater collection, treatment and disposal.

**Current Situation**

Currently almost 50% of sewerage and wastewater produced in Surabaya is either untreated or inadequately treated. In addition:

- One eighth of the population defecates in the open; usually in rivers or drainage channels.
- One third of the population use wastewater facilities which directly discharge into surface water drainage channels.
- Only one third of the sludge (septage) that accumulates in existing on-site systems, mainly leaching pits, is collected and treated. The remainder is either collected manually and dumped into the Surabaya river, or accumulates in the system, leading to malfunctioning, overflow, and pollution of ground water and drainage channels;
- The present sludge treatment facility at Keputih has a capacity to treat all the septage of Surabaya up to 2030, but only functions at half capacity. Even so, the effluent of the treatment facility frequently exceeds acceptable effluent discharge standards.

In response to these problems there are some very promising neighbourhood scale initiatives in Surabaya, where the community is treating collected wastewater and reuses it for gardening purposes. Also, the city government has taken up the challenge of improved wastewater management and is spending funds on wastewater projects like the large anaerobic baffle reactor (ABR) at the ITS Institute which awaits connection to the adjoining student and staff quarters.

1 We use the term wastewater to differentiate from the more common term of sanitation because sanitation usually includes solid waste management and drainage. Wastewater consists of black water (excreta and urine plus water used for flushing and anal cleansing) and grey water (water originating from washing, cleaning and laundry)

Unfortunately, very few initiatives are fully successful and the potential environmental benefits are not being achieved. Sometimes the wrong technology is selected, such as the application of an ABR to treat grey-water; sometimes the right technology is not implemented adequately.

**Master Plan Goals**

In this Wastewater Master Plan we aim to identify the present shortcomings and the conditions necessary for improved practices in the future. Practical and cost effective plans have been developed which, if implemented, will allow for very substantial improvements in the management of wastewater, leading to better environmental and living conditions and removing a major barrier for Surabaya's economic growth.

Measurable aims include a reduction of the current daily environmental pollution load from 60 ton BOD (Bio Oxygen Demand) to 20 ton BOD by the year 2030 and to become Open Defecation Free (ODF) by 2020.

It should be noted that whilst worthy in their own right, these pollution reduction targets for Surabaya will have most effect if they are coupled with initiatives to improve the water quality of the rivers which are already heavily polluted on arrival in Surabaya. Hence, we strongly advise the start of a Brantas River catchment river quality improvement scheme, involving all up stream communities.

**Social Inclusion**

Inadequate waste water management effects all sectors of society but has a disproportionate impact on the urban poor. The wastewater improvement programme developed is a poor-inclusive programme: that means the programme has been developed in such a way that the environmental conditions of the city's slum dwellers is improved.

**Appropriate Solutions**

A pragmatic approach has been taken in the masterplan to produce low cost short term investment priorities which will offer immediate benefits that compliment medium and long term approaches that works towards providing a comprehensive sewerage system suitable for a major city of nearly 4 million inhabitants. This leads to the phased adoption of "quick fix" on-site solutions, medium term intermediate solutions and the foundations for long term of-site systems.

On-site Systems Appropriate to Surabaya Conditions

Where first stage sanitation improvements are required, on-site systems are often preferred because they can be constructed by the local community or the individual householder for low capital and operational cost. Well constructed and well maintained on-site sanitation systems can provide the same level of wastewater management and health benefits as a conventional off-site sewerage system.

The repair and improvement on existing on-site systems and the installation of new good quality systems will go a long way towards meeting the masterplan's goals. By 2030, more than 60% of the wastewater systems will be acceptable private on-site systems.

However, all on-site systems need to be appropriate to the conditions in which they are used including ground water level, soil permeability and population density. These systems must be developed along side suppliers and manufactures and must "fit" Surabaya.

Households will need to be persuaded, incentivised and then helped to install or upgrade to these systems. Once installed, procedures need to be in place to ensure that tanks are emptied regularly (approximately once every 1-2 years) and systems are maintained to avoid malfunction or overflow and the renewed pollution of groundwater and watercourses.

Increased institutional support and financial assistance, e.g. subsidies for the poor or credits for the medium-income will be required along side technical guidance, support and mass media coverage so that the population at large understand the benefits available and how to access / implement them.

Intermediate Wastewater Systems

Intermediate wastewater systems have been developed because there are areas where high ground water level, impermeable soils and/or population density render on-site systems inappropriate and where many households either do not generate enough wastewater for a conventional gravity sewerage system to operate effectively or cannot afford the estimated Rp 30,000/month off-site sewage fee required.

These intermediate systems will ultimately serve one fifth (22%) of the total population of the City and are located in low to medium income areas. (i.e. 30% of the population living in areas with a population density of more than 300cap/ha and 13% of the population living in areas with a population density between 150 and 300 cap/ha). In other areas

where there are private on-site systems needing improvement, small bore sewerage systems or shallow sewers will be utilised.

Conventional Citywide Sewerage

The Master Plan includes an “embryo” off-site wastewater system in a mixed commercial and high-density residential area near the River Kali Asin, comprising of 9,200 connections to match Pemkot expectations and capability. This “embryo” system will operate as an independent module with a decentralised STP (Sewerage Treatment Plant). This STP needs to be operated and maintained by a professional entity, which can develop knowledge and experience of wastewater collection, transport and treatment.

This Kali Asin sewerage system should be profitable and its success will act as a proof of concept for the off-site model. This will form the impetus behind the purchase of land for the 2 future STPs for the planned city-wide sewerage systems that form the later stages of the Master Plan. One STP is planned at the Morokrembangan Boezem (11ha) and the other STP at the Suramadu Bridge (6ha). The future STPs will also receive discharges from the planned septage discharge stations (SDS), which will provide local septage emptying facilities for the on-site systems of nearby communities.

Two city-wide wastewater collection zones have been identified for the West and East of Surabaya, with trunk sewers and associated STPs, described above. Ultimately these sewerage systems will serve 140,000 connections; 70% of the population living in areas with a population density of more than 300cap/ha. The trunk sewers will also receive effluent from a number of intermediate systems and will allow the proposed Septage Management Service (SMS), to be expanded to cover the whole City.

**Implementation Time Line**

Suitable phasing of the introduction of technologies in key to the success of this masterplan and is summarised below:

By 2015:

a. Reduce open defecation by more than 50% compared to 2010, but may not yet have reached the status of Open Defecation Free (ODF);
b. Reduce the number of unacceptable on-site facilities by 1/3 compared to 2010;
c. Develop one new off-site embryo system in high density / commercial area;
d. Increase the septage collection to 75% of the on-site sanitation systems with all collected septage to be treated in an environmentally acceptable way;

By 2020:

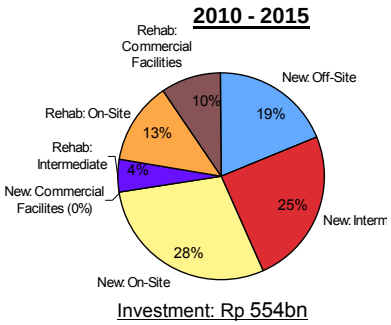
a. Surabaya has reached the status of Open Defecation Free (ODF);
b. All unacceptable wastewater facilities removed or replaced;
c. Overall 40% of the high density areas are served by off-site systems;
d. The septage collection services cover 100% of the on-site sanitation systems and all collected septage is treated in an environmentally acceptable way;
e. 50% of the operation and maintenance costs of off-site and intermediate systems are covered by the collection of user fees (maximum 50% subsidy).

By 2030:

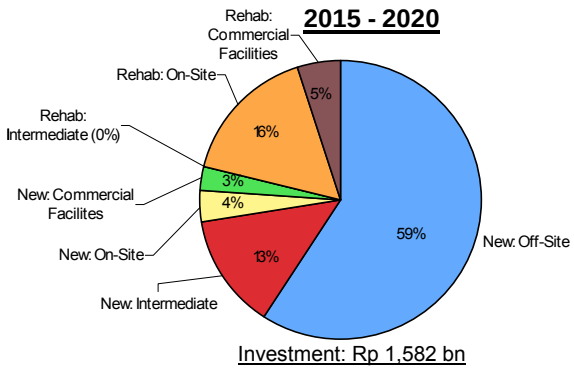
a. 70% of high density and commercial areas are served by off-site systems;
b. Remaining 30%, of the high density areas are served by intermediate systems;
c. All operation and maintenance costs of off-site and intermediate systems are covered by the collection of user fees, i.e. no subsidy.

## Investment Costs

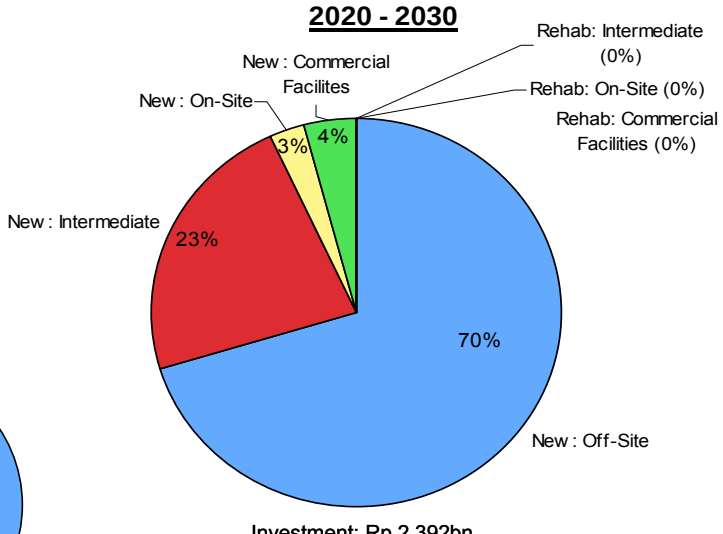
Total investment cost is estimated in the region of **Rp 4.5 trillion (US $ 503 m.)** over 20 years. A breakdown of investment costs is graphically represented below.



Investment: Rp 554bn



Investment: Rp 1,582 bn



Investment: Rp 2,392bn

### Operation and Maintenance Costs

Operation and Maintenance (O&M) costs are around 2% of the investment costs.

- Rp 30,000/household/month for off-site systems;
- Rp 15,000/household/month for intermediate systems;
- Rp 5,000/household/month for on-site systems.

### Bottleneck Avoidance Strategies

Improvements to the wastewater situation are hampered by 3 recognised bottlenecks. These are the fact that;

1. Many people are unconcerned about the present unsanitary conditions.
2. Few stakeholders, including the general public, the private sector and responsible government agencies have any knowledge of good wastewater systems. It is not regarded it as a prestigious issue.
3. The common belief that improvement of wastewater collection, transport and treatment costs too much money and provides poor value.

This Master Plan deals with these aspects by recommending the creation of an enabling environment by:

- **Improving public perception of environmental and health issues related to wastewater.** This has been dealt with in the WWMP Capacity Building Plan (CBP) and our proposals on 'software'.
- **Improving wastewater collection and treatment management knowledge.** This has been dealt with in the CBP and includes developing local knowledge among stakeholders, mass media campaigns and the dissemination of good practices.
- **Proposing cost effective interventions.** This has been dealt with by identifying "on-site" system programmes to cover as large an area as practical. "Intermediate" wastewater system proposals should be based on medium level technology, where appropriate. Finally "off-site" wastewater collection zones should be targeted at the properties that can afford to pay for the significant operation and maintenance costs of these systems.

# 1. Introduction

## 1.1 Background

The Government of Australia (GoA) announced the Water and Sanitation Initiative (WSI) in December 2008. The approved allocation for Indonesia is A$60.5 million. The bilateral funds are to be expended during the period 1 July 2009 - 30 June 2011. Mott MacDonald Indonesia was appointed by IndII as consultants for Package 1 – Surabaya and Bogor. A project commencement was given for 1st September 2010 with a project completion date of 30th June 2011.

The preparation of Wastewater Investment Plans under this assignment is one component of the WSI for Indonesia. Other components of WSI include the water and sanitation hibah, and support to PAMSIMAS. The WSI programme for Indonesia is being delivered through the Indonesian Infrastructure Initiative (IndII), which is a bilateral cooperation project between Australia and Indonesia, funded by the Australian Agency for International Development (AusAID). Tenders were issued for 3 packages of Wastewater Investment Masterplans covering 7 Cities.

## 1.2 Framework

This wastewater Master Plan project is one element of the National Wastewater Strategy and Policy Implementation plan. The Master Plan and wastewater system proposals that are included are identified within the national strategies for the development of domestic wastewater management systems. The implementation of the Master Plan is directed through several regulations and commitments. The two main relevant regulations with regard to investment planning are:

4. Public Work Regulation No. 16/PRT/M/2008 on National Strategy and Policy on Domestic Wastewater Management, and
5. Government Regulation No. 16/2005 on Water Supply Development

The above regulations provide a framework on the common vision and mission of wastewater management system development and activities and do not provide so much technical guidance specific to wastewater. However, they have both been used in the development of the Master Plan for the City, with adjustments to match the wastewater topic and the areas' specific characteristics.

The Government of Indonesia (GoI) has also committed to achieve MDG's target in the sector of sanitation by 2015. This is that 76.8% of the national population should have access to safe and proper sanitation.

## 1.3 Definition of waste water

The term 'wastewater' led to some confusion during discussions in the early stages of the development of the masterplan. A more appropriate term would be 'human waste management', to distinguish it from storm water. In the framework of the Master Plan, we distinguish the following three terms:

- **Domestic wastewater**, consisting of:
  - 'Black' water ('kakus') = human waste (excreta and urine) + water used for anal cleansing and flushing the toilet (usually by hand, pour-flush)

  - 'Grey' water = water produced during bathing ('mandi') and cleaning/laundry ('cuci')

- **Non-domestic wastewater**[2]: water originating from small businesses, home industries, industrial areas;
- **Septage**: faecal sludge: the residue from faeces that remains after a period of anaerobic digestion in the leaching pit ('cubluk'), septic tank ('tanki septik') or any other treatment/storage system.

In the framework of the Master Plan the term **'wastewater' refers to domestic wastewater consisting of black water, grey water and septage, but excluding storm water**. The removal, transport and treatment of septage are included in the Master Plan.

## 1.4 Aim and objectives of the Master Plan

The overall aim of the project is to develop a long term (2030) Master Plan and to develop, together with the City Governments, the tools and skills to prepare their own City Sanitation Strategies (CSS). In future years the City Governments should be able to develop better focussed goals, to be able to re-structure the management process where necessary, to facilitate the implementation of the programmes and to be better able to deliver, operate and maintain the physical infrastructure projects in the future.

The immediate objective of the Master Plan is to identify selected priority projects for implementation in the first five year period of the Master Plan, i.e. by 2015 and to enable Multilateral Development Banks (MDB's) and bilateral development agencies to commit to further development of the wastewater proposals in agreement with GoI. The output is tailored to match the specific requirements of MDB's or bilateral agencies that have committed to provide funding, provided that GoI has agreed to proceed with the funding proposals at a sufficiently early stage in the activity.

The project was divided into four Task Groups (TG) in the Terms of Reference (TOR), namely:

1. Reviewing the City Sanitation Strategy (TG1)
2. Master Plan Based on City Sanitation Strategy (TG2)
3. Feasibility Studies (TG3)
4. Capacity Building (TG4)

The selected projects for the first five year period are to be subject to a feasibility study, TG3, if found necessary, which will be prepared under this project. The proposed investment programs must be approved by local government and carefully assessed. Necessary institutional/legislative changes should be proposed in order to facilitate implementation. These changes are identified in TG4 of this project.

2 Note. Non-domestic wastewater from home industries such as 'tahu' production or 'industrial' type pollution from animal slaughter etc can produce significant environmental effects on local communities. As we were unable to identify these locations, due to the study timescale, we are not covering this issue in the Master Plan. See Section 6.6 for comments.

All work carried out during the project, in the development of the Master Plan, has been done in close consultation and collaboration with the local governments, to enhance their capacity in the skills for sustainable future wastewater management. The Master Plan covers physical infrastructure, capacity building elements and the financial implications of wastewater system development.

## 1.5 The Target for the City and strategic objectives of the Master Plan

### 1.5.1 Target

The Master Plan targets to create a healthy living environment in Surabaya through the effective and sustainable collection, transport, treatment and final disposal/reuse of wastewater ('wastewater management').

### 1.5.2 Strategic objectives

1. Immediate improvement of the wastewater situation of those people who defecate in the open: Open Defecation Free (ODF) status by 2020.
2. Target wastewater system provision for housing areas where people have relatively unhealthy living conditions. This is reflected in the EHRA Sanitation Risk score of the area.
3. Improvement of the quality and quantity of the city's wastewater infrastructure in such a way that the pollution load of Surabaya is at least halved by 2030, compared to the pollution load in 2010. See Chapter 4, figure 4.1.
4. Identification of the main sewer lines that will be part of the long-term (2030) city wide sewerage system. This will allow decision on spatial reservations to be made for the main spine/skeleton sewers and sewage treatment plant (STP) that would be part of the long-term infrastructure.
5. Commencement of development of 'starter' (embryo) off-site wastewater system in one of the Central Business Districts and surrounding high-density housing areas by 2015
6. Development of a sustainable legal and institutional framework for management, operation and maintenance of improved wastewater facilities by 2015
7. Motivation of the population, commercial enterprises and institutes to implement, operate and maintain adequate wastewater facilities
8. Development of physical, financial and technical capability regarding wastewater improvements at all levels: government, institutes, commercial enterprises, neighbourhood and community.
9. Establish control over the growing backlog of wastewater infrastructural needs in Surabaya.

## 1.6 Study area

The area covered by the Master Plan is the administrative area of the City, see Figure 1.1. For those developed areas that are contiguous across the City boundary, only the land in the City is included in the Master Plan. While the Province of East-Java has been involved in the master planning, further discussions should be held in the future about cross border cooperation with regard to the development of wastewater solutions for these areas.

## 1.7 Basis

The Master Plan has had to be developed in 5 months. This has meant various limitations and constraints on the study, namely:

- Inability to do detailed topographical surveys.
- SOSEC surveys had to be held in representative sample areas. Not all areas of the city were sampled.
- Use of secondary data without detailed review.
- General area analysis for recommended solutions.
- Use of Kelurahan boundaries, rather than geographical (built-up) community areas
- City data and statistics based on a Kelurahan records.
- Inability to include specific solutions to home industry wastewater
- Industrial wastewater has not been included in the study, Waste should be treated by the industry that is producing the waste.

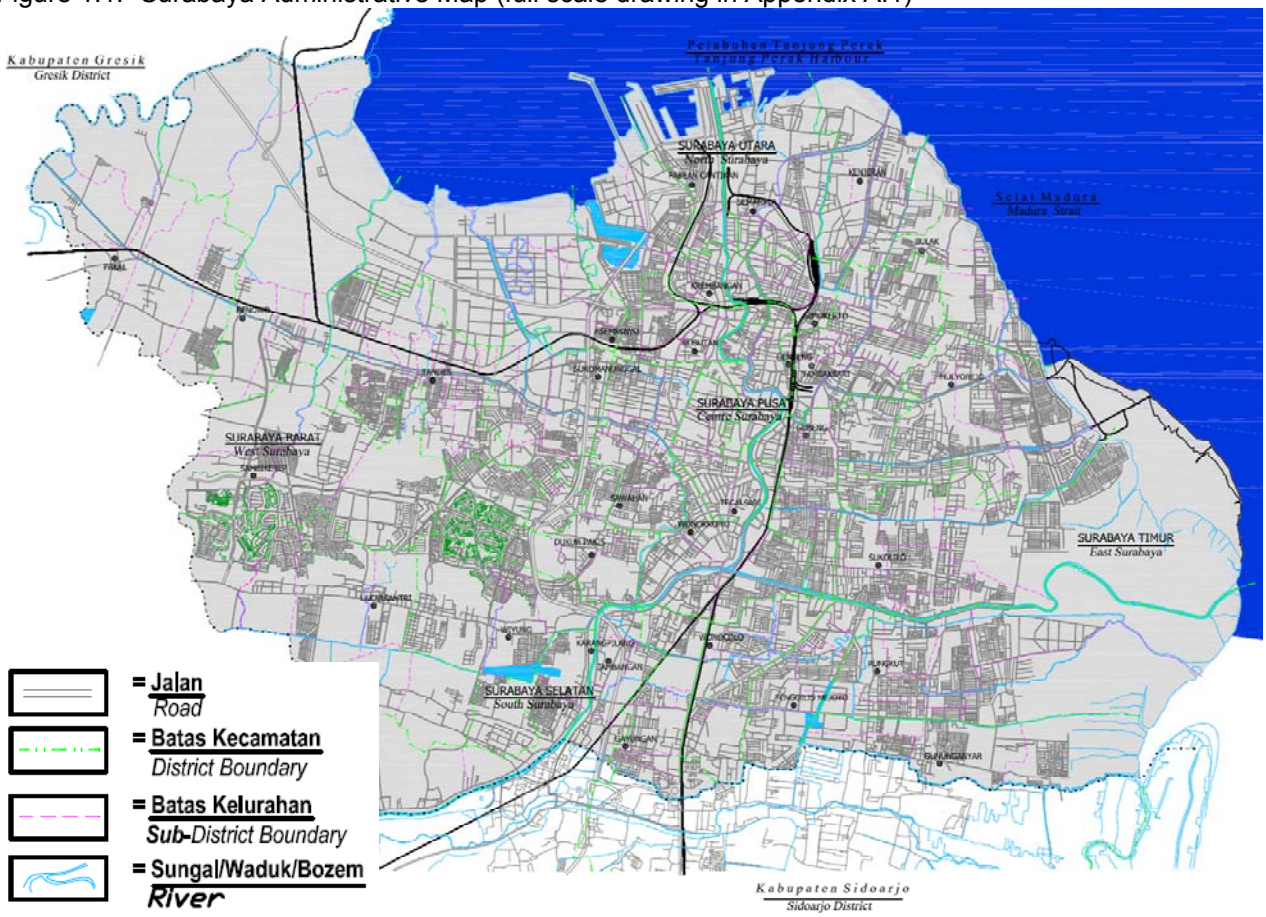
Identification of the sites for the wastewater treatment plants has been limited to land within the administrative area of the City. Cross border cooperation could identify better sites.

## 1.8 Technical approach and methodology

The general approach and methodology consists of:

1) Population and Land Use Projections
2) Review of the City Sanitation Strategy
3) Development of Wastewater Systems' Coverage Spreadsheet
4) Identification of Appropriate Wastewater Systems
5) Selection of Wastewater Systems using following terminology:
   a) "On-site" systems (individual household level)
   b) "Off-site" systems, being conventional sewerage (city wide level);
   c) "Intermediate" systems: a mix of communal systems and "off-site" systems, other than conventional sewerage (neighbourhood/cluster/module level).
6) Development of Off-Site City-Wide Conventional Sewerage Systems
7) Prioritisation

Figure 1.1: Surabaya Administrative Map (full scale drawing in Appendix A.1)




## 1.9 Planning horizons

The TOR requires that the Master Plan describes agreed interventions, both physical and non-physical, over a planning horizon of 20 years and groups them into four 5-year periods. The subsequent feasibility studies to be carried out under the project are to address the projects in the first 5-year period only.

In consultation with IndII, it was agreed to modify the grouping to three periods: a short period (5 years), medium-term period (10 years) and a long-term period (20 years). This is more in line with current planning practices in Indonesia: immediate improvements (5 years), paving the path for sustainable solutions (10 years) and indicating the long-term goal (20 years). In addition, Indonesia is developing so rapidly that another 'benchmark' between 10 and 20 years is not very effective.

Consequently, the target years used are: 2015 (as year 5), 2020 (as year 10) and 2030 (as year 20). The main reason is that 2015 is a very important benchmark: the year of the Millennium Development Goals (MDGs).

From a foreign funding perspective the end of the short-term period, year 2015, might be very optimistic. Under normal circumstances the Master Plan would be approved in July 2011. Detailed feasibility studies would be approved in October 2011 and projects could be funded from 2012/13 onwards. Hence in terms of actual construction of the projects, year 5 of the Master Plan would in effect be 2017/18.

**Recommended Planning Horizons**

- Existing situation 2010 (year '0')
- Short-term period 2015 (year '5')
- Medium-term period 2020 (year '10')
- Long-term period 2030 (year '20')

## 1.10 How to read the Master Plan

A brief description of the different sections of the Draft Master Plan document, below, may help to explain the structure of the report:

- Chapter 2 - a brief description of the city and its character
- Chapter 3 - a brief summary of the current wastewater situation and the effect that it has on the society and environment of the city
- Chapter 4 - how we have looked at the future with regard to demand for services and strategic objectives
- Chapter 5 - a brief description of how we have selected the appropriate system for each area of the city and developed the timing recommendations for different interventions
- Chapter 6 - descriptions of the recommendations, timing and costs for the different types of wastewater systems, by area
- Chapter 7 - a detailed summary of the institutional situation of the current operation of the wastewater system and an analysis of the City Government's proposals for the future
- Chapter 8 - possible financing options for investments
- Chapter 9 - aspects and recommendations for capacity building
- Chapter 10- comments on private sector participation
- Chapter 11 - a description of the main investment proposals and recommendations for implementation
- Chapter 12 - a list of the priority projects for the first five years of the Master Plan and brief recommendations for "follow up" activities and studies that should support the implementation of the wastewater improvements identified in the Master Plan.

**NOTE** - The plans included for illustration in the main text in the main text are also included in the appropriate section Appendix at a larger scale for increased clarity

# 2. General description of the city

## 2.1 Study area

The city of Surabaya is located in the East Java province of Indonesia. It is geographically located between 7º 12'0" - 7º 21' latitude and 112° 36' -112° 57' longitude. The area of the city is 32,520 Ha and the marine area managed by the city government is 19,040 Ha. The city's administrative area consists of 31 Kecamatans, 163 Kelurahans, 1,298 RW and 8,338 RT.

On the northern and eastern part of the city of Surabaya there is the Madura Strait, on the southern part of the city is the Sidoarjo regency and on the western part of the city is the Gresik regency. The city map, up to the level of Kecamatan and Kelurahan, is presented in Figure 2.1 and shows the city administrative areas of the City.

## 2.2 Physical conditions

### 2.2.1 Topography

The topography of the city ranges from 1m below sea level to 20m above sea level, distributed as follows:

- The elevation between 0 – 10m, covers 80% of the eastern, northern, southern, and central part of the city.
- The elevation between 10 -20m, 12% of the western part of the city, covering Pakal, Lakasantri, Sambikerep, and Tandes.
- The remaining 8% lies below sea level.
- 80% of Surabaya has a slope that varies from 0-2%.
- The topographical situation of the city is shown in Figure 2.2.

### 2.2.2 Geology

Based on the physical and environment condition, the sea around Surabaya is not on an active fault line, nor is it facing the ocean directly, therefore it is relatively safe from natural disasters.

The soil is mainly composed of alluvial deposits, originating from rivers (Brantas and Rowo) and sea: (Madura Strait). The granular size of this soil is between 0.075 mm up to 2 mm. It encompasses clay, silt and silty clay. West of Surabaya lime is found.

### 2.2.3 Climate

The climate of the city is typical of Indonesia and south of the equator. It is affected by the significant difference between conditions in the rainy season and dry season. The range in average monthly temperature is between 21C in August to 31C in April. In the rainy season, the average humidity would normally reach 80%, while in the dry season it would normally reach 60%.

The average annual rainfall in the City, according to the Perak Meteorology Station's data for 43 years (1955 – 1998) is 1,560 mm, 90% of which falls during the rainy season. The highest monthly rainfall (more than 300mm) normally occurs in January and the lowest (23 mm) in August.

Figure 2.1: Administrative areas (see Appendix B.1)

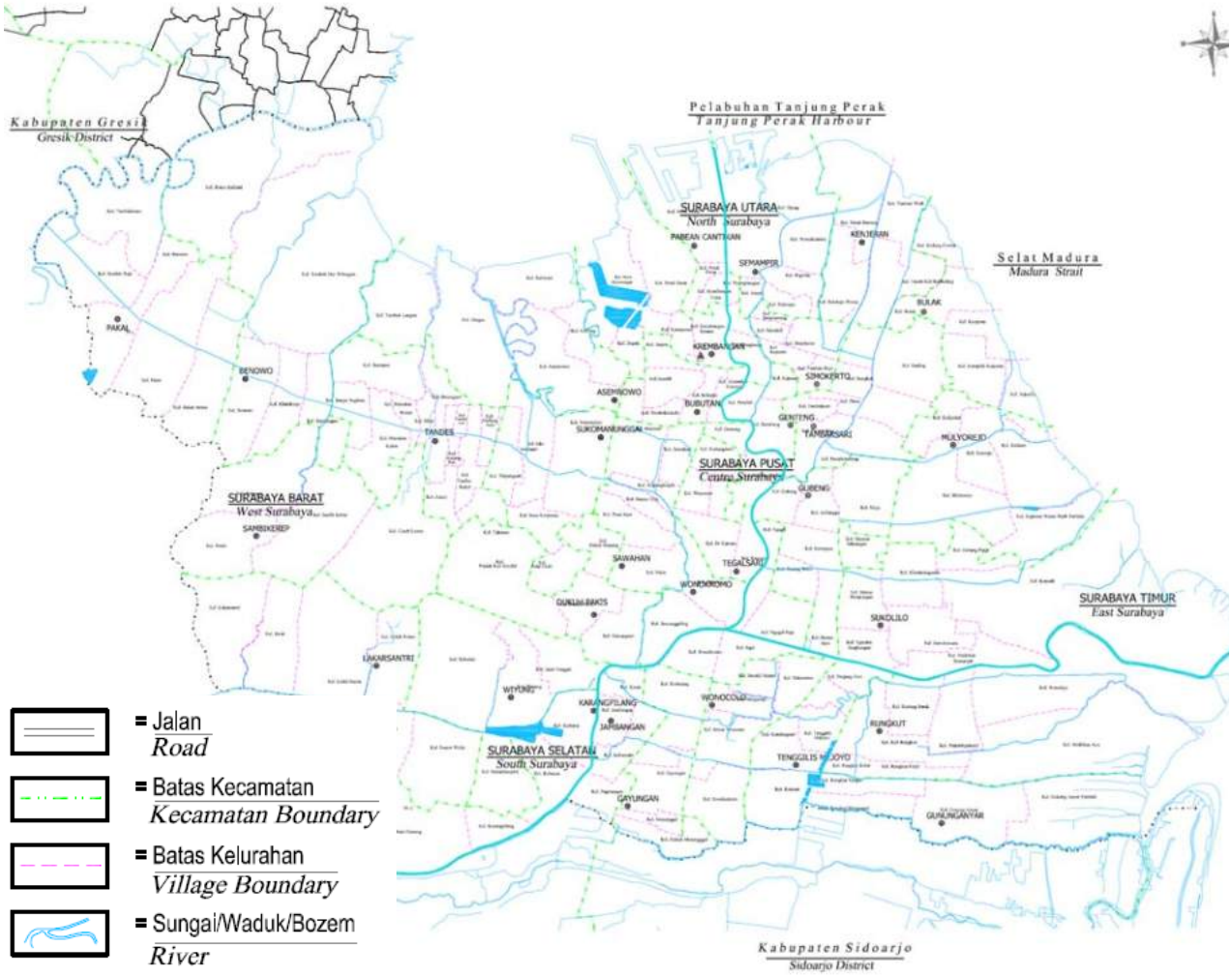
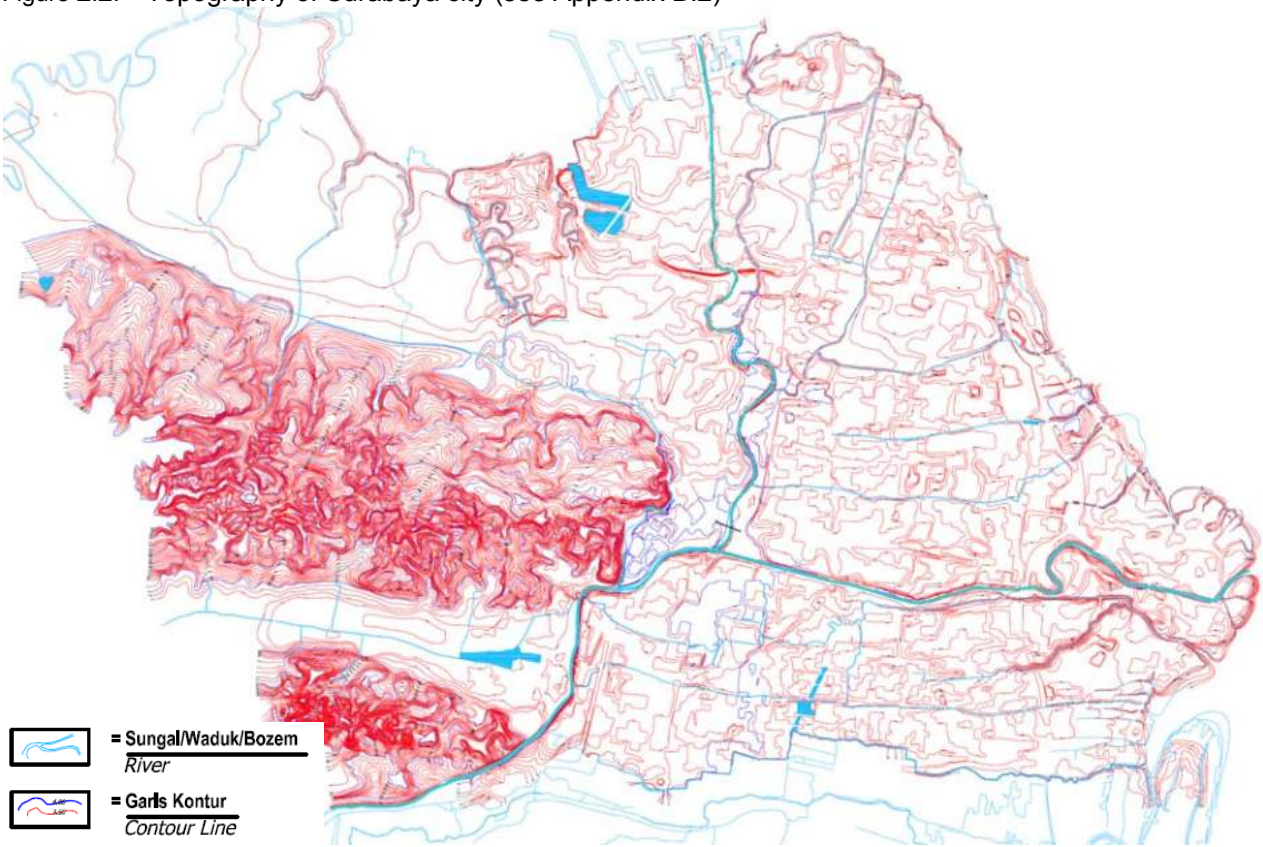


Figure 2.2: Topography of Surabaya city (see Appendix B.2)




### 2.2.4 Hydrology

Surabaya drinking water resources come from surface water and ground water. The largest source of water is from the three main rivers that flow through Surabaya from the R. Brantas.

#### 2.2.4.1 Surface Waters

The three main rivers are the Kali Surabaya, Kali Mas and Kali Wonokromo. Descriptions of the 3 rivers are given below.

**Kali Surabaya**

Kali Surabaya is the main source of water for the city. It is the main raw water supply for the PDAM. The Surabaya headwater starts from Mlirip Mojokerto Dam to Surabaya Jagir Dam, a range of 41 km. The maximum recorded flow rate of the Kali Surabaya is 252 $m^3$/sec, while the minimum is 13.2 $m^3$/sec (as recorded at Gunung Sari floodgate, July 2010)

Kali Surabaya water is used for multiple purposes. In addition to being the PDAM raw water supply, the Kali Surabaya is also used to supply industrial water. The industrial wastewater is returned back into the river. Given the fact that there are numerous inadequate industrial waste treatment plants, the pollution load carried by the river tends to increase further downstream, see Section 3.1 for further detail.

**Kali Mas**

The Kali Mas river flows from Ngagel Dam (Rolak) in Kecamatan Wonokromo toward the northern shore of Surabaya, passing through the centre of the city. The river flows through 8 Kecamatan.

Water from the drains in the city, particularly the central part, discharge into the Kali Mas. The river water is currently used for Industrial activities in the Ngagel Area (IGLAS – Glass Factory) and also for Port activity in the Perak area. Compared to the quality of the water from the other rivers coming from Brantas river, the quality of the water of Kali Mas is considered poor. This is closely related to the discharge of household waste (solid and liquid) into the river. Another source of pollution are discharges from local markets and drains that carry hospital waste and commercial waste. The tidal interface between the Kali Mas river water and the sea water (salt water) is in the Kayun area, Kelurahan Embong Kaliasin.

There are significant mud sediments in Kali Mas, with an average depth of about 1m. The reason for the sediment is due to the physical character of the river and because the sediments come from the Surabaya river and the city drainage system, the Darmo line and the Dinoyo line.

Slum areas have developed along the banks of Kali Mas, at Dinoyo, Gemblongan, around Akhmad Jais, and in the northern part of the Surabaya City area. The slum areas discharge wastewater and solid waste directly into the Kali Mas.

**Kali Wonokromo**

The Kali Wonokromo river runs from the Jagir floodgate (Holland floodgate) along Jalan Jagir Wonokromo. The river water serves as one of PDAM's sources of raw water.

#### 2.2.4.2 Ground water condition

Surabaya City generally has high ground water levels. Table 2.1 shows the result of an analysis of ground water depth distribution. It relates to 164 wells (as hydrogeology observation points) across the City.

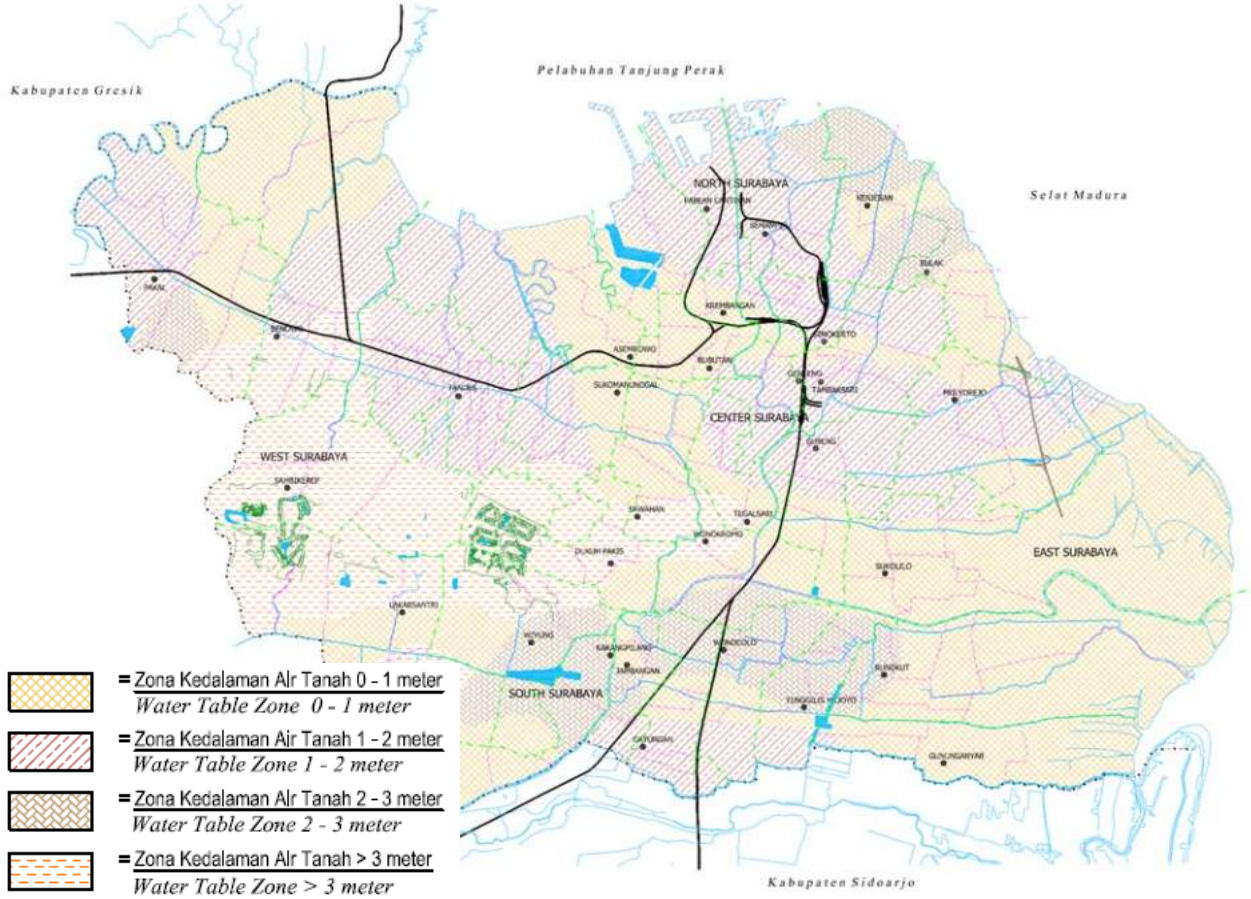
Table 2.1: Surabaya Ground water depth

| Zone No | Ground Water Depth (m below ground level) | Kecamatan |
|---|---|---|
| 1 | 0 - 1 | Sukolilo, Tegalsari, Rungkut, Gunungsari, Sukomanunggal, Eastern part of Benowo |
| 2 | 1 - 2 | Genteng, Tandes, Asem Rowo, Genteng, Gubeng, Mulyorejo, Gayungan, Wonocolo |
| 3 | 2 – 3 | Kenjeran, Trenggilis Mejoyo, Northern part of Karangpilang |
| 4 | > 3 | Lakar Santri, Wiyung, Sawahan, Dukuh Pakis |

Source: Review RISPK Surabaya, 2008

Ground water in Surabaya City generally flows east, towards the coast. Figure 2.3 shows ground water depths for the City.

Figure 2.3: Ground water depths (full scale drawing in Appendix B.3)




## 2.3 Services

### 2.3.1 Drainage

The drainage system of Surabaya City has two functions. That of flood control from rivers from the outer part of Surabaya and urban drainage within the City of Surabaya. The systems operate according to the following pattern:

- **Floods from outside Surabaya:** Kali Surabaya, Kali Wonokromo and Kali Mas function as primary drainage lines to channel flood water from the outer part of the city.
- **Rainwater flooding within the urban area of Surabaya city:** The city urban drainage system collects rainwater through tertiary and secondary drainage lines. The channels then flow into primary drainage lines that connect to Kali Mas in the central area.

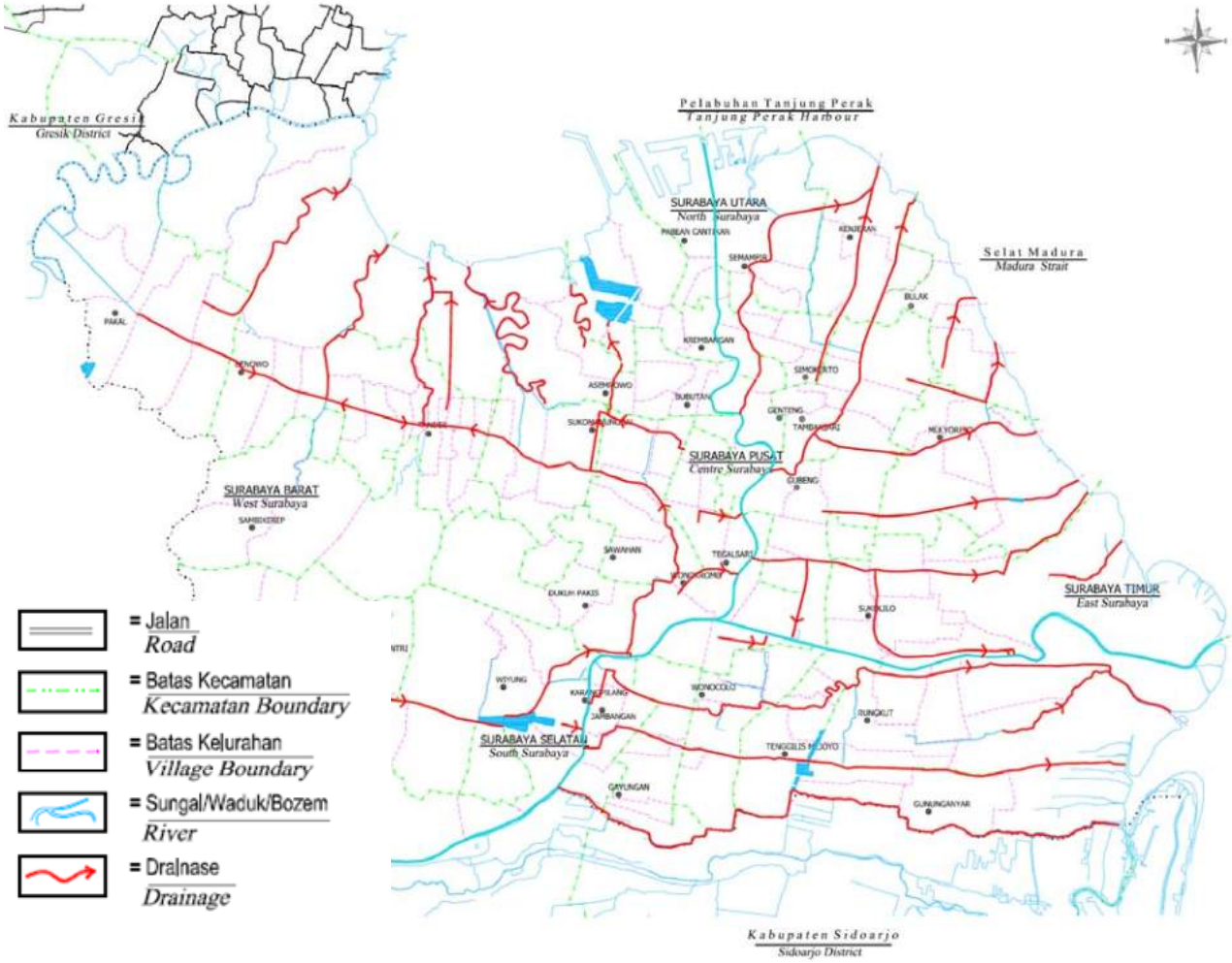
The above operative system is supported by a flood protection system that deals with excessively high tide levels from the sea or high flows from primary, secondary and tertiary storm water channels during heavy rain. The system operates as follows:

- Shore protection and sluice gates at the end of primary drainage channels

- Primary and secondary drainage and irrigation channels from the flow regulating structures at Gunung Sari and Gubeng during the rainy season
- Flood storage areas (Bosem) with pumping stations.

The drainage network of Surabaya city is shown in Figure 2.4.

Figure 2.4: Drainage System of Surabaya City (see Appendix B.4)

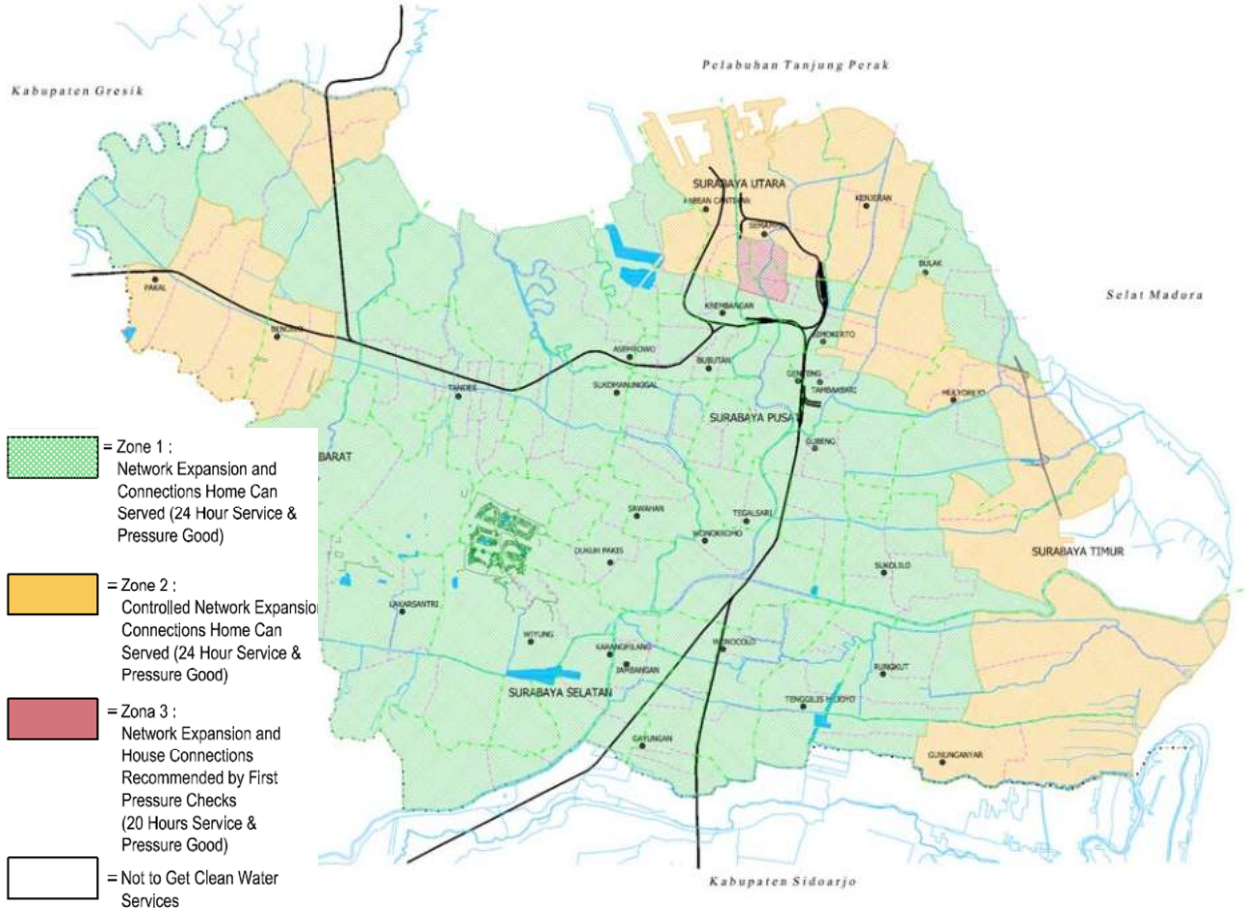



## 2.3.2 Water supply

The main water supply system in the City of Surabaya is run by the PDAM, Surabaya Water Company, supplying 9,100 l/sec. A small-scale water supply system, supplying 160 l/sec is run by a private corporation, Citraland.

Currently the PDAM serves mains water to nearly 80% of the population. There are 7 water treatment plants, 6 using ground water sources and 1 surface water abstraction. Based on a 24 hours supply, the total capacity installed is 10,830 lit/sec and the treated water production for December 2010 reached 9,100 lit/sec. The number of domestic household connections is 395,960 and non-domestic connections is 36,893 units. The PDAM water supply network is shown in Figure 2.5.

Figure 2.5: Coverage of piped water supply (full scale drawing in Appendix B.5)




### 2.3.3 Solid waste management

Waste management in the city of Surabaya is the responsibility of the Cleansing and Garden Agency of the Municipality of Surabaya (Dinas Kebersihan dan Pertamanan Kota). It is the inhabitants' responsibility to take household waste to local waste collection and compaction sites (TPS). Transportation from the TPS to landfill (TPA) is the responsibility of the city government.

There are 5 waste service zones in Surabaya:

- Central (4 Kecamatans)
- East (7 Kecamatans)
- South (8 Kecamatans)
- North (5 Kecamatans)
- West (7 Kecamatans)

The controlled landfill site is at Benowo and it covers an area of about 374 Ha.

The following Table 2.3 describes waste generation in the city for the years 2006, 2007 and 2008.

Table 2.2: Solid Waste Generation in Surabaya city

| Location of waste generation | Waste generation | | |
|---|---|---|---|
| | 2006 | 2007 | 2008 |
| Stockpiled at TPS (m3/day) | 950 | 750 | 512 |
| Transported to TPA (ton/day) Benowo | 1640,73 | 1480 | 1.258,70 |

From Table 2.3 we can see that the volume of waste generated decreases from the year 2006 to 2008. This is the result of good stockpiling in the TPS and the work of the 3R programme (Reduce, Reuse, Recycle) in Surabaya. However when travelling around the city it is easy to see that there is still a considerable amount of solid waste disposed of in wasteland, ditches, drains and rivers.

## 2.4 Land use and demography

Population data and data from the Urban Development Plan was used to project the population for 2010, 2015, 2020 and 2030. The projections are in line with the methods required in the National Drinking Water Master Plan Guidelines[3].

### 2.4.1 Existing land use and population

#### 2.4.1.1 Land use

The built up area of Surabaya is approximately two thirds of the total area. Physical development of the city is relatively concentrated in the central area and north to south. The trend for the future is a shift to the west and south. In general, physical development is dominated by real estate and commercial facilities.

The Surabaya City Spatial Plan (RT/RW 2015) identifies the type of “land use” for 2007 as a percentage for each category: housing 42 %, rice field and farming (Tegalan) 16.24 %, fish ponds (tambak) 15.20 %, services 9.10 %, trade (commercial) 1.76 %, industry & warehouses 7.30 %, unused/empty land 5.50 % and other 2.9 %. Whereas the draft RT/RW for 2029 gives current land use proportions as shown in Table 2.3.

Table 2.3: Current Land Use

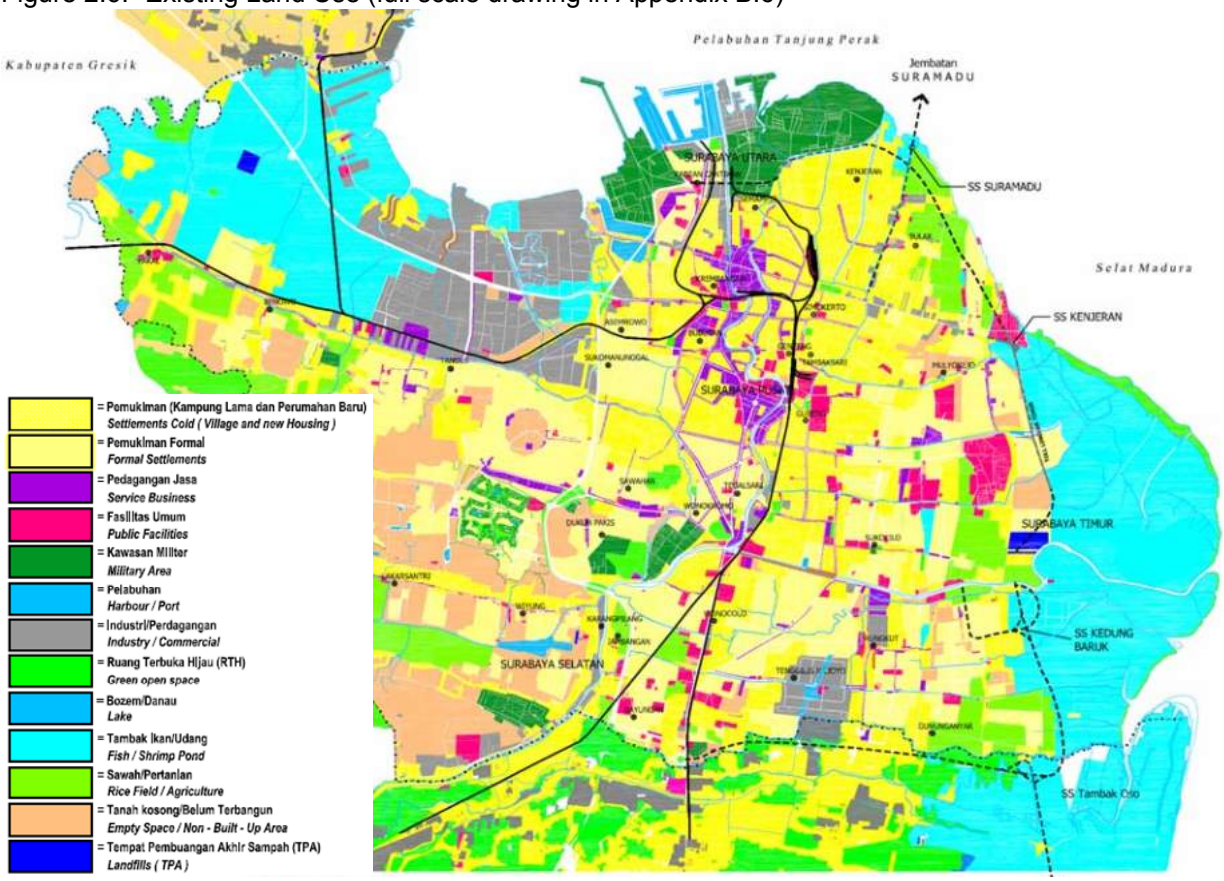
| | Land Use | Area (Ha) | % |
|---|---|---|---|
| 1 | Housing | 13,184.14 | 39.89 |
| 2 | Public Facilities | 1,129.66 | 3.42 |
| 3 | Trades & Services (Commercial) | 1,124.68 | 3.40 |
| 4 | Industry | 1,916.45 | 5.80 |
| 5 | Streets | 2,558.54 | 7.74 |
| 6 | Rivers | 361.83 | 1.09 |
| 7 | Ponds/Tambak | 4,561.26 | 13.80 |
| 8 | Open Green Space | 6,706.64 | 20.29 |

3 Peraturan Menteri Pekerjaan Umum Nomor: 18/Prt/M/2007 Tentang Pengembangan Sistem Penyediaan Air Minum

| | Land Use | Area (Ha) | % |
|---|---|---|---|
| 9 | Lakes and flood storage areas | 132.92 | 0.40 |
| 10 | Military | 585.92 | 1.77 |
| | TOTAL | 32,519 | 100 |

Housing areas in the form of Kampung are concentrated in the central area of the City, whereas real estate developments, with houses, are distributed across west, east, and southern areas. Simple flats, apartments and condominiums have been constructed in some locations. See Figure 2.6 for existing land use of Surabaya City.

Figure 2.6: Existing Land Use (full scale drawing in Appendix B.6)

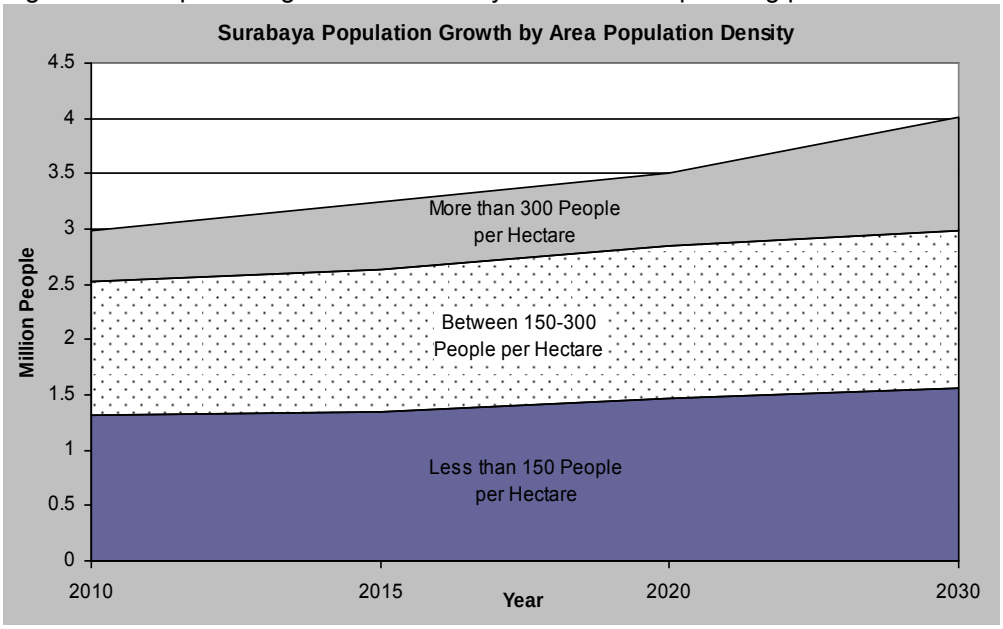


#### 2.4.1.2 Population

The population of Surabaya in 2010 is estimated as 2,990,000. The rate of growth of the population has shown a decline in the past 20 years. The annual average population growth rate between 1980 and 1990 was quite high, at 2.06 %. During the period of 1990 – 2000 the population growth rate has been moderate, at 0.5 %. These figures are based on the 2010 Census data. The City Government has tried to control population growth rate so that it doesn't exceed 1 % per year. City Government policy forecasts that the population should only rise by 100,000 people every 5 years and gives figures of 2,622,100 for 2010 and 2,722,900 for 2015. In fact, the actual registered population of 2008, based on statistics from Surabaya Demography DINAS, is 2,902,507, which is already higher than the City Government policy's population forecast for 2015 which indicates the failure of the population control growth strategy.

The relationship between population size and population density is of critical importance for the management of wastewater. Figure [] below shows the growth of the population in three different density bands over the planning period. This clearly demonstrates that the majority of population growth is in the most densely populated areas, (more than 300 people per hectare[4]), compounding wastewater management problems.

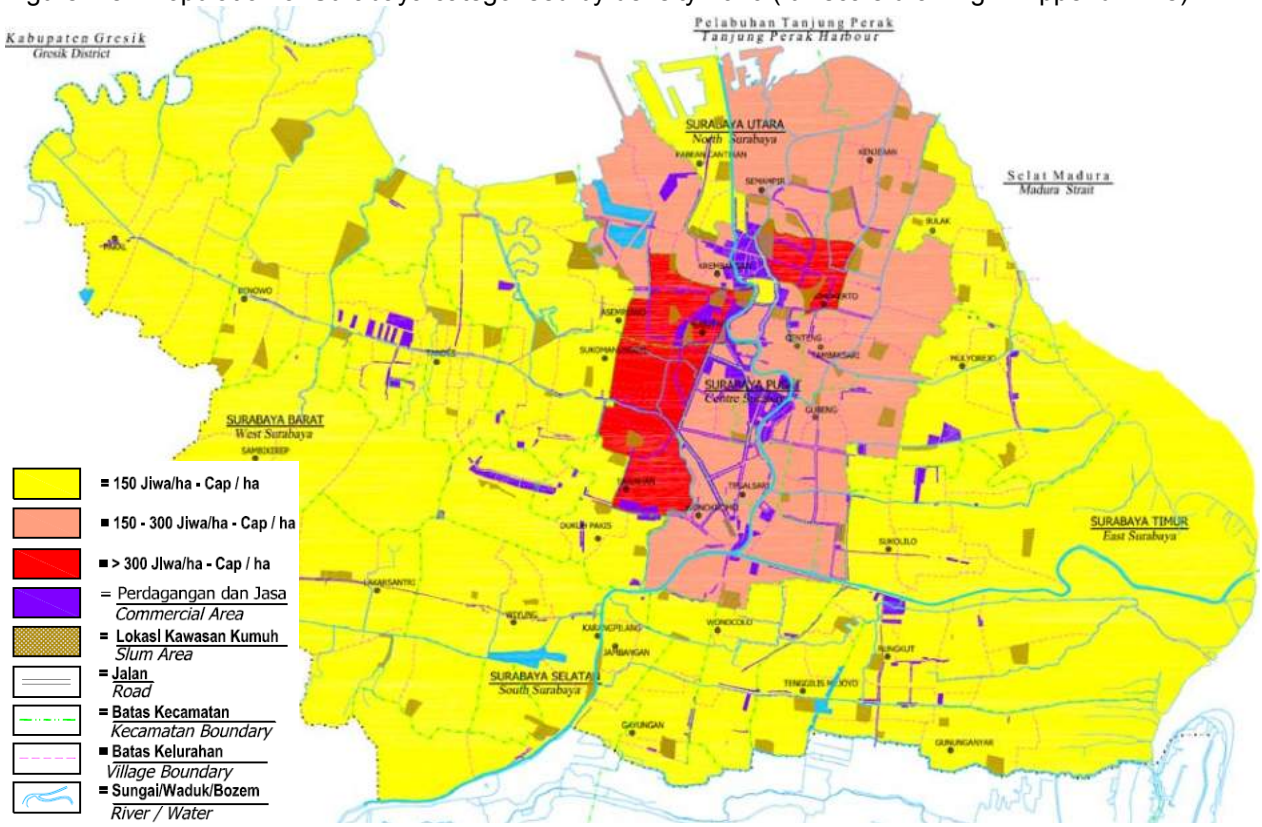
Figure 2.7: Population growth and density variance over planning period




An analysis of the population density of each Kelurahan has been completed. The distribution of population density, along with commercial areas, is shown graphically in Figure 2.8.

4 We use the gross population density: the number of people living in a Kecamatan (Sub district) divided by the total area of the Kecamatan. A better figure would be the net population density but unfortunately the area of the built-up area (net area) is not available.

Figure 2.8: Population of Surabaya categorised by density 2010 (full scale drawing in Appendix B.8)




## 2.4.2 Land use and population projections

### 2.4.2.1 Projected land use

The planned city road networks, main industrial, main commercial and housing activities of the city will determine the future structure of Surabaya city and its pattern of land use. The draft of the Surabaya City Spatial Planning study, which covers the period up to 2029, aims to reach 5 goals, these include reducing traffic load in central networks, improved accessibility between the Eastern and Western parts of the city, accelerate West area development, opening better access from the airport to the central area of the city and finally improving public transportation routes. The spatial planning direction statements include 6 action categories and the identification of areas from which future land use has been projected. Table 2.4 shows the main categories and action areas.

Table 2.4: Main action categories and areas for Surabaya City

| No | Main Action Category | Activity Area |
|---|---|---|
| 1 | Industry & warehousing | Surabaya Industrial Estate Rungkut (SIER), Industrial Area Tambak Oso Wilangun, Tandes (Margomulyo industri) and Krembangan |
| 2 | Commercial | Central Surabaya:<br>Plasa Tunjungan (exclusive goods), Pasar Turi (groceries), Pasar Blauran (gold), Pasar Praban (shoes), Pasar Gemblongan/Kramat gantung (furniture), Pasar Kedungdoro (automotive spareparts),WTC (cellular phones), Pasar Atom (groceries), Pasar Pabean (fish), Jembatan Merah Plaza, and Waterfront City<br>West Surabaya:<br>Pakuwon Trade Center (exclusive goods)<br>South Surabaya:<br>Maspion Square (hypermarket) |
| 3 | Public facilities | Government and private offices along Jalan A. Yani, Universities: ITS, UNAIR, Unesa and private universities |
| 4 | Green open space & sport areas (20.7 %) | Parks /green belt, sports centres, etc |
| 5 | Strategic areas | Military areas, strategic industry (PT. PAL), harbour (Tanjung Perak) |
| 6 | Conservation/Tambak | East coast area, tambak (fish pond) in Benowo |

Source: Draft Review RTRW 2029, Surabaya

#### 2.4.2.2 Population projections

We have developed a population projection for the Master Plan horizons by using the linear rate of arithmetic growth using the least square method. This is deemed reasonable due to fact that Surabaya exhibits stable population growth indicators, such as life expectancy, fertility and mortality rates. The base data uses the registered population for the 6 years, 2003 to 2008 for each Kecamatan, from Surabaya Demography DINAS. Detailed calculations are given in Appendix B.12. See Table 2.5 for the key demographic figures used in our analysis of population growth.

Table 2.5: Key Demographic Figures

| | Surabaya | Remarks |
|---|---|---|
| Annual Population Growth Rate 1980 – 1990 (%) | 2.06 | |
| Annual Population Growth Rate 1990 – 2000 (%) | 0.50 | Census 2010 |
| Registered Population 2003 (million) | 2.6 | |
| Planned/Projected Population 2015 (million) | 2.7 | |
| Registered Population 2008 (million) | 2.9 | Exceed projected 2015 |
| Annual Population Growth Rate 2008 – 2030 (%) | 1.72 | Mott MacDonald Calculation |

Source: Surabaya Demography DINAS (2010) & RTRW Surabaya, 2015

General information of the projected population results for Surabaya is presented in Table 2.6.

Table 2.6: Surabaya Population Projection 2010 – 2030

| Description | Unit | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|
| Area with population density < 150 cap/ha | ha | 25,344 | 24,664 | 24,664 | 23,567 |
| Area with population density 150-300 cap/ha | ha | 5,855 | 6,105 | 6,105 | 6,302 |
| Area with population density > 300 cap/ha | ha | 1,320 | 1,749 | 1,749 | 2,649 |
| Total area | ha | 32,519 | 32,519 | 32,519 | 32,519 |
| Population in areas with population density < 150 cap/ha | persons | 1,310,000 | 1,340,000 | 1,470,000 | 1,560,000 |
| Population in areas with population density 150-300 cap/ha | persons | 1,220,000 | 1,290,000 | 1,380,000 | 1,430,000 |
| Population in areas with population density > 300 cap/ha | persons | 460,000 | 610,000 | 650,000 | 1,020,000 |
| Total population | persons | 2,990,000 | 3,240,000 | 3,500,000 | 4,010,000 |
| Population in areas with population density < 150 cap/ha | % | 44% | 41% | 42% | 39% |
| Population in areas with population density 150-300 cap/ha | % | 41% | 40% | 39% | 36% |
| Population in areas with population density > 300 cap/ha | % | 15% | 19% | 19% | 25% |
| Household size | persons/hh | 5 | 5 | 5 | 5 |
| Households | number | 598,000 | 650,000 | 700,000 | 802,000 |

Source: Mott MacDonald Calculation, 2010

Figures 2.9, 2.10 and 2.11 show the projected population densities for the years 2015, 2020 and 2030 and the commercial areas projected for 2029 based on the Draft City Spatial Plan which had a horizon of 2029.

Figure 2.9: Projected population densities 2015 (full scale drawing in Appendix B.9)

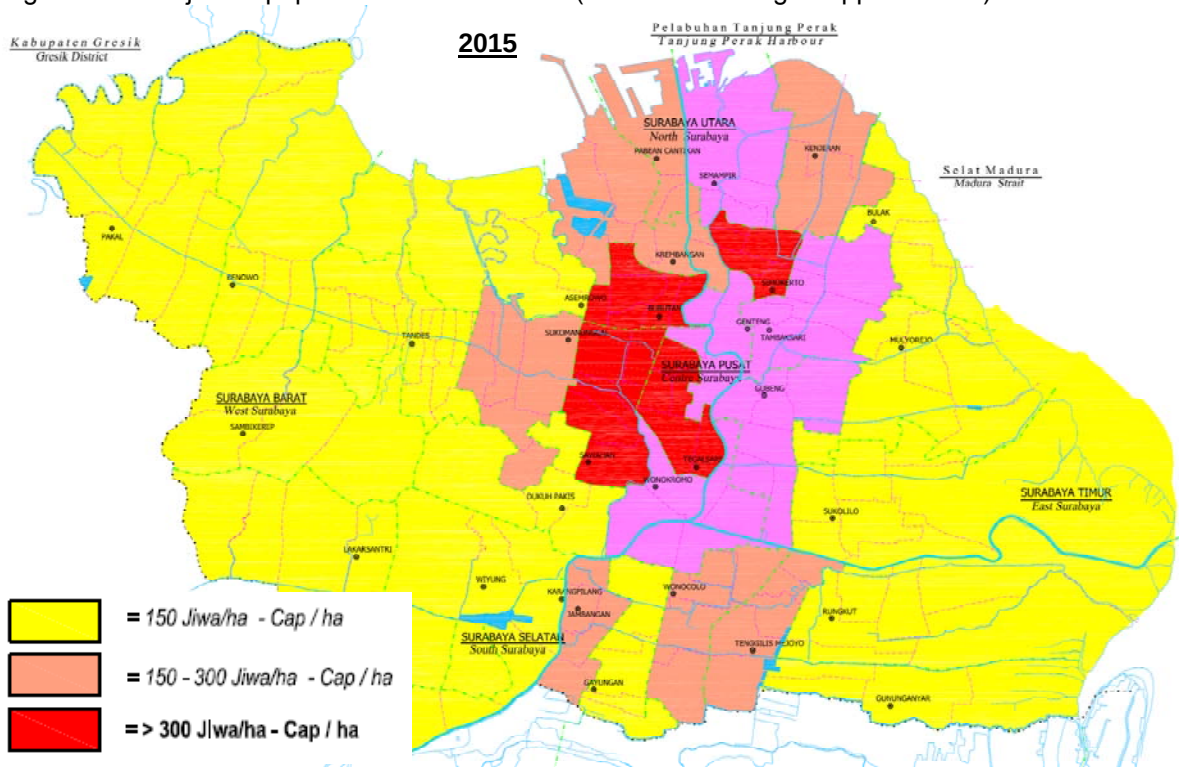



Figure 2.10: Projected population densities and commercial areas 2020 (full scale drawing in Appendix B.10)

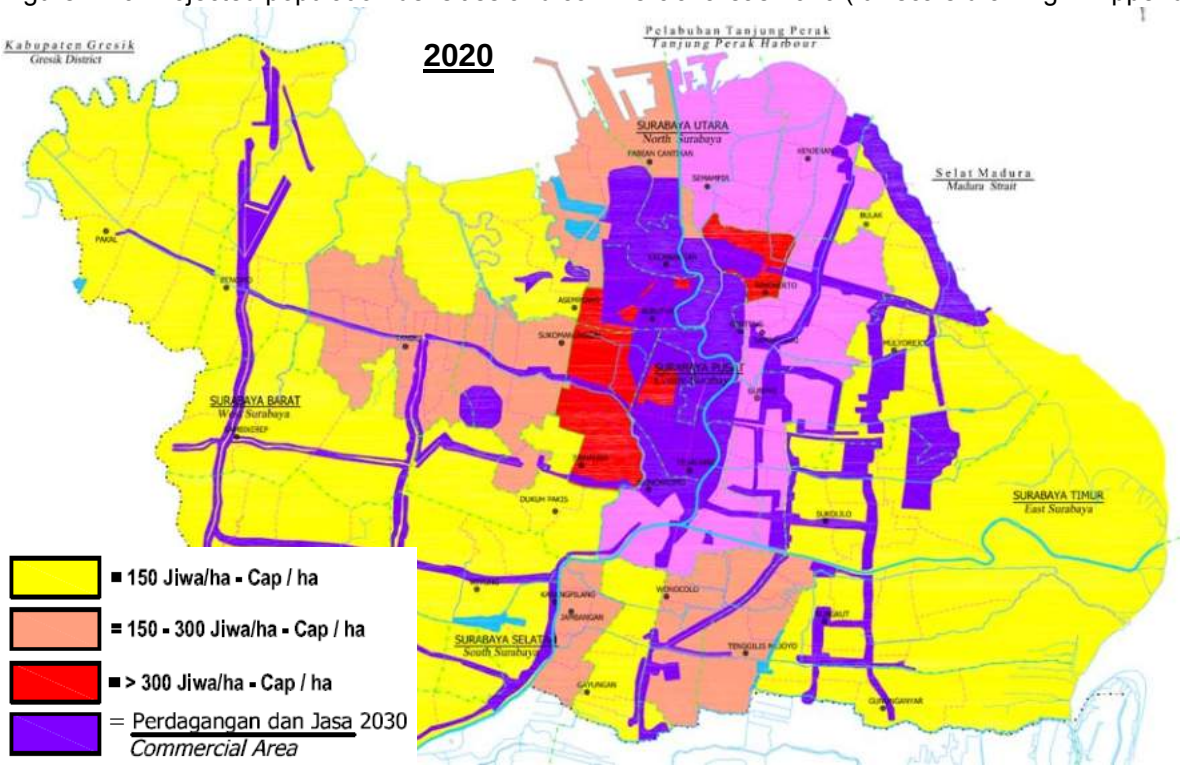
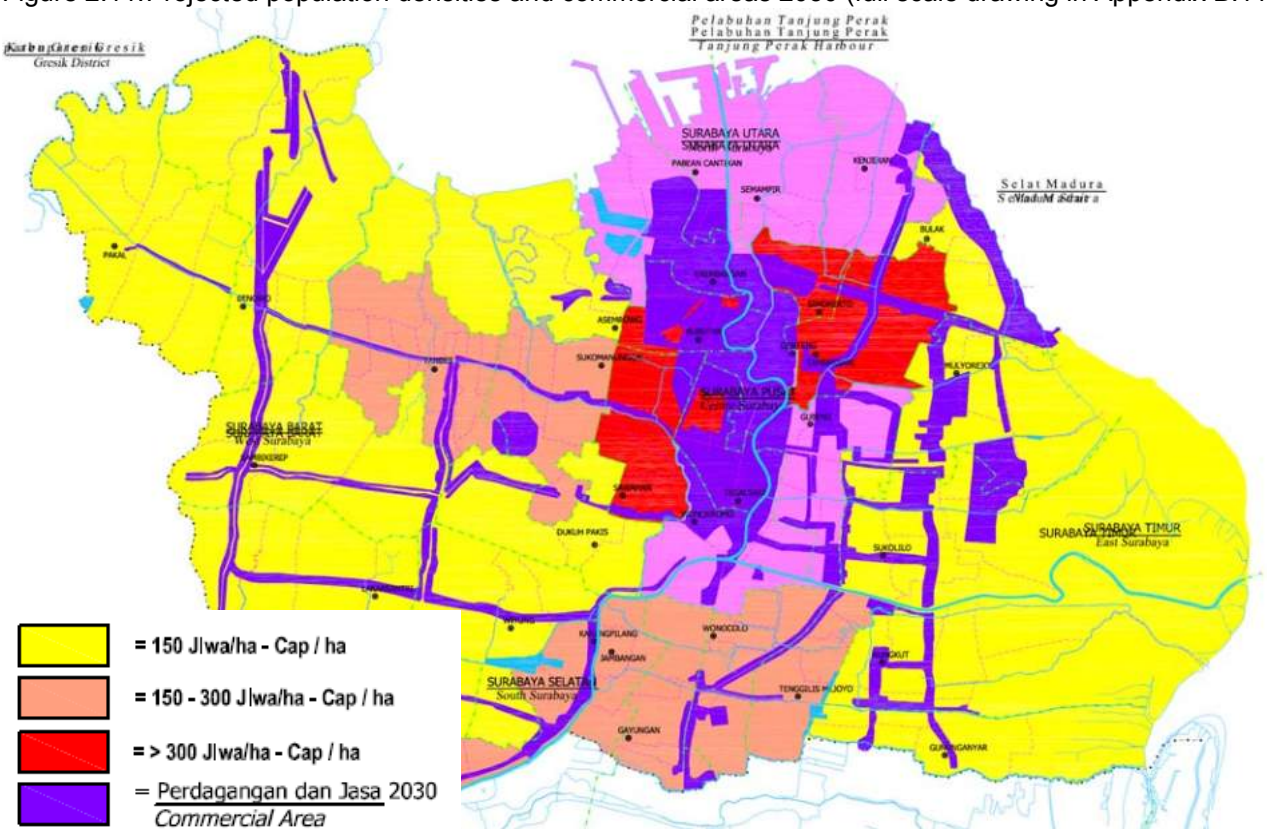


Figure 2.11:Projected population densities and commercial areas 2030 (full scale drawing in Appendix B.11)



# 3. Description and review of the existing wastewater situation

## 3.1 Existing wastewater studies

Surabaya has a long history of wastewater studies over the past 30 years. The earliest study from 1988 recommends an off-site system for the City. Previous studies are:

1. Surabaya Integrated Urban Infrastructure Development Programme 1988-1992 (Surabaya-IUIDP, MPW Project);
2. Surabaya Sewerage and Sanitation Development Programme, 1998 (Surabaya-SSDP, MPW Project) with planning horizon until 2020;
3. Review of Surabaya-SSDP, 2008 (City Government Project);
4. DED Review of Surabaya Wastewater Modular System 2008 (MPW Project);
5. City Sanitation Strategy, 2009 (ESP-USAID Technical Assistance);
6. The City Sanitation Strategy 2010-2014, which has just been completed.

The existing wastewater studies are divided into two categories:

i. city government documents, such as Surabaya City Spatial Plan and;

ii. past wastewater studies from which we can see how these studies evolved and support each other. This masterplanning project needs to have a close interaction with the City Sanitation Strategy 2010 – 2014. Table 3.1 shows the interrelationship of the various studies.

Table 3.1: Interrelationship of the wastewater studies in Surabaya between 1988 and 2010

| Project | Funder | Recommendations | Planning Horizon | | | | | System Options | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 95-00 | 00-05 | 05-10 | 10-20 | 20-30 | On-site | Intermediate Modular | Off-site sewers | Septage Collection |
| IUIDP 1988-1992 | MPW | Sewerage System | X | X | X | X | | X | | X | X |
| SSDP 1996-2000 | MPW | Modular systems next to centralised system | X | X | X | X | | X | X | X | X |
| Review SSDP 2008 | City Gov | Updated modular systems next to centralised system | | | X | X | | X | X | X | X |
| CSS 2009-2013 | ESP | Capacity & Policies improvement strategies | | | | X | | | | | |
| CSS 2010-2014 | City Gov & Bappenas | Strategies on how to accelerate sanitation development | | | | X | | X | X | | X |
| Draft City Spatial Plan 2029 | City Gov | Future wastewater development | | | | X | X | X | X | X | |

### 3.1.1 City Sanitation Strategy 2010 – 2014 (Draft)

The Surabaya City Sanitation Strategy (CSS) is a City Government response to the "Indonesia Roadmap to Sanitation" development, formulated through a programme for acceleration of sanitation development (PPSP–Percepatan Pembangunan Sanitasi Permukiman) with MPW regulation number 16/PRT/M/2008 as its legal basis. The biggest challenge stated by the Ministerial regulation is the significant number of people that still practice open defecation (OD). One of the goals set for the National mid-term development plan (RPJMN) is to be OD Free by 2014, the current OD figure in Surabaya is 12.5 % of the population. OD reduction is also the first priority of the PPSP – Sanitation POKJA of Surabaya which was established in June 2010 by city government as a mission driven working group.

We have reviewed the current CSS and evaluated the wastewater proposals included in it. Where appropriate we have included the City proposals and priorities in the Master plan. Where we have not included proposals we have identified them and justified this to the POKJA.

The CSS includes the following Vision and Mission statement

**Vision**: Create environmental friendly sanitation in Surabaya city by 2015

**Mission:**

1. Improve drinking water quality so that it conforms to the latest standards for drinking water quality based on Health Ministry Regulation No 492/2010.
2. Creating sustainable wastewater management systems for settlements conforming to affordability
3. Creating an independent and sustainable solid-waste management for the city;
4. Creating an integrated and sustainable drainage management, involving community participation
5. Improving community awareness of healthy behaviour
6. Improving community and private sector participation in all aspects of sanitation management

**The following strategic issues for wastewater were included in the CSS:**

- Discharge of untreated wastewater to the river and/or nearest open ditch;
- Illegal settlements: It is very difficult for the city government to improve the wastewater situation for illegal settlements, especially along the river basin, because as soon as any improvements are made it effectively recognises the rights of the squatters.
- Poor construction of existing communal latrines (MCK) facilities, such as in Wonokromo and Kenjeran;
- The IPLT operation is under capacity and under performing : there is 75% unused capacity at Keputih IPLT. Present installed capacity is 400 m3/day, the operating capacity is 100 m3/day.
- The distance between the IPLT and service areas is too far. It leads to high cost for transporting the septage and encourages illegal dumping of the tankers' contents in the rivers and drains, causing pollution.

**The following wastewater service strategies are included in the CSS**

- Develop wastewater systems so that rivers and drainage systems only receive treated wastewater;

- Locate and build an alternative IPLT location, that is more accessible to the vacuum tankers;
- Develop and strengthen existing institutions that will be responsible for managing the wastewater service;
- Develop private sector participation in wastewater management;
- Improving community awareness and participation to develop better sanitation.

**The following wastewater programmes and activities are included in the CSS**

- Programmes: build new communal latrines (jamban keluarga), new MCK and new IPLT, rehabilitation and capacity improvement of existing communal latrines and MCK, improve operation and maintenance of existing IPLT;
- Activities: develop "needs assessment" for wastewater service facilities, on the basis of existing conditions of the facilities as shown in Appendix C.1, the activities that have been scheduled are shown in Appendix C.2. , they are performance based monitoring and evaluation activities that are planned as a regular activity for the POKJA.

The Environmental Health Risk Assessment (EHRA) survey was part of the development of the CSS. The EHRA survey covered 8 indicators of health, including household characteristics, latrine (jamban) ownership, defecation habits, solid waste handling, hand washing using soap, road conditions in front of houses, water supply, condition of channel which transports wastewater from the household to open drain, flooding risk, children's hygiene habits. EHRA estimated 92.15% of population have toilets and 7.85% with no facilities. The EHRA results were used to formulate a Sanitation Health Risk number ranging from 0.0 – 1.0 (no risk), 1.1 – 2.0 (low risk), 2.1 – 3.0 (middle risk), and 3.1 - 4 (high risk). This Sanitation Health Risk number has been used in the area categorisation for the SOSEC surveys and the investment prioritisation used in this study.

### 3.1.2 Integrated Urban Infrastructure Development Project (IUIDP) 1988 – 1992

The Surabaya IUIDP 1988 – 1992 was the first project that recommended a centralised sewerage system for the City. The project was funded by DGHS – MPW, through IBRD and the World Bank.

### 3.1.3 Sewerage and Sanitation Development Programme 1996-2000 (SSDP) May 1998

Surabaya SSDP (1996 – 2000) followed the recommendations of the 1998-1992 IUIDP. The recommendations were:

- **Master Plan and Immediate Action Plan**: The masterplan for sewerage and sanitation rested on two basic premises: (i) areas having the worst sanitation conditions would be prioritised and (ii) low income but sustainable communities would be prioritised. The parameters used to identify both of these situations was as follows: (1) population density, (2) monthly family income, (3) water consumption, (4) percent of families having toilets, (5) percent of families discharging sullage to open drains, diarrhoea index, including incidence and trends. High priority areas were selected for immediate action. The following action plans were determined:

– Short term programmes: 1997- 2010

  – Sewerage and modular treatment systems for 3 Kelurahan covering 64,000 people, including: (1) Wonokromo Module covering 22,000 persons, proposed STP location was in Jl. Jagir

Wonokromo; (2) Kapasan Modul covering 20,000 persons, STP located along Kali Mas River at Genteng Kali street; (3) Bongkaran Modul covering 22,000 persons, STP location was in Bongkaran – Peneleh on Kali Mas at Genteng Kali street;

- Modular systems in Kejawan Putih Tambak, Benowo. The proposed system was planned to cover about 44,000 persons;
- Increase the capacity of IPLT in Keputih Village, in the East of Surabaya to treat septage from 880,000 persons and construct a new IPLT in Benowo to cover an additional 440,000 persons.

- Long term programmes: 2011- 2020
  - Centralised sewerage systems in 3 collection zones, including North Surabaya, East Surabaya and West Surabaya where each zone had its own sewerage system and STP. The STPs would discharge to the Java Sea for the North and East zone and the Madura Strait for the West zone.

- **Detail Engineering Design:** The activities consisted of (1) capacity improvement of IPLT Keputih from 100 m3/day to 400 m3/day and new septage treatment plant in Benowo for capacity 250 m3/day, (2) modular wastewater system in Wonokromo, the proposed treatment system was an Imhoff tank, the collection system was shallow sewers with a pumping station, (3) modular wastewater systems in Kapasan, Bongkaran-Wonokromo, the proposed treatment systems consisted of rotating biological contactors, shallow sewers and pumping stations.
- **Institutional Issues:** It was recommended that the wastewater service operator be integrated with the PDAM. For this purpose the Mayor issued the letter 1997 No. 44/97, but it was changed within two years, by 1999 the Mayor decided to assign Dinas Kebersihan dan Pertamanan (DKP) as the agency responsible for managing the wastewater service through letter No. 800/4863/402.06.01/99 dated 8 June 1999.

### 3.1.4 Surabaya City Sanitation Master Plan Review (Review RISPK/SSDP) 2008

The review project was developed under City Government budget and implemented by Surabaya Environmental Agency (BLH). Its aim was to update the SSDP (1997 – 2020) to cover the period 2008 - 2020 along with preparing draft local regulations on wastewater services for Surabaya City. The study focused on a wastewater service for all income levels, in all residential types (slum area and well organized housing). Priority was given to high density and high sanitation risk areas. To improve the quality of receiving water bodies (rivers), a pattern of off-site sewerage systems for Central, South, and East Surabaya, following the river basins. The study also updated the modular system approach and the priorities for the short term programme, based on social survey results. The long term plan (2020) focused on the integration of treated wastewater disposal from 5 treatment sites: Kecamatan Benowo, Kecamatan Kenjeran, Kecamatan Krembangan, Kecamatan Sukolilo, Kecamatan Rungkut.

The main difference between RISPK and the SSDP is that the off-site sanitation system proposed, covered the whole area along the river basin of the three main rivers, Kali Surabaya, Kali Wonokromo and Kali Mas. The targets of this study were: river pollution control, un-acceptable on-site sanitation in the study areas (high population density, high groundwater tables, flat topography, limited space, etc.). The recommendations included trunk sewers running along each side of the rivers from upstream to downstream, where the treatment plant was to be located. On-site sanitation systems were still to be applied in areas where the technology was appropriate.

### 3.1.5 Detailed design review of the Wastewater Modular Systems for Surabaya City

This project was funded by Central Government in 2008 and focused on the development of the modular wastewater systems promoted in the Surabaya SSDP 1997. The study targeted the areas of Surabaya that could be commenced by 2016. The recommendations said that it was not able to be implemented due to institutional and land availability reasons.

### 3.1.6 City Sanitation Strategy 2009-2013 supported by ESP- USAID.

The formulated strategies were:

- Strengthen the capacity of institutions and personnel in managing wastewater services;
- Development of regulatory tools
- Improve community access to wastewater services, both off-site and on-site
- Improve community participation in wastewater and sanitation system development
- Improve and develop some alternatives for funding the wastewater infrastructure development.

### 3.1.7 Draft Surabaya City Spatial Plan 2029

Based on the availability of land owned by the City Government, the draft Spatial Plan 2029, recommended STP sites for the future Surabaya wastewater system. Sites included the East coast of Kecamatan Benowo, Kecamatan Kenjeran, Kecamatan Krembangan, Kecamatan Sukolilo, and Kecamatan Rungkut. Land availability in Kecamatan Rungkut includes 3,000 m2 in Kelurahan Wonorejo, 10 hectares surrounding Wonorejo Bozem. Land in Kecamatan Sukolilo, an ex solid waste incinerator site in Keputih. Plus two site locations (56,340 m2) and (89,795 m2) in Kelurahan Tambakwedi Kecamatan Kenjeran. The land available in Kecamatan Krembangan was land around Bozem Marokrembangan, it is owned by the Navy. The land in Kecamatan Benowo lies in Kelurahan Tambak and is about 10 hectare. The proposed technology is stated as biological treatment.

### 3.1.8 Conclusions and developments from the past wastewater studies

#### 3.1.8.1 IUIDP and SSDP

Based on the recommendation of the SSDP, the capacity of Keputih IPLT was increased to 400 m3/day from the original 100m3/day. However, the three planned modular wastewater systems planned in Wonokromo, Kapasan, and Bongkaran were not implemented, neither was the proposed IPLT in Benowo (250 m3/day). The main reason the projects did not proceed was land availability and people's unwillingness to connect or pay for the proposed sewerage systems (survey results showed 62% were unwilling to pay connection fees and 81% did not want to pay a monthly sewerage bill). There were also some technical aspects, such as:

- The location of toilets and septic tanks/leach pits were generally behind the houses, so partial demolition was needed to allow connection to the sewer;
- Street size in many places was less than 1.5m wide, with many turns and generally the space between the houses was about 0.5 m, which would make construction very difficult.

#### 3.1.8.2 Detailed Design Review of Wastewater Modular Systems

The modular concept originally presented in the 1998 SSDP is technically acceptable as a transition phase from “on-site” systems to a centralised city-wide system, but the planned sewer routes along the rivers would have required too much pumping, resulting in high O&M cost.

#### 3.1.8.3 Critical Assessment of CSS

The CSS has a draft status. Nevertheless, the following can be observed:

- The CSS provides a good overview of the exiting situation but does not reflect on the underlying causes;
- There are no strategic goals set for the future and the CSS does not mention how it intends to fulfil the goals (on-site or off-site systems). It is also not clear how the targets on ODF are going to be fulfilled;
- There is little relation between the programme proposed and the findings. For example, there is an intention to build a new IPLT, but the existing IPLT at Keputih is still under capacity and underperforming.

Further details of the relationship between the CSS and Master Plan can be found in Section 6.8.

## 3.2 Current Situation

### 3.2.1 Existing wastewater services for residential and commercial areas

#### 3.2.1.1 Individual houses

Most houses have individual on-site systems and use a cubluk (leach pit) only or septic tank and leach pit, they discharge the grey water to the storm water channel at the front or behind the houses. Most people in residential areas have the perception that the cubluk is the same as a septic tank and is acceptable for waste treatment. Some people who have limited land built the leach pit under kitchen or living room and cover it with tiles, leaving no access chamber cover, this makes desludging impossible without digging up the floor.

#### 3.2.1.2 Communal and small sewerage systems

There are communal systems in some residential areas, these were mostly installed by the City Government and the MPW Province, as an initial activity in implementing an intermediate system. They used modular treatment plants, MCK++[5] and public toilets with treatment facilities. Table 3.2 gives details of systems installed and planned across the city

5 MCK++ is a combination of an MCK facility (Mandi Cuci Kakus) and a decentralised wastewater treatment system (DEWATS) where wastewater from neighbouring housed is being treated. The anaerobic treatment is supposed to generate biogas that can be used for cooking.

Table 3.2: Communal and small sewerage systems in Surabaya

| Type | Location | Funded | Remarks |
|---|---|---|---|
| **Communal STP** | | | |
| MCK | High pop. density area, 547 Units | MPW - Province | *35% acceptable* |
| MCK++ with DEWATS'') | 7 Units: Rungkut,T.Mejoyo,Wonokromo | Borda/Best, 5 ESP-USAID/JT, 5 | *JT = Jasa Tirta* |
| MCK++ | some resident area | City Gov & MPW Province | |
| ABR | ITS - Keputih | Shared MPW-City Gov, 2008 | *Small sewerage: system is not connected yet only the treatment facility has been constructed.* |
| Bio-Filter + small sewerage*) | Wonokromo (RW 7) | DAK Budget to DINAS CKTR | |
| **Programmed by National allocated fund to DINAS CKTR Surabaya, 2010** | | | |
| ABR | Randu Flats, Kecamatan Semampir | DAK – DINAS CKR | *Constructed* |
| | Urip Sumohardjo Flats, Tegalsari | DAK - DINAS CKTR | *Cancelled**)* |
| ABR | RW 10 – Kelurahan Gundih, Bubutan | DAK – DNAS CKTR | *Constructed* |
| ABR | RW 07 – Kelurahan Gundih, Bubutan | DAK - DINAS CKTR | *Constructed* |
| ABR | RW 03 - Kelurahan Pakis, Sawahan | DAK - DINAS CKTR | *Constructed* |
| | RW 02 – Kelurahan Gubeng | DAK – DINAS CKTR | *Cancelled**)* |
| | RW 05 – Kel. Karah, Jambangan | DAK - DINAS CKTR | *Cancelled**)* |
| | RW 05 – Kel Ngagel, Wonokromo | DAK – DINAS CKTR | *Cancelled**)* |
| | RW 08 – Pegirikan, Simokerto | DAK – DINAS CKTR | *Cancelled**)* |
| | RW 01 – Margorejo - Wonocolo | DAK – DINAS CKTR | *Cancelled**)* |

*) sewer often clogged by grease and rubbish as screens removed from the storm water drainage channel which carries flow to the treatment plant.

**) Land problems and NIMBY (not in my backyard) cases, some communities surrounding of the proposed treatment site rejected construction of the communal STP.

^) 92 unit (35.4 %) good conditions, service coverage per MCK unit is 40-50 households

'') DEWATS Decentralised wastewater system

#### 3.2.1.3 Institution ITS sewerage system

A small sewerage system was constructed by DGHS – MPW (2008) in the ITS student flats, Keputih - Sukolilo. The system consists of one communal STP, to treat wastewater from the lecturers housing combined with student flats through a simple sewer network. The ITS campus was chosen as a pilot model to assess its operational sustainability. The system used is an Anaerobic Baffle Reactor (ABR). The main sewer was laid in the road passing from Block A to Block X, the lateral pipe and house connections have not been made yet and the STP has not been commissioned.

#### 3.2.1.4 Real-estate housing developments

Real-estate areas are spreading up the eastern and western parts of the city, the biggest one is Citraland in Kecamatan Larasati (2,000 ha out of 3,536.65 ha). Most developments use individual septic tanks plus single or twin leaching pit/s. Citraland and Pakuwon Indah Estate (West Surabaya) and Pakuwon City

(East Surabaya) use individual septic tanks with a bio filter package, these are supplied with starter bacteria to accelerate faecal destruction and to deodorise sulphides, ammonia and other gasses.

#### 3.2.1.5 Kampong and slum areas

Typically a kampong is an unplanned housing area that mostly exist in the central and CBD areas of Surabaya. Slum areas are categorised by having a very high population density, poor construction; very low income and limited access to water supply and sanitation. The residents are mostly migrant workers, with very low income. Kampong sanitation is either individual or communal on-site systems. Some Kampong households shared toilet facilities. Cipta Karya's Surabaya City report noted there are approximately 557ha of slum areas in Surabaya City, with an estimate of 24,300 houses categorised as unhealthy.

#### 3.2.1.6 Vertical housing and apartments

Typical apartment tenants have medium to high income, whereas "flats" (rumah susun) are normally for low income tenants with a regulated rent ranging from Rp 88,000 to Rp.175,000 a month (Mayor Regulation 59/2010). Wastewater treatment plants are normally available for each building and are the responsibility of the property owners.

#### 3.2.1.7 Commercial areas

Buildings in commercial areas include malls, hotels, offices, commercial houses, shop-houses (ruko), and office-houses (Rukan), they normally have wastewater systems. The PDAM records show there are about 29,600 commercial connections. Municipal regulations state commercial buildings should install a STP. Treated wastewater discharged from hotels should be less than BOD 30 mg/l (Governor Decree 61/1999). There are different types of STP used in commercial buildings, some have activated sludge or rotating biological contactors (RBCs) and one hotel has a reverse osmosis plant (RO). Some offices use onsite systems with a septic tank plus bio filters. Most commercial buildings use a third party to operate their wastewater treatment plants.

#### 3.2.1.8 Commercial Houses, Ruko and Rukan

Most types of commercial houses, ruko and rukan are located in the real-estate or central business districts and are spread all around the city, they are rented by companies. Currently some cheap laundries exist in housing areas especially in the areas near campuses. Formal commercial houses use septic tank plus leach pits, but some rented houses in Kampong discharge the wastewater into rainwater channels without treatment. Some fast food restaurants only use a grease trap to separate the grease before the wastewater discharges to open drains.

#### 3.2.1.9 Septage removal and treatment

**Removal of septage by means of vacuum trucks and transport to Keputih IPLT**

The IPLT is operated under UPTD of City Cleaning and Garden Office DINAS, built in 1989-1990 and improved 1995 and 2000, design capacity is 400 m3/day. Sludge volumes taken to the IPLT average about 100 m3/day. 27 vacuum companies are registered; there are about 69 tankers with a capacity of 3-4 m3/truck. The City Government also has 1 vacuum truck it is used for desludging the public toilets. The emptying charge by the vacuum tanker company ranges from Rp 75,000 to 150,000 per m3 of sludge

depending on distance and negotiation between the customer and the company. The company only pays Rp 3,750/m3 to empty the tanker at the IPLT.

**Field observations at Keputih IPLT**

An analysis of BOD concentrations is given in Table 3.3 below.

Table 3.3: BOD analysis for Keputih IPLT

| Treatment Units | 2008 | | | | 2009 | | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|
| | June | Aug | Oct | Nov | Jan | May | Jul | March | Oct |
| Solid Separation Chamber (inlet) | 1,120 | 7,000 | 170 | 12,500 | 2,800 | 3,605 | 11,515 | 13,550 | 3,234 |
| Clarifier | 770 | 240 | 70 | 540 | 63 | 20 | 109 | 57 | 57 |
| Polishing Pond (outlet) | - | 133 | 28 | 490 | 60 | 39 | 33 | 50 | 45 |

Comments on observations:

- Quality of the effluent is very variable
- There is little improvement after the polishing pond
- In the IPLT field office, laboratory results are found to be incomplete.

**Manual removal of septage**

In several locations along the riverbank, there are manual services for septage removal with a tariff about Rp 25,000 per service. This service serves houses which are located in narrow streets or alleys where the vacuum trucks cannot enter. The problem with this system is the septage is dumped into the river directly and causes pollution. This is a particular problem along Peneleh riverbank in Genteng Sub District.

### 3.2.1.10 Community initiatives

Since 2005, Surabaya City has had an annual programme called "Surabaya Green and Clean", this programme is the result of cooperation between the government of Surabaya with the private sector, namely Unilever and newspaper media "Java Post". The programme was implemented in an effort to increase community involvement in addressing the problem of clean water, wastewater, and solid waste. Some community initiatives emerged from the project, including the idea of creating small community sewerage systems and simple STPs for recycling grey water.

### 3.2.1.11 Sanitation coverage

Data collected from the National Socio-economic Survey (SUSENAS) for East Java Province (2009), PDAM Surya Sembada Surabaya, DINAS of Health Office Surabaya City, and Surabaya City Planning and Development Board (Bappeko), gave the coverage of wastewater sanitation in Surabaya city, with 87.5% of population with sanitation coverage (on-site and intermediate systems) and 12.5% of population practicing open defecation. However, the coverage of acceptable sanitation systems is only estimated at 56.6%. Table 3.4 gives a summary of the 2010 data from surveys from DINAS Keewatin.

Table 3.4: Existing condition and coverage of sanitation - Surabaya 2010

| Description | Unit | 2010 |
|---|---|---|
| Open defecation | % total | 12.5% |
| Coverage sanitation | % total | 87.5% |
| Coverage unacceptable systems | % total | 30.9% |
| Total coverage open defecation and unacceptable systems | % total | 43.4% |
| Coverage acceptable systems | % total | 56.6% |
| Coverage off-site sanitation | % total | 0.0% |
| Coverage acceptable intermediate systems (MCK Umum, Sanimas etc.) | % total | 2.7% |
| Coverage unacceptable intermediate systems (MCK Umum, Sanimas, etc.) | % total | 1.8% |
| Coverage acceptable on-site systems | % total | 53.9% |
| Coverage unacceptable on-site systems | % total | 29.0% |
| Coverage of septage collection | % production | 38% |
| BOD load | %BOD produced | 49% |

Source: Data analysis from various sources stated above.

#### 3.2.1.12 Key findings from the assessments above

The following findings are considered to be key to the issues of wastewater in the City:

- Current sanitation facilities used in Surabaya are mainly on-site individual and communal systems, there is one small pilot scale sewerage system at ITS in its development stage;
- Kampong and real-estate residents have poor knowledge of different types of sanitation facilities available, they need knowledge improvement so that they recognise the different types of sanitation facility, function and suitability of location (some people have built their leach pit under the kitchen or living room);
- Most citizens are aware that they should regularly empty their septic tanks (findings from direct interview), but they do not;
- Dinas Kesehatan inspects community sanitation facilities once a year, to check the use of the facility and the discharge of the treated wastewater (SPAL).
- Survey results for 2009, indicate that 77% of Kecamatan have individual toilets, of these 89% are rated as acceptable. It is important to note that the survey was more focused on household sanitary facilities (toilet/bathroom) rather than the underground structures (the septic tank).
- Commercial areas use their own wastewater treatment facilities and most of them outsource the operation of the facility to a third party.
- The IPLT is not being used by all the properties with septic tanks, it is operating at 75% under capacity. This strongly suggests that a lot of the septage that is removed by tankers is being dumped elsewhere or septic tanks are not being emptied regularly enough.

A map with the summary of the findings is shown in Appendix C.3.

### 3.2.2 Environmental assessment

This section (3.2.2) contains a summary of the environmental assessment. Full details are contained within Appendix C.4.

#### 3.2.2.1 Water quality

The quality standards for the rivers and the treated wastewater effluent discharge standards are determined by East Java Governor Decree No 45/2002 in addition to the City Government PERDA No 02/2004, which regulates the quality and beneficial usage of rivers, streams and drainage inside the city.

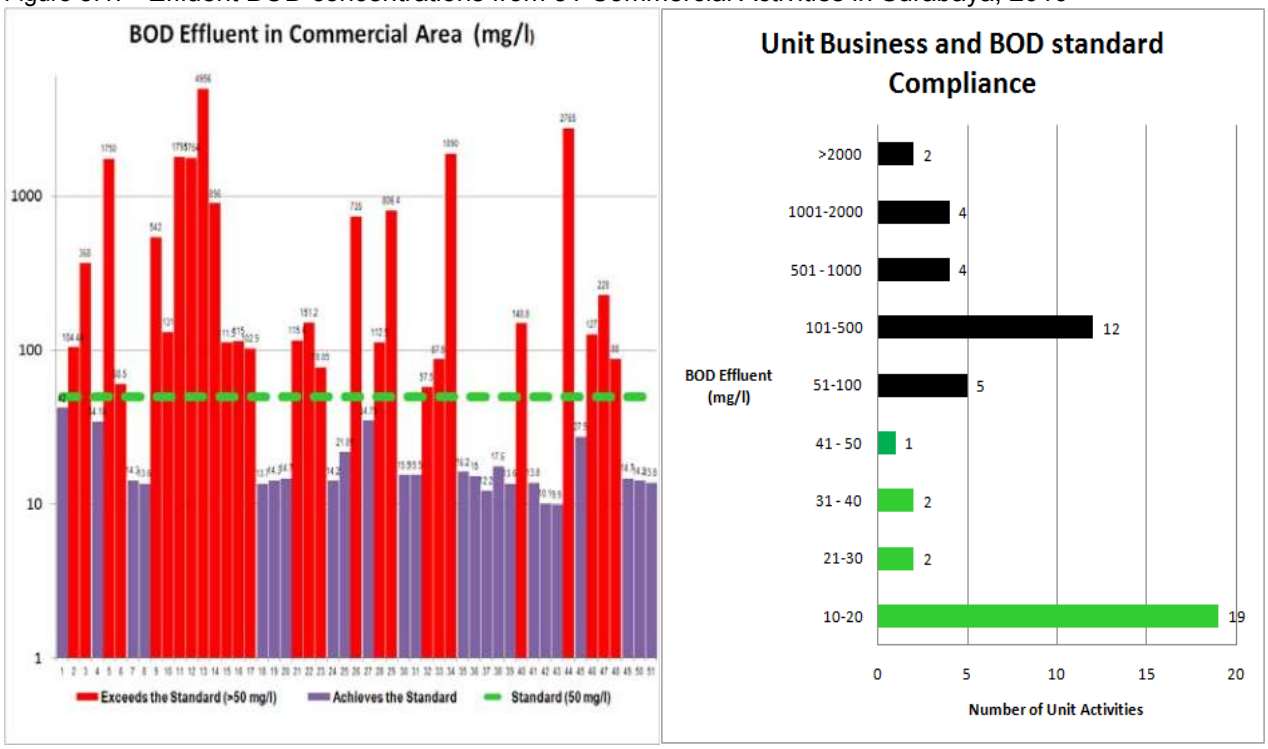
Field findings shows that Surabaya rivers and streams are heavily polluted. Also the shallow ground water conditions are both biologically and chemically unacceptable for use as a safe drinking water source. In many locations, residents have well that are contaminated by *E-coli* bacteria and have nitrate/nitrite. This contamination is caused by poor septic tanks and pollution of drains, the well water is also salty and coloured. The high ground water levels and impermeable nature of the soil means it is difficult to build properly working septic tanks. People generally use PDAM water supplies as it is known that well water is not safe or good enough to be used for drinking water.

Hence, the improvements proposed in the WWMP will only be beneficial to the river water environment if and when the water quality of the rivers upstream of Surabaya are also improved, as they are already polluted when they arrive in Surabaya. We advise to start a Brantas River catchment river quality improvement scheme, involving all communities along the Brantas River: A possible motto could be “get the Ikan Mas back into the Kali Mas” i.e. “get the goldfish back into the golden river”.

#### 3.2.2.2 Commercial wastewater discharges

Surabaya city environmental agency (BLH) categorises commercial wastewater in the same group as domestic wastewater when they monitor effluent quality. Some hotels, office towers and restaurants in the CBD still breach the required effluent standard level of BOD 50 mg/l. From a study of the BLH data for 51 commercial enterprises, there were 24 units (47%) that achieved the effluent standard while 27 units (53%) failed to meet the standard. All commercial enterprises monitored had their own sewage treatment plant, with the exception of some fast food restaurants which only had physical pre-treatment in the form of grease traps. Figure 3.1, illustrates the BOD concentrations from the 51 commercial activities in Surabaya monitored by BLH in 2010. BoD is shown on a logarithmic scale in the left hand graph.

Figure 3.1: Effluent BOD concentrations from 51 Commercial Activities in Surabaya, 2010




### 3.2.3 Health - trend of diarrhoea illness

Surabaya City DINAS of Health has developed diarrhoea illness estimates, based on reportable illness data from all community health centres (Puskesmas) in Surabaya. This indicates that for last 4 years: 63,690 persons (2007), 70,940 persons (2008), 69,020 persons (2009) and 80,761 persons (2010) suffered from Diarrhoea. The trend of diarrhoea shows a 25% increase over the last 4 years. On a city scale the number of diarrhoea cases increased from 3.85% to 4.23% of the total population. 151 people are reported to have died of diarrhoea related illness during 2010.

### 3.2.4 Social Economic Survey (SOSEC) Study

A SOSEC survey of 650 households was carried out in November 2010 and several community FGDs were carried out during November and December. For full details of the SOSEC and FGD findings see Appendix C.5. The following is a brief summary of some of the analysis of the responses:

- **Household sanitation**: 92.2% of households use private toilets, 1.1% share with neighbours, 4.3% use public toilets and 2.5% open defecate. Those respondents who do not have private toilets said; they had no money to build them (43.8%), land not sufficient (31.3%), no clean water for flushing (6.3%), thought it was normal to defecate in the river / sea (12.5%).
- **Connection willingness:** 58.3% of households surveyed said that they wanted to have a connection to the new systems, while 41.7% of the respondents said they were not interested in connecting as they thought their existing sanitary conditions were good or they do not want the additional household expense.

- **Household data**: Household expenditure per month ranges approximately from Rp1.6m to Rp2.9m. With 2.9% used for drinking and clean water, 24.5% for food, 43.9% for health care and only 0.2% for sanitation. The remainder is split between education, electricity and gas, transportation, recreation and others. NOTE - the health care costs seem very high, we plan to investigate this during the feasibility study phase of the project.

## 3.3 Overall Assessment of the existing wastewater situation

### 3.3.1 Weaknesses

The key weaknesses regarding the sanitation sector in Surabaya City are categorised in the following sections.

#### 3.3.1.1 Physical

- The rivers entering Surabaya are already polluted. They become more polluted as they flow through the City. This impacts on raw water quality and causes illness due to waterborne disease such as diarrhoea, cholera and typhus.
- Physical conditions are not very favourable for the development of wastewater systems (high ground water table, low soil permeability and flat elevations).
- There is very little land available for sites for treatment plants and also the construction of sewers and pumping stations.

#### 3.3.1.2 Technical

- Poor construction of on-site facilities. Most of the community have perceptions that the leach pit is a septic tank and is acceptable. The existing systems cause groundwater contamination from human waste;
- Leach pits or septic tanks are often constructed under the living room or kitchen and covered by tiles (mostly in Kampong), this makes it difficult to empty the septage.
- Some individual and public toilets have been constructed without wastewater treatment, wastewater is discharged to the drain or river.
- The city government has taken up the challenge of improve wastewater and is spending considerable sums of money. For the time being, not all initiatives are fully successful, but they are yielding the environmental benefits which were foreseen during the planning of the initiative. Sometimes the wrong technology is selected, such us the ABR costing Rp144m for treating grey water from washing and bathing. Sometimes the right technology is implemented inadequately, such as the AUF costing Rp7m per unit, where the filter outlet has the same level as the inlet, hence, there is no hydraulic head to force the wastewater through the filter, so the filter fills up, it doesn't flow. These findings lead to the impression that the city government does not have the necessary skills to select the right system and to supervise proper construction in the field.

#### 3.3.1.3 Social

- Low perception by the community of the need for good wastewater systems, they think the current situation is acceptable.

- Septage (septic tank sludge) is dumped illegally. Some septage sludge from houses is not transported by vacuum truck to IPLT but discarded into the nearest river because of the long distance and non-willingness to pay for proper disposal.
- Community perception on sanitation facilities is more concerned about the bathroom and toilet and less priority given to the wastewater treatment.
- Some public toilets and communal STPs are badly maintained and the facility is not used due to low willingness to pay by the community.
- Waterborne diseases such as diarrhoea, especially among children under 5 years is high, 4.23% of the total population were estimated to have been ill with diarrhoea, this illness can lead to fatalities, especially the young and elderly. 151 people died of diarrhoea related illness in 2010.

#### 3.3.1.4 Economic and financial

- Some planned wastewater programmes have not been implemented yet, due to the high costs and the budgets being unavailable.
- Most people do not realise that illness from waterborne disease has an economic impact due to work absences, payment for medicine, transportation to clinics and medical treatment costs.

#### 3.3.1.5 Institution Aspects

- Low priority given by both city government and local legislature (DPRD) to proper and sustainable wastewater sanitation programmes;
- Several local offices and agencies in Surabaya City have partial responsibility for wastewater related issues. This makes it difficult to coordinate budgeting and programme planning.

### 3.3.2 Strengths

Surabaya City has some potential strengths to assist in improving the wastewater situation. They are:

- Surabaya has about 27,000 – 30,000 community based cadres that are involved by the city government in handling city environmental problems, these can be used to support social aspects of the wastewater programmes.
- Some community initiatives on wastewater recycling for watering gardens are in use and are working well.
- Surabaya city government has developed a sanitation working group, POKJA, the members are very active and supportive on planning for the development of the wastewater systems in the city.
- There are many studies of the wastewater sector that have been done; these give a good basis for future initiatives.

# 4. Assessment of future demands and strategic objectives

## 4.1 Achieving the aims and strategic objectives of the Wastewater Master Plan

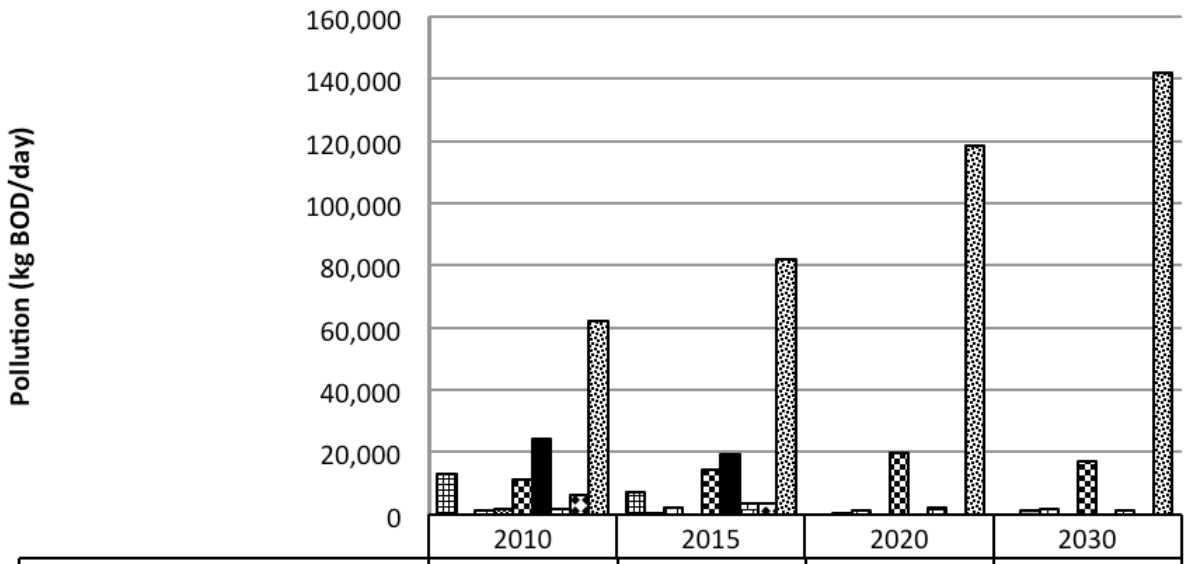
A master spreadsheet has been developed which includes the coverage of wastewater systems, incorporates the strategies and objectives included in the Master Plan (Chapters 1.4 and 1.5). This includes the timescales for meeting the objectives; current BOD load into the environment; calculates BOD removal scenarios; includes the wastewater system categorisations and calculates the investments needed to meet the objectives. See Appendix A, for details.

The spreadsheet shows:

1. A summary section with existing coverage's calculated (2010) and targeted (2015, 2020, 2030).
2. A general section with the summary of the population forecasts.
3. The targeted coverage of off-site and intermediate systems is entered (2015, 2020, 2030).
4. The coverage of on-site systems is calculated from the difference between the total coverage and coverage of off-site and intermediate systems in Step 3.
5. Grey-water system targets are derived from the on-site coverage.
6. Calculation of the volume of septage and consequently a calculation of the need for septage collection in terms of truck and trips are derived from the number of on-site systems.
7. A summary of the existing number of non-domestic systems and the targets for the planning period.
8. Based on the values generated in Steps 2 to 7 and using professional engineering judgement regarding the treatment efficiencies, a calculation of the pollution load in terms of BOD/day was determined for all periods.
9. Calculation of the capacities of the treatment plants and composition of wastewater.
10. Calculation of the cost of the programme implementation based on generated unit cost rates.

Figure 4.1 was developed from this spreadsheet and illustrates achievement of Strategic Objective 3 i.e. improvement of the quality and quantity of the city's wastewater infrastructure in such a way that the pollution load of Surabaya is at least halved by 2030, compared to the pollution load in 2010.

Figure 4.1: Environmental Pollution Load Surabaya




| | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|
| BOD load-non served households | 13,060 | 7,268 | 0 | 0 |
| BOD load off-site | 0 | 80 | 489 | 1 223 |
| BOD load acceptable intermediate systems | 1 136 | 2 126 | 1 468 | 1 541 |
| BOD load unacceptable intermediate systems | 1 515 | 0 | 0 | 0 |
| BOD load acceptable on-site facilities | 11,269 | 14,428 | 19,569 | 16,966 |
| BOD load unacceptable on-site facilities | 24,272 | 19,238 | 0 | 0 |
| BOD load acceptable facilities commercial enterprises | 1,892 | 3,483 | 1,974 | 1,132 |
| BOD load unacceptable commercial enterprises | 6,191 | 3,715 | 0 | 0 |
| BOD removed by treatment systems | 62,343 | 81,804 | 118,541 | 141,901 |

## 4.2 Guiding principles

The following were the guiding principles used[6]:

- In line with good governance principles there should be full transparency regarding the responsibility for wastewater management at city level, neighbourhood level and at the level of households, enterprises and institutes;
- In line with good governance principles there should be a clear distinction between policy making, legislation and operation and maintenance levels;
- Human dignity, quality of life and environmental security at household, enterprise and institute level should be at the centre of the approach, which should be responsive and accountable to needs and demands in both the Surabaya and national setting:
  - Solutions should be tailored to the full spectrum of social, economic, institutional, health and environmental concerns;
  - The household and community environment should be protected;
  - The economic opportunities of waste recovery and use should be harnessed;
- In line with good governance principles, decision- making should involve participation of all stakeholders, especially the consumers and providers of services:
  - Decision-making at all levels should be based on informed choices;
  - Incentives for provision and consumption of services and facilities should be consistent with the overall goal and objective;
  - Rights of consumers and providers should be balanced by responsibilities to the wider human community and environment;
- Treated effluent and septage should be considered a resource, and its management should be holistic and form part of integrated water resources, nutrient flows and waste management processes:
  - Inputs should be reduced so as to promote efficiency and water and environmental security;
  - Transport of effluent and septage should be minimised to promote efficiency and reduce the spread of pollution;
- The domain in which the environmental sanitation problems are resolved should be kept to the minimum practicable size (i.e. household, community, kelurahan, kecamatan, catchment, and city) and wastes diluted as little as possible.
  - Waste should be managed as close as possible to its source;
  - Water should be minimally used to transport waste;
  - Additional technologies for waste sanitisation;
  - Reuse should be developed;

6 Based on the Bellagio principles, see for instance Household-Centred Environmental Sanitation, Implementing the Bellagio Principles in Urban Environmental Sanitatio, Provisional Guideline for Decision-Makers, "Eawag: Swiss Federal Institute of Aquatic Science and Technology, June 2005"

- The investments aimed at improving immediate and short-term sanitary problems should be 'non-regret' investments. That is they should be designed to form part of the longer-term infrastructure and not to be abandoned when they are no longer needed.

## 4.3 Priorities and prioritisation

### 4.3.1 Priority Zones

For the initial development of the City-wide sewerage system we have identified an "embryo" (or starter) sewerage area based on the combination of high population density, the presence of a central business district (CBD) and commercial areas and the availability of land for the embryo STP.

For the areas identified for "onsite" and "intermediate" wastewater systems, each Kelurahan has been assigned a priority, based on population density and the "health risk" assessment for the area. The health risk assessment was identified from the EHRA household survey carried out during 2010 as part of the development of the CSS.

This is in line with the aims and objectives of the Wastewater Master Plan in which the following areas are to receive priority:

b. Commercial areas with enterprises like malls, hotels, restaurants, etc. which can afford to contribute financially to cover operating and maintenance costs of a professional waste water entity;

c. Areas where people are living in relatively unhealthy living conditions. This is reflected in the EHRA Sanitation Risk score;

d. Areas where there is a lot of open defecation: in general, these are areas where, at the moment, the coverage of wastewater facilities is relatively low and also coincide with areas near watercourses;

e. Areas where it is relatively cost-effective to implement wastewater improvement: areas with high population densities and a low coverage of wastewater facilities.

**a. Commercial areas Surabaya**

The following commercial areas have been identified to receive attention during the short and medium term period. The identification of the area was based on their stated ability and willingness to connect to a sewerage system if it were available. These statements were made during Focus Group Discussions held in November 2010. This was followed by interviews with Surabaya Chamber of Trade and Commerce (KADIN) on February 14th 2011, the areas are:

- Along Kembang Jepun – Jembatan Merah streets area in North Surabaya, as the first priority as the highest density mixed area between commercial and housing;
- Kedung Doro, as CBD area in Central Surabaya;
- Dupak, as high density housing surrounding by commercial activities;
- Along Kayun Street in Kelurahan Embong Kali Asin, an area covering official buildings.

**b. EHRA score**

The most recent EHRA Sanitation Risk score for Surabaya was prepared in 2010 and it has resulted in Risk scores per Kelurahan (see Chapter 3.1.1 for further details). The Risk scores are based on characteristics of the houses, the source of drinking water, the sanitary habits reflected in the fact whether people are washing their hands with soap before meals and how they deal with children's faeces, the solid waste management, the physical conditions of the roads in the area, wastewater facilities: both for black water and for grey water, water based, water related and water borne diseases and whether messages from the media are reaching the population.

**c. and d. Wastewater facilities coverage and population density**

Per Kecamatan information is available regarding the coverage of wastewater facilities and gross population density. The 'lack of coverage' multiplied by the gross population density also provides a score that can be used in the prioritisation.

### 4.3.2 Prioritisation of the timing of the intervention

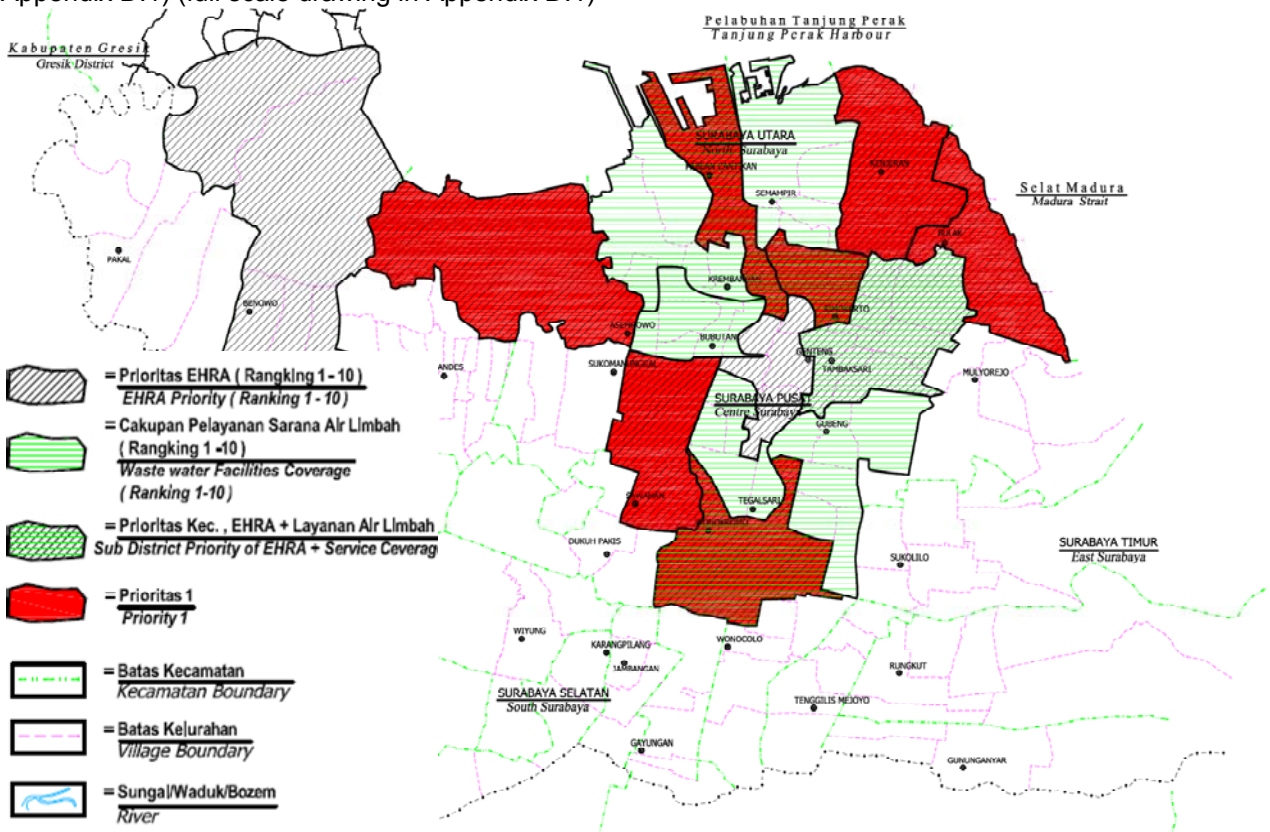
The prioritisation that has been developed is based on a combination of the EHRA Sanitation Risk Score, the coverage figures for wastewater facility availability and population density for the specific area. The "combined priority" was determined based on the EHRA ranking and the coverage/density ranking. For example, a Kelurahan that had a high EHRA ranking with a high population density and low wastewater facilities coverage was of high priority as compared to one with a low EHRA ranking, low population density and high wastewater facilities coverage. This resulted in a "high priority" list of 7 Kecamatan, covering about a quarter (25%) of the population of Surabaya See Table 4.1 for details of the analysis.

Table 4.1: Priority areas for wastewater improvement in Surabaya

| | No. | Sub District / Kecamatan | Population density | Coverage wastewater facilities | EHRA Ranking | Ranking Score Lack of coverage * Density | Combined Priority | Population in priority area |
|---|---|---|---|---|---|---|---|---|
| | | | *cap/ha* | *% coverage* | | | | |
| Centre | 1.01 | BUBUTAN | 324 | 70% | 26 | 6 | - | - |
| Centre | 1.02 | SIMOKERTO | 419 | 57% | 5 | 1 | 1 | 108,388 |
| Centre | 1.03 | TEGALSARI | 286 | 63% | 9 | 4 | - | - |
| Centre | 1.04 | GENTENG | 175 | 72% | 10 | 11 | - | - |
| North | 2.01 | SEMAMPIR | 224 | 54% | 11 | 5 | - | - |
| North | 2.02 | PABEAN CANTIKAN | 141 | 24% | 6 | 3 | 1 | 95,597 |
| North | 2.03 | KREMBANGAN | 154 | 48% | 11 | 8 | - | - |
| North | 2.04 | KENJERAN | 151 | 76% | 1 | 12 | 1 | 115,150 |
| North | 2.05 | BULAK | 53 | 62% | 1 | 18 | 1 | 36,189 |
| East | 3.01 | GUBENG | 209 | 68% | 11 | 9 | - | - |
| East | 3.02 | TAMBAKSARI | 263 | 65% | 6 | 7 | - | - |
| East | 3.03 | SUKOLILO | 44 | 71% | 11 | 23 | - | - |
| East | 3.04 | MULYOREJO | 58 | 80% | 27 | 24 | - | - |
| East | 3.05 | RUNGKUT | 45 | 74% | 11 | 25 | - | - |
| East | 3.06 | TENGGILIS MEJOYO | 105 | 75% | 11 | 15 | - | - |
| East | 3.07 | GUNUNG ANYAR | 55 | 83% | 11 | 27 | - | - |
| South | 4.01 | WONOKROMO | 236 | 74% | 1 | 10 | 1 | 199,890 |
| South | 4.02 | SAWAHAN | 342 | 64% | 11 | 2 | 1 | 237,172 |
| South | 4.03 | WONOCOLO | 126 | 79% | 27 | 14 | - | - |
| South | 4.04 | JAMBANGAN | 106 | 76% | 11 | 16 | - | - |
| South | 4.05 | GAYUNGAN | 75 | 77% | 27 | 19 | - | - |
| South | 4.06 | KARANGPILANG | 76 | 79% | 11 | 20 | - | - |
| South | 4.07 | WIYUNG | 48 | 80% | 11 | 26 | - | - |
| South | 4.08 | DUKUH PAKIS | 61 | 75% | 27 | 21 | - | - |
| West | 5.01 | TANDES | 86 | 75% | 11 | 17 | - | - |
| West | 5.02 | ASEMROWO | 24 | 45% | 1 | 22 | 1 | 37,735 |
| West | 5.03 | SUKOMANUNGGAL | 107 | 73% | 11 | 13 | - | - |
| West | 5.04 | BENOWO | 15 | 71% | 6 | 30 | - | - |
| West | 5.05 | PAKAL | 19 | 79% | 11 | 31 | - | - |
| West | 5.06 | LAKARSANTRI | 23 | 73% | 27 | 29 | - | - |
| West | 5.07 | SAMBIKEREP | 31 | 76% | 11 | 28 | - | - |
| | | **Total** | **92** | | | | | **830,121** |

Source: EHRA 2010, Dinas Kesehatan Kota Surabaya, Data analysis.

Figure 4.2: Map showing the high priority areas, based on EHRA data and the MMI data analysis: Kecamatan Simokerto, Pabean Cantikan, Bulak, Kenjeran, Wonokromo, Sawahan, and Asem Rowo (see Appendix D.1) (full scale drawing in Appendix D.1)




Source: ERHA data and Mott MacDonald analysis

## 4.4 Desired future situation

The desired future wastewater situation in Surabaya is presented in Table 4.2.

Table 4.2: Desired future situation in Surabaya

| Description | Unit | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|
| Summary | | | | | |
| Open defecation | % total | 12.5% | 6.4% | 0% | 0% |
| Coverage sanitation | % | 87.5% | 93.6% | 100% | 100% |
| Coverage inacceptable systems | % total | 31% | 21% | 0% | 0% |
| Total coverage open defecation and inacceptable systems | % total | 43% | 28% | 0% | 0% |
| Coverage acceptable systems | % total | 57% | 72% | 100% | 100% |
| Coverage sanitation | % total | 88% | 94% | 100% | 100% |
| Coverage acceptable off-site systems | % total | 0% | 1% | 8.0% | 17% |
| Coverage inacceptable off-site systems | % total | 0% | 0% | 0% | 0% |
| Coverage acceptable intermediate systems | % total | 3% | 7% | 12% | 22% |

| Description | Unit | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|
| Coverage unacceptable intermediate systems | % total | 2% | 0% | 0% | 0% |
| Coverage acceptable on-site systems | % total | 54% | 64% | 80% | 61% |
| Coverage unacceptable on-site systems | % total | 29% | 21% | 0% | 0% |
| Coverage septage collection | % production | 38% | 75% | 100% | 100% |
| BOD load | %BOD produced | 49% | 38% | 17% | 13% |

Source: Mott MacDonald in consultation with Pokja Sanitasi Surabaya

In line with this and the aims and strategic objectives stated in Chapter 1 we have identified the following desired situation for planning horizons:

**By 2015:**

e. Reduce the number of open defecation cases by more than 50% compared to 2010, but may not yet have reached the status of Open Defecation Free (ODF);

f. Reduce the number of unacceptable wastewater facilities by 1/3 compared to 2010;

g. Develop two new off-site systems in commercial areas;

h. Increase the septage collection to 75% of the on-site sanitation systems and all collected septage to be treated in an environmentally acceptable way;

**By 2020:**

f. Surabaya has reached the status of Open Defecation Free (ODF);

g. All unacceptable wastewater facilities removed or replaced;

h. Overall 40% of the high density areas are served by off-site systems;

i. The septage collection services cover 100% of the on-site sanitation systems and all collected septage is treated in an environmentally acceptable way;

j. 50% of the operation and maintenance costs of off-site and intermediate systems are covered by the collection of user fees (maximum 50% subsidy).

**By 2030:**

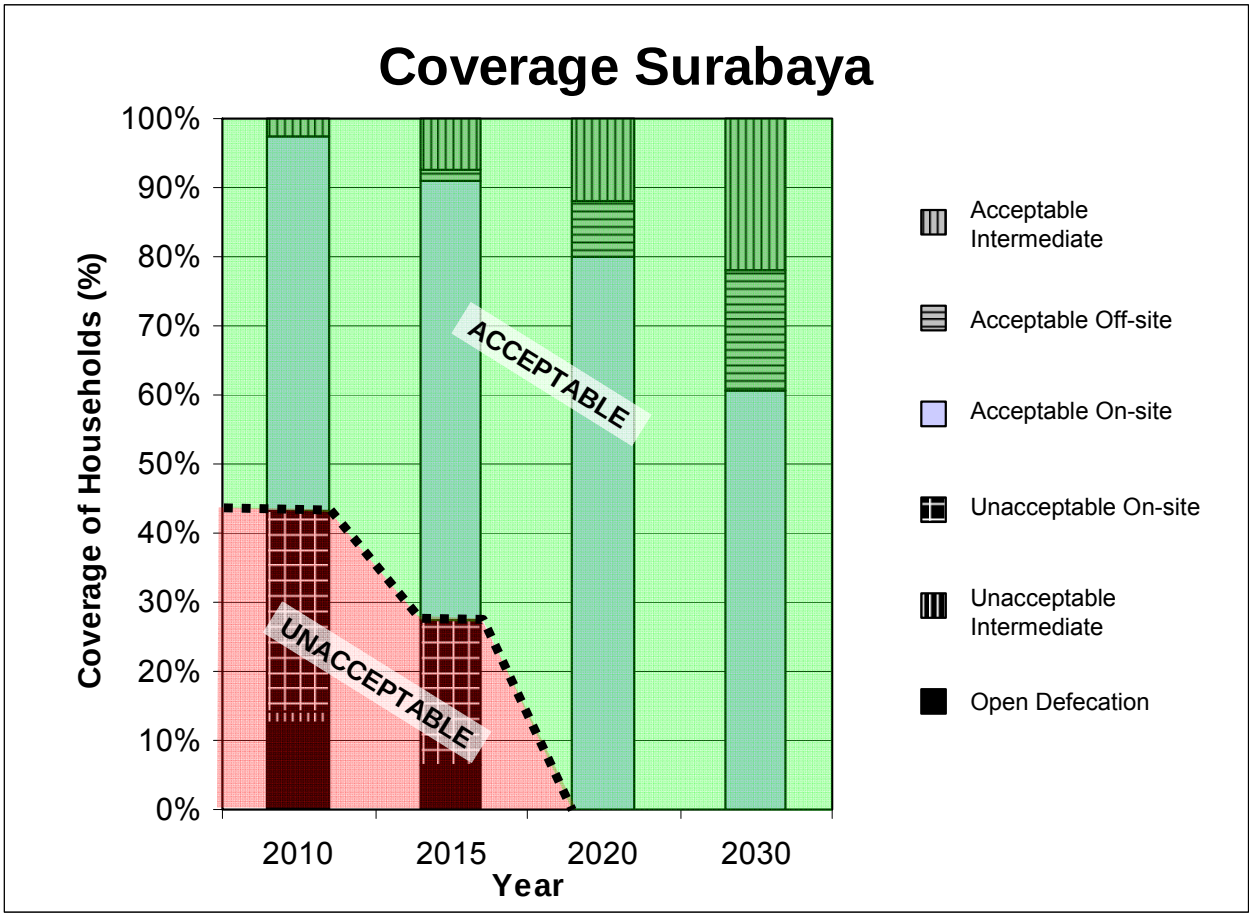
d. Overall, 70% of the high density and commercial areas are served by off-site systems;

e. The remaining 30%, of the high density areas are served by intermediate systems;

f. All operation and maintenance costs of off-site and intermediate systems are covered by the collection of user fees, i.e. no subsidy.

The desired future situation is presented in Figure 4.3.

Figure 4.3: Desired future situation



# 5. Wastewater system selection and 'timing'

## 5.1 Selection criteria and wastewater category flow chart

Where first stage sanitation improvements are required, on-site systems are often preferred because they can be constructed by the local community or the individual householder for low capital and operational cost. It is often the case that well-constructed and well-maintained on-site sanitation systems can provide the same level of wastewater management and health benefits as an off-site conventional sewerage system with STP.

Nonetheless off-site or communal sanitation systems are more typical in high densely populated developed cities due in part to the scarcity of space required for on-site systems at each individual dwelling. This is of increasing relevance in cities where populations are more commonly being housed in residential tower blocks, and off-site or communal sanitation systems may be seen as an indicator and possibly a contributor to a city's economic development. In Surabaya the application of on-site systems is further constrained by adverse site and ground conditions:

- High building density;
- High groundwater table;
- Impermeable soils.

These constraints favour the selection of off-site solutions for Surabaya. However, a sewerage system should only be considered if:

- Enough water is available to transport the waste and to prevent deposition in the sewers;
- The population can afford to cover the higher operation and maintenance costs or the government can afford to subsidise it;
- Site conditions are favourable for sewer gradients: the area should have enough natural slope to minimise the need for pumping.

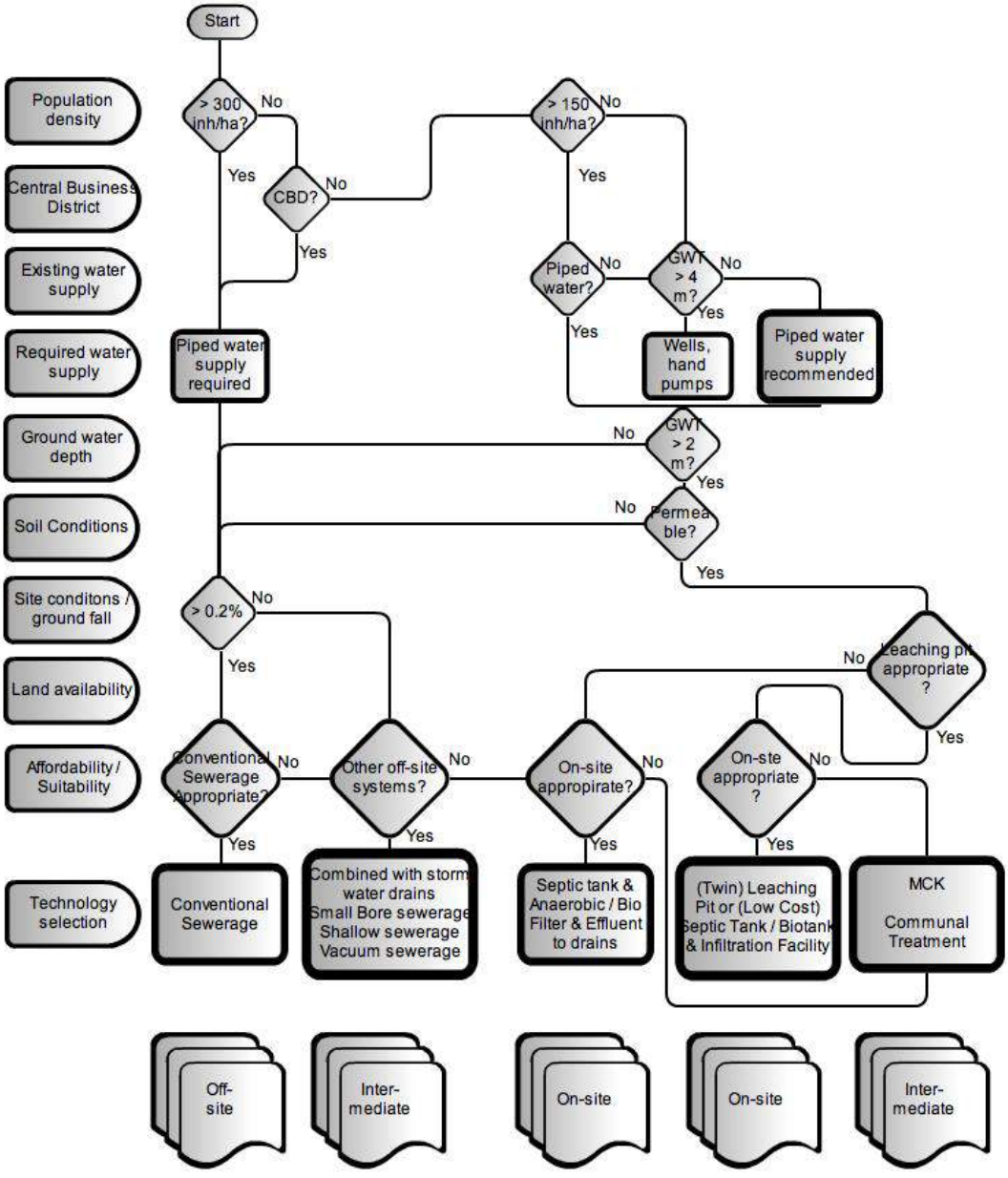
These constraints must be carefully considered when planning wastewater systems. An indicative flow chart, see Figure 5.1, has been developed as a tool to assist in the planning process. This is the first 'rough' step to determine where on-site systems are possible and where off-site solutions are suitable.

The chart uses the following indicators:

- Kelurahan/Kecamatan gross population density, as the figures of the built-up or net density are not available;
- Presence of a Central Business District or linear commercial district;
- Existing or planned public water supply;
- Groundwater depth, soil conditions/permeability;
- Slope of the ground surface, availability of land;
- Affordability and suitability.

If conventional sewerage was determined to be unaffordable and suitable “on-site” systems not possible, then other systems were considered. In the framework of the Master Plan these have been termed ‘intermediate’ systems.

Figure 5.1: Indicative flow chart technology selection




This flow chart is in line with the Minimum standards for Urban Residential Wastewater Services. See Table 5.1.

Table 5.1: Minimum Standards for Urban Residential Wastewater Services[7]

| Type of Service | Minimum Service Standard Indicator | Remarks | Deadline |
|---|---|---|---|
| **A. Access to Wastewater Collection Infrastructure and Facilities** | | | |
| A.1 Provision of wastewater infrastructure and facilities to meet public need, in the form of private toilets, communal toilets or public toilets | • Private or communal or public toilets available, equipped with at leas<br>- Squat/sit toilet bowl<br>- Goose-neck/water seal | • National policy of development of water supply and environmental sanitation community based, Bappenas, 2003.<br>• SPM Peraturan Menteri PU<br>• Reference book, national systems and technology options, 2010 | 2015 |
| A.2 Watewater management using low-density (≤ 300 people/ha) on-site system | • In cities: toilets are connected to septic tanks with absorption fields<br>• The distance between the septic tank absorption field and water well is at least 10 meters. | National Standard (SNI) 03-2398-2002 concerning Procedures for planning septic tanks with absorption field | 2015 |
| **B. Access to Sludge Collection** | | | |
| B.1 Removal of sludge from septic tanks | • Vacuum sludge truck available<br>• Easily contactable service centers established | Reference book, national systems and technology options, 2010 | 2015 |
| **C. Wastewater Management** | | | |
| C.1 Management of sludge removed from septic tanks | • Sludge treatment plants set up, at least in cities with a population of 50.000 septic tanks user | Reference book, national systems and technology options, 2010 | 2015 |
| C.2 Quality management of sludge treatment plant | • Effluent complies with quality standards | Decree of the Minister of the Environment 112/2003 concerning Domestic Wastewater Quality Standards and amendments | 2015 |
| C.3 Wastewater management using off-site sanitation system in cities with a high population density (› 300 people/ha) and cities that are not technically suited to on-site | • Local/community wastewater pipe network and treatment system established, or<br>• Area wastewater pipe network and treatment systems established | Decree of the Minister of the Environment 112/2003 concerning Domestic Wastewater Quality Standards and amendments | 2015 |
| C.4 Quality management of wastewater treatment plant | • Effluent complies with quality standards | Decree of the Minister of the Environment 112/2003 concerning Domestic Wastewater Quality Standards and amendments | 2015 |
| **D. Regulation and Management** | | | |
| D.1 Implementation of management and delivery of residential wastewater services | • Wastewater management unit/agency established at the municipal level | National policy of development of water supply and environmental sanitation community based, Bappenas, 2003.<br><br>Management unit alt municipal level | 2015 |
| D.2 Provision of regulatory framework for residential wastewater services | • Regional Government Regulation on wastewater management established | | 2015 |
| D.3 Implementation of outreach and campaigns to promote public participation | • Public outreach/campaign conducted at least twice a year | | 2015 |
| D.4 Provision of funding for wastewater development and management | • Regional budget funds allocated for wastewater management, at least for operation and maintenance (O/M) | | 2015 |

7 Minimum Service Standards (SPM) are based on the Government Regulation PP 38/2007 and Ministerial Decree 14 PRT/2010

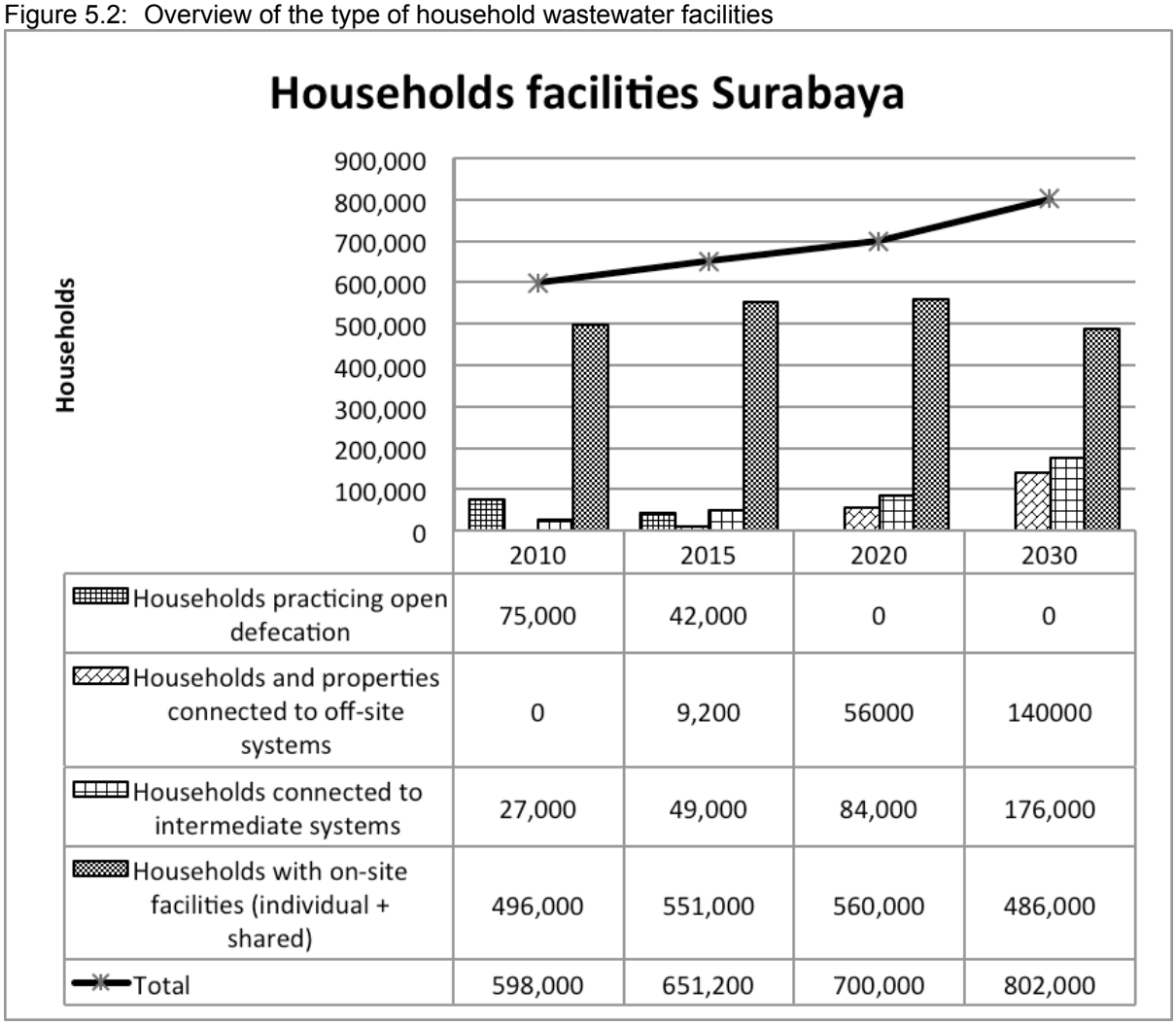
We adopted the following procedure to identify possible locations for off-site systems for the City:

1. We identified those areas with a projected population density in excess of 300 persons/ha in 2015, 2020 and 2030, based on population density calculations (see Section 2.3.1).
2. We identified existing and planned central business or commercial districts (CBDs) based on the existing situation and urban development plans
3. We combined high density and CBD areas on maps and assessed the suitability/affordability of conventional sewerage in these areas from a financial point of view based on:
    - The outcome of Focus Group Discussions with the private sector
    - Discussions with the Pokja
4. The areas that 'remain' after step '3' were plotted as potential 'sewage collection areas' on topographical maps of the City
5. Subsequently we 'connected' potential sewage collection areas in a logical way and defined possible locations of future trunk sewers, considering potential land availability for sewage treatment plants. These alignments were checked in the field (GPS) and discussed with the Roads Department (Bina Marga)
6. We have incorporated the lessons learned from the feasibility studies carried out for those projects included in the first five year period of the masterplan.

## 5.2 Area categorisation by 2015, 2020 and 2030

Following the methodology explained in section 5.1 we have identified the coverage of on-site, intermediate and off-site systems required to meet the aims and strategic objectives for Surabaya stated in Section 4.4 for each of the planning horizons. The overall result is presented in Figure 5.2.

Figure 5.2: Overview of the type of household wastewater facilities




| | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|
| Households practicing open defecation | 75,000 | 42,000 | 0 | 0 |
| Households and properties connected to off-site systems | 0 | 9,200 | 56000 | 140000 |
| Households connected to intermediate systems | 27,000 | 49,000 | 84,000 | 176,000 |
| Households with on-site facilities (individual + shared) | 496,000 | 551,000 | 560,000 | 486,000 |
| Total | 598,000 | 651,200 | 700,000 | 802,000 |

The number and different types of new systems per Kecamatan is shown in Appendix E.2.

Figures 5.3, 5.4 and 5.5 show the distribution of new wastewater systems programmes that are proposed for 2015, 2020 and 2030 for Surabaya City.

Figure 5.3: Wastewater system distribution for 2015 (full scale drawing in Appendix E.3)

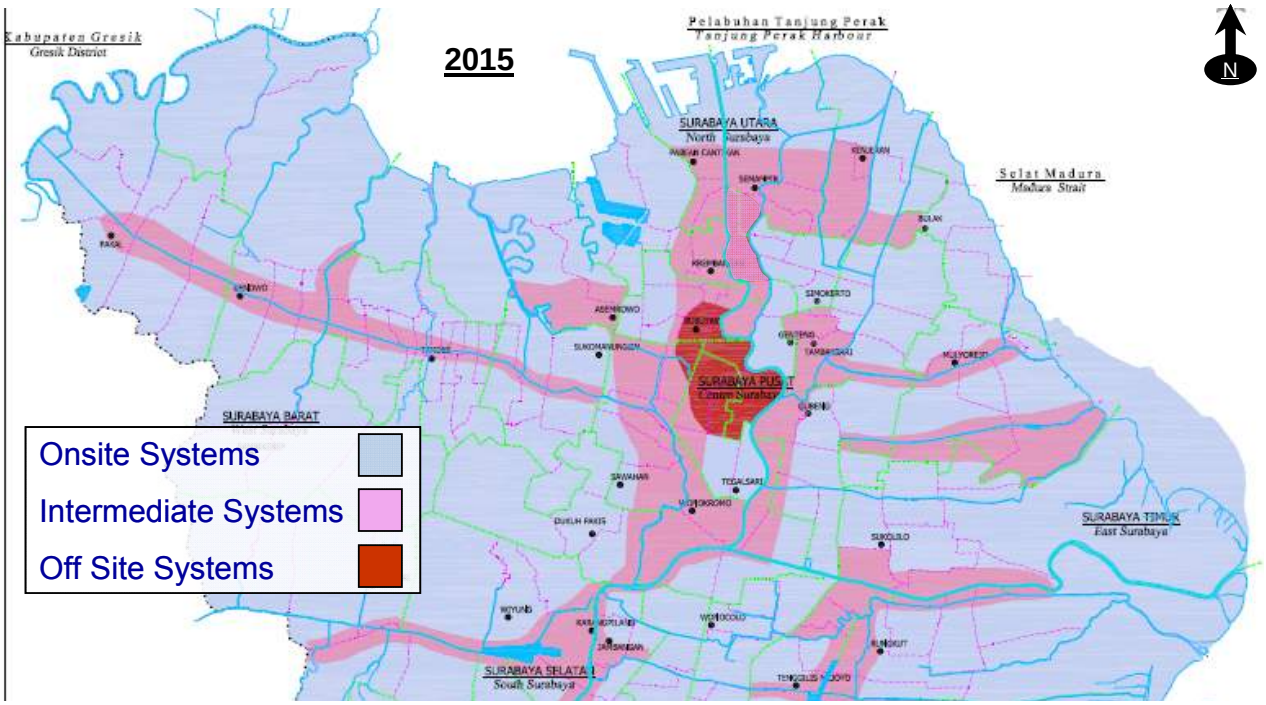



Figure 5.4: Wastewater system distribution for 2020 (full scale drawing in Appendix E.4)

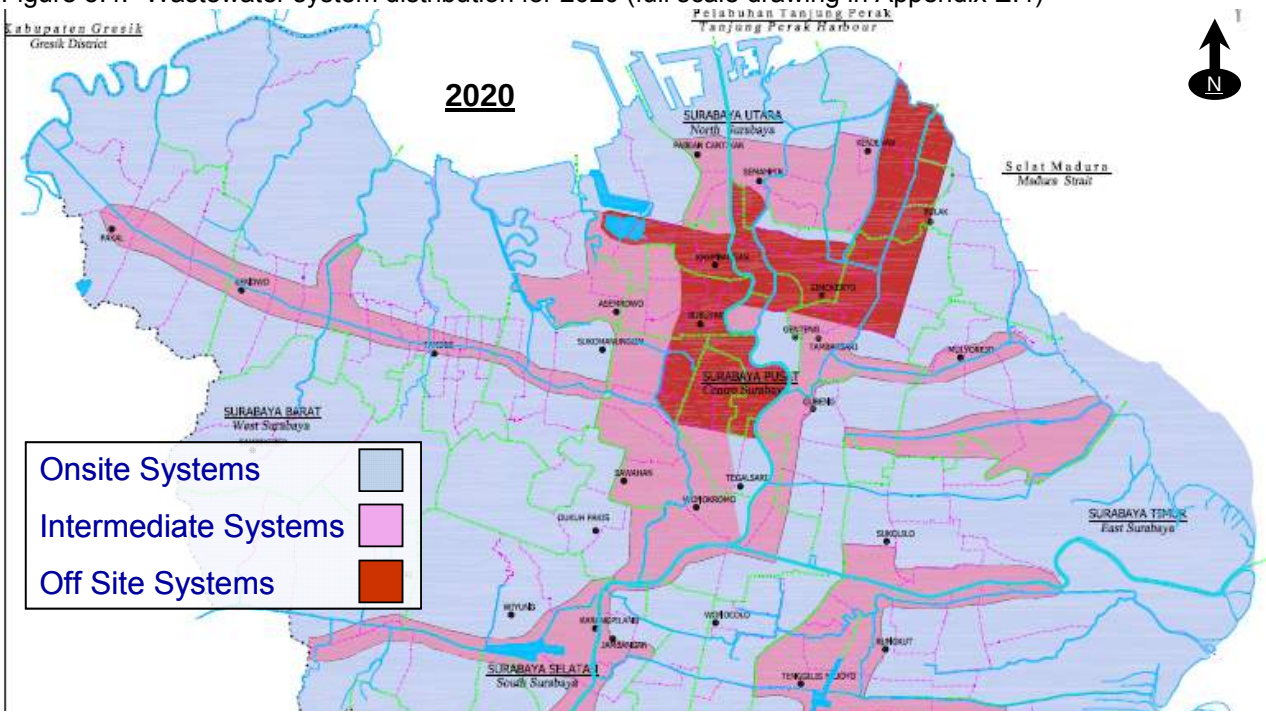
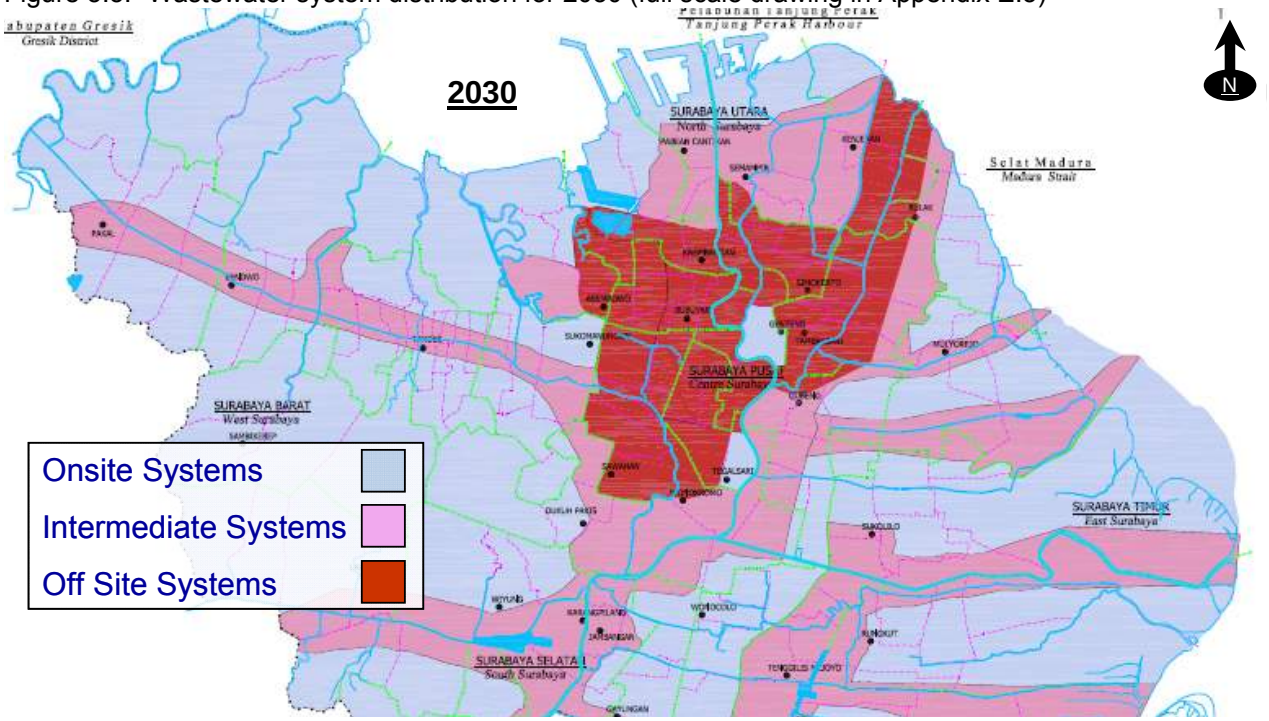


Figure 5.5: Wastewater system distribution for 2030 (full scale drawing in Appendix E.5)

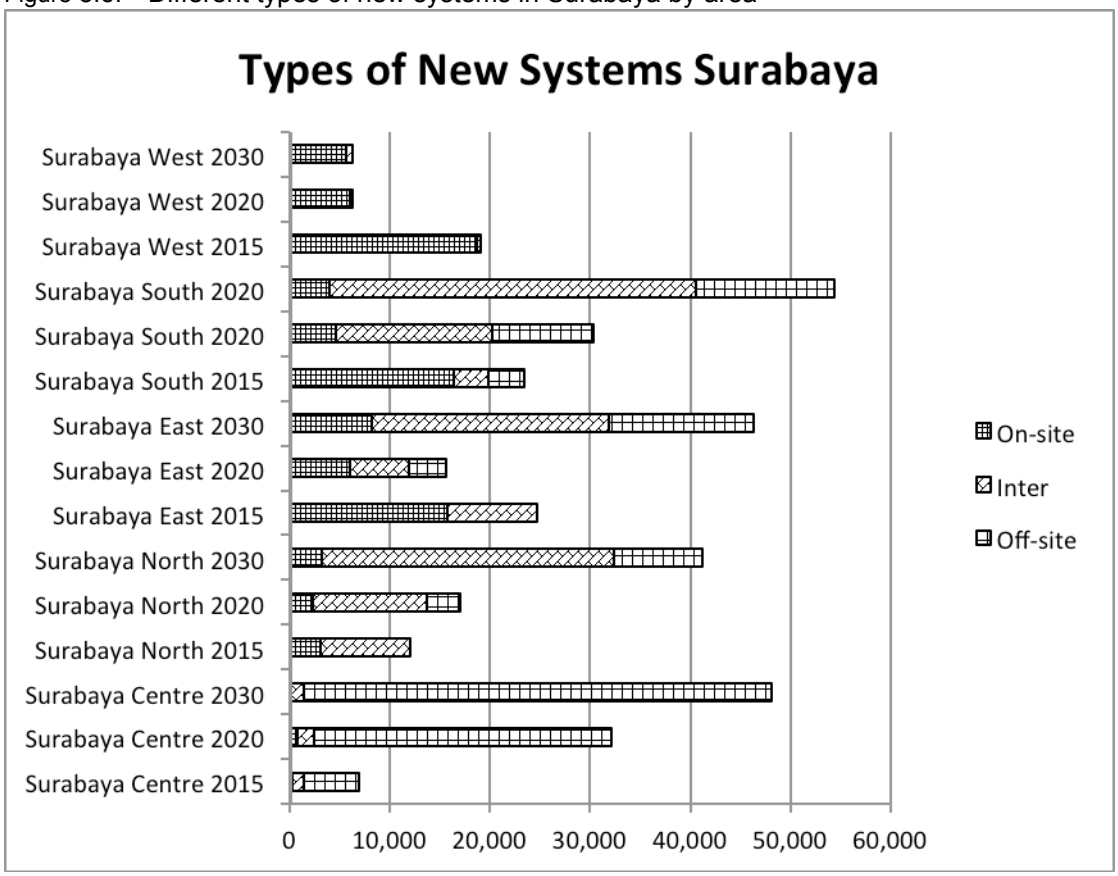



The composition of the different types of new systems required to achieve this situation, across the planning horizons is presented in Table 5.2 and Figure 5.6.

Table 5.2: Different types of new systems in Surabaya (number of households served rounded and %)

| Area | | 2015 | | 2020 | | 2030 | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| (% land) | System | Number | % | Number | % | Number | % | Number | % |
| Central (4 %) | **On-site** | 200 | 3% | 800 | 3% | | 0% | 1 000 | 1% |
| | **Inter** | 1 200 | 17% | 1 600 | 5% | 1 400 | 3% | 4 200 | 5% |
| | **Off-site** | 5 600 | 80% | 29 700 | 92% | 46 700 | 97% | 82 000 | 94% |
| North (12 %) | **On-site** | 3 000 | 25% | 2 300 | 13% | 3 100 | 8% | 8 400 | 12% |
| | **Inter** | 9 000 | 75% | 11 400 | 67% | 29 200 | 71% | 49 600 | 71% |
| | **Off-site** | - | 0% | 3 300 | 20% | 8 900 | 22% | 12 200 | 17% |
| East (28 %) | **On-site** | 15 700 | 64% | 6 000 | 38% | 8 200 | 18% | 29 900 | 35% |
| | **Inter** | 8 900 | 36% | 5 900 | 38% | 23 700 | 51% | 38 500 | 45% |
| | **Off-site** | - | 0% | 3 600 | 23% | 14 500 | 31% | 18 100 | 21% |
| South (20 %) | **On-site** | 16 400 | 70% | 4 600 | 15% | 3 900 | 7% | 24 900 | 23% |
| | **Inter** | 3 500 | 15% | 15 600 | 51% | 36 600 | 67% | 55 700 | 52% |
| | **Off-site** | 3 600 | 15% | 10 100 | 33% | 13 800 | 25% | 27 500 | 25% |
| West (36 %) | **On-site** | 18 700 | 98% | 6 000 | 96% | 5 600 | 89% | 30 300 | 96% |
| | **Inter** | 400 | 2% | 300 | 4% | 700 | 11% | 1 400 | 4% |
| | **Off-site** | - | 0% | - | 0% | - | 0% | - | 0% |
| **Total** | **On-site** | 54 000 | 63% | 19 700 | 19% | 20 800 | 11% | 94 500 | 25% |
| | **Inter** | 23 000 | 27% | 34 800 | 34% | 91 600 | 47% | 149 400 | 39% |
| | **Off-site** | 9 200 | 11% | 46 700 | 46% | 83 900 | 43% | 139 800 | 36% |

Figure 5.6: Different types of new systems in Surabaya by area




## 5.3 Prioritisation of the development of the wastewater system

The priorities for the development of the wastewater system for Surabaya were directly derived from the strategic objectives and area prioritisation discussed in Section 1.5 and Chapter 4:

### 5.3.1 Priority interventions for the short term (2015)

The proposed interventions for the first 5 years of the masterplan are as follows:

- Immediate improvement of the wastewater situation of those people who defecate at the moment in the open to achieve Open Defecation Free (ODF) in Surabaya City. This programme is focused on urban poor. The system proposed is intermediate systems for the urban poor in the areas with low sanitation coverage. Based on the EHRA survey of sanitation service facilities, the locations are in Kecamatan Simokerto, Pabean Cantikan, Kenjeran, Bulak, Wonokromo, Sawahan and Asem Rowo;
- Development of the skeleton sewerage system for Surabaya for the long-term (2030) that will allow adequate off-site wastewater service levels in the Central Business Districts: This will be used to identify the land acquisition for the STPs and routing of the planned trunk sewers;

- Identification of the starter “embryo” wastewater collection system in one of the Central Business Districts and surrounding high-density areas by 2015;
- Land identification for the starter “embryo” off-site wastewater system STP;
- Detailed design, and tendering of the “embryo” off-site wastewater collection system
- Connecting the existing ITS Institute, sewage treatment plant (Module ITS) to the adjacent housing complex with instalment of 1,000m of lateral pipes, diameter 200 mm to serve 600 households, including marketing and persuasion to ensure that property owners will connect;
- Further development of the relatively new concept of intermediate systems in 7 modules according to the methodology developed for the ‘pilot’ intermediate system Peneleh.
- Development of a sustainable legal and institutional framework for management, operation and maintenance of improved wastewater facilities;
- Motivate the population, commercial enterprises and institutes to implement, operate and maintain adequate wastewater facilities;
- Develop the physical, financial and knowledge capacity regarding wastewater improvements at all levels: government, institutes, commercial enterprises, neighbourhood and community;
- Execute supporting studies for:
  - Performance of the existing IPLT at Keputih
  - Monitoring performance of the installed ABRs used by existing buildings;
  - Technical demonstration models for on-site systems that are appropriate for Surabaya conditions;
- Training/education of the government staff on sanitation and wastewater;
- Develop an information centre for sanitation where people can obtain drawings, instructions, guidance and support for appropriate on-site solutions.

## 5.4 Achievement indicators

The proposed overall achievement indicators are shown in Figure 5.7 and Table 5.4.

Figure 5.7: Achievement indicators

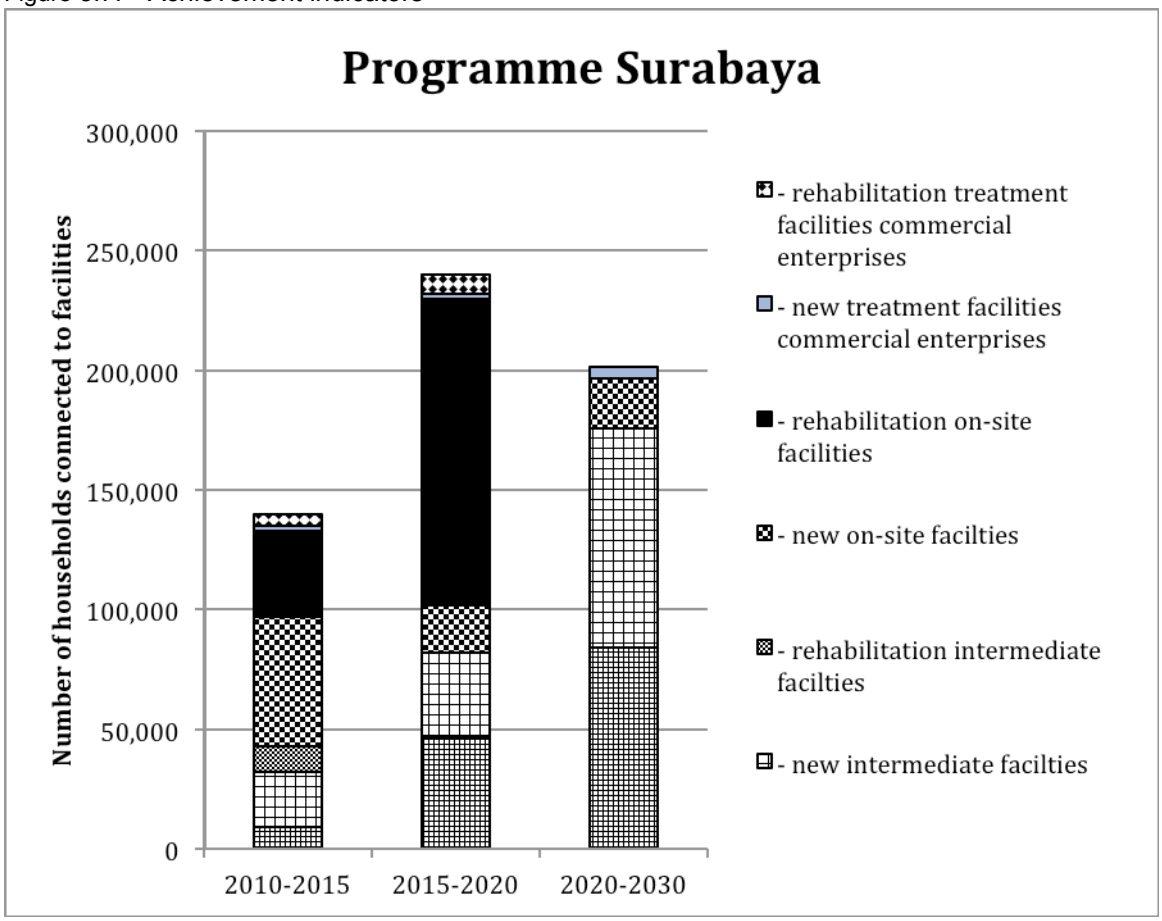



Table 5.3: Achievement indicators for the wastewater master plan programme

| Programme Master Plan Surabaya | 2010-2015 | 2015-2020 | 2020-2030 | Total |
|---|---|---|---|---|
| - new off-site house connections | 9 200 | 46 800 | 84 000 | 140 000 |
| - rehabilitation off-site facilities | - | - | - | - |
| - new intermediate facilities | 22 900 | 35 000 | 91 500 | 149 400 |
| - rehabilitation intermediate facilities | 10 800 | - | - | 10 800 |
| - new on-site facilities | 54 000 | 20 000 | 21 000 | 95 000 |
| - rehabilitation on-site facilities | 36 000 | 128 000 | - | 164 000 |
| - new treatment facilities commercial enterprises | 2 000 | 2 000 | 5 000 | 9 000 |
| - rehabilitation treatment facilities commercial enterprises | 5 000 | 8 000 | - | 13 000 |
| **Total** | **139 900** | **239 800** | **201 500** | **581 200** |

## 5.5 Sustaining the programme and key performance indicators

### 5.5.1 Sustaining the programme in general terms

The planned programme of system interventions will be sustained if all stakeholders that are involved (city government, private sector and community) are able to continue the operation of the systems without additional special programmes and interventions. After 5 years the initial programs will have been implemented and it will probably take another 5 years for them to become sustainable. Besides institutional development planned, table 5.4 shows the desired results and the activities that are necessary to achieve a sustainable situation by 2020. These activities have been elaborated in the WWMP Capacity Building Plan report.

Table 5.4: Sustaining the programme by 2020

| Problem | Solution/Desired result | Activities |
|---|---|---|
| Wastewater installations installed do not work properly due to poor design/ wrong locations/ wrong operation and maintenance. | Government agencies and staff are knowledgeable on wastewater management so they can guide designers and contractors in a good way.<br><br>Contractors and general public have good information and good examples of appropriate wastewater technologies. | Government level:<br>Education of existing government staff;<br>Only recruit knowledgeable staff (part of job descriptions);<br>Develop wastewater information centres where contractors and the general public can obtain information on appropriate technologies (models, construction drawings, etc.). |
| Wastewater management has a very low priority (is not 'sexy'. | High priority for wastewater management | The local leaders (Mayor) to make sure wastewater becomes an important issue;<br>Award and rewards for most clean and green area/government official;<br>Good examples at government offices, hospitals, School sanitation, Puskesmas sanitation. |
| Poorly installed wastewater installations keep on polluting the environment. | Every owner of a wastewater treatment installation is responsible for good operation and maintenance. | Publish the effluent quality of all licensed waste treatment installations on the internet;<br>Award and reward for the best working installation, visit by the Mayor and publicity. |
| The perception is that the treatment of wastewater only costs money. | At all levels it is realised that there is also an economical benefit in living healthy. | PR campaigns and interviews with influential people. |

The conditions required to sustain the programmes outlined above in Table 5.4 are listed in Table 5.5.

Table 5.5: Conditions required to make the programme sustainable

| Programme | Conditions |
|---|---|
| Construction of new off-site house connections | Income from wastewater fee should be equal or more than the operation and maintenance costs. |
| Construction of new intermediate facilities | Monitoring of the appropriateness and success of the intermediate facilities;<br>Dissemination of the monitoring results. |
| Construction of new on-site facilities | Within the building permit there should be a requirement that every house should have an adequate on-site facility;<br>Monitoring of the facilities; Law enforcement. |
| Construction of new treatment facilities for commercial enterprises | Within the business permit there should be a prescription that every commercial enterprise should have an adequate wastewater treatment facility; Law enforcement. |

### 5.5.2 Performance indicators

Recommendations for performance indicators have been developed to monitor the implementation of the planned wastewater programme. In this respect they are output indicators based on the indirect results of the implementation of the wastewater programme. The list of performance indicators is shown in Table 5.7 and has been elaborated in the WWMP Capacity Building Plan report.

Table 5.6: Recommended Performance Indicators

| Indicator | Target 2015 | Target 2020 |
|---|---|---|
| Financial: cost recovery for public facilities (sewerage system, intermediate systems) | 50% | 100% |
| Institutional: is there an institution which:<br>Oversees, monitors the operation of public facilities;<br>Operates public facilities (off-site, septage treatment, intermediate systems etc);<br>Oversees and monitors private and community wastewater facilities. | Available | The 'man in the street' knows who is responsible and where to complain. Complaints are followed up within 3 days. |
| Environmental: the proportion of BOD load Surabaya town discharging into the environment compared to the BOD load produced. | 38% | 17% |
| Technical: treatment efficiency of off-site, intermediate and on-site systems | 60% | 80% |
| Social/behavioural: hand washing after toilet use and before food preparation | 50% | 100% |

# 6. Proposals for future wastewater facilities

## 6.1 Introduction

The different technical solutions proposed fall into three categories, which are covered in the following sections:

1. Off-site systems –Conventional sewerage with wastewater treatment plants, all managed by centralised operator;
2. On-site systems – both new and upgraded facilities with maintenance generally wholly under the responsibility of the householder or community groups;
3. Intermediate systems –A combination of the above two with maintenance duties shared between centralised operator and community participation.

Also included in this chapter, is consideration of:

- Grey water disposal;
- Non-domestic wastewater; and
- Septage collection and treatment

## 6.2 Design approach and system definition

Designing a sewer system for major cities which are already densely populated and developed will present an infinite number of possible solutions, particularly when considering the need to incorporate previous thinking and studies already completed on the topic.

The design of the sewerage system has therefore been approached as an iterative staged process whereby parameters may be defined first which allow the prescription of a certain type of wastewater collection system and then appropriate design options of these systems will be presented.

1. Review client requirements – section 1.4
2. Review existing and future demographics and land use – section 2.3
3. Review city needs and previous studies – section 3.1
4. Review existing sewerage already implemented (and their performance) - section 3.2
5. Meet the defined guiding principles – section 4.2
6. Work within the identified priority zones – section 4.3
7. Meet the desired future situation – section 4.4

The outcome of this data review has allowed the development of a wastewater system programme for the administrative area of Surabaya for the planning horizons 2015, 2020, and 2030. By relating the available wastewater collection technologies to the parameters defined above an outline plan for system investment type can be developed. This is presented in Figures 5.3, 5.4, and 5.5.

Together with this overview plan for development a list of short term investment priorities, shown in section 5.3, will be used as a quick reference for devising and then comparing the suitability of system option design.

## 6.3 Off-site systems

### 6.3.1 Sewerage

The first part of the off-site wastewater systems to define is the trunk main routes, from this then collection zones can be outlined, and finally detailed analysis of off-site sewerage design options.

#### 6.3.1.1 Development of trunk main routes

For the development of trunk main routes reference is made to the wastewater system programme city plan for the 2030 horizon, Figure 5.5.

The areas, recommended for off-site sewer development, are shown shaded in dark red colour and occupy the central areas of Surabaya. By using the 2030 horizon picture we are able to define the trunk sewers which can most effectively collect all the areas to develop off-site sewerage over the time frame of this development programme.

A trunk sewer for any given area should take an efficient route through the centre of the thinnest corridor as this will allow connections to be made from contributors on both sides with the shortest necessary lengths of lateral sewer. In the case of Surabaya there is a ground level fall from south to north so the trunk sewers should make use of this to reduce the requirement for pumping stations.

This allows outline trunk sewer routes to be defined for Surabaya. A decision was taken to define two separate trunk sewer routes known as 'West from Kali Mas' and 'East from Kali Mas', thus avoiding the challenge of crossing the Kali Mas but still best serving the collection areas. The sewers will run from south to north and therefore flows at the north end will need to be treated at this point or transported via pumping to an alternative site.

The outline routes for the two trunk sewers are shown in Figures 6.1 and 6.2 with suggested treatment sites at the north end. For ease of laying, the pipes themselves are preferably located in existing corridors such as along major highways. Where necessary routes may be altered in detailed design to account for major construction challenges, such as railway line or watercourse crossings. The trunk sewers in summary:

- 'West from Kali Mas' covers an area of 1,700 ha. The trunk sewer runs from the Surabaya Zoo to an area near the Boezom which has land available suitable for a sewage treatment plant (STP). Ultimately it is planned to serve 90,000 connections; see Figure 6.1. The Kali Asin "embryo" system, which is part of the initial 5-year programme, is a subset of this and will initially be connected to a temporary STP (STP Kayun)
- 'East from Kali Mas' covers an area of 1,400 ha. The trunk sewer runs from Jembatan Merah along Jl Putro Agung and Jl Kedung Cowek (at the base of the Suramadu Bridge) to the Suramadu Bridge in Kelurahan Bulak/Kel Kedung Cowek which has land available suitable for a STP[8]. Ultimately it is planned to serve 50,000 connections; see Figure 6.2.

8 The preferred route along Jalan Kenjeran to Dukuh Sutorejo is not possible as the identified STP site for that sewerage system is not available: the land is already owned by housing developers. (Information from Pak Sri Mulyono, Head Public Works Bina Marga & Pematusan, 22.02. 2011).

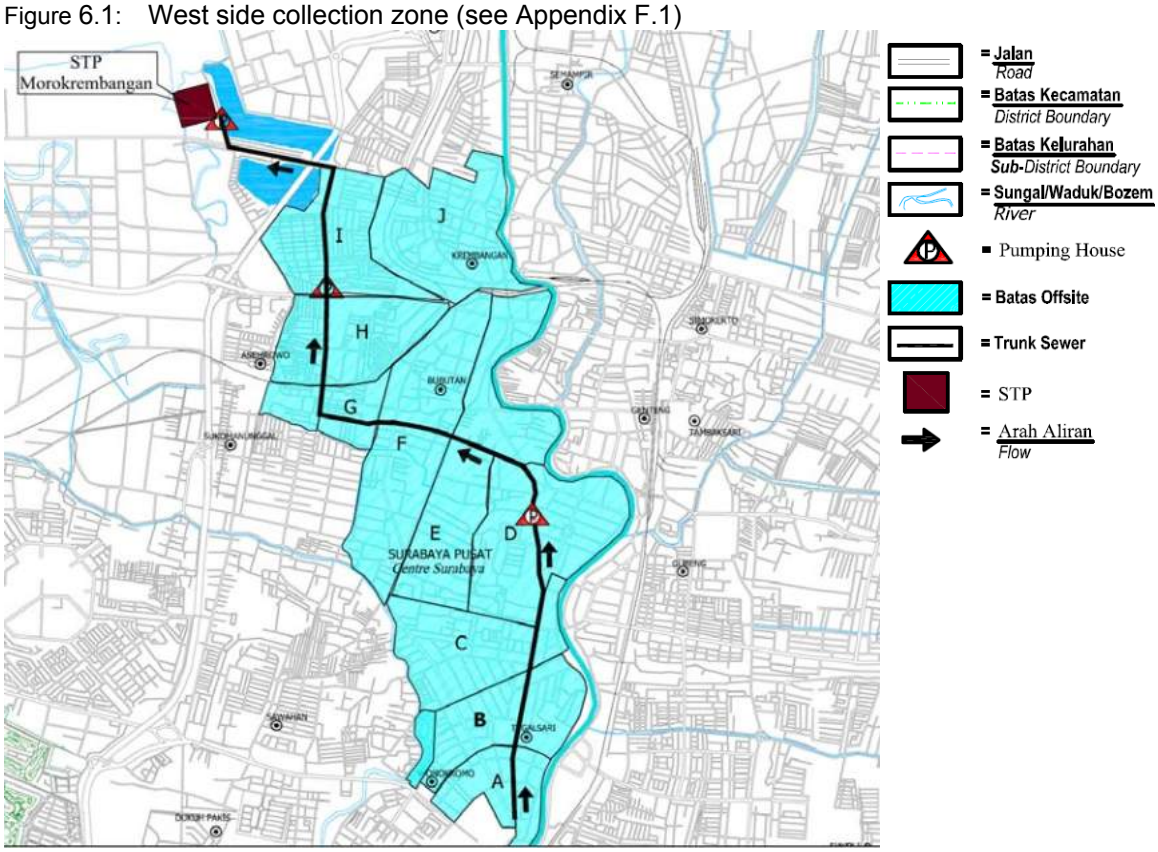
- Both areas are relatively flat: the highest point of the area West of Kali Mas is 5.5m above mean sea level (dpl) at Surabaya Zoo and along the river bank, with the lowest area at 3m dpl. The land at Jembatan Merah is at the same level as the planned STP at Suramadu Bridge, at 3.5m dpl;
- Both areas have relatively high groundwater tables.
- Appendix F.7 shows the coverage area for these systems with regards to Kecamatan.

The sewerage scheme will be developed in phases; it is proposed to follow the 'classical module' approach, as promoted in the 1998 SSDP Surabaya Masterplan. The phasing is explained in Section 6.1.4.

- A trunk sewer along the 'Jalan Protokol', the main streets along a route with the best hydraulic gradient to minimise the requirement for pumping stations;
- Lateral sewer lines which collect wastewater from the adjacent commercial and high density or high income areas;
- Connector sewer lines, which collect water from the 'modules': i.e. neighbourhood small bore sewerage or shallow sewerage systems (see Section 6.4).

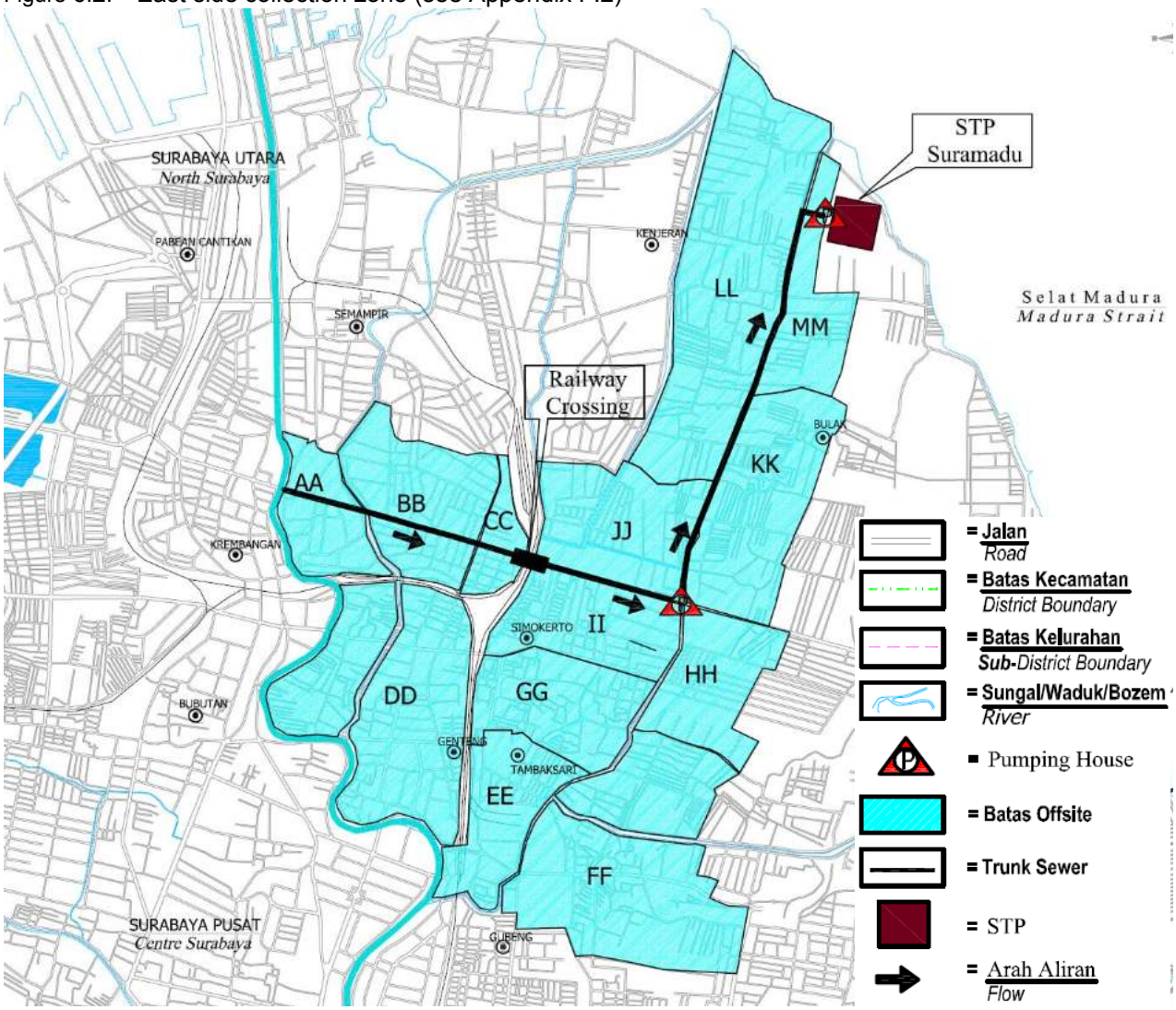
The main reason for following the 'classical' approach is to minimise capital costs, operation costs and maintenance costs and is more cost effective than the previous Surabaya City proposal which has the collector/trunk sewers running along both sides of the rivers[9].

Figure 6.1: West side collection zone (see Appendix F.1)




9 See section 3.1.4 on Surabaya City Sanitation Master Plan Review (Review RISPK/SSDP) 2008

Figure 6.2: East side collection zone (see Appendix F.2)




### 6.3.1.2 Division into wastewater collection zones

Figures 6.1 and 6.2.show the different wastewater collection zones. They have been defined in the context of the trunk sewer positions, and each collection zone will have a network of lateral sewers which convey sewage from the properties within to the trunk sewer. Each collection zone may be initially developed as a stand alone module which may be operated separately without connection to the trunk sewer, by connecting to a decentralised temporary STP. This will help provide catalyst for a lower risk staged development of the trunk sewer by providing a base of connected customers before committing resources to the building of the trunk sewer infrastructure. Once the trunk sewer is constructed, the individual collection zone module can then be disconnected from the temporary STP and allowed to flow by gravity to a manhole on the new trunk sewer line.

#### 6.3.1.3 Design

The design and implementation of starter 'embryo' sewerage systems will allow a long-term investment programme to be devised for the trunk sewers and the citywide off-site sewerage. The design of such embryo systems will be constrained by a number of factors:

- Meeting minimum technical design criteria;
- Major construction challenges – such as crossing large watercourses;
- Minimising costs by designing to limit requirement for new assets which are costly to operate and maintain (i.e. pump stations) ;
- Land availability for new assets (pump stations and STP);
- Attainment of 'Achievement Indicators', as defined in section 5.4, table 5.4;
- Compatibility of initial investment in embryo with overall long-term investment programme.

The above factors were used in comparing the suitability of embryo options for investment. The comparisons of the starter embryo systems options will therefore involve many qualitative comparisons as well as comparing the likely upfront investment costs. Each of these factors for comparison will be converted to a qualitative score using **plus + or minus - marks** which can be tallied to give a meaningful complete measurement. In the next sections the method of scoring for each factor will be outlined.

**Minimum technical design criteria:**

The design for the sewerage system will comply with the minimum design criteria described in this section. All proposed options must meet these criteria as they represent best practice in design which intend to increase operational efficiency by reducing operational costs and increasing the lifespan of assets, as such no score will be given to the options for meeting the design criteria:

- The system will, as much as possible be separated from storm water. However, this will not always be possible as inflow during heavy storms through manholes cannot be avoided and some allocation of the design flow has to be made for illegal/inappropriate connections and cross connections. Hence, some overcapacity is to be defined and emergency storm-water overflows will need to be located at strategic locations;
- The system will include grey water the water originating from washing, laundry and cleaning. A waste return ratio of 80% of water supplied will be used to calculate wastewater contribution. The average water supplied to domestic properties is 182 litre/capita/day (average per capita water use in Surabaya according to PDAM statistics from 2008-2010);
- As we are dealing with high groundwater levels, the design will also incorporate infiltration from ground water. The 1998 SSDP project recommended 100 litre/m'dia/km/day, which gives a figure of 3,600 m3/day for a trunk sewer (20 km long, 1.8 m dia) . The Medan Urban Development project used 10 m3/ha/day, which gives 30,000 m3/day. This is around 15% of the ultimate design capacity. Literature suggests 50-5,000 litres/day/mm diameter. We recommend to use the figure of 10 m3/ha/day in the design: The reason for this recommendation is that, on the one hand we are dealing with silt/clay soil which means it is not necessary to take the maximum value. On the other hand we must take into consideration the fact that the contractors who will be hired to construct the sewers are not necessarily familiar with the construction of sewerage and infiltration rates could be high;

- Flushing requirements. In the beginning not all sewers will work at maximum capacity despite the modular approach. As the sewers are designed for maximum capacity at a relatively shallow slope, sedimentation and blockages are to be expected. The flushing device should be carefully designed and operated so as to prevent 24 hours/ 7 days a week flushing, which would lead to excessive pumping costs and underperformance of the STP.
- Interceptor tanks: for new property connections, the use of interceptor tanks should be discouraged, as it will unnecessarily increase the costs to the householder. For existing properties which have a watertight interceptor (septic tank) it will be useful to have the septic tank as a pre-settling tank. In that case the system can function as a small bore sewer and sewer lines can be laid at shallower gradients;
- When Manning's formula is used for the sewerage design, we suggest use of a Coefficient of roughness pipes (n) of 0.013. This gives a velocity of 0.9 m/s at full bore conditions for a 900 mm diameter pipe;
- Peaking factor: for the trunk sewer a value of 2 is suggested, for the lateral sewers a value of 3-4;
- A minimum velocity of 0.7 m/s at ultimate flow conditions and 0.6 m/s at initial flow conditions is suggested to ensure self-cleansing;
- Maximum velocity: 1.5 m/s to prevent damage to the pipes due to scouring;
- Minimum gradients: in order to attain a 0.7 m/s minimum velocity the theoretical minimum slope for a 200 mm diameter pipe is 0.0052 m'/m' and for a 600mm diameter pipe 0.0012 m'/m'. We suggest to keep a minimum slope of 0.001 m'/m' as the installation of pipes at a lower gradient will be difficult to be constructed by inexperienced contractors;
- Maximum depth to invert: the maximum depth should be 6m, as it will be very difficult to construct deeper trenches in the silt soils;
- Minimum invert depth at manholes should be around 1.5 m as we have to take into account that many sewers will have to pass under storm water drainage channels. See Figure 6.3;
- Grease traps (see Figure 6.4) are a necessary element for domestic connections, as wastewater from the kitchen may contain an appreciable amount of fat and grease, which can cause blockages on small diameter pipes.

Figure 6.3: Explanation of minimum inverts level: 1.5 m

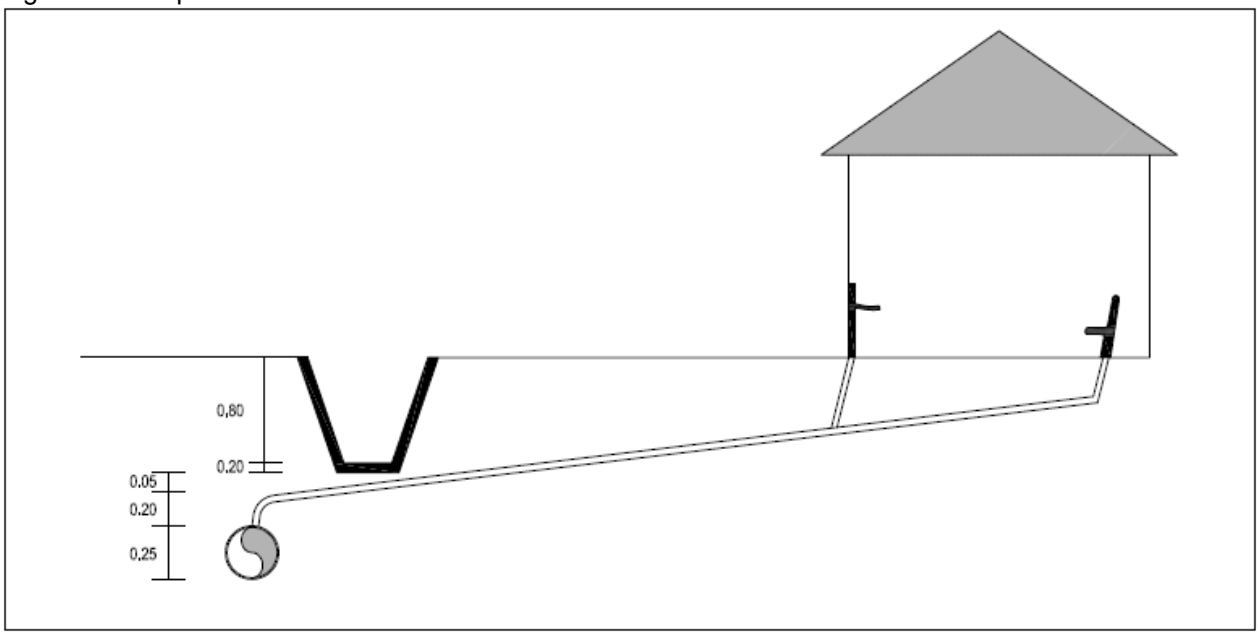
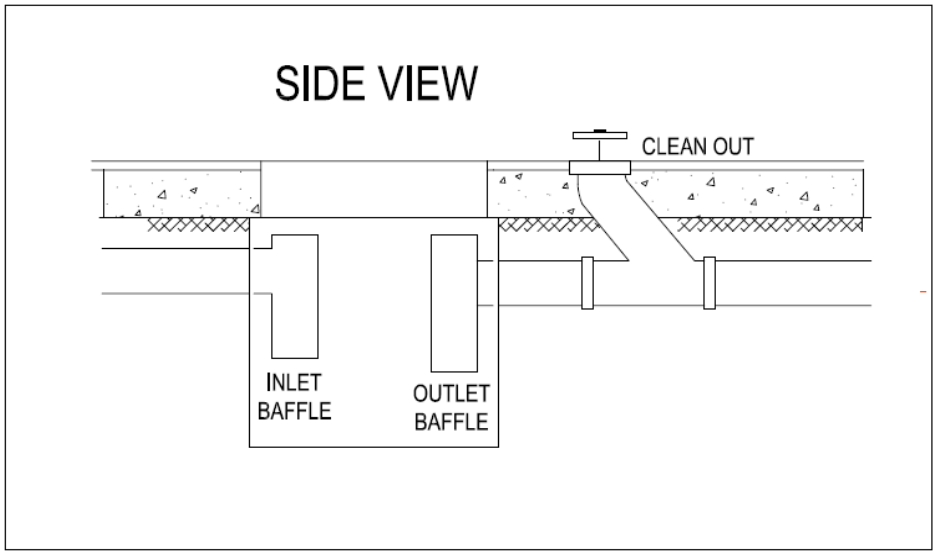



Figure 6.4: Typical cross-section of a grease trap




**Major construction challenges:**

When considering options for designing the routes of the off-site sewer systems qualitative design judgments are taken to avoid complex or costly configurations.

Examples of design decisions taken include limiting crossing under railway lines with the trunk sewer since this can be very costly, requiring trenchless technologies, and also will require third party approvals which can take a long time to obtain. Additionally watercourse crossing is also avoided where possible due to the expense of trenchless techniques and where the watercourse is deep, passing underneath may require a depressed sewer (or siphon) arrangement which can be unreliable and difficult to maintain.

Such design decisions are taken from experience representing best practice in design which intend to make the options realistic, buildable and maintainable.

**Minimising operating costs though intelligent design**

Due to the flat topography of Surabaya it is impossible to run the full length of the trunk sewer under gravity whilst adhering to the minimum design criteria. For example, sewer laid at gradient 1:1000 will have minimum depth to invert of 1.5m at the upstream end, and a maximum depth to invert of 6m at the downstream end, therefore falls 4.5 m over a distance 4500 m, which is insufficient to cover the full length of the west or east trunk sewers.

Use of lift pumping is necessary to gain sufficient falls to transport sewage the full length of the trunk sewers. Pumping stations may also be used to rapidly convey collected sewage from one point to another where no further connections are required such as over the top of an obstacle or for passing forward to a STP site. This allows for a reduction in capital costs on pipe laying (which are shallower, smaller diameter) against gravity sewers but will increase operational expenditure.

Therefore to minimise operation and maintenance costs, pumping requirement should be minimised as much as possible by design.

**Land availability for new assets (pump stations and STP):**

In terms of site selection, an agreement to acquire land for use by new wastewater asserts will be the most valuable part of the programme. Where all required sites have been identified and purchase has been agreed, a ++ mark may be awarded. For each site required and identified but purchase not yet agreed the following marks may be awarded:

1. Government/agency-owned undeveloped land: award a further neutral 0 score
2. Government/agency developed land: award a negative score –
3. Privately-owned undeveloped land: award a double negative score --
4. Privately-owned developed land: award a triple negative score ---

**Attainment of 'Achievement Indicators':**

Ensure that the correct number of people being served by embryo and there is sufficient growth potential to meet the defined indicators from section 5.4 e.g. presence of commercial areas with ability to pay.

**Compatibility of initial investment in embryo with overall long-term investment programme:**

The embryo system should minimise 'regret' and 'redundant' investments i.e.:

- 'regret' investment where infrastructure is built and then is incompatible with future development plans
- 'redundant' investment where infrastructure is built at first stage with huge scale provision for future connections, and then second stage of investment falters or focus is altered and oversized infrastructure is not fully utilised.

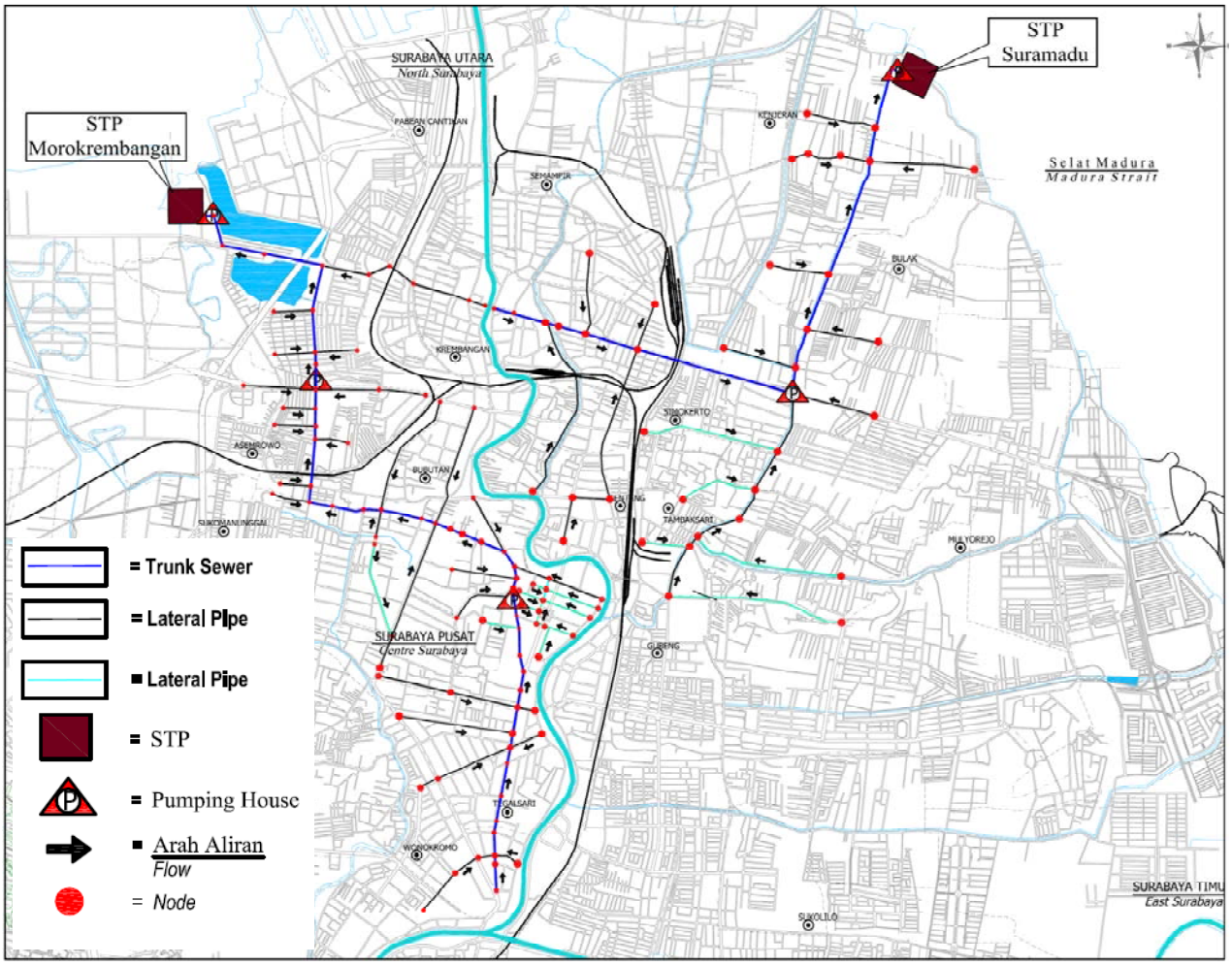
In the Draft Master Plan and Feasibility Study, we studied two locations as potential off-site "embryo" wastewater collection zones with temporary STPs, these are referred to as Kali Asin and Jembatan Merah. The Jembatan Merah zone has a relatively high number of commercial enterprises, however it has been

impossible to find a suitable location for a temporary STP. Therefore, the focus is on the Kali Asin zone where we have been able to locate a suitable site for the planned temporary STP.

**Ultimate design of sewerage system**

Using the design parameters above, the ultimate design of the trunk sewers and lateral sewers of the sewerage stems is shown in figure 6.5.

Figure 6.5: Ultimate sewerage system 2030 (see Appendix F.3)




### 6.3.1.4 Selection of suitable "Embryo" system

In section 4.3.1 priority zones were identified for the sighting of a starter embryo off-site system. This was based on stated ability and willingness to connect to a sewerage system during Focus Group Discussions held in November 2010, and subsequent interviews with Surabaya Chamber of Trade and Commerce (KADIN) on 14 February 2011. Four areas have been proposed to be considered for embryo development, and are summarised as follows:

1. Jembatan Merah: An area east of the Jembatan Merah a highest density mixed-use area comprising commercial and residential properties;

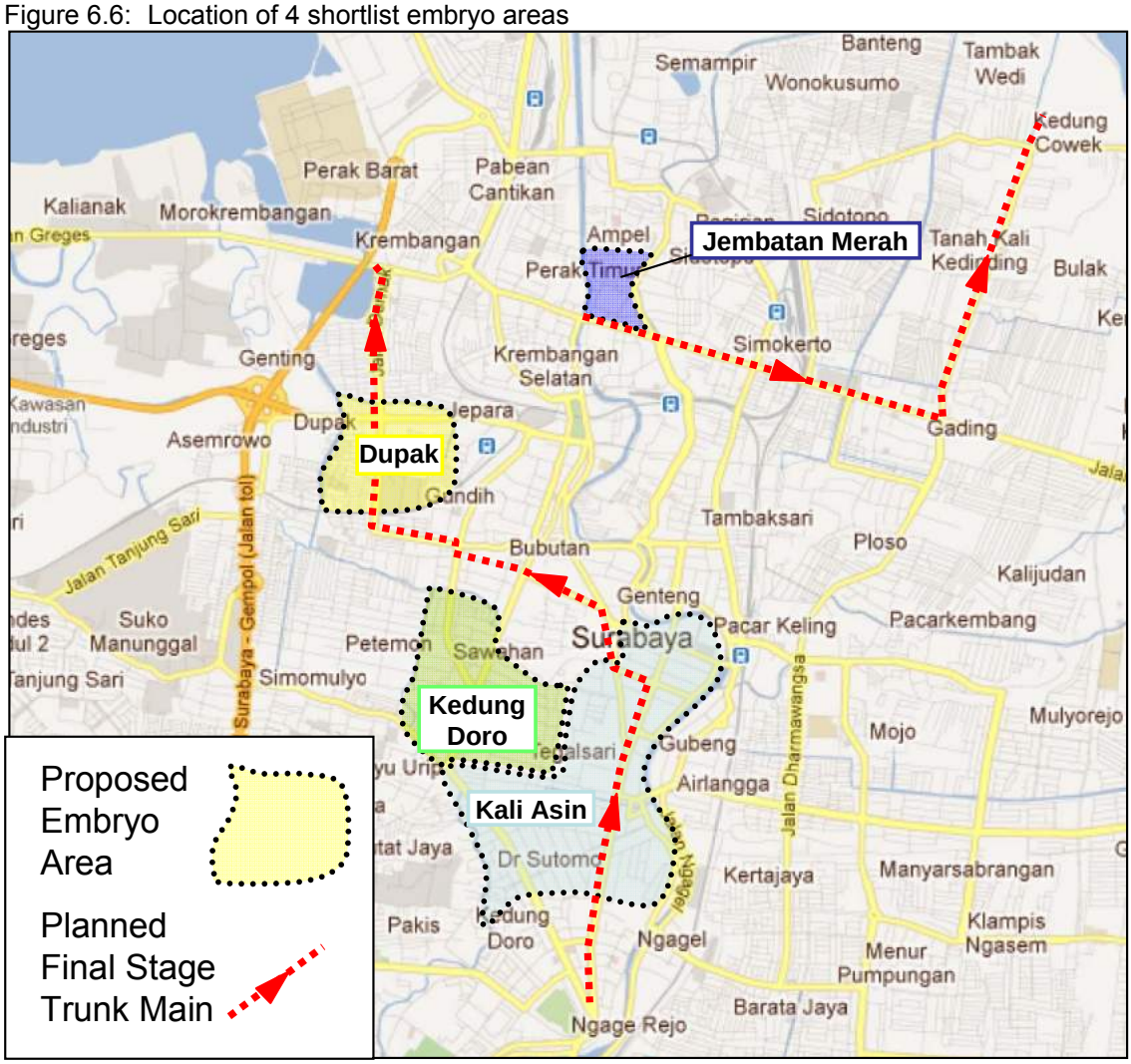
2. Dupak: a high density housing area with surrounding by commercial activities, located just to the south of the Buzem Kalianak;

3. Kali Asin: the area to the west of Jalan Kayun, containing official buildings and dense residential areas.

4. Kedung Doro. a CBD area of Surabaya city, adjacent to the Kali Asin embryo;

These locations are shown below in Figure 6.6 along with their interaction with final main trunk sewers.

Figure 6.6: Location of 4 shortlist embryo areas




A comparative assessment was carried out between each of the locations. The results of this assessment are contained in Table 6.1 below.

Table 6.1: Comparative assessment of possible Embryo locations

| Criterion \ Option | Option 1 - Embryo Jambatan Merah | Option 2 - Embryo Kaliasin | Option 3 - Embryo Kedung Doro | Option 4 - Embryo Dupak |
|---|---|---|---|---|
| **Suitability of area for off-site sewerage (according to wastewater programme plans figure 5.3, 5.4, 5.5)** | Area immediately east of Jembatan Merah is part of 2015 off-site sewerage programme, and area extends further eastwards into 2020 and 2030 programme | Embryo area is large part of 2015 off-site sewer programme and proposed sewered areas expand further north, west and south in 2020 and 2030 programme | Embryo area is large part of 2015 off-site sewer programme and proposed sewered areas expand further north, east, west and south in 2020 and 2030 programme | Area is proposed for only on-site collection for 2015 horizon. By 2020 area is wholly intermediate, and by 2030 is wholly within a proposed off-site sewer zone. |
| **Score** | **+** | **++** | **++** | **-** |
| **Population served by embryo** | 2,000 possible connections (2015 target 9200 connections rising to 46800 connections by 2020) | 90,000 possible connections in the surrounding area (2015 target 9200 connections rising to 46800 connections by 2020) | 90,000 possible connections in the surrounding area, (2015 target 9200 connections rising to 46800 connections by 2020) | Although high density with as many as 24,000 properties it is assessed as few as 2,000 possible connections making target coverage difficult |
| **Score** | **--** | **++** | **++** | **--** |
| **Proportion of commercial properties in embryo** | High proportion of commercial properties in the area, ~50% | High proportion of commercial, business and government properties in the area ~50% | Central business district >50% commercial properties | Mainly housing with commercial properties on the surrounding areas |
| **Score** | **++** | **++** | **++** | **0** |
| **Likely overall commercial viability** | Good commercial proportion and suitability for on-site sewerage is predicated to increase over time, final user numbers may not be sufficient | High numbers of potential customer with high likelihood and ability to pay. Area is part of the immediate city off-site sewer strategy with significant prospect for expansion up to the 2030 wastewater programme | High numbers of potential customer with high likelihood and ability to pay, though Kali Greges at the south of the area forms a natural barrier to collecting flows from the south into this region. | Area is likely to be more suited to on-site collection in the immediate term, and limited numbers of commercial customers may stall evolution of wastewater collection to off-site. |
| **Score** | **-** | **++** | **0** | **-** |
| **Availability of suitable land parcels for embryo treatment site** | Limited land plots available in embryo area for implementation of sewage treatment, all of which are privately owned, some with derelict buildings on site, and are more than 300m from a watercourse for discharge of treated effluent | Land plots available within embryo area adjacent to the Kali Mas of suitable size for treatment plants. Currently informally occupied by flower sellers | High density developed area, no evident free plots available. Land would have to be requisitioned for the purpose of the STP | Area is densely developed with housing though a free land plot is available 300m from a watercourse. Also green space to the north at Makam Morokrembangan would be a perfect position if STP development was permitted, although it is not confirmed |
| **Score** | **-** | **+** | **--** | **0** |
| **Ability for embryo to integrate with planned trunk mains as part of long term wastewater programme.** | Embryo area covers collections on both sides of the trunk sewer. However since there is no | Embryo area is such so that the trunk sewer runs straight through the middle. However the | Embryo area is to the south side of the trunk sewer only, so contributions from the north side | Embryo area is more to the west side of the trunk sewer only, so contributions from the |

| Criterion \ Option | Option 1 - Embryo Jambatan Merah | Option 2 - Embryo Kaliasin | Option 3 - Embryo Kedung Doro | Option 4 - Embryo Dupak |
|---|---|---|---|---|
| | treatment site available at the downstream end of this section of trunk sewer, there would need to be further pumping station assets constructed to convey the collected waste from the trunk sewer to the temporary treatment site. This would be a 'regret' investment when considered with the future stages of trunk sewer in the wastewater programme | position of the temporary STP site is 350m away from the trunk sewer itself, so there will be infrastructure required for the embryo that will become redundant when sewage collection to be passed forward through the trunk sewer to a permanent STP site | will have to be added in future. Since no evident STP site is available it is difficult to assess how much regret investment would be part of this scheme option. | east will have to be added in future. Though if a temporary STP could be implemented at Makam Morokrembangan there would be very little regret investment in infrastructure for this embryo. |
| **Score** | **--** | **0** | **-** | **0** |
| **Investment risks associated with embryo solution.** | Being at the upstream end of the trunk sewer means that the sewer would only be sized for what was to be collected from the embryo area itself, so in the event that no further development of the trunk sewer was undertaken (or the programme was changed) there would be no unnecessary investment through oversizing. | This embryo is towards the upstream end of the trunk sewer but not at the uppermost end. The trunk sewer pipes would need to be slightly oversized for future contributions from the south. | This embryo further downstream than option2, so the trunk sewer pipes would need to be slightly further oversized than those in option 2 for future contributions. | The embryo is at the very downstream end of the trunk sewer, so the trunk sewer pipework should be at it's largest size at this point for future provision. Therefore if the trunk sewer programme was stopped or altered, significantly oversized pipes would be in place here. |
| **Score** | **++** | **+** | **0** | **--** |
| **Preference of City Government** | One and the only available space is a very narrow river bank along Pegirikan river, but the City has optioned to use this space to construct a box culvert for improvement of drainage system in Jembatan Merah area. It has been suggested that this area may instead be used for an intermediate system | City government have learnt from past experience that a 'market oriented' policy to start the new era of sewerage system is very attractive to commence the sewerage system in the City. The Kaliasin area is the heart of Surabaya CBD and has high potential to earn return on investment faster. | Close to Kaliasin so government interest is similar here for this area. | Less government preference for Dupak than Kaliasin and Kedung Doro. As Dupak population lacks economic potential for revenue generation by provision of wastewater services. |
| **Score** | **+** | **++** | **++** | **--** |
| **Total Score** | **0** | **+12** | **+5** | **-8** |

The Kaliasin embryo site is clearly shown by the comparative assessment to be the most suitable.

### 6.3.2 Off-site centralised sewage treatment plants

#### 6.3.2.1 Introduction

As indicated above, the following centralised STPs are required:

- The temporary STP Kayun for the Kali Asin 'embryo' area serving 9,200 connections up until 2020;
- 'STP Morokrembangan', serving initially (2020) 40,000 connections and ultimately (2030) 90,000 connections;
- 'STP Suramadu', serving initially (2020) 16,000 connections and ultimately (2030) 50,000 connections.

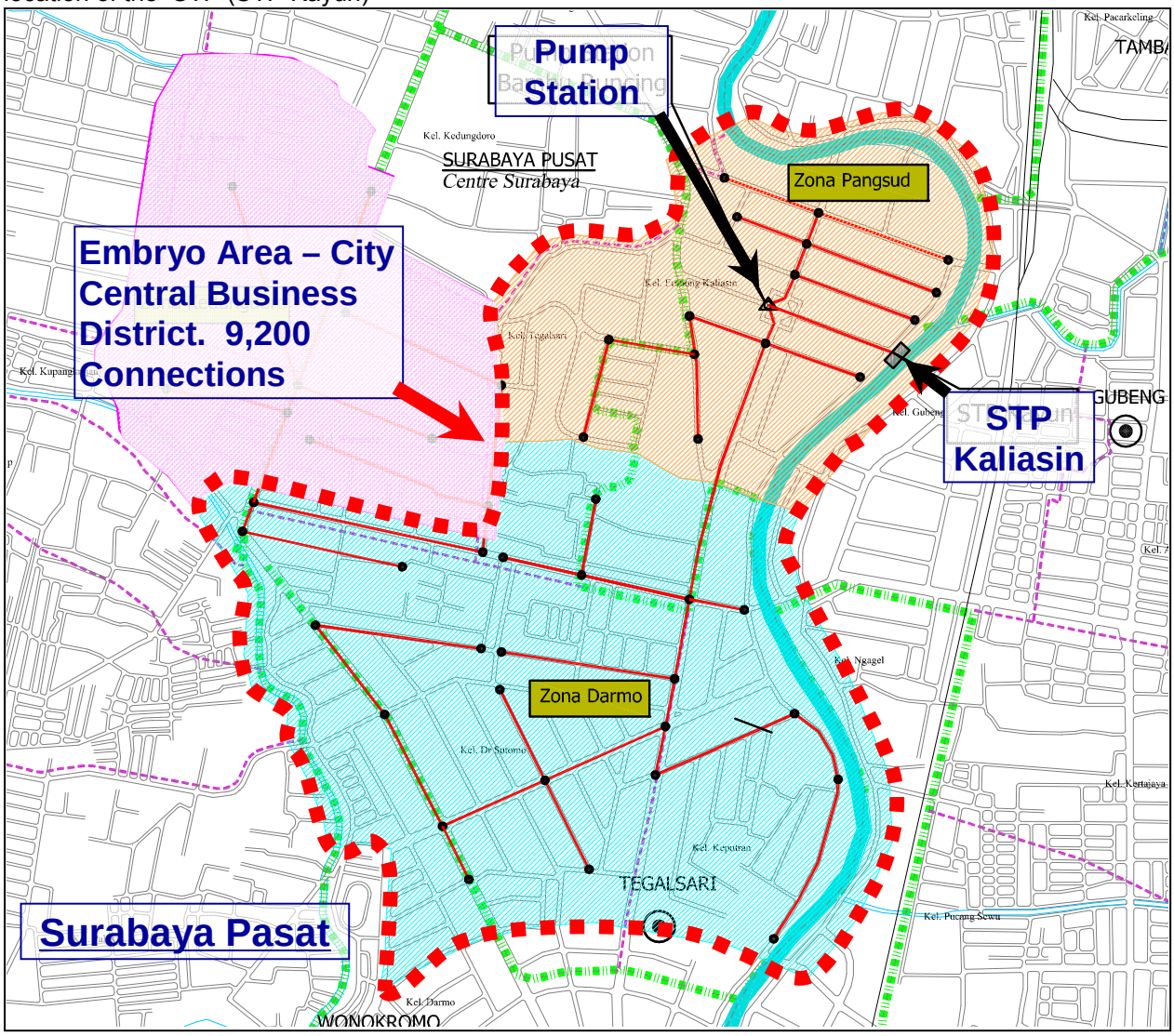
#### 6.3.2.2 Embryo Kali Asin STP (STP Kayun)

For the embryo Kali Asin STP (STP Kayun), a strip of land between Jalan Kayun and the river Kali Mas, which is owned by the East Java Province (Dinas Penairan / Water Resources Department), needs to be made available. This land previously served as a site for a package water treatment plant of the PDAM and is now temporary occupied by florists. The site measures around 25m wide and 100m long. The wastewater will be pumped to the site from the pumping station at the Bambu Rucing Monument, which forms a part of the future 1.8m diameter Central area trunk sewerage system, through a pressure sewer.

Once the trunk sewer is installed the pressure sewer can then be converted back to function as a gravity sewer. If for one reason or another, the land cannot be made available, an unoccupied strip of land (20m wide and 50m long) 600m south of the proposed site can be considered. This site also belongs to the East Java Province.

A plan of the embryo site is shown in Figure 6.7 below.

Figure 6.7: Layout of the Kali Asin embryo sewerage system indicating the pumping station and the location of the STP (STP Kayun)




### 6.3.2.3 STP Morokrembangan

For the STP Morokrembangan two options can be considered. One option is an area of 6 ha along the corner of Jl. Kali Anak and Jl. Pintu Air, formally occupied by warehousing. The other option is an area of 12 ha vacant land owned by the Navy at the end of Jl. Pintu Air, an aerial view of these locations is shown in Figure 6.8 below.

Figure 6.8: Possible locations for STP Morokrembangan


Source: Google Earth Professional

#### 6.3.2.4 Suramadu Bridge STP

The Suramadu Bridge STP is located at the foot of the Suramadu Bridge in Kecamatan Kenjeran, an areal view of which is shown in Figure 6.9.

Figure 6.9: Location of Suramadu Bridge STP

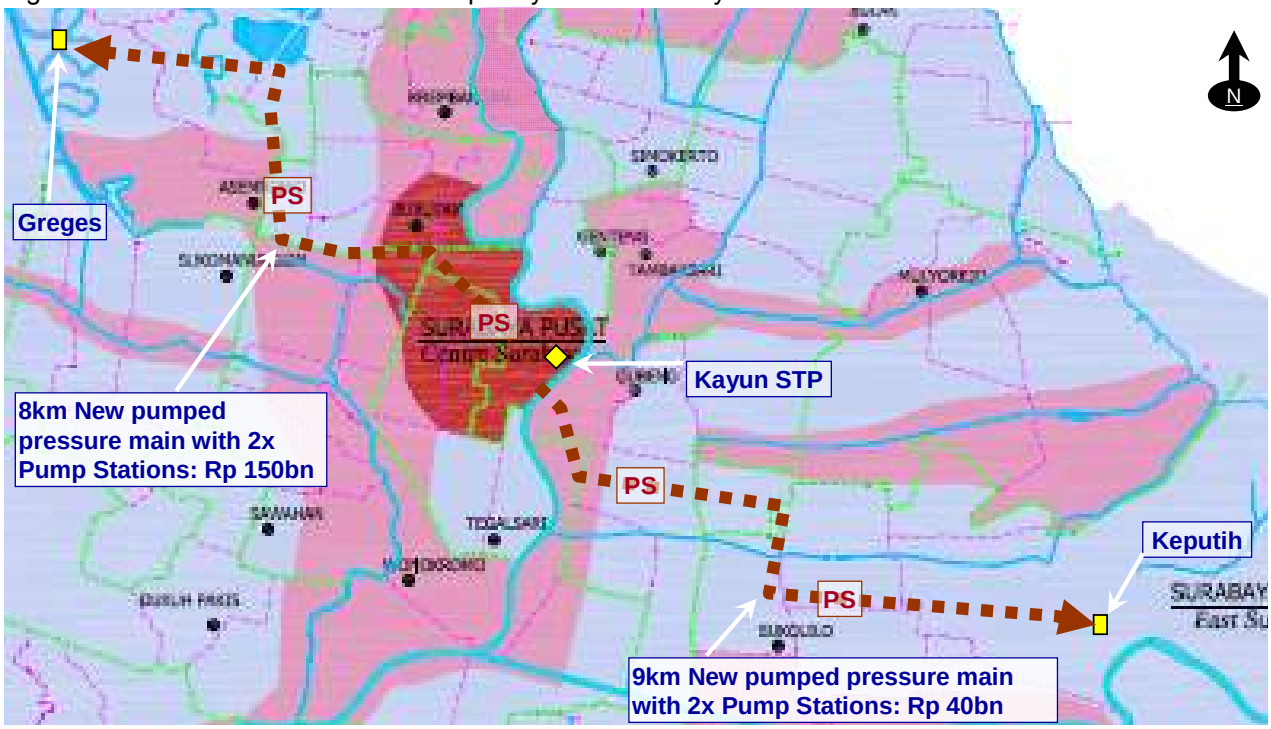

Source: Google Earth Professional

### 6.3.2.5 Alternative STP locations

**Temporary STP for Embryo Kali Asin**

During consultation with the City, concern was expressed over the Kayun location since the land is not owned by the City, two alternative City-owned sites were proposed for consideration; Greges and Keputih. These sites are located some distance from the Embryo location and would require the addition of considerable pumped pressure main, as shown below in Figure 6.10.

Figure 6.10: Alternative locations of temporary STP for Embryo




Futher examination of the alternative sites was carried out and a summary of results, using Kayun as a 0 score base case, are contained in Table 6.2 below.

Table 6.2: Comparison of alternative locations for STP for Kali Asin Embryo system

| Criterion / Alternative | Kayun | Greges | Keputih |
|---|---|---|---|
| In line with planning methodology. | 100% Follows from the planning methodology. | Follows planning methodology. Would require different phasing. | Completely contrary to planning. Connector pipe will run through an area that normally would not be sewered. |
| **Score** | **0** | **-** | **--** |
| Additional investment costs. | Nil. Estimated budget now Rp 103,000 m. (US$ 11 m.) | Extra costs around 150%: Rp 150,000 m (US $ 17 m.). No regret investment. | Extra costs around 50%: Rp 40,000 m. (US $ 4 m.). Regret investment. |
| **Score** | **0** | **--** | **--** |
| STP land ownership. | Dinas Pengairan of Province of East Java. Site was in use by PDAM for | City of Surabaya | City of Surabaya (50 ha) |

| Criterion / Alternative | Kayun | Greges | Keputih |
|---|---|---|---|
| | package treatment plant. | | |
| **Score** | **0** | **+** | **++** |
| Land occupancy. | Illegal occupied by florists and scavengers. An unoccupied site is available 600m south of the preferred site. | Partly fish ponds partly warehouses | Former Solid Waste Dump. Solid waste needs to be removed. |
| **Score** | **0** | **0** | **-** |
| **Total Score** | **0** | **-2** | **-3** |

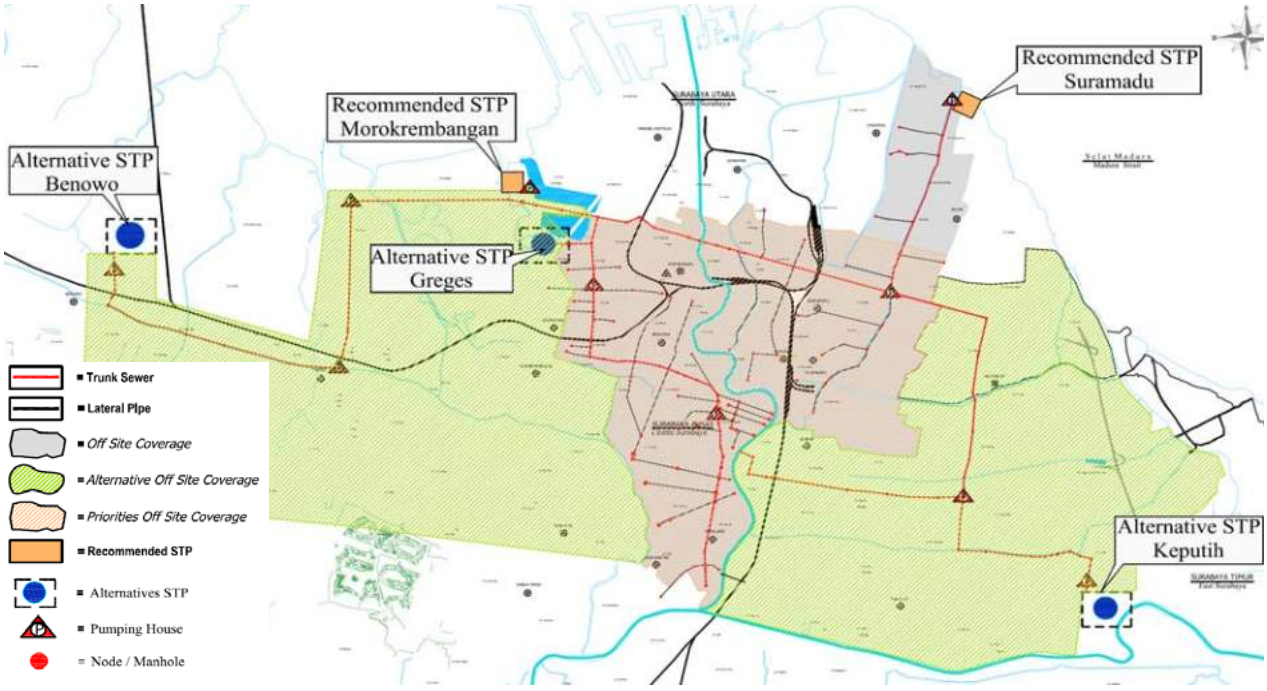
Source: Mott MacDonald analysis

The exercise clearly shows Kayun to be the preferred STP location.

### Final case STP

Alternatives sites for the final case STP were also considered. These are shown in Figure 6.11 below.

Figure 6.11:Alternative locations Final Centralised STPs (full scale drawing in Appendix F.9)




### West side STP

If the land at Morokrembangan can not be acquired, two alternative locations for the STP have been identified by the Pokja: one in Greges and one in Benowo. A comparison of the alternatives is presented in Table 6.3. From the comparison, it can be concluded that the Greges site is more favourable than the Morokrembangan site because the land is owned by the City Government. The alternative site at Benowo is prohibitively more expensive and should be abandoned.

Table 6.3: Comparison of alternative locations for West Side STP

| Criterion / Alternative | Morokrembangan | Benowo | Greges |
|---|---|---|---|
| In line with planning methodology. | 100% Follows from the planning methodology. | 100% Follows from the planning methodology. | 100% Follows from the planning methodology. |
| **Score** | **0** | **0** | **0** |
| Additional investment costs. | Nil. | Extra costs: 8 km trunk sewer (to be checked) | Nil. |
| **Score** | **0** | **- -** | **0** |
| STP land ownership. | Navy | City of Surabaya. | City of Surabaya. |
| **Score** | **0** | **+ +** | **+ +** |
| Land occupancy. | Vacant | Vacant | Partly fish ponds, partly warehouses |
| **Score** | **0** | **0** | **0** |
| **Total score** | **0** | **0** | **+2** |

**East side STP**

If the land at Suramadu Bridge can not be acquired an alternative location has been identified by Pokja at Keputih. A comparison of the alternatives is presented in Table 6.4. From this table it can be concluded that the site at Keputih is acceptable but less appropriate because the trunk sewer runs through medium-density domestic areas and would involve the removal of the (now decomposed) solid waste previously dumped at the site.

Table 6.4: Comparison of alternative locations for East Side STP

| Criterion / Alternative | Suramadu | Keputih |
|---|---|---|
| In line with planning methodology. | 100% Follows from the planning methodology. | 50% Does not follow from the planning methodology / through low density areas |
| **Score** | **0** | **-** |
| Additional investment costs. | Nil. | Solid waste needs to be moved |
| **Score** | **0** | **-** |
| STP land ownership. | Province | City of Surabaya. |
| **Score** | **0** | **+** |
| Land occupancy. | Vacant | Vacant |
| **Score** | **0** | **0** |
| **Total score** | **0** | **-1** |

### 6.3.2.6 Selection of technology

**Selection of technology for the 'temporary' STP Kayun**

The surface area of sites for the temporary STP is very limited. Hence, the technology applied should either be anaerobic or high rate aerobic. Anaerobic digestion requires relatively little volume compared with a high rate aerobic system. The aerobic systems, like activated sludge treatment also requires a high level of skill of the operators. Only the private sector in Surabaya has experience with this kind of operation and maintenance, e.g. the technical staff of Plaza Tunjungan. For the time being, we assume that it will not be possible to arrange the O&M by the private sector and we assume that a government agency will be

responsible for O&M. Surabaya has experience with the operation of an oxidation ditch at the IPLT, but the effluent samples show a very high variation of the effluent quality, indicating O&M problems, problems are also clearly visible at the site. Hence, we propose to select an anaerobic system with relatively few moving parts and minimum electricity requirements. The anaerobic systems, which would be suitable is the Upflow Anaerobic Sludge Blanket Reactor (UASB). The widely applied Anaerobic Baffle Reactors (ABR) are only suitable for relatively small systems and would require too much space. An Imhoff Tank would produce an effluent that would not be acceptable as it would be above 100 mgBOD/l.

Based on the concerns being expressed about the UASB process due to the experiences in Medan, it is recommended that the use of the Rotating Biological Contactor (RBC) is studied in more detail during the implementation phase of the wastewater programme. The structure of both the UASB and RBC for the STP can be in glass-fibre reinforced plastic (GRP), hence after 10 years of operation the installation can easily be reused at other sites. The UASB has the advantage of being a 'modern' technology with few moving parts. The RBC has the advantage of being a proven technology with good effluent quality. If UASB technology is proven to be suitable for Indonesia and the Medan problems are proven to be temporary, then UASB is the recommended system as it is more cost-effective than the RBC.

The treatment efficiency achievable by a UASB is 55 to 80% BOD removal and effluent from the UASB would normally require further treatment prior to discharge to the river. However land is not available for secondary treatment and as the Kali Mas is still rather polluted, the effluent from the UASB reactor (50mg BOD/l) can be considered to be insignificant and can be accepted in the short term.

This information is summarised in Table 6.5 below.

Table 6.5: Comparison of Temporary STP Kayun Technology Options

| Criterion | UASB | Rotating Biological Contactor |
|---|---|---|
| Land | < 2500m2 → 'go' | < 2500m2 → 'go' |
| Effluent Quality | Good: 48 mgBOD/l → 'go' | Very good: 36 mgBOD/l → 'go' |
| Investment | Rp. 10.5 bn. | Rp. 16.7 bn. |
| O&M Costs | 2% (Rp 200 m/y) | 1% (Rp 200 m./year) |
| Odour Emissions | Likely | Possible |
| Operation Complexity | Simple | Very simple |
| Experiences in Indonesia for domestic wastewater | Not very positive. E.g in Medan. In South America and India there are many well functioning installations. | Long experience, very good e.g. Banjarmasin |

Source: Adapted from Final Feasibility Report

Further details of these treatment technologies can be found in Appendix F.10.

**Selection of technology for the ' Morokrembangan' STP and 'Suramadu Bridge' STP**

Given that there are limited operation and maintenance skills available in the region, the Facultative Aerated Pond (FAP) system has been selected. The application of this system has the best track record in Indonesia (see Comparative Study on Centralised Wastewater Treatment Plants in Indonesia). The FAP is a waste stabilisation pond, using mechanical aerators to get higher oxygen transfer into the wastewater. With higher oxygen transfer the ponds can be designed with smaller hydraulic retention time and therefore have smaller volumes and so need smaller areas of land for the STP. However electrical energy is necessary, which increases the operational cost. This technology is widely used in Indonesia. Yogyakarta

has a very good system based on this technology, see Figure 6.12. Other locations using the FAP are, Tangerang which has three smaller aerated pond systems and Cirebon, Parapat, Solo (Mojosongo), Jakarta, and Medan Industrial Park KIMA. The term facultative indicates that we have aerobic conditions on top of the pond and anaerobic conditions at the bottom.

Figure 6.12: Facultative Aerated Pond – Yogyakarta

#### 6.3.2.7 Design criteria and technological aspects

**Calculation of the composition of the wastewater**

The composition and strength of the wastewater varies between one area and another in Surabaya and depends mainly on the prosperity: the more prosperous, the richer the diet and the more water used, the stronger the wastewater. There are not reliable wastewater samples present. Hence a forecast has been made which is presented in Table 6.5

Table 6.5: Forecast composition of wastewater in Surabaya

| Description | Source | Unit | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|---|
| Domestic piped water usage | PDAM Surabaya | lcd | 182 | 182 | 182 | 182 |
| Ratio drinking water/wastewater ( return ratio) | Mott MacDonald Indonesian experience | % | 80% | 80% | 80% | 80% |
| Daily wastewater production | Calculation | lcd | 146 | 146 | 146 | 146 |
| Ratio volume black/grey water | Mott MacDonald Estimate | % | 25% | 25% | 25% | 25% |
| Strength black water | Mott MacDonald Estimate | mg BOD/l | 450 | 450 | 450 | 450 |
| Strength grey water | Mott MacDonald Estimate | mg BOD/l | 170 | 170 | 170 | 170 |
| BOD contribution black water | Calculation | gBOD/cap /day | 16 | 16 | 16 | 16 |
| BOD contribution grey water | Calculation | gBOD/cap /day | 19 | 19 | 19 | 19 |
| Ratio black/grey BOD | Calculation | % | 88% | 88% | 88% | 88% |
| Domestic waste production per capita (pe) | Calculation | gBOD/cap /day | 35 | 35 | 35 | 35 |

| Description | Source | Unit | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|---|
| Daily BOD load domestic wastewater | Population forecast | kg BOD/day | 104,483 | 113,568 | 122,304 | 140,125 |
| Daily BOD load wastewater commercial enterprises | Number enterprises: PDAM | kg BOD/day | 17,197 | 18,575 | 19,736 | 22,638 |
| Daily BOD load domestic wastewater and ww commercial enterprises | Calculation | kg BOD/day | 121,680 | 132,143 | 142,040 | 162,763 |
| Strength domestic wastewater | Calculation | mg BOD/l | 240 | 240 | 240 | 240 |
| Strength wastewater commercial enterprises | Calculation | mg BOD/l | 400 | 400 | 400 | 400 |

Source: PDAM Surabaya, investigations PemKot Surabaya and assessment Mott MacDonald

### Design of the possible treatment systems for STP Kayun

The treatment system is designed for the 2020 situation as it is to be expected that by that time the trunk mains to the centralised STP will be commissioned and the STP Kayun can be taken out of service. The calculation of the treatment capacity and composition of the wastewater is presented in Table 6.7. The main characteristics are:

- Daily capacity 3,800 and 16,800 $m^3$/day;
- BOD influent 240 mg/l;
- BOD load 900 and 4,000 kg BOD/day.

Table 6.6: Calculation of the capacity of Kayun STP and strength of the influent

| EMBRYO KALIASIN | | Pangsud 2020 | Pangsud &Darmo 2020 |
|---|---|---|---|
| Sewerage connections = number houses | nrs | 3 900 | 10 000 |
| Population | capita | 50 000 | 99 000 |
| Persons per sewerage connection | cap/conn | 13 | 10 |
| Wastewater generation | | | |
| Wastewater return ratio | % | 80% | 80% |
| Wastewater contribution | m3/d | 2 968 | 13 048 |
| Infiltration, flushing, stormwater | % | 29% | 29% |
| Wastewater generation | m3/d | 3 800 | 16 800 |
| Wastewater per person | lcd | 76 | 170 |
| Peak factor sewage treatment | | 4 | 3 |
| Maximum flow treatment | m3/h | 600 | 2 100 |
| BOD black water | mgBOD/l | 450 | 450 |
| Black water per person | lcd | 19 | 42 |
| BOD black water contribution per capita | gBOD/cap | 9 | 19 |
| BOD Grey water | mgBOD/l | 170 | 170 |
| Volume grey water per capita | litres | 57 | 127 |
| Total BOD | gBOD/capita | 18 | 41 |
| BOD wastewater | mgBOD/l | 240 | 240 |
| BOD load | kgBOD/d | 900 | 4 000 |

The design of the UASB and RBC is presented in Appendix F.10. The UASB initially needs two reactors 20m' * 6 m' and finally 6 units. The RBC initially needs 4 units 3.7m' diameter, 7.6 m' long and finally 17 units.

**Design for the FAPs**

The design criteria and the design for the FAP systems for the years 2020 and 2030 are presented in Appendix F.11.

#### 6.3.2.8 Land requirements

The land requirements for the UASB or RBC is 2500 $m^2$. The land requirements for the FAP for the years 2020 and 2030 is presented in Table 6.7. It is essential that this land is reserved in the development plans for the City and secured as soon as possible.

Table 6.7: Land requirements for the FAP system

| Treatment Options | Surabaya STP 1: West | | Surabaya STP 2: East | |
|---|---|---|---|---|
| | 2020 | 2030 | 2020 | 2030 |
| Gross Land Requirement (ha) | 11 | 11 | 4 | 6 |

### 6.3.3 Phasing 2015/20/30

The following phasing is foreseen:

- Start up phase (2010-2015):
  - Development of one self-funding embryo ('starter') system in a mixed housing and commercial area: embryo 'Kali Asin' (9,200 connections) using a conventional sewerage system. The collected wastewater is treated in a decentralised location along the River Kalimas at STP Kayun;
  - Development of at least three 'Modules' i.e. "intermediate systems" located in areas with a high priority as identified in Chapter 4.3;
- Extension and 'skeleton' phase (2015-2020):
  - The experience of the embryo will be used to extend the sewerage "skeleton" to give a total of 40,000 connections in the Western collection system and around 16,000 connections in the Eastern collection system;
  - The success of the embryo will be used to secure funds to help fund and provide a model for the construction of the 2 STPs and trunk sewers from the Kali Asin "embryo" to the STP Morokrembangan and the STP Suramadu Bridge. The STP Kayun can now be dismantled;
- Maturing phase: (2020-2030):
  - Extension to 90,000 connections in the West collection system and 50,000 connections in the East collection system;
  - Extension of the trunk sewer in the West collection system from Kali Asin area to the Surabaya Zoo;
  - Connection of all modular 'intermediate' systems to the centralised sewerage systems, which have been developed in the collection areas.

### 6.3.4 Investment cost estimate

We present a summary of the investment costs for the centralised sewerage systems and STP in Table 6.8. The investment costs are based on recent cost estimates in Makassar, Medan, Yogyakarta and the feasibility study. The average cost per house connection in for the embryo is estimated at Rp 11.2 m. This includes the costs for the sewage treatment. The average cost per house connection for the phase 2 (2015-2020) and phase 3 (2020-2030) is estimated at Rp 20 m: Rp 10/connection for the connection, the lateral and the connector sewers; Rp 5/connection for the trunk sewer and Rp 5/connection for the sewage treatment. These costs are higher because of the trunk sewers, which are absent in the embryo phase and the more advanced sewage treatment. Hence total investment costs for 140,000 connections are Rp 2,720,000 m. (US $ 302 m.).

Table 6.8: Investment costs (Rp mln) for off-site systems

| COST ESTIMATE (m) (engineer's base costs) | 2010-2015 | 2020-2020 | 2020-2030 | Total |
|---|---|---|---|---|
| Number new connections | 9,200 | 46,800 | 84,000 | 140,000 |
| Total investment cost (million IDR) | Rp104 000m | Rp936 000m | Rp1 680 000m | Rp2 720 000m |
| Total investment cost (million US$) | $12m | $104m | $187m | $302m |

### 6.3.5 Operation and maintenance (O&M) costs

Based on a recent USAID-funded study[10], the operation and maintenance costs are estimated at Rp 30,000/connection/month. This is around 2% of the investment costs. Hence, the ultimate O&M costs are Rp 54,000 m./year.

### 6.3.6 Sustaining programme for off-site systems

As explained in Section 5 there are certain risks involved in applying off-site solutions. In Table 6.9 we indicate the major risks and remedial actions to minimise the risks. The actions have both a motivational nature (both intrinsic and extrinsic) and a capacitating nature (physical, mental, financial and social/cultural).

Table 6.9: Sustaining off-site systems

| Risk | Motivational and capacitating activities |
|---|---|
| Not all households and enterprises want to connect to the off-site system<br>1. Underperformance of the system<br>2. Lack of O&M funds | • Campaigning (mass media, individual approach) to explain the benefits of sewerage;<br>• Legislation that 100% of properties need to be connected;<br>• All properties pay a fee whether they are connected or not;<br>• Install property connections together with the collector sewers;<br>• Subsidise households that are not able to pay or cross-subsidise; |
| Risk: people discharge unwanted materials (grease, fat, chlorine, etc.) into the sewers. | • Explain how a sewerage system works and what is required from a behavioural point of view by means of mass media;<br>• Install grease traps at all property connections |

[10] Comparative study Centralised wastewater treatment in Indonesia, ESP, 2004

| Risk | Motivational and capacitating activities |
|---|---|
| Contractors do not construct the pipes properly. | • Pay contractors only after the whole system has been inspected;<br>• Strict supervision during construction;<br>• Hire only contractors who have experience with sewerage if possible. |
| Not enough flow in the system. | • All properties connected should have a piped water supply connection;<br>• Install flushing devices. |
| Too much flow in the system due to entry of storm water through manholes and illegal connections at household level, leads to 'thin' wastewater (low BOD) and failures at the STP. | • Install emergency overflows and flush at intervals. |
| The staff does not know how to operate and maintain the STP | Appoint only educated staff to run the STP;<br>• Joint venture with other effluent and sewage treatment entities to facilitate peer visits and learning-on-the job; |
| The land for the STP is not made available. | Do not start construction of sewers until land has been purchased for sewage treatment |
| Contractors do not properly construct the STP. | Pay contractors only after the whole system has been inspected;<br>Strict supervision during construction;<br>Hire only contractors, who have experience with sewage treatment works. |
| Not enough flow in the system for STP | Build the STP in relatively small parallel units.<br>Ensure full property connection to the sewerage system |
| Low BOD of the incoming sewage due to too much flow in the system due to entrance of storm water through manholes and bad flushing procedures. | Install emergency overflow. |

## 6.4 On-site domestic systems

### 6.4.1 The challenges to be met

In order to fulfil the future demands and objectives identified in Chapter 4, a large number of on-site facilities need to be rehabilitated and new facilities need to be implemented. In this section we identify what kinds of technologies are required for the new systems.

### 6.4.2 Technology options

In Chapter 5 we have indicated that the selection of appropriate wastewater technologies depends on several physical factors and non-physical factors. The most appropriate technology is that technology which provides the most socially and environmentally acceptable level of service at the least economic cost. More precisely an appropriate technology is:

- Environmentally acceptable: the wastewater is handled in such a way that it cannot affect human beings. The wastewater is not accessible to flies, mosquitoes, rodents etc. The handling of fresh excreta is avoided. In areas where the people depend on ground water as a resource for drinking water, the groundwater should not be polluted;
- Convenient: there are limited odours and unsightly conditions. The facility is a short walking distance from the house;

- Simple to operate: the daily operation is minimal and only requires simple and safe routines;
- Long lasting with minimal maintenance: a long technical lifetime and only occasional maintenance, i.e. every 1 or 2 years;
- Upgradable: in the future “step-by-step” (incremental) improvements and extensions are possible;
- Acceptable cost: this does not mean necessarily that the system is cheap. The technology selected should be within the economic and financial reach of the household and city budgets.

Figure 6.13 is a matrix showing the range of on-site wastewater technology options appropriate for specific conditions within Surabaya. We refer to:

- Population density: on-site systems are usually restricted to low (< 150 cap/ha) and medium (150-300 cap/ha) densities: in these areas there is almost always room for the construction of an on-site wastewater facility;
- Income: we differentiate between low-income (< Rp 1.1 million/month), medium income (Rp 1.1-3 million/month) and high income (> Rp 3 million/month);
- Favourable soil or unfavourable soil: in Surabaya unfavourable soil means high groundwater table and/or impermeable soils (clay).

We have made the following assumptions:

- The majority of the population uses piped drinking water as the PDAM coverage is very large and the shallow groundwater tastes salty and has a yellow colour;
- All parts of the town can be served by septage collection services; hence there is no need to identify systems that can be emptied by hand.

Figure 6.13:Matrix for the appropriate on-site technologies options for Surabaya.

| *Density / Income* | *Low density [< 150 cap/ha]* | | *Medium density [150-300 cap/ha]* | |
|---|---|---|---|---|
| *Low income [< Rp 1.1 mln/month]* | Favourable soil | Unfavourable soil (high gwt / impermeable) | Favourable soil | Unfavourable soil (high gwt / impermeable) |
| | **TWIN LEACHING PITS [1.1]** / reuse of septage | **MCK [3]** WITH IMPROVED (RAISED/COLLAR) TWIN LEACHING PITS / reuse of septage OR IMHOFF TANK AND ANAEROBIC FILTER / EFFLUENT TO DRAINS | (SHARED) **LEACHING PIT / LOW COST SEPTIC TANK [1]** | **LEACHING PIT OR LOW COST SEPTIC TANK / ANAEROBIC UPFLOW FILTER [1.5]** ('BIO TANK') / DRAIN |
| *Medium income [Rp 1.1 - Rp 3 mln.* | Favourable soil | Unfavourable soil (high gwt / impermeable) | Favourable soil | Unfavourable soil |
| | **LEACHING PIT OR LOW COST SEPTIC TANK [1]** | **IMPROVED** (RAISED/COLLAR) **LEACHING PIT OR LOW COST SEPTIC TANK [1.2]** | **LEACHING PIT OR LOW COST SEPTIC TANK [1]** | **LEACHING PIT OR LOW COST SEPTIC TANK / ANAEROBIC UPFLOW FILTER [1.5]** ('BIO TANK') / DRAIN |
| *High income [> Rp 3 mln./month]* | Favourable soil | Unfavourable soil (high gwt / impermeable) | Favourable soil | Unfavourable soil (high gwt / impermeable) |
| | **SEPTIC TANK WITH EFFLUENT INFILTRATION PIT [2] /** reuse effluent | **SEPTIC TANK WITH (RAISED) EFFLUENT INFILTRATION FIELD [2.1]/** reuse effluent | **SEPTIC TANK WITH EFFLUENT INFILTRATION PIT [2] /** reuse effluent | **SEPTIC TANK / ANAEROBIC UPFLOW FILTER [2.2] ('BIO TANK')** / DRAIN |

Using the matrix indicates the following range of technologies is appropriate for conditions in Surabaya:

**Leaching pits**

1: Leaching Pit (LP);

1.1: Twin Leaching Pits (TLP);

1.2: Improved (raised/collar) Leaching Pit (LP+);

1.5: Leaching Pit with Anaerobic Upflow Filter and discharge of effluent into storm water drains;

**Septic tanks**

2: Septic Tank with effluent infiltration pit (ST);

2.1: Septic Tank with (raised) effluent infiltration field (STei)

2.2: Septic Tank with Anaerobic Upflow Filter ('Biotank') and discharge of effluent into storm water drains (ST/AUF).

Details of on-site technology options are contained in Appendix F.10.

### 6.4.3 Technology recommendations

We have studied the specific conditions per Kecamatan for the different years and identified the most appropriate technologies. We present the result of our analysis (rounded figures) in Table 6.10. The details of the calculations are presented in Appendix F 8.

Table 6.10: Recommended on-site technologies for new systems

| | Systems | | 2015 | 2015 | 2020 | 2020 | 2030 | 2030 |
|---|---|---|---|---|---|---|---|---|
| | | | Number | % | Number | % | Number | % |
| 1 | Leaching Pit | LP | 10 200 | 19% | 4 700 | 24% | 700 | 4% |
| 1.1 | Twin Leaching Pits | TLP | 1 800 | 3% | 600 | 3% | 700 | 3% |
| 1.2 | Improved Leaching Pit | LP+ | 7 600 | 14% | 2 600 | 13% | 5 200 | 25% |
| 1.5 | Leaching Pit / AUF / drain | LP/AUF | - | 0% | 400 | 2% | 3 500 | 17% |
| 2 | Septic Tank / effluent infiltration | ST/ei | 23 800 | 44% | 6 400 | 33% | 3 500 | 17% |
| 2.1 | Septic Tank with / Infiltration Field | ST /if | 10 600 | 20% | 4 200 | 21% | 4 000 | 19% |
| 2.2 | Septic Tank / UAF / 'biotank' / drain | ST/AUF | - | 0% | 800 | 4% | 3 200 | 15% |
| | **Total** | | **54 000** | **100%** | **19 700** | **100%** | **20 800** | **100%** |

### 6.4.4 Incremental improvements

Some staged incremental improvements are also appropriate:

- Single leaching pit to twin leaching pit;
- Single leaching pit to leaching pit with anaerobic upflow filter and discharge into stormwater drains;
- Septic tanks to Septic tank with Anaerobic Upflow Filter and discharge of effluent into storm water drains.

Other incremental improvements relate to the conversion of on-site systems into intermediate systems, more details of intermediate systems are contained within section 6.5, they are listed here for reference:

- Leaching pits via pipes to communal treatment systems;

- Leaching pits into covered storm water drains;
- Leaching pits/septic tanks into small bore sewer systems.

In the period 2020 to 2030 around 100,000 household systems will need to be improved in this way.

### 6.4.5 Phasing 2015/20/30

### 6.4.6 Investment Cost Estimates

The costs are indicated in Table 6.11. Given the rather challenging site conditions in Surabaya, the use of a leaching pit will not always be possible and the installation of a septic tank will be necessary. In this case the low cost septic tank is recommended or a Biotank. Based on information of the suppliers, we have used the figure Rp 3 million per domestic on-site system. When rehabilitating/improving existing on-site systems part of the existing infrastructure can be used, so the costs are less than the costs of a new on-site system: around Rp 2 million.

Table 6.11: Cost of program of on-site systems (Rp million)

| | Unit Cost | Unit | 2015 | 2020 | 2030 | Total |
|---|---|---|---|---|---|---|
| - new on-site facilities | Rp3 | m/hh | Rp162 000m | Rp60 000m | Rp63 000m | Rp285 000m |
| - rehabilitation on-site facilities | Rp2 | m/hh | Rp72 000m | Rp256 000m | Rp- | Rp328 000m |
| **Total** | | | **Rp234 000m** | **Rp326 000m** | **Rp63 000m** | **Rp613 000m** |

### 6.4.7 Operation and Maintenance (O&M) Costs

The operation and maintenance costs are restricted to emptying of the facility once every two years. At the moment the private operators charge Rp 300,000 / trip. Hence, the annualised cost is Rp 150,000 / facility or 5% of the investment cost. The private vacuum truck operators are being charged around Rp 10,000 per trip to empty the tank contents at the septage treatment plant (IPLT), the costs could be significantly reduced if competition is improved and O&M costs can be reduced to Rp 60,000/household/year or 2%.

### 6.4.8 Sustaining the programme of on-site systems

As explained in Chapter 3, existing wastewater situation in Surabaya, there are many risks involved in applying on-site solutions. In Table 6.12 we indicate the major risks and the recommended remedial actions to minimise the risks. The actions have motivational nature (both intrinsic and extrinsic) and a capacitating nature (physical, mental, financial and social/cultural) and have been elaborated in the WWMP Capacity Building Plan report.

Table 6.12: Sustaining the on-site sanitation programme

| Risk | Motivational and capacitating activities |
|---|---|
| Wastewater management is not regarded as an issue, the construction of on-site systems has a very low priority, and nobody is interested in upgrading | • Persuasion and campaigning to explain the benefits of on-site systems;<br>• Legislation that 100% of properties need to be provided with an on-site system;<br>• School sanitation;<br>• Good toilets at Puskesmas and other government institutions; |

| Risk | Motivational and capacitating activities |
|---|---|
| their existing facility of purchasing a new system. | • Explain how an on-site system works and what is required from a behavioural point of view by means of mass media reporting;<br>• "Blame and shame" neighbourhoods with poor on-site sanitation systems;<br>• Rewards for areas with good systems: a new mosque or kindergarten; |
| Many households think that on-site systems are expensive, nobody wants to purchase one. | • Provide good, cheap solutions;<br>• Subsidise the purchase of on-site systems;<br>• Micro-credit schemes to assist in the purchase of an on-site system;<br>• "Arisan" schemes to purchase on-site systems; |
| Existing systems fail because of the high groundwater level and impermeable soils, nobody wants to pay for a new system. | • Develop a good 'Surabaya' toilet and marketing;<br>• Mass media coverage for appropriate examples. |

### 6.4.9 The challenges of rehabilitation of on-site systems

As a household is usually not aware that its on-site system is not functioning well, the rehabilitation of on-site systems is as challenging, if not more so, than the introduction of new appropriate on-site systems. Hence, an integral part is 'software' on on-site systems and the creating an enabling environment, as elaborated in the WWMP capacity building report. Activities have a motivational and capacitating nature, including:

- Study performance existing on-site systems: what parts are failing?
- Develop Surabaya fit system for rehabilitation: what is the most effective way to rehabilitate?
- Pilot projects on rehabilitation and dissemination of the results
- Marketing rehabilitation of on-site systems
- Organise the community through NGO's to motivate and capacitate and technical backstopping of the NGO's
- Training of sanitarians and government staff on how to rehabilitate on-site systems
- Dissemination of plans, drawings, maquettes etc. through the (mobile) Wastewater Information Centre
- Rehabilitation of the sanitation at schools, Puskesmas and institutes
- Award households with the best rehabilitation and blame and shame household that are not interested in cooperating.

These activities need to be elaborated in the DED phase of the implementation.

## 6.5 Intermediate domestic systems

### 6.5.1 The challenges to be met

In order to deal with the present problems as identified in Chapter 3, Section 3.4 and to fulfil the future demands identified in Chapter 4, Section 4.3, a large number of new facilities need to be implemented. In high-density area (> 300 cap/ha) on-site solutions are not possible any more due to the lack of space and off-site solutions may not always be operationally of financially feasible. Hence, a new generation of systems is required. In the framework of this wastewater master plan we have termed them 'intermediate

systems'. These are well-established and well developed solutions that can be adapted to the specific site conditions of Surabaya area.

Surabaya has a long-history of wanting to launch intermediate systems. In the recommendations of the SSDP 1998 masterplan, these were termed 'modules': they were systems that could be operated by the community on a neighbourhood basis. However, none of the SSDP proposals were implemented.

### 6.5.2 Technology options

In Figures 6.13 and 6.18. we indicate the range of technology options appropriate for specific conditions within Surabaya. We refer to:

- Population density: a particular type of intermediate system, the MCK is applicable for low (< 150 cap/ha) density areas. More complicated Intermediate systems are typically solutions for higher (>300 cap/ha) density areas. In these areas there is almost never room for the construction of a wastewater treatment facility;
- Income: we differentiate between low-income (< Rp 1.1 million/month), medium income (Rp 1.1-3 million/month) and high income (> Rp 3 million/month);
- Level of community involvement to be expected;
- Coverage of existing on-site wastewater facilities.

See Figure 6.14 below for a matrix showing the different intermediate wastewater technologies appropriate to different categories of population density, income and soil types.

Figure 6.14: Appropriate intermediate technology options for Surabaya.

<table>
<tr><td>Density / Income</td><td colspan="3">High density [> 300 cap/ha]</td></tr>
<tr><td rowspan="3">Low income [< Rp 1.1 mln/month]</td><td colspan="2">Low coverage on-site sanitation</td><td rowspan="2">High coverage on-site sanitation</td></tr>
<tr><td>High level community involvement</td><td>Low level community involvement</td></tr>
<tr><td>COMMUNAL TREATMENT [3.1] / ANAEROBIC BAFFLE REACTOR / biogas / ANAEROBIC UPFLOW FILTER / EFFLUENT TO DRAINS / reuse garden watering</td><td>Directly to covered drains: COMBINED DRAINAGE [4] / PARTIAL TREATMENT</td><td>INTERCEPTOR / COVERED STORMWATER DRAINS [4.1] / PARTIAL TREATMENT</td></tr>
<tr><td rowspan="2">Medium income [Rp 1.1 - Rp 3 mln.</td><td colspan="2">Low coverage on-site sanitation</td><td>High coverage on-site sanitation</td></tr>
<tr><td colspan="2">SHALLOW SEWERAGE [5]</td><td>INTERCEPTORS - SMALL BORE SEWERAGE [6]</td></tr>
<tr><td rowspan="3">High income [> Rp 3 mln./month]</td><td colspan="2">Ground fall < 2 o/oo</td><td rowspan="2">Ground fall > 2 o/oo</td></tr>
<tr><td>Low coverage on-site sanitation</td><td>High coverage on-site sanitation</td></tr>
<tr><td>SHALLOW SEWERAGE [5]</td><td>INTERCEPTORS - SMALL BORE SEWERAGE [6]</td><td>CONVENTIONAL SEWERAGE / STP [7]</td></tr>
</table>

Hence, the following range of technologies is appropriate for Surabaya conditions:

- 3.1: MCK;
- 3.2: Communal treatment systems (CT);
- 4.1: Direct discharge into adapted covered stormwater drains (CD);
- 4.2: Interceptors (leaching pit which has been made watertight or septic tank) and discharge of the effluent in adapted covered stormwater drains (iCD);
- 5: Shallow Sewerage (SS);
- 6: Small Bore Sewerage (SBS);

The areas identified for new intermediate wastewater systems are shown in Appendix's E2, E3 and E4. These systems are described in Appendix F.10.

### 6.5.3 Recommended pilot project in Peneleh

#### 6.5.3.1 Selection of Technology

Based on the WWMP Final Feasibility Study report which evaluated possible sewerage options for two different representative intermediate areas, Peneleh using SBS/SS and Kapasan using combined sewerage (CDS). The costings analysis shows that CDS is significantly more expensive than the SBS/SS systems. This is illustrated in Table 6.13 where we have compared the costs of the intermediate systems comprising of SS/SBS and CDS sewer systems with the costs of conventional "off-site" sewerage systems. It is obvious that the SBS/SS approach is very promising and it can be implemented in small modules for those areas where the community support for a 'piped' solutions is the strongest and its costs are significant lower than the conventional sewerage. The Peneleh area was chosen as a pilot project for the design of this typical intermediate system to be applied to similar areas with scaling-up, as necessary.

Table 6.13: Comparison of costs for communal sewerage and treatment projects

| Costs per house connection | Conventional (Rp. m) | SS/SBS (Rp. m) | CDS (Rp.m.) |
|---|---|---|---|
| Preparation | Rp0.24m | Rp0.24m | Rp0.24m |
| Trunk sewer | Rp2.29m | Rp1.19m | Rp2.40m |
| Collector/lateral sewers | Rp4.08m | Rp1.19m | Rp2.48m |
| Electro-mechanical | Rp0.36m | Rp0.18m | Rp0.18m |
| Manholes | Rp0.21m | Rp0.14m | Rp0.04m |
| Flushing etc. | Rp0.50m | Rp0.50m | Rp0.30m |
| House connections | Rp2.00m | Rp2.00m | Rp1.50m |
| STP | Rp1.18m | Rp1.13m | Rp1.13m |
| Tools | Rp0.36m | Rp0.33m | Rp0.22m |
| Engineer's Base Costs | Rp11.24m | Rp6.81m | Rp8.50m |

#### 6.5.3.2 Area description

The intermediate system has been proposed within the defined boundary area comprising Peneleh and Bongkaran as a low cost sewerage option for the area. The Peneleh/Bongkaran area selected has physical

constraints around the entire boundary; the river Kali Mas runs around the south and west edges, a channelled watercourse describes the eastern boundary edge, and the main railway line and railway sidings enclose the area to the north. The presence of these watercourses and railway tracks would make the laying of gravity sewers crossing the boundary edge very challenging, and therefore increases the suitability of the area for development of a more localised wastewater collection and treatment system. In this design the western half of the populated area has been specifically targeted. If the system proves to be a success the coverage may be spread to the eastern half of the Peneleh and Bongkaran area, using a mirrored version of this system. See Figures 6.15 and 6.16 for an impression of the area.

Figure 6.15: Aerial view of Peneleh


Source: Google Earth Professional

Figure 6.16: Street view of Peneleh

Source: Mott MacDonald Field Survey

For this design a collector sewer has been proposed to be laid along the east bank of the river Kali Mas running from south to the proposed STP at the north. The sewer is to be laid to shallow gradient and increasing depth to approximately 6m, this is to minimise the need for pumping. It is anticipated that a pumping station will be required at the Peneleh/Bongkaran STP site in order to lift the flows from 6m depth to the treatment tank. The collector sewer is to be built to conventional design standards (i.e. provision for full man access every 120m or less), and should be centrally maintained.

The lateral sewers connecting to the collector sewer are designed as Shallow Sewers (SS) and Small Bore Sewers (SBS). The design difference for SS and SBS involves designing out normal design allowances, which would generate unnecessary additional sewer capacity, which would never be utilised, thus reducing costs and increasing efficiency.

SBS and SS systems are laid at shallower depth than would be recommended for conventional sewers, and the upstream end of the sewers have inverts 0.5m below ground (i.e. 350mm cover for a 150mm pipe). Laying sewers at shallow depth is appropriate in corridors where clashes with other underground utility

services are unlikely and the maximum surface loading is likely to be less than in main roads. The narrow alleys of low income areas are suitable for shallow sewers as they are not accessible to large vehicles, the largest loading will be restricted to pedestrians and motorcycles. It is important that if local information suggests that large vehicles (e.g. delivery lorries for small business) are anticipated above the position of SBS or SS then the appropriate design analysis be conducted to ensure loading is within the permissible crushing strength of the pipe.

In the design for the Peneleh/Bongkaran system outline, the design flow for each sub catchment has been used for the full length of each lateral pipe. This is to allow the greatest flexibility in planning the connections to the lateral pipes. Once the connection positions have been defined it is suggested that in the detailed design it should be able to reduce the sizes of some of the upstream ends of the lateral pipes to 100mm.

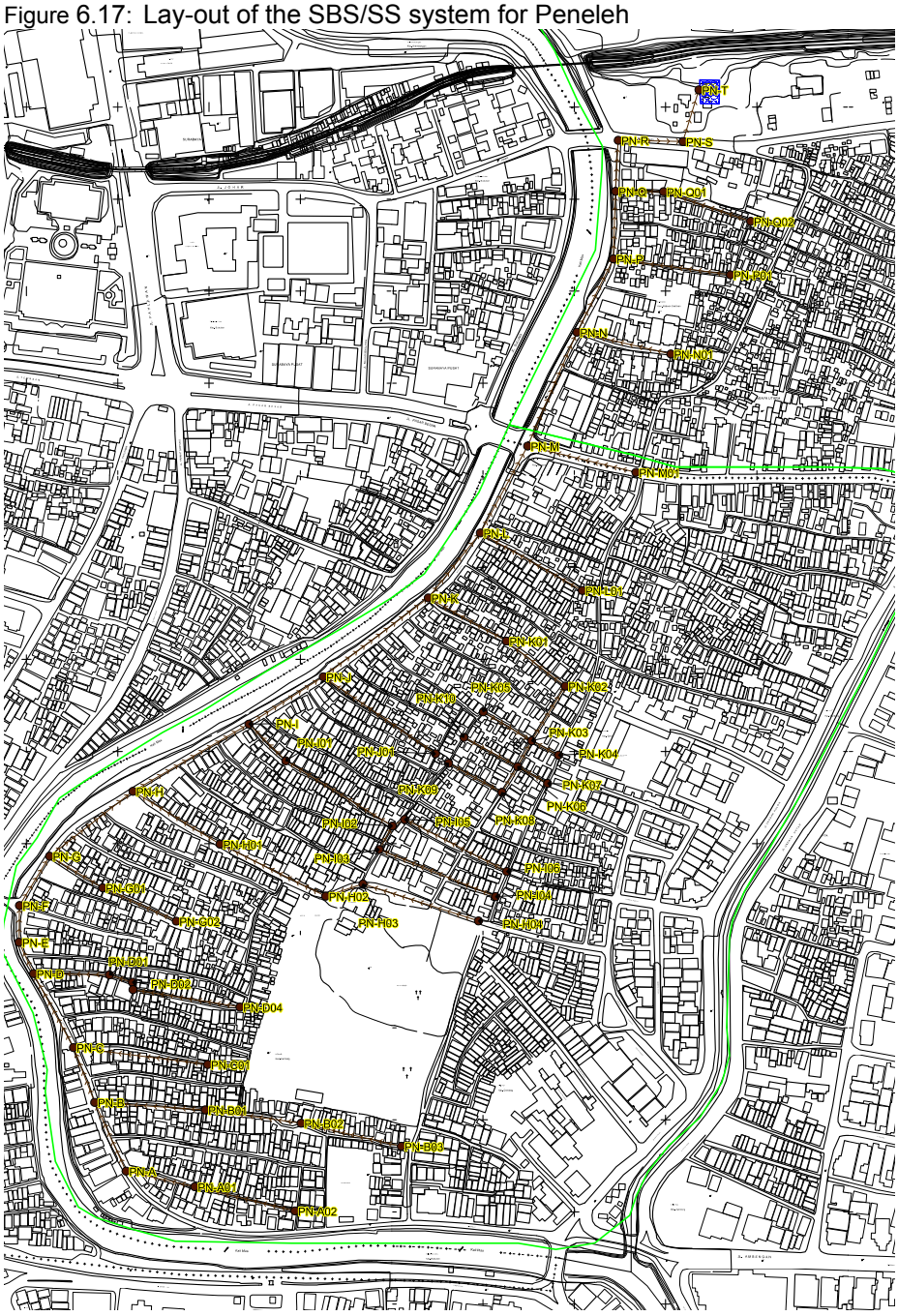
Finally it is very important that SS and SBS do not receive connections for surface water run-off as there is no over-capacity available in the pipe, and surcharging the sewers will lead to foul water flooding of residences, which would damage customer confidence in the sewerage system. Additionally any surface water entering the system will convey grit, which can build up and thus reduce the carrying capacity of the sewers.

The difference between SS and SBS can be considered to be that SBS sewers will require less maintenance cost than SS, however for households that do not already have septic tanks the capital cost will be greater to implement SBS than SS.

For both systems, it is considered likely that households will dispose of significant volumes of grease or fats down the sewer. Hence, a household grease trap has been specified to reduce the likelihood of blockages. However community engagement should be used upfront to educate people not to dispose of fats and grease in the new sewer system.

The planned wastewater system for Peneleh is presented in Figure 6.17 below. Details of the system are provided in Appendix F.5 of the June WWMP Final Feasibility Study report.

Figure 6.17: Lay-out of the SBS/SS system for Peneleh




## 6.5.4 Technology recommendations

We have studied the specific conditions for each Kecamatan for the different years and identified the most appropriate technologies. We present the result of our analysis in Table 6.14. See Appendix F 8 for details.

Table 6.14: Recommended intermediate new systems

| | Systems | 2010-2015 House Holds | % | 2015-2020 House Holds | % | 2020-2030 House Holds | % |
|---|---|---|---|---|---|---|---|
| 3 | MCK / improved leaching pits/ anaerobic treatment/ AUF | 6 800 | 30% | 4 900 | 14% | - | 0% |
| 3.1 | Communal Treatment | 2 300 | 10% | 2 400 | 7% | - | 0% |
| 4 | Direct combined drainage | - | 0% | - | 0% | - | 0% |
| 4.1 | Interceptor / stormwater drainage | - | 0% | - | 0% | - | 0% |
| 5 | Shallow sewerage | 8 000 | 35% | 10 300 | 30% | 22 800 | 25% |
| 6 | Interceptor / SBS | 5 800 | 25% | 17 300 | 50% | 68 700 | 75% |
| | **Total** | **22 900** | **100%** | **34 900** | **100%** | **91 500** | **100%** |

### 6.5.5 Incremental improvements

Intermediate systems are by definition, systems fit for incremental improvement:

- MCKs can become communal treatment systems, provided they are situated sufficiently low to receive wastewater from neighbouring houses;
- Combined drainage systems can become Shallow Sewerage systems;
- Modular Shallow Sewerage and SBS neighbourhood systems' can become part of an off-site conventional sewerage system.

### 6.5.6 Phasing 2015/20/30

The phasing of the different systems is indicated above in Table 6.14.

### 6.5.7 Investment cost estimates

The investment costs are indicated in Table 6.15. The unit rates are based on the analyses of the Feasibility Study.

Table 6.15: Cost of the planned programme of intermediate systems (Rp million)

| Cost intermediate programme | Unit cost | 2015 | 2020 | 2030 | Total |
|---|---|---|---|---|---|
| - new intermediate facilities | Rp6 | Rp136 000m | Rp210 000m | Rp549 000m | Rp895 000m |
| - rehabilitation intermediate facilities | Rp2.5 | Rp27 000m | Rp-m | Rp-m | Rp27 000m |
| **Total** | **Rp4.8** | **Rp163 000m** | **Rp210 000m** | **Rp549 000m** | **Rp922 000m** |

### 6.5.8 Operation and maintenance costs

The operation and maintenance costs differ from one system to another: besides removing the septage every 2 years, the sewer lines and the decentralised treatment facilities need regular operation and maintenance. Hence, O&M requirements are the same % as for conventional sewerage, at around 2% of the investment costs per year: total Rp 20,000 m/year.

### 6.5.9 Sustaining the programme of planned intermediate systems

As mentioned previously, Surabaya has an unfortunate history of unfulfilled and non-implemented intermediate systems, hence, there are many risks involved in applying these systems. In table 6.15 we indicate the major risks and remedial actions to minimise the risks. The actions have motivational nature (both intrinsic and extrinsic) and a capacitating nature (physical, mental, financial and social/cultural) and have been elaborated in the WWMP Capacity Building Plan report.

Table 6.16: Sustaining the intermediate system programme

| Risk | Motivational and capacitating activities |
|---|---|
| Nobody feels responsible for operating and maintaining modular intermediate neighbourhood systems. | Organise construction, operation and maintenance in such a way that the private sector or a neighbourhood organisation can make a living → O&M fees should be more than enough to cover the O&M costs. |
| There are relatively few skilled wastewater personnel and staff in Surabaya, including government staff. | Hire experienced consultants and contractors to design, construct and supervise the systems;<br>Cooperation/peer visits with international enterprises who have experience with wastewater operation and maintenance;<br>Hire only staff which has an education in wastewater management; |
| Not all households and enterprises want to connect to the off-site system, leading to 1.Underperformance of the system and 2. Lack of O&M funds | Campaign to explain the benefits of sewerage;<br>Legislation that 100% of properties need to be connected;<br>All properties pay a fee whether they are connected or not;<br>Install property connections together with the collector sewers;<br>Subsidise households that are not able to pay or cross-subsidise; |
| People discharge unwelcome materials (grease, fat, chlorine, etc.) into the shallow/ small bore sewers. | Explain by means of mass media programmes how an intermediate system works and what is required from a behavioural point of view;<br>Install grease traps at all property connections |
| Contractors do not properly construct the pipes. | Pay contractors only after the whole system has been inspected;<br>Strict supervision during construction;<br>Hire only contractors who have experience with intermediate systems. |
| Many households think that intermediate systems are expensive, nobody wants to connect. | Provide good, cost effective solutions;<br>(Cross-) Subsidise the funding for intermediate systems;<br>Micro-credit schemes to assist in the development of an intermediate system;<br>Legislation that 100% of the neighbourhood has to connect;<br>All properties pay a fee, whether they are connected or not. |

## 6.6 Grey water disposal

### 6.6.1 Grey water disposal when applying off-site systems and communal piped intermediate systems (Communal treatment, SBS and SS)

An important advantage of the off-site conventional sewerage and the piped intermediate systems like SBS and SS is that they can also convey and treat the grey water.

### 6.6.2 Grey water disposal when applying on-site systems and non-piped intermediate systems (MCK)

The environmental benefits of acceptable “on-site” black water systems and MCKs will be nullified if acceptable on-site grey water management does not accompany them. Grey water improvements are implemented hand-in-hand with the implementation of the improved and new “on-site” systems. Figure 6.18 shows the technological options for grey water management.

Figure 6.18: Technological options grey water management

| *Low-Medium density [< 300 cap/ha]* | | | | *High density [> 300 cap/ha]* | |
|---|---|---|---|---|---|
| Favourable soil | | Unfavorable soil (high gwt/low permeability) | | | |
| Septic Tanks used for wastewater treatment | Leaching Pits, Low Cost Septic Tanks, Biofilters and other on-site systems receiving only black water | Demand for reuse - Strong community organization required | No demand for reuse - Good solid waste and drainage management | Favourable soil | Unfavourable soil |
| **Large (> 4m3) Septic Tank: Septic Tank / Small (< 4m3) Septic Tank: Soakaway** | **Soakaway** | **Treatment and Reuse** | **Anaerobic Upflow Filter /drain** | **Soakaway** | **Small Bore Sewers / Shallow Sewers / Sewerage** |

Key:

| |
|---|
| **On-site systems** |
| **Intermediate systems** |

The following technologies are appropriate for grey water treatment:

- Second chamber septic tank;
- Soak-away;
- Anaerobic Upflow Filter and discharge into storm water drains.

Details of these options are presented in Appendix F.10.

## 6.7 Non-domestic systems

### 6.7.1 Introduction

This wastewater masterplan mainly deals with domestic wastewater and information was not collected on non-domestic wastewater. Non-domestic wastewater is wastewater from:

**Industries**. Surabaya has a relatively large number of industries and the impact of the lack of wastewater collection, transport, treatment and reuse/disposal can be rather significant, for example see Figure 6.46. The large planned industrial area near the airport has its own wastewater collection system and treatment plant.

Figure 6.19: Local pollution probably of industrial origin

- Home industries, especially food related, fish cleaning, tahu production but also small metal industries etc. can have a large local negative environmental impact. There are some NGO initiatives in Surabaya attempting to deal with this. For an example see Figure 6.47.
- Commercial enterprises: hotels, restaurants, malls, etc.;
- Institutes, Government offices etc.

Figure 6.20: Small installation to treat waste from fish preparation by NMCP and ITS in Kelurahan Kenjeran, Kecamatan Kenjeran

As explained in Chapter 4.1, it has been decided to include commercial enterprises in the proposals for the "embryo" off-site sewerage areas. The reason is not necessarily that these are major polluters, but because the improvement of the commercial areas (Central Business Districts) is thought to be a good trigger to get a responsible and responsive wastewater operator off the ground.

### 6.7.2 The challenge

In order to fulfil the future demands identified in Chapter 4, Section 4.3, the number of commercial enterprises to be dealt with is presented in Table 6.17.

Table 6.17: Programmed improvement of wastewater treatment at commercial enterprises

| Description | Unit | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|
| COMMERCIAL | | | | | |
| Number of commercial enterprises | number | 29,627 | 32,000 | 34,000 | 39,000 |
| Population equivalent commercial enterprise | pe/enterprise | 17 | 17 | 17 | 17 |
| Wastewater production commercial enterprises | m3/e/day | 1.45 | 1.45 | 1.45 | 1.45 |
| - % acceptable treatment units | % commercial enterprises | 55% | 75% | 100% | 100% |
| - % unacceptable treatment units | % commercial enterprises | 45% | 25% | 0% | 0% |
| PROGRAMME COMMERCIAL ENTERPRISES | | | | | |
| - new treatment facilities commercial enterprises | number | | 2,000 | 2,000 | 5,000 |
| - rehabilitation treatment facilities commercial enterprises | number | | 5,000 | 8,000 | - |

### 6.7.3 Recommended technologies

If the commercial enterprises are located in the "embryo" areas to be sewered in the first phase of the masterplan: i.e., the sewerage area 'West of Kali Mas' and 'East of Kali Mas', they are to be connected to the sewerage area. However, if they are located in areas that are not to be sewered yet, then, specific technologies are recommended as appropriate to the type of business. The businesses considered with general recommended technologies are:

- Institutes – ABR or constructed wetland;
- Hotels – ABR followed by RBC;
- Restaurants - ABR;
- Shopping malls – Activated Sludge Reactor.

### 6.7.4 Phasing 2015/20/30

The phasing of the different systems is indicated in the previous Table 6.17.

### 6.7.5 Investment Cost Estimates

The costs are indicated in the following Table 6.18.

Table 6.18: Cost of the program for improvement of the wastewater facilities of commercial enterprises (Rp million)

| Description | | 2015 | 2020 | 2030 | Total |
|---|---|---|---|---|---|
| - new treatment facilities commercial enterprises | Rp20 | Rp- | Rp40 000m | Rp100 000m | Rp140 000m |
| - rehabilitation treatment facilities commercial enterprises | Rp10 | Rp53 000m | Rp80 000m | Rp- | Rp133 000m |
| **Total** | | **Rp53 000m** | **Rp120 000m** | **Rp100 000m** | **Rp273 000m** |

**Note**: the properties indicated for new treatment facilities in 2010-2015 are actually planned for connection to the "embryo" off-site wastewater collection system.

### 6.7.6 Operation and Maintenance (O&M) Costs

O&M requirements are the same % as for conventional sewerage: around 2% of the investment costs per year: total Rp 5,000 m/year.

### 6.7.7 Sustaining the programme of improvement of wastewater facilities of commercial enterprises

Several commercial wastewater treatment plants were visited during January 2011, the high percentage of rather poorly constructed and maintained facilities indicates that there are many risks involved in applying wastewater treatment improvements at commercial enterprises. In Table 6.19 we indicate the major risks and remedial actions to minimise the risks. The actions have motivational nature (both intrinsic and extrinsic) and a capacitating nature (physical, mental, financial and social/cultural) and have been elaborated in the WWMP Capacity Building Plan report.

Table 6.19: Sustaining non-domestic/commercial wastewater system programme

| Risk | Motivational and capacitating activities |
|---|---|
| Treatment plants do not perform as commercial enterprises are interested in running their enterprise and have no interest in proper wastewater management. | Explaining the importance of proper wastewater management through the Chambers of Commerce;<br>Awards for best performing enterprises;<br>Licensing of the enterprises and regular strict monitoring of the treatment plant effluents;<br>Naming and shaming of poorly performing enterprises. |

## 6.8 Septage collection and treatment

### 6.8.1 The challenge

Our calculations, shown in Table 6.20, regarding the immediate and future demands identified in Chapter 4, Section 4.3 shows that there is no need for additional septage treatment or collection services in Surabaya. The existing treatment plant has a treatment capacity of 400 $m^3$/day.

Table 6.20: Septage collection and treatment

| Description | Unit | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|
| **SEPTAGE COLLECTION (DESLUDGING)** | | | | | |
| Annual septage production | litres/cap/year | 40 | 40 | 40 | 40 |
| Annual septage production on-site facilities | m3/year | 99,230 | 109,613 | 112,398 | 97,103 |
| Monthly septage production | m3/m | 8,269 | 9,134 | 9,367 | 8,092 |
| Number of septage collection trucks | number | 69 | 69 | 69 | 69 |
| Volume septage collection truck | m3 | 3.5 | 3.5 | 3.5 | 3.5 |
| Number of trips septage collection trucks per month | number/m | 13 | 28 | 39 | 34 |
| Volume septage collected monthly | m3/m | 3,140 | 6,851 | 9,367 | 8,092 |
| Coverage septage collection | % | 38% | 75% | 100% | 100% |
| **SEPTAGE (SLUDGE) TREATMENT** | | | | | |
| Monthly capacity sludge treatment | m3/m | 3,140 | 6,851 | 9,367 | 8,092 |
| Capacity sludge treatment | m3/d | 157 | 343 | 468 | 405 |

From this analysis, we conclude:

- As far as the number of septage collection trucks is concerned, we conclude that the existing city-wide armada of 69 trucks is sufficient to collect all the septage from the on-site systems. The only thing that is required is that the number of trips needs to increase from 13 per truck per month to 28 trips per truck per month; this rate of trips is required to be able to empty all of the septic tanks at the recommended emptying interval of a minimum of once every two years.
- As far as the capacity of the existing septage treatment plant (IPLT) is concerned, the existing capacity of 400 $m^3$/day is sufficient up to 2030. Around year 2020, will there be a moderate lack of capacity. After 2020 some of the properties with septic tanks will connect to the city wide sewerage system and they can then abandon their tanks. The period of under-capacity can easily be accommodated at the IPLT.

Hence, capacity wise, there are no problems. However, there are some challenges regarding septage collection:

- The existing IPLT is located in the east of Surabaya. Hence, all trucks from the western part of Surabaya have to pass the centre of the town and the trips are relatively long.
- At present, only 38% of the estimated septage generated across the city is collected by tankers. This indicates that:
  - Leaching pits and septic tanks are not emptied regularly or at all: people wait till the tanks are completely full and overflow or backflow, before calling upon a vacuum truck service; and/or
  - More septage is being collected but the trucks dispose of the septage in the nearest watercourse; and/or
  - The manual septage collectors collect a considerable amount of septage, which is then dumped in the Kali Surabaya. See figure 6.51.

Figure 6.21: Manual collection of septage

The septage treatment facility at IPLT Keputih, Kecamatan Sukolilo, currently operates at 50% of the installed design capacity, design capacity was 400m$^3$/day. The current operator is presently improving the facility so that, within a year, the treatment capacity is expected to be at 100%. There are some challenges however:

- The quality of the treated effluent that is discharged fluctuates, sometimes it is below the required effluent standard of 50 mg BOD/l, sometimes (far) above the effluent standard;
- All sludge-drying beds are full and scrubs and trees are growing in the sludge drying beds. The operator now transports sludge to the landfill nearby.

In the past, proposals have been prepared to position a new IPLT in the western part of the town in Kecamatan Benowo. This proposal is aimed at reducing the tanker travel distance to the IPLT. These plans have not materialised yet.

**Conclusions**

- There are currently not enough clients (tanker company visits): septage removal has a low priority, people wait till their tanks are full;
- There is a widespread practice of manual septage collection. Apart from being an unhealthy practice this leads to direct pollution of the Kali Surabaya, as this is where they empty the sludge. Manual septage collection provides a livelihood for a large number of people, so, for social reasons, it is felt that this practice cannot be stopped immediately;
- The present challenge at the IPLT facility is mainly in the field of operating and maintaining the facility.

### 6.8.2 Technology options

As long there is no demand for septage collection and treatment, there is no need to consider alternative options for the IPLT. Regarding the manual septage collection however, some alternatives could be considered, such as motorised collection and transport to either a transfer station or the IPLT.

**A. Motorised collection**

The men that currently collect septage from areas that the tankers cannot access could start to use the new transport system that has been developed which is a motorbike with a small vacuum trailer attached, a photograph of which is shown in Figure 6.22.

Figure 6.22: Motorized small scale septage collection

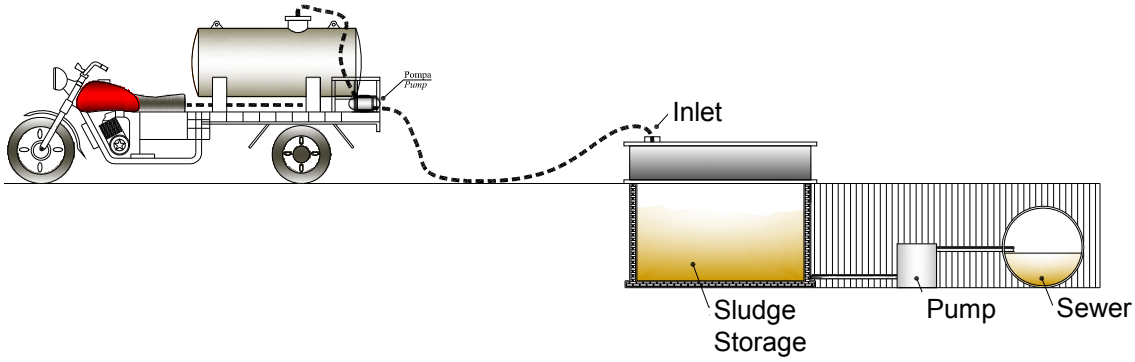
**B. Septage transfer station**

When the city wide sewerage systems become available, the presence of the trunk sewers will facilitate the start-up of an SMS : Septage Management Service. The proposed SMS is a septage collection system that will be unique to Surabaya, it will facilitate the easy receival of septage waste into the “embryo” sewerage system. The households wanting the septic tank emptying sends an sms text to the entrepreneurs ( who at present empty the leaching pit/septic tank manually ), they will remove the septage with a vacuum motorcycle in an environmentally sound way and discharge it to the septage discharge station on the trunk sewers. The discharge point can be legally accessed and used for discharging septage and sludge directly into the sewer for treatment.

The septage discharge stations (SDS) are intermediate transfer points for septage that cannot easily be transported to the IPLT, but it can also be used by the large vacuum trucks. Sludge can be emptied into the SDS rather than either a) dumping it illegally in the Kali Surabaya or b) trying to travel to the IPLT which is 10 km from the town centre. Septage can be emptied into the SDS and then either released directly to the sewer or held in a temporary storage tank before being released to the sewer at a set time. Timed release of the septage can help prevent solids from building up in the sewer line and also help optimise the treatment efficiency of the STPs by reducing peak loading. SDSs are especially appropriate for the dense, urban areas of Surabaya where there is no alternative discharge point (e.g. faecal sludge thickening pond)

and where there is likely to be a sewer available. Multiple SDSs in Surabaya will help to reduce the incidence of illegal septage dumping. SDSs are a good idea for Surabaya as there are many locations where sludge is manually removed from leaching pits. The construction of an SDS also stimulates the independent-emptying market. When the Kali Asin “embryo” area is connected to the city-wide sewerage system, the UASB STP is not needed anymore and the site can be used for an SDS as it is easily accessible, conveniently located, and easy to use. The system for issuing permits or charging access fees must be carefully designed so that those who most need the service are not excluded because of high costs ( and continue dumping septage in the river), while still generating enough income for the wastewater system operator. See figure 6.23 for details of the planned SDS.

Figure 6.23: Septage discharge station




### 6.8.3 Recommendations

We recommend the City Government to refrain from large-scale investment programs for septage collection and treatment and to concentrate on improving and optimising the operation and maintenance of the present system and IPLT at Keputih. As septage collection is a profitable business, the city should leave it to the private sector, but regulate it appropriately.

No investment on septage collection and treatment has been identified for inclusion in the master plan.

### 6.8.4 Future studies and activities regarding septage collection and treatment

The recommended programme of studies is presented in Table 6.21 and have been elaborated in the WWMP Capacity Building Plan report.

Table 6.21: Programme of studies and activities for septage collection and treatment

| Problem | Activity |
|---|---|
| The reasons for the low coverage of septage collection and treatment are unknown. | Study the reasons: no demand? Illegal practices? Transport distance too far? |
| Present manual septage collection practice is both unhygienic and adds to the pollution of the Surabaya River. | Provide the manual septage collectors with mechanical motorcycle devices e.g. by means of Micro Credit Scheme. Credit given if septage is transported to the IPLT. |
| The operation and maintenance of the IPLT is below expectations: effluent quality is below standard and the sludge-drying beds are full. | Train the staff of the IPLT e.g. by the support of a professional sludge treatment entity (i.e. water board). |

## 6.9 Relationship between CSS and Master Plan

Table 6.22 gives an analysis of the relationship between the CSS and the policies and strategies included in this master planning project.

Table 6.22: Relationship between the CSS and this masterplanning project

| Wastewater Systems | CSS | WWMP Package 1 |
|---|---|---|
| On-site System | Seems to jump to solutions in planning for rehabilitation of the existing systems and building new facilities, does not use tools for identification of technology options | Developed a comprehensive model for identification of technology options to decide most appropriate technology conforming to the local conditions |
| Intermediate Systems | Proposals based on allocated budgets not on need | Developed intermediate system programme to improve sanitation coverage (ODF by 2020) and BOD load reductions |
| Off-site – Centralised system | No off-site system proposed until 2014 | 2 embryo areas identified, alternative sewer routes developed to avoid too many pumping stations and high OM costs |
| Septage Treatment | Proposing a new IPLT | Not proposing new IPLT |

Source: data analysis

# 7. Wastewater institutional arrangements in Kota Surabaya

## 7.1 Overview / identification and evaluation of existing wastewater services and institutional arrangements

### 7.1.1 Existing wastewater services

In Kota Surabaya, black water facilities and services for households are managed from within the Cleansing and Parks Services Department (Dinas Kebersihan dan Pertamanan – DKP). These are limited to the operation and maintenance of a septage treatment plant (IPLT Keputih Sukolilo) for disposal of domestic septic tank sludge. Collection of the sludge is carried out by private sector businesses operating vacuum tanker trucks. 69 such trucks, with a total capacity of 306 $m^3$, have been licensed by DKP and there may be other unlicensed operators. Operators respond to calls from households wishing to have their tanks emptied. Fees are subject to negotiation between operator and household and are reported to range between Rp 75,000 to Rp 150,000 per $m^3$, depending on travelling distance and ease of access for the truck to the septic tank. In addition, one (1) truck is operated directly by DKP to empty sludge from the septic tanks of public toilets (MCK). Sludge is then conveyed by the tankers to the IPLT where it is discharged and disposed of environmentally.

The IPLT is operated by a UPTD with a staff of 31 (22 of whom are permanent and 9 on contract). Only licensed truck operators are allowed to access the IPLT. There is a tipping fee of Rp 3,750 per $m^3$ which has remained unchanged since 2000 (Regional Government Decree (*Perda*) No 04/2000). However, there are no checks to ensure that all the sludge is environmentally disposed of at the IPLT; since household septic tank coverage is nearly 90% in Surabaya and IPLT daily utilisation in recent years has been approximately 100 $m^3$ against a design capacity of 400 $m^3$ per day, it is assumed not, even though many households do not empty or maintain their septic tanks. To put it another way, given an average IPLT utilisation of 111 $m^3$ per day and an average truck capacity of 4 $m^3$, The number of trucks visiting the IPLT is 28 out of a total of 69 licensed operators (plus any unlicensed ones). It may therefore be concluded that most of the sludge is probably dumped into water courses or open fields so that operators can save on tipping fee and fuel costs.

The IPLT is heavily subsidised, with a 2010 operating ratio of 0.16, although even this is an improvement over the results of 2008 and 2009.

Community services consist of MCKs and SANIMAS installations connected to small wastewater treatment facilities. There seems to be little institutional responsibility at city government level, with the recently constructed SANIMAS facilities being managed by local community heads (RW/RT). Accountability for user fees appears to be lacking. In addition, there are intermediate systems on residential housing estaes where disposal of wastewater is managed by the developer and paid for by the residents.

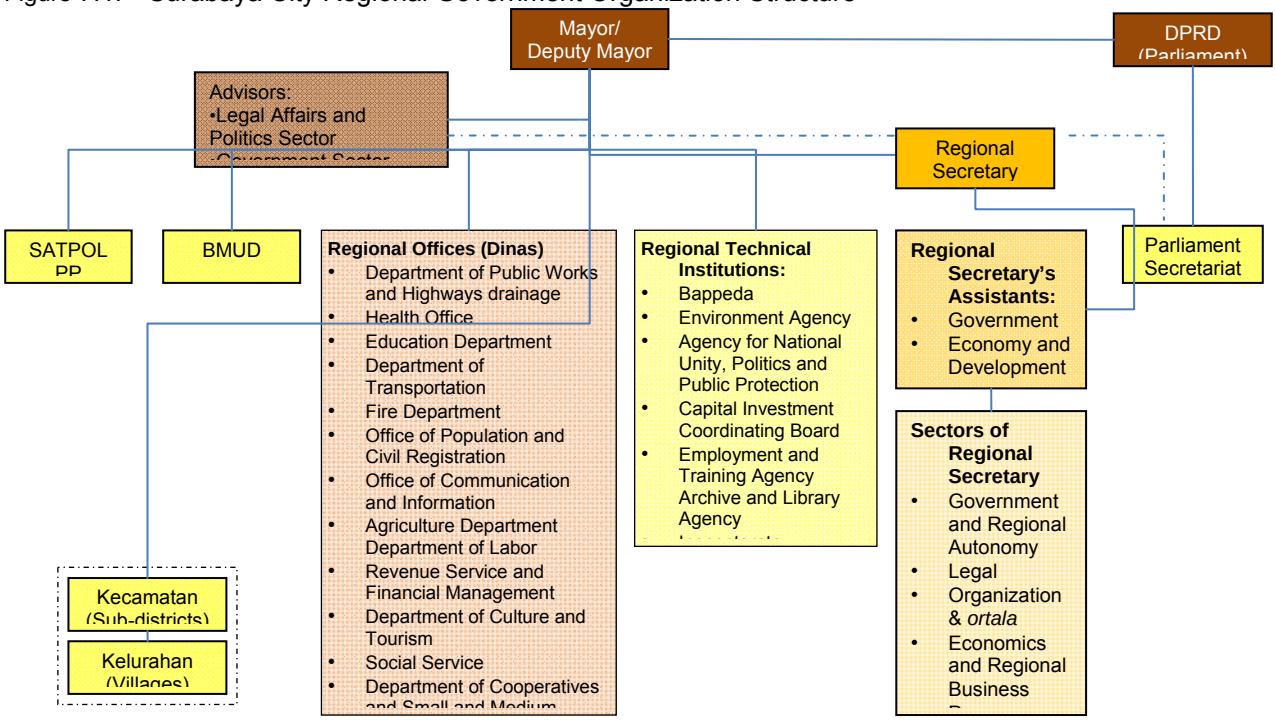
Responsibility for grey water services is with the Roads and Drainage Department (*Dinas Bina Marga dan Pemutusan*). As far as investment is concerned, the central government is responsible for primary drainage, the provincial government for secondary drainage, and the city government for tertiary (including grey water) drainage. O&M for all drainage categories is the responsibility of the city. However, in practice, tertiary draiange O&M is left almost entirely to the community.

### 7.1.2 Current institutional arrangements

The principal regulatory framework for prescribing regional government management and organisation is contained in PP No 41/2007. This PP derives from a requirement in Law No 32 on Regional Government (Section 128). It provides the fundamental responsibilities, tasks and functions (*TUPOKSI*) of regional government departments; it sets out the regional government structure and apparatus, in terms of secretariat, service and technical institutions and their divisions and sub-divisions, as well as stipulating management positions and grades which determine management compensation; it also provides criteria (size of population, territorial area and budget) for determining the size of a regional government; for example, Surabaya City may have a regional government secretary (the senior civil servant in local government), up to 4 assistant secretaries, 18 service departments and 12 technical departments (Surabaya has the full allowed complement of assistant secretaries and service departments, but only 10 technical departments).

Based on PP 41/2007, the regional government structure of Surabaya City was established by *Perda*) No 08/2008, subsequently superseded by *Perda* No 12/2009. The regional government organisation structure is shown in Figure 7.1.

Figure 7.1: Surabaya City Regional Government Organization Structure




Sumber: Perda No 8/2008 dan Perda No 12/2009

Source: Perda No. 8/2008 and Perda No. 12/2009

### 7.1.3 Existing institutional arrangements for the wastewater sector

Four (4) Surabaya City government service departments (*dinas*) and one (1) technical department (*badan*) currently have functions and responsibilities (*TUPOKSI*) for wastewater management. They are:

1. **The Cleansing and Parks Department (*Dinas Kebersihan dan Pertamanan* – DKP)**. This department has responsibilities for preparing decrees relating to policies and development planning and implementation for wastewater in connection with sludge collection, transport and treatment.

   DKP manages and operates the only wastewater physical infrastructure in the city – the septage treatment plant (IPLT Keputih Sukolilo) for disposal of domestic septic tank sludge - through a Technical Service Unit (UPTD-IPLT) with a staff of 31. The capacity of the plant is severely underutilised (about 27% effective) and it is heavily subsidised.

   The regulatory framework for UPTD-IPLT Keputih is Section 22, Sub-Section 1 of *Perda* No 08/2008, as amended by *Perda* No 12/2009 on Surabaya City Regional Government Organisation and Mayoral Decree (*Perwali*) No 70/2008 on the Establishment of UPTD-IPLT Keputih Sukolilo. The figure of Appendix G.1 shows the position of the UPTD within DKP and the figure of Appendix G.2 its position within the Surabaya City regional government structure as a whole.

2. **The Human Settlements and Spatial Planning Department (*Dinas Cipta Karya dan Tata Ruang* – DCKTR)**. DCKTR has wastewater responsibilities in connection with housing and spatial planning in accordance with minimum service standards and technical policy.

   It is therefore surprising that the IPLT is managed by DPK, whose primary function is the management and operation of the solid waste (*sampah*) service, instead of DCKTR. A possible explanation is that the human waste sludge (*lumpur tinja*) is classified as “special waste” (*sampah khusus*).

3. **The Health Department (Dinas Kesehatan – *DinKes*).** Its responsibilities are related to environmental heath, and therefore planning and implementation of campaigns and support to the community in relation to hygiene improvements and disease prevention caused by unsanitary wastewater conditions and practices.

4. **The Roads and Drainage Department (*Dinas PU Bina Marga dan Pematusan – DBMP*)**. The Drainage Division in this department is responsible for management and implementation of drainage construction and planning.

In addition; **The Environment Department (*Badan Lingkungan Hidup – BLH*)** has a co-ordinating role with the four (4) city government departments described above, with special responsibilities for environmental impact.

In addition to the above service and technical units, there are other units indirectly involved with wastewater management, according to their *TUPOKSI*, i.e. the city government’s secretariat office (*SekDa*) with its legal and organisational responsibilities, BAPPEKO with its function of integration and coordination of city development planning (including its co-ordinating tasks for wastewater programmes), the Personnel Department (*Dinas Kepegawaian*) and the district (*kecamatan*) and sub-district (*kelurahan*) administrative organisations.

To conclude, the relationship of all these units is based on *TUPOKSI* stipulated in the following regulations:

- *Perda* No 08/2009 on Surabaya City Regional Government Organisation, as amended by *Perda* No 12/2009
- *Perwali* No 70/2008 on the UPTD-IPLT Keputih Sukolilo Organisation within DKP
- *Perwali* No 93/2008 on the Duties and Functions of BAPPEKO
- *Perwali* No 94/2008 on the Duties and Functions of the *kecamatan*
- *Perwali* No 95/2008 on the Duties and Functions of the *kelurahan*
- *Perwali* No 96/2008 on the Duties and Functions of the Regional Government Secretary
- *Perwali* No 53/2010 on the Details and functions of the Service (*Dinas*) Departments
- *Perwali* No 54/2010 on the Details and functions of Technical (*Badan*) Departments

Details of current *Tupoksi* for wastewater services are given in Appendix G.3.

The above summary of *TUPOKSI* indicates that wastewater services are highly fragmented, involving a large number of institutions without any common thread which might provide a pathway towards a comprehensive approach to domestic wastewater management. This report proposes institutional arrangements to provide such an integrated approach.

There have been plans for an integrated institutional approach to domestic wastewater management since the Surabaya SSDP Study of 1997, which recommended the placement of an “embryo” PD-PAL within PDAM Surabaya. The Surabaya City Sanitation Master Plan (RISPKS) of 2008 noted that there had been no measures in the intervening period to establish a dedicated institution to manage domestic wastewater and advised the setting-up of a Technical Service Unit (UPT) to be located on one of the service departments (*dinas*). The USAID-sponsored Strategic Sanitation Plan for Surabaya City (2009) and the Surabaya City White Book (2010) both recognise the lack of such a unit, with the latter stating that one would be established by the end of 2013. Consequently, the proposals made in this chapter of the Master Plan are intended to get this process underway and to end the present fragmentation of responsibilities.

## 7.2 Leadership by the city executive and legislature

Good governance is a recurring theme in the FOPIP/LIDAP process throughout the sections of this capacity-building report. In developing a definition of “good governance” has been taken from the Ottawa (Canada) Institute of Good Governance, which states that “good governance is the process by which stakeholders articulate their interests, their inputs are absorbed, decisions are taken and decision-makers are held accountable.” This definition has been taken into account whilst defining and developing a series of specific activities and FOPIP/LIDAP actions to implement them.

It is therefore appropriate that the initial action in making a commitment of good governance to the wastewater sector through endorsement of the Master Plan and its objectives should be taken by the city’s executive, including the mayor, and its legislative branch.

The mayor and the regional government legislature (DPRD) should take the lead in publicly committing to the Master Plan and its strategic objectives. The most suitable time and place for doing this would be in the Mayor’s annual accountability speech and policy address to and its adoption by the DPRD, accompanied by extensive media coverage. The first occasion for this would be the adoption of the Master Plan and its

incorporation in the Medium-Term Regional Development Plan (RPJMD) and the Investment Plan (RPIJM) before the end of 2011. Successive annual events would be used to report on the progress made in implementing the Master Plan, and to recommend any necessary updates to it, also for incorporation in the RPJMD and RPIPD.

The vision for the wastewater sector could be defined as “progress towards a sustainable environmentally friendly wastewater condition in Surabaya by 2015”, thus implying that the sector will be managed with a focus on environmental control and health. Based on the city’s vision, the mission statement should include the following:

- Creating a policy of progressive and sustainable wastewater management in co-operation with the community;
- Integrating wastewater management with good drainage management in a sustainable manner with community participation;
- Improving public awareness of the link between good wastewater management and good health;
- Increasing community and private sector participation in managing wastewater;
- Improving the quality and quantity of wastewater facilities and utilities towards a greener and more healthy environment;
- Setting up rules and regulations to enhance and sustain environmental quality;
- Improving the institutional management of wastewater through principles of good governance by means of establishing an office for a wastewater regulator and a stakeholder committee representing the interests of off-site customers and the rest of the community with their on-site and intermediate wastewater facilities.

The mission statement will be advanced during the first phase of the Master Plan through the accomplishment of a series of strategic objectives, including:

- Construction of two (2) off-site wastewater facilities, with small bore sewered systems and wastewater treatment plants;
- Technical support for on-site and community intermediate facilities and tertiary (grey water) drainage;
- Decreasing open defecation by 50% by 2015 towards an Open Defecation Free (ODF) condition in accordance with Indonesia’s commitment to the Millennium Development Goal (MDG) of reducing to about 50% of the 2015 population those people without proper access to environmentally-supportive wastewater facilities;
- Increasing the volume of sludge collected from on-site wastewater facilities, to be treated in an environmentally correct manner;
- Increased budgets for physical development of the sector;
- Providing the institutional mean to deliver the above services through financial support, appropriate capacity-building measures and good governance..

## 7.3 Adoption and updating of the master plan

The following steps should be taken for adoption of the Master Plan and its updating

- A special team will prepare the initial draft of the Mayor's vision and mission statement, employing recommendations from Chapter 2.3.1 above.
- Another special team will draft a *perda* for the adoption of the Master Plan and its placing in the RPJMD and the RPIJM;
- Institutional successors to the UPTD-IPLT Keputih Sukolilo (UPTD Plus, embryo BLU-D and full BLU-D) will draft progress reports on the development of the wastewater sector for incorporation in annual policy speeches by the mayor;
- The successors to the current UPTD will be responsible for drafting annual updates to the Master Plan and incorporation into the RPJMD and RPIJM.

Table 7.1 summarises the regulatory process required for commitment to and continuing support of wastewater policy.

Table 7.1: Schedule of Perda/Perwali Required for Commitment to Wastewater Policy

| Proposed Actions | Target Date | Regulatory Action |
|---|---|---|
| Establish team to prepare adoption of Wastewater Master Plan | Sept 2011 | New perwali required |
| Adoption of the Wastewater Master Plan | October 2011 | New perda required |
| Revisions to RPJMD to incorporate provisions of Wastewater Master Plan | October 2011 | New perda still at draft stage |
| Annual revisions to wastewater component of RPJMD | 2012 and thereafter as required | Revise October 2011 decrees |

## 7.4 Selection of proposed operator/manager

### 7.4.1 Sewered system service providers in operation in Indonesia

At present, sewered wastewater systems elsewhere in Indonesia are operated by the following regional government service providers.

| Operator | Regional Government(s) |
|---|---|
| Dinas | None |
| UPTD | DKI Yogyakarta (UPTP), Surabaya |
| BLU-D | Greater Denpasar |
| PDAM | Balikpapan, Bandung, Cirebon, Medan, Solo |
| PD-PAL | Banjarmasin, DKI Jakarta |

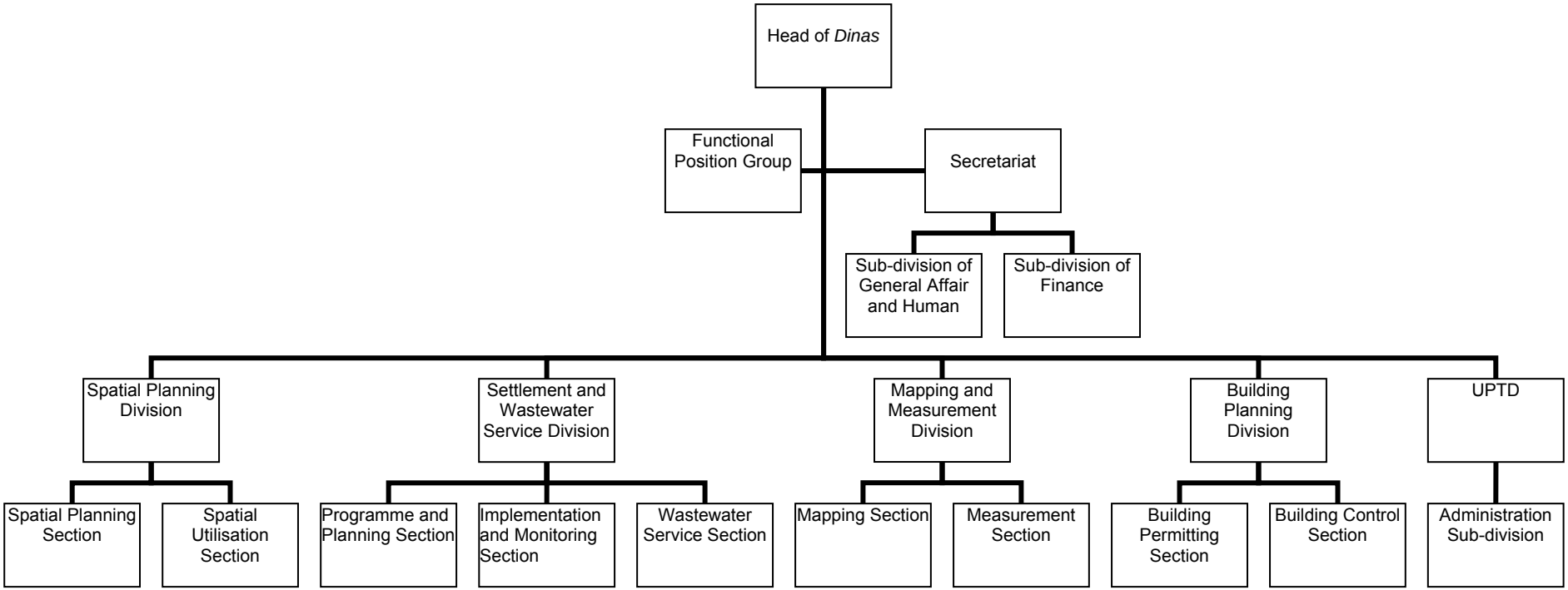
It should be noted that all PDAM operators were appointed before the issue of PP 23/2005 and Ministry of Home Affairs Decree 61/2007, both of which are concerned with BLU and BLU-D.

A brief description of the institutional options available to organise the delivery of the wastewater service is given in Appendix G.4.

### 7.4.2 Conceptual approach to future wastewater institutional arrangements

As a sector which is going to be almost completely transformed, wastewater management will be involved in many environmental issues which will have to be solved by reaching out to the community through pro-environmental actions which will attract the support of large sections of the community. In an era of regional autonomy, wastewater institutional arrangements will require vision, political initiative and goodwill from the city's chief executive, its legislative body and senior government officials, since appropriate regulatory measures will be much needed to support the programme. Interdependency between these various players is essential to ensure that appropriate synergy is created which will overcome the bureaucratic, conventional approach to the attainment of conservatively-determined physical targets which is unlikely to guarantee sustainability of the sector. Figure 7.2 illustrates this approach.

Figure 7.2: Conceptual Approach to Wastewater Master Plan Institutional Arrangements 2011 – 2030



In order to operationalise the new tasks and responsibilities of the upgraded wastewater sector, the existing UPTD will require significant capacity improvements if it is to achieve its long-term goals as illustrated in Box 7.1, irrespective of the choice of "full" operator. These capacity-building measures will be introduced through step-by-step approaches, including: (i) improvements oriented towards focused tasks and responsibilities (*TUPOKSI*) aimed at efficient management control of a city-wide wastewater service, and (ii) recruitment of personnel with capabilities to fit the task and responsibility requirements. Both of these approaches must take into account performance indicators.

Box 7.1 Indicative Long-Term (2011-2030) Institutional Reforms for the Wastewater Sector

- Establishment of an operator with accountability for implementing the piped sewerage service and the environmentally friendly collection and disposal of human waste sludge;
- Introduction of building permit regulations with appropriate technical standards for wastewater disposal which reflect environmental needs as the wastewater sector is progressively developed;
- Provision of capacity building to establish a regulator for the wastewater sector in accordance with prevailing laws and regulations;
- Improvement of community awareness of the importance of wastewater management;
- Regular preparation of regular strategy and business plans
- Introduction of retributions and recourse to other sources of revenue (such as property taxes) to fund wastewater sector recurrent expenditure (operations, maintenance, administration, community awareness, campaigns, etc);
- Promotion of a full cost-recovery tariff for non-domestic sewered premises;
- Assistance to low-income households for wastewater management
- Establishment of stakeholder committees
- Introduction of enforcement procedures with sanctions for transgressors
- Development of benchmarks
- Encouragement to the private sector to invest in wastewater management infrastructure

### 7.4.3 Selection process for the sewer system operator

A series of presentations was given to senior officials from technical and executive departments of Kota Surabaya, as well as from the POKJA, to allow them to assess the strengths and weaknesses of the potential candidates. Appendix G.5 compares the candidiates by means of a set of relevant institutional issues. In addition, guidance was provided in respect of MPW Decree 16/2008 (concerning National Policy and Strategy for the Development of Domestic Wastewater Management) which, inter alia, recommends the appointment of a semi-autonomous operator and a separate regulator. This would preclude the selection of either a Dinas or a UPTD. Officials were also advised that, in the event of a decision being made to establish a separate division within the PDAM as the operator, the central government would expect any subidies to the operator to be provided by the city government, i.e. that there should be no cross-subsidies from the water supply division tariff revenues.

On 1 February, 2011, city government officials selected a BLU-D as the operator, setting the end of 2017 as the time when the institutional process of establishing a "full" BLU-D would be complete, i.e. in a suitable condition to assume the operation of the off-site sewered system and wastewater treatment facilities as well as supervision of intermediate and on-site wastewater management.

The selection of a BLU-D was made on the basis of the following considerations:

- PDAM's organisation structure can be reasonably replicated in a separate wastewater division with separate fixed assets, personnel and accounting systems;
- PDAM's experience of managing fixed assets and O&M requirements would lead to a more rapid development of sewered wastewater services; but
- PDAM is profit-oriented, whilst a BLU-D is not necessarily a "for profit" agency;
- Wastewater and sanitation are social services with an important focus on environmental control and health, and therefore the BLU-D profile is more appropriate;
- Management and supervision of community on-site and and intermediate wastewater disposal facilities may not be a suitable fit for a BLU-D structure.

In the Draft Capacity Building Plan, the intention of the city government was to transfer UPTD-IPLT Keputih Sukolilo to the Human Settlements and Spatial Planning Department (*Dinas Cipta Karya dan Tata Ruang*), as per the meeting of February 1, 2011, at which the city government originally decided to select a BLU-D as the operator of the wastewater services sector. This intention was reversed at a workshop to discuss the Draft Master Plan on June 13, 2011. This means that only three (3) regulatory stages are required to establish the full BLU-D, as opposed to four (4) stages given in the Draft Capacity Building Plan (Chapter 7.5 below).

## 7.5 Institutional arrangements for establishment of the wastewater sector

The selection of a BLU-D for the wastewater operator/manager, already accepted in principle by Surabaya City and awaiting ratification by the mayor, which will be established through a series of upgrades of the existing wastewater services unit (UPTD). The regulatory process whereby wastewater management is progressively converted from operation of a sludge treatment plant to operation of off-site conventional and off-site intermediate small bore sewered systems with wastewater treatment plants, as well as oversight of all other wastewater physical infrastructure in the city, will be carried out in three (3) stages. Table 7.2 below summarises the regulatory process and provides a proposed schedule for the various pieces of regulation. All stages of these institutional arrangements are clearly set out in existing central government regulations and decrees which can be mirrored by the issue of a series of parallel regional government *perda* and *perwali* decrees.

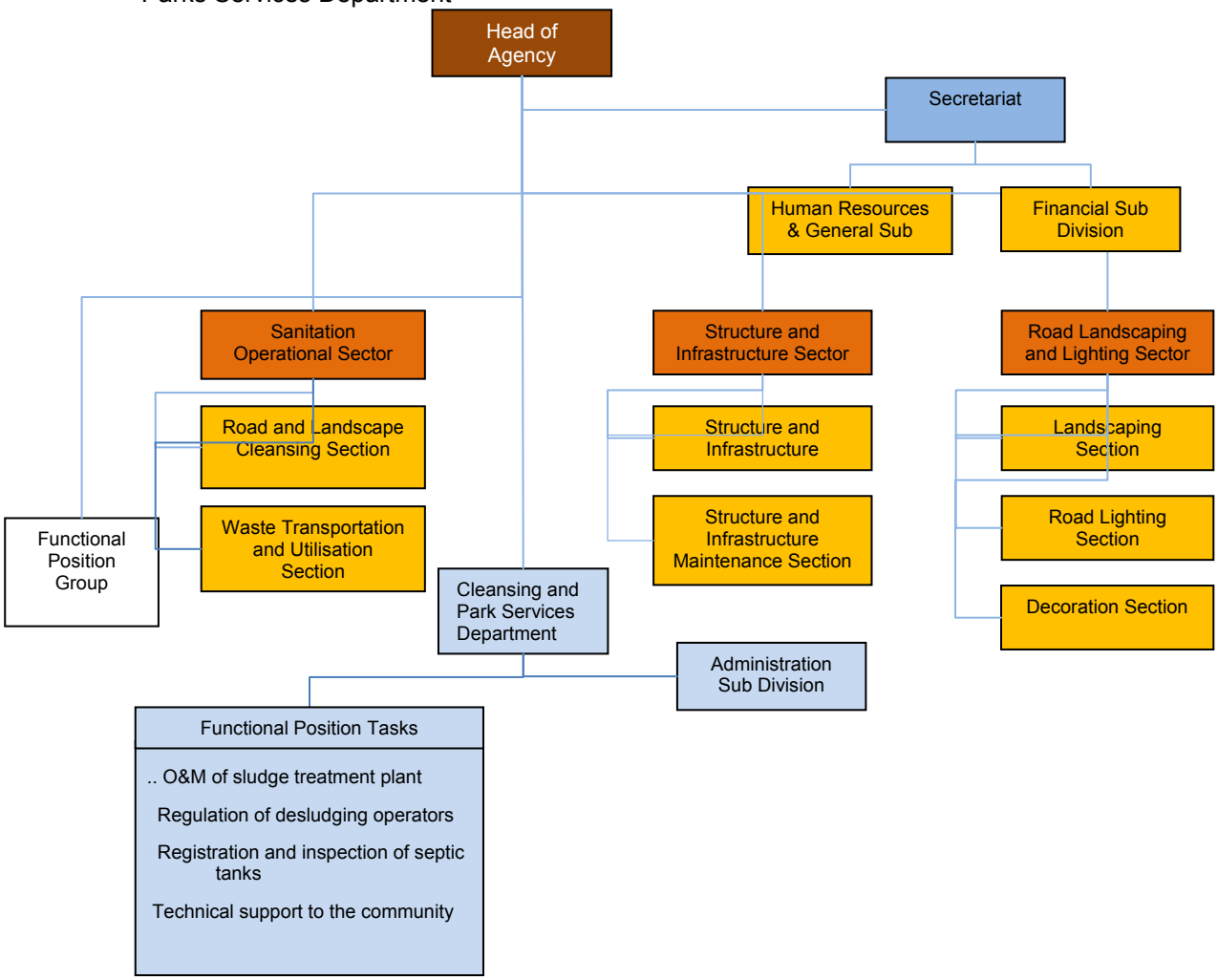
**The first stage** of the institutional process involves an upgrading of the existing UPTD-IPLT by means of the establishment of a wastewater services technical unit (*UPTD layanan air limbah* or UPTD Plus) with increased functions and responsibilities.

This unit will also be located in DPK and will report to the head of the department. In addition to management of the IPLT, the UPTD Plus will progressively manage and co-ordinate the licensing and

operation of the private sector vacuum truck and motor cycle operators, begin the registration and inspection of on-site septic tanks, provide guidance to community and private residential estate management of intermediate systems and support grey water environmental control activities.

According to Section 29, Sub-Section 2 of PP No 41/2007, a UPTD should consist of two (2) units, one functional and the other administrative. The head of the functional unit would have the structural position of Echelon IVA and the head of the administrative unit that of IVB, as per Section 35 of PP No 41/2007. Figure 7.3 shows the proposed organisation structure of the UPTD Plus.

Figure 7.3: Organisation Structure UPTD Wastewater Services (UPTD Plus) 2012-2014 Cleansing and Parks Services Department

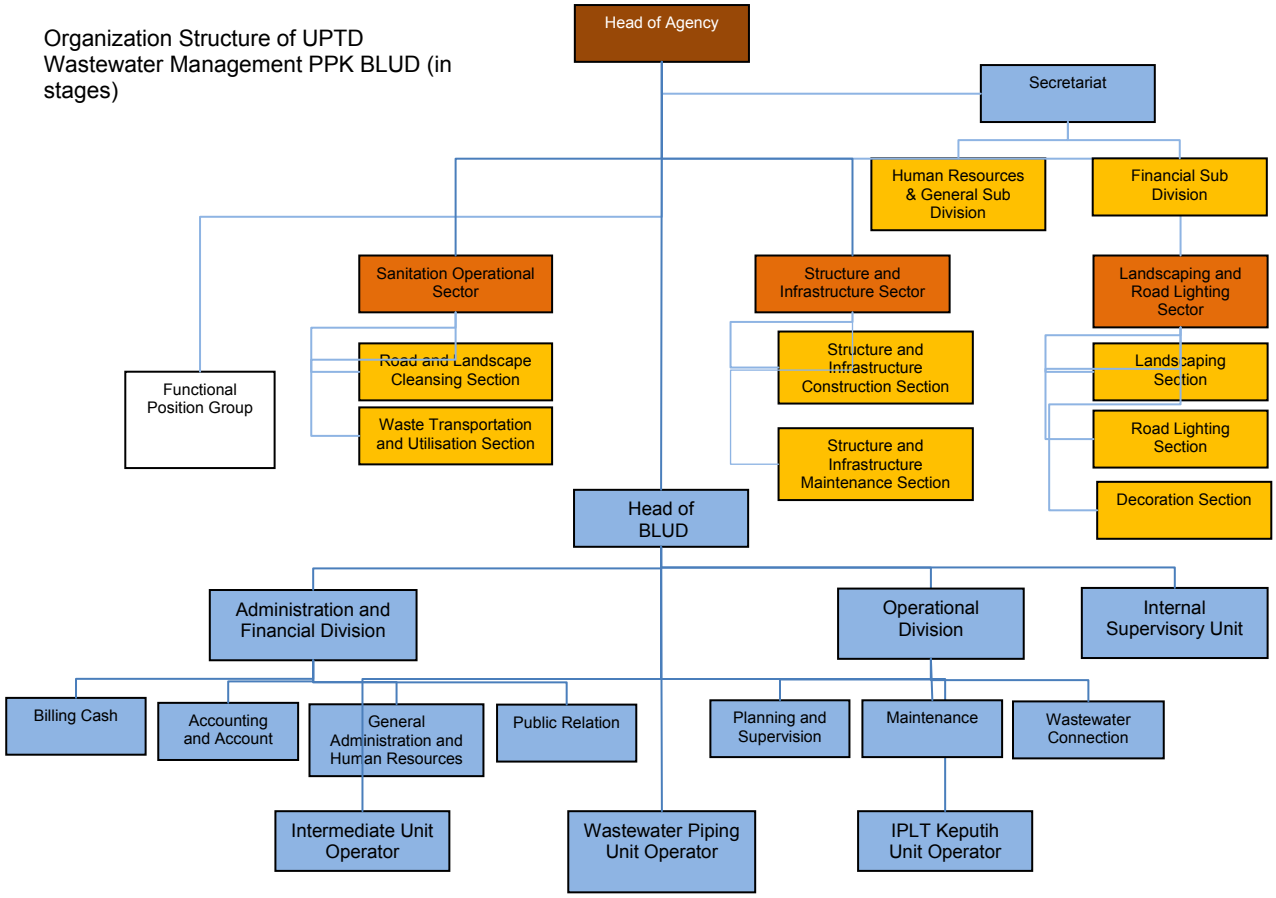



These arrangements would be authorised by a new *perwali* and would be put in place by the end of 2011. It is anticipated that the UPTD Plus will require three (3) years of capacity-building and development before the second stage of the institutional process can be regulated and implemented.

**The second stage** involves the upgrading of the UPTD Plus into an embryo (*bertahap*) BLU-D (UPTD *Pengelola Air Limbah Domestik PPK BLU-D*), reporting to the head of DPK. This step implies that the UPTD Plus will have met the substantive and technical requirements to become a full BLU-D, but not the administrative requirements. Services to the community will be much the same as in the second stage, but will be improved, extended and consolidated. In addition, responsibilities will be increased through improvement of human resources development and capacity building so that the embryo BLU-D will be able to operate off-site intermediate small bore sewered systems and can also prepare for the establishment of a full BLU-D which will operate off-site conventional sewered systems with wastewater treatment plant to be implemented in the second phase of the Master Plan.

The embryo BLU-D will be managed in accordance with PP No 23/2005. It is proposed that this process would take place by the end of 2014 by means of a revision to the 2011 *Perwali* issued to implement the first stage. Figure 7.4 shows the proposed organisation structure of the embryo BLU-D. The formal establishment of the embryo BLU-D for Wastewater Services will be mandated through the issue of a *perwali* based upon Perwali No 41/2009 concerning the Financial Management of a BLU-D.

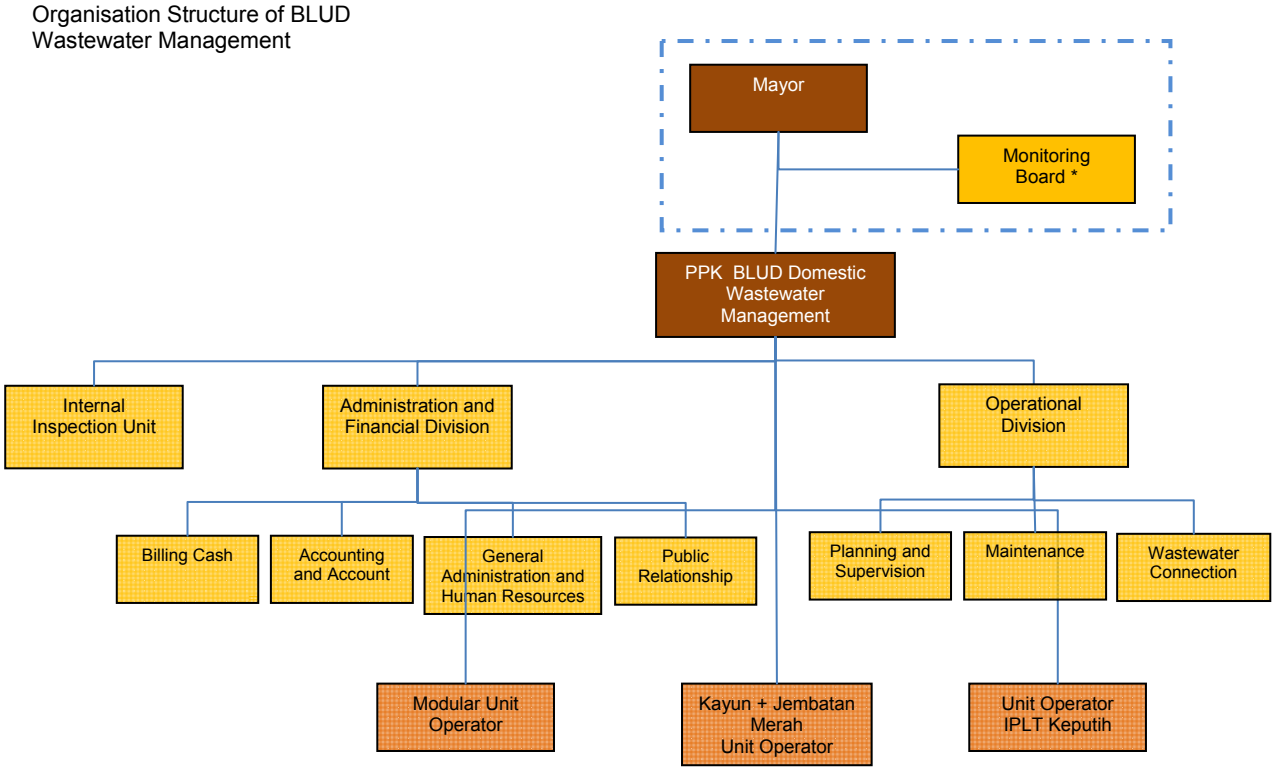
Figure 7.4: Organization Structure UPTD Wastewater Management PPK BLU-D (BLU-D Embryo) 2015-2017 Cleansing and Parks Services Department



**The third and final stage** concerns the formal establishment of a fully-fledged BLU-D reporting directly to the mayor as the operator of off-site conventional and off-site intermediate small bore sewered systems with wastewater treatment plants, as well as the manager or facilitator of all other wastewater physical facilities, with substantive, technical and administrative responsibilities, as per Section 4 of PP No 23/2005.

The organisational structure of the BLU-D (both embryo and full) will be in accordance with Section 34 of MOHA Decree No 61/2007 concerning Technical Guidance on the Financial Management of BLU-D. It will consist of a technical unit and a financial unit. The BLU-D will be headed by a manager in accordance with Section 34 of MOHA Decree No 61/2007. A major feature of the organisation structure is the proposed establishment of a Customer and Community Relations (*Hubungan Pelanggan dan Masyarakat*) Sub-Unit, attached to the technical unit. If the regulatory structure had allowed, it would have proposed as a unit on its own, such is the importance attached to the function. Figure 7.5 shows proposed organisation structure of the full BLU-D. Remuneration of civil service staff will be determined in accordance with Section 36 of PP No 23/2005

Figure 7.5: Organization Structure Satuan Kerja (SKPD) Wastewater Management PPK BLU-D (Full BLU-D) 2018 - , Reporting to the Mayor of Surabaya City




The establishment of the full BLU-D would be finalised by the end of 2017 through the issue of a revision to the *perwali* for the embryo BLU-D. The three-year interval between establishment of the embryo BLU-D and of the full BLU-D is required by Section 22 of *Perwali* No 22/2008 concerning Administrative Procedures for Proposing and Establishing a Work Unit (*Satker*) for Financial Management of a Regional Government Service Agency (BLU-D), which in turn is based on MOF Decree 07/2006, as amended by MOF Decree No 119/2007, and ultimately on Section 5, Sub-Section 6 of PP 23/2005.

Table 7.2: Schedule of Perda/Perwali Required for Institutional Arrangements for Wastewater Management

| Proposed Actions | Target Date | Regulatory Action |
|---|---|---|
| Establish POKJA to develop framework for regulatory process | October 2011 | New Perwali required |
| Establish wastewater services UPTD (UPTD Plus) in Dinas Kebersihan dan Pertamanan | December 2011 | New Perwali required |
| Establish wastewater services UPTD Plus as embryo BLU-D in Dinas Kebersihan dan Pertamanan | December 2014 | New Perwali required |
| Establish full wastewater services BLU-D | December 2017 | New Perwali required |

## 7.6 Responsibilities of the wastewater operator/manager

The selection by Surabaya City of BLU-D as the operator/manager of wastewater services will facilitate an integrated approach to the management of the entire physical infrastructure in the sector, including a strong focus on the social aspects of the services. The BLU-D will directly manage the conventional and intermediate small bore sewered systems, as well as the collection (through private operators) and disposal of human waste sludge, whilst it will also provide technical supervisory support for community intermediate and on-site systems. In addition, it will collaborate with other soft service deliverers to guide the community, especially low-income households, towards higher standards of hygiene and environmental control. The summary descriptions below of services to be provided by the full BLU-D operator/manager are divided into on-site, community intermediate, conventional and intermediate small bore sewered systems, and grey water disposal.

### 7.6.1 On-Site wastewater services

**Registration and Inspections**

- Identify locations of septic tanks and leaching pits; prepare, maintain and update a central register, divided into household, community, non-household (schools, markets, etc) and commercial categories. It is accepted that it may not be possible to locate all such facilities or to access them with vacuum equipment;
- Ensure that all new buildings have adequate provisions for on-site human waste disposal (toilet construction, waste pipes and septic tanks), that all such facilities are registered, and that approvals are signed off by the operator/manager and returned to the Spatial Planning Division of DCKTR before building permits (IMB) are issued;
- Carry out periodic inspections of all such facilities and report on condition; the report to be recorded on the central register, to include recommendations on requirements to empty or repair septic tanks, provision of subsidies or micro-credit to low-income families on high-density areas to upgrade existing facilities, etc;
- Advise the Health Department on areas with unsanitary wastewater conditions so that intensive focus can be provided to communities on household hygiene;
- Report to the regulator any breaches of environmental regulations;
- Deploy environmental cadres to assist in the provision of the above services as necessary and in accordance with capacity-building progress;

- Liaise with community heads (RW/RT).

**On-Site Facilities Desludging and Sludge Disposal at the IPLT**

- Organise vacuum truck and motor cycle desludging as a city government service; operators to remain in the private sector, but will be licensed and their services contracted for by the operator/manager through a standard service contract, with fees regulated by *perda* and published, and based on distance travelled and volume of sludge transported;
- Report to the regulator any breaches of environmental regulations;
- Management, operation and maintenance of the IPLT;
- Authorisation of payments by the city government treasury on production by private sector operators of receipt certifying delivery of sludge to the IPLT.

### 7.6.2 Community intermediate system wastewater services

- Identify locations of all community facilities; prepare, maintain and update a central register;
- Conduct periodic inspections of community facilities; provide technical advice to community supervisors on operation and maintenance;
- Check accounting records to ensure accountability for user fees;
- Identify and make recommendations for installation of new community facilities in areas currently un-served or inadequately served, or the refurbishment of existing facilities; make required budgetary provisions;
- Conduct periodic inspections of intermediate systems and disposal facilities on private residential housing estates and ensure that O&M conditions are in accordance with the building permit;
- Report to the regulator any breaches of environmental regulations;
- Deploy environmental cadres to assist in the provision of the above services as necessary and in accordance with capacity-building progress;
- Liaise with community heads (RW/RT).

### 7.6.3 Off-Site conventional and intermediate wastewater systems

- Operation and maintenance of conventional and intermediate small bore sewered systems, including periodic inspections of mains and manholes;
- Operation and maintenance of the wastewater treatment plant facilities (IPAL);
- Observance of all technical and environmental standards;
- Formulation of technical plans for improving and expanding the system;
- Commercialisation of tariffs for non-household and non-social customers;
- Establishment of policies for connection fees and billing and collection procedures;
- Provision of affordable solutions to low-income households with regard to connections, user tariffs and service charges;
- Accountable management of financial and administrative systems in accordance with regulations;

- Responsiveness to customer attitudes and complaints in order to enhance customer satisfaction, including inspections of tertiary mains and connections;

### 7.6.4 Grey water disposal services

- As part of periodic inspection duties, check functionality and condition of tertiary drainage; record observations in a central register;
- Report problems to responsible city government agency, e.g. blockages, construction and repair problems;
- Advise households community heads (RW/RT) on the need for and methods of corrective action in the case of minor repair problems;
- Provide guidance to households and community heads on the need to maintain drainage in good operating conditions in the interests of hygiene and environmental control;
- Provide guidance to households and community heads on simple repair methods;
- Advise *Dinas Bina Marga dan Pematusan* of needs for new construction of tertiary drainage;
- Report to the regulator any breaches of environmental regulations;
- Deploy environmental cadres to assist in the provision of the above services as necessary and in accordance with capacity-building progress;

## 7.7 Office of the regulator

The need to establish an independent regulator to ensure an equitable balance between the requirements of the semi-autonomous wastewater operator/manager, the community and the executive and legislative city authorities is absolutely essential to avoid conflicts of interest and contribute to good governance. The city administration has selected a BLU-D, a not necessarily for profit agency as the operator/manager; therefore the regulator should have a different perspective to that of a supervisory board (*badan pengawas*) of a profit-mandated BUMD such as a PDAM where commercial considerations prevail. The city administration has recognised the need for a more socially and environmentally-oriented supervisory body by nominating the Environment Department (*Badan Lingkungan Hidup*) as the prospective regulator.

The recent law on the Protection and Management of the Environment (Law No 32/2009) places much responsibility on regional governments for sustaining and improving the quality of the environment and advocates a prominent role for participation by the community. It makes provision for the appointment of a regulator within the regional government apparatus (Section 15). However, the necessary central government implementing regulations (PP) have not yet been issued, although all PP required by the law were supposed to have been completed by the end of 2010.

In addition, the office of the regulator should have the responsibility of ensuring that the provisions of Law No 25/2009 on Public Services are carried out in accordance with the service quality requirements laid down for the wastewater sector. It is noted that, under this law, the community has the right to its own supervisory institution for the oversight of public services (Section 39.).

Experience of the regulator in Indonesia has, for the most part, been limited to the economic and operational functions stipulated in private sector participation (PSP) infrastructure arrangements, with the objectives of:

- Ensuring that customers receive essential goods and services on a sustainable and affordable basis;
- Encouraging PSP in the development of an infrastructure to provide these goods and services

These functions essentially concern the setting or approving of tariffs and service charges in return for the operator/manager meeting defined indicators for service deliveries, i.e. indicators over which the operator/ manager has a substantial measure of control. However, given the need for tariff s not to exceed a 2% household income ability-to-pay factor and thus the requirement for a public service obligation to be provided by the city government in order to ensure full recovery of recurrent O&M costs, the tariff issue will probably be of more concern to the city government executive and legislature than to customers. Consequently, in addition to financial and operational benchmarks, some of these performance indicators must relate to environmental and social issues which ought to be of major concern to the regulator of a wastewater management service, but which, to date, have not figured significantly in Indonesia within the regulatory context.

Service delivery standards are defined in a set of internal performance indicators (i.e. annual targets for the operator/manager), a proposal for which is given in section 7.8.1. These would form the basis of any performance contract between the regional government (as the employer) and the operator/manager. Compliance with these indicators would be monitored and evaluated by the regulator, whose decisions and publicised report would be further shaped by discussions with the operator/manager and the stakeholder committee.

In addition, the regulator would participate with the operator/manager and stakeholder committee in the setting and review of a set of external wastewater indicators which would mainly relate to social, health and environmental issues. External wastewater indicators are substantially outside the control of the operator/manager but are extremely relevant to the environment and health of the community. They are, therefore, of much importance for the community and the city executive and legislative authorities. A set of proposed external indicators is given in section 7.8.3.

A further responsibility of the regulator should be the enforcement of sanctions against transgressors of the law on the environment. The ability of the regulator to discharge this task will depend on the contents of the yet-to-be-issued implementing regulations on the function of the regulator, which will be reflected in the decrees (*perda* and *perwali*) which will be required to make the PPs operational at regional government level. Ideally, these will include the need for public accountability of city government institutions, private businesses and individual contraveners of the law. The responsibilities of the operator/manager in section 7.6 contain a provision for reporting any breach of the law to the office of the regulator for appropriate action.

To summarise, the role of the wastewater regulator is seen as follows:

- **Service standards.** The regulator should participate in the setting of standards for services to be provided by the operator/manager.
- **Advice on policy.** The regulator should review inputs from the operator/manager, stakeholder committee and the city government on policies to be formulated and implemented for the improvement of wastewater service deliveries.

- **Review, issue or cancel approvals.** Based on environmental, social and health considerations, the regulator should make decisions on licensing for issues such as locations for wastewater and septage treatment plants, as well as the methodologies and technologies employed for treatment and disposal.
- **Tariffs and service charges.** The regulator should review tariffs and service charges and take into consideration the views of the stakeholder committee; however, given the need for a PSO to support O&M full cost recovery, this will be of more concern to the city executive and the DPRD (ref Chapters 8.4 and 8.8)
- **Performance.** The regulator should monitor and evaluate the performance of the operator/ manager, either by means of reports submitted by the operator/manager, information from the stakeholder community and other representatives of the community, or independent survey by the regulator. The evaluation of performance may impact, positively or negatively, upon capital investment in the sector and compensation to the staff of the operator/manager.
- **Stakeholder participation.** The regulator should encourage stakeholder participation in regulatory decision-making by convening meetings on regulatory issues, at which stakeholder comments would be actively solicited.

The delay on the part of the central government in issuing implementing regulations on the role and functions of the environmental regulator, together with the absence of any relevant regulatory precedent in Indonesia, do not provide a firm foundation for identifying and defining the role of the regulator for a regional government service delivery. In such a context, there is currently no basis on which to propose a truly independent office of the regulator. The selection of the Environmental Department of the city government as the location for the office of the regulator represents a compromise between the ideal and the practical. Collaboration between the city and provincial governments may be necessary to reinforce the role of the wastewater regulator in Surabaya.

The current regional government decrees (*perda*) No 07/1992 on the Granting of Building Permits and No 07/2009 on Buildings have been reviewed for clarity and adequacy of sections concerning wastewater disposal arrangements required for the issue of building permits. Overall, the contents of the decree are satisfactory for toilets, waste pipes and individual septic tanks, but there is a need for additional regulatory provisions to manage the transition from almost universal on-site systems to the progressive introduction of off-site conventional and intermediate sewered systems.

A revision to *Perda* No 07/2009 is required to include wastewater disposal technical standards and arrangements for off-site conventional and intermediate sewered systems (including intermediate small bore sewer systems on private residential housing estates), and community intermediate installations (MCK Plus and SANIMAS). The revision should cover not only individual household premises, but also commercial establishments and light industrial units.

It is recommended that the Operator/Manager be given authority to sign off on the adequacy of wastewater arrangements for all new building permits. This change to the process may need an amendment to *Perda* No 07/1992.

## 7.8 Performance indicators

### 7.8.1 Internal performance indicators

Internal performance indicators are used by an organisation to monitor actions for improvement which are within the control of the organisation's management. The basic concept is to identify the mission, objectives, customers and traceable outputs to find the best indicators so that the process becomes a systematic tool to foster continuous improvement.

The performance indicators selected should be an appropriate blend of management, operational and financial results, each of which is compared with a target within a single concise report. This is commonly known as the balanced scorecard. The report is not meant to replace traditional management reports, but rather a focused, succinct summary which captures the information most relevant to its recipients.

In the wastewater sector, the balanced scorecard report should be studied by the operator/manager itself and the regulator, in consultation with the city government executive and legislature and the stakeholder committee, to determine the financial, legal, technical, environmental, management and institutional implications of performance indicator outcomes. This will enable all parties to consult and decide what corrective actions, including policy changes, are needed to remedy unsatisfactory performance and also to yield the expected benefits. The report can also be used by the regulator and the city government to determine the future pattern of investment in the wastewater sector and to provide incentives, including material incentives, to the staff of the operator/manager.

The operator/manager, regulator and stakeholder committee should agree on a set of internal performance indicators. This will be a work in progress for the first 3-4 years, especially in the case of development of the indicators for the sewered systems which will be the last of the wastewater system typologies to become operational. The regulatory requirements schedule of Table 7.2 anticipates this. Thereafter annual discussions of the number and nature of the indicators reaches a (more or less) permanent status.

The operator/manager will take a prominent role in discussions and decisions and actions to be taken when annual reviews of the internal performance indicators take place.

A set of potential internal performance indicators is shown in Table 7.3 below. It has been designed with the particular objectives and characteristics of the full BLU-D in mind; that is an efficient, effective and productive service with social and environmental priorities and not necessarily for profit.

Table 7.3: Proposed Internal Performance Indicators

| No | Internal Performance Indicator | Unit |
|---|---|---|
| **A** | **Financial (Sewered Systems Only)** | |
| 1 | Change in annual investment budget (+/-) | % |
| 2 | Change in annual revenues (+/-) | % |
| 3 | Actual accrued revenue | Rp |
| 4 | Average tariff | Rp/m3 |
| 5 | O&M cost | Rp/m3 |
| 6 | O&M cost recovery factor from Tariff | % |
| 7 | Change in PSO required (+/-) | Rp/connection |
| 8 | Collection efficiency | |

| No | Internal Performance Indicator | Unit |
|---|---|---|
| **B** | **Operational** | |
| 1 | Number of connections on sewered systems | no |
| 2 | Number of manholes opened | no |
| 3 | Number of septic tanks inspected | no |
| 4 | Number of septic tanks emptied | no |
| 5 | Tertiary drainage inspected | km |
| 6 | Number of complaints received | no |
| 7 | Number of complaints resolved | no |
| 8 | Average response time to complaints | days |
| 9 | Number of sewage back-ups reported | no |
| 10 | Number of sewage overflows reported | no |
| 11 | Wastewater treatment plant (IPAL) | |
| 11.1 | Average hours per day in operation | hrs |
| 11.2 | Annual capacity utilisation | % |
| 11.3 | Volume of wastewater treated | M3 |
| 11.4 | Electricity consumption | Rp/m3 |
| 12 | Septage treatment plant | |
| 12.1 | Average hours per day in operation | hrs |
| 12.2 | Annual capacity utilisation | % |
| 12.3 | Volume of wastewater treated | M3 |
| 12.4 | Electricity consumption | Rp/m3 |
| 13 | BOD | |
| 13.1 | Effluent at wastewater treatment plant (IPAL) | mg/lit |
| 13.2 | Effluent at septage treatment plant (IPLT) | mg/lit |
| 13.3 | Overload at wastewater treatment plant (IPAL) | % |

### 7.8.2 Performance contract

The use of performance contracts is an effective means of improving the performance of government-owned enterprises, agencies and departments. Essentially, a performance agreement is an agreement between a government (including a regional government) and a public or private agency which establishes goals for the agency. It usually includes a variety of incentive-based mechanisms for controlling outputs rather than the process itself. Performance agreements are now considered an essential tool for enhancing accountability for results and good governance in the public sector.

Recourse to a performance contract between the regional government and the operator/manager is an obvious consequence to the process of formulating and reviewing internal performance indicators. However, it should be borne in mind that the wastewater management sector in Indonesia is at a very early stage of development and that the proposals outlined for implementation of infrastructure and technical support services are wide-ranging and ambitious, and have yet to be fully confirmed by the city government. In other words, the future pathway of the wastewater sector is yet to be fully formulated and may have to be modified during its evolution because of the need to consider budget constraints which could impact upon the length of time needed to phase in the technical support for the non-revenue generating services. It is therefore considered that recommendations for a performance contract are premature.

It is suggested that internal performance indicators are used for guidance and training during the first phase of the Master Plan, rather than as a carrot-and-stick approach with incentives and disincentives. The development of a performance contract could be included as an activity for the late stages of the proposed comprehensive capacity-building technical assistance assignment when progress to full wastewater service management by the BLU-D should have become clearer. The performance contract could thus come into effect during the second phase of the Master Plan when the full BLU-D is operational.

### 7.8.3 External performance indicators

The operator/manager, the regulator and the stakeholder committee should agree on a set of external performance indicators. The list should be limited to those indicators which can be collected with relative ease.

Examples of external performance indicators, which should be collected by the regulator, with the assistance of other city government agencies, such as the Health Department and the Statistics Office, and disseminated to the general public, are given in Table 7.4 below.

Table 7.4: Proposed Internal Performance Indicators

| Indicator | Measurement | 2012 | 2013 | 2014 | etc… |
|---|---|---|---|---|---|
| Toilet coverage | % | | | | |
| Open defecation | % | | | | |
| E-coli in groundwater | mg/BOD/lit | | | | |
| E-coli in surface water | mg/BOD/lit | | | | |
| Incidence of diarrhoea | no per 1,000 | | | | |
| Tertiary drainage built | km | | | | |
| Number of times per year wastewater is discussed in the DPRD | no | | | | |

# 8. Wastewater financing and financial management

## 8.1 Sources of funds for investment

### 8.1.1 Identification and evaluation of existing and potential resources available for development

Surabaya City's plans for development of the wastewater sector require major investments in the construction and, where, appropriate, rehabilitation of three (3) types of wastewater services.

- **Off-Site systems** which collect household black and grey waters, which are conveyed through a sewered pipe system to a wastewater treatment plant (WWTP);
- **Intermediate systems** (such as SANIMAS and MCK Plus), each of which collects and treats the black water of approximately 50 households;
- **On-Site Systems** which collect the black water of individual households in septic tanks (or similar storage facilities); once the tank is full, it is emptied by a vacuum truck, which transports the sludge to a dedicated septage treatment facility (IPLT).

In addition to these physical investment requirements, the city will need to invest in improving the capacity of institutions involved and the awareness of the community during the first phase of the Master Plan. The total cost of the required investment is estimated at Rp 1.9 over the 20-year period of the Master Plan (Table 8.1) estimated in mid-2011 constant engineering base costs, excluding physical contingencies and PPN tax.

Table 8.1: Investment Costs for Wastewater Services in Surabaya City 2011-2030 (Rp Billion, Indicative)

| Service | Phase I 2011-2015 | Phase II 2016-2020 | Phase III 2021-2030 | Total 2011-2030 |
|---|---|---|---|---|
| Off-Site | 104 | 936 | 1,680 | 2,720 |
| Intermediate | 163 | 210 | 549 | 922 |
| On-Site | 234 | 316 | 63 | 613 |
| Commercial Facilities | 53 | 120 | 100 | 273 |
| Capacity Building* | 94 | - | - | 94 |
| **Total** | **648** | **1,582** | **2,392** | **4,622** |

* Including "software component"

### 8.1.2 Allocation of responsibilities for financing wastewater services

In 2008, the Ministry of Public Works (MPW), which is responsible for regulation of the wastewater sector in accordance with PP No 38/2007 on the Division of Responsibilities between Central, Provincial and City/Regency Governments, issued Decree No 16/2008 on the National Policy and Strategy for the Development of Domestic Wastewater Management. It stipulates that central government is responsible for financing: (i) provisions to encourage the mobilisation of funds for household wastewater management (*dana stimulan*); (ii) the facilitation private-public participation (PPP) for wastewater services and (iii) the initial investment in piped sewerage and wastewater treatment facilities, which would be further developed by regional governments. Since the issue of this decree, MPW has been involved in the preparation of one (1) major wastewater project – the Metropolitan Wastewater Management and Health Project (MSMHP).

The Directorate General of Human Settlements (DGHS) in MPW has confirmed that the financing principles used for MSMHP will also apply for investments and O&M for Phase I of the WWMP in Surabaya, as described below and as shown in Table 8.2.

- **Off-Site**: MPW will finance the costs of new primary and secondary piped sewerage systems and their wastewater treatment plants, provided these costs are eligible for financing from a multilateral or bilateral loan. City governments are responsible for tertiary pipes and connections and the expansion of existing systems, all O&M, plus non-eligible costs such as land acquisition and resettlement. Households and businesses will finance private toilets and plumbing to connect to the sewer system.
- **Communal**: MPW and the city government will provide funds to communities to construct communal wastewater facilities (MCK and SANIMAS types); communities (households) are responsible for O&M.
- **On-Site**: Households/businesses will finance toilets and septic tanks; vacuum trucks by either the city government or the private sector; the city government, possibly supported by the province is responsible for investments in septage treatment facilities.
- **Drainage**: MPW is responsible for investment in primary drainage, the provincial government for secondary drainage and the city government for tertiary drainage. The city government is responsible for O&M of all drainage.
- **Capacity Building**: MPW wishes to use its own training centres or to finance this activity from external grants. Multilateral loans may be used to fund comprehensive sector-wide capacity building management. The city, community groups, NGOs and the private sector will be encouraged to support activities in high-density, low-income areas.

Table 8.2: Financing Responsibility for Wastewater Services

| Service | Investment | | | | O&M | |
|---|---|---|---|---|---|---|
| | MPW | Province | City | Private | City | Private |
| Off-Site | | | | | | |
| Private Toilet | | | | * | | * |
| Connections<br>Tertiary Sewer Pipes[11] | | | * | | * | * (fees) |
| Primary & Secondary<br>Sewer Pipes | * | ** | *** | | * | * (fees) |
| IPAL | * | | | | * | * (fees) |
| Communal Wastewater | | | | | | |
| MCK | * | | * | | | * |
| SANIMAS | * | | * | | | * |
| On-Site | | | | | | |
| Private Toilet<br>Septic Tank | | | | * | | * |

[11] Defined as all pipes located in alleys (*gang*)

| Service | Investment | | | O&M | |
|---|---|---|---|---|---|
| Vacuum Truck | | | * | * (fees) | * (fees) |
| IPLT | | * | * | | * (fees) |
| Capacity Building | * | | | | |
| Land Acquisition | | | * | | |
| Resettlement | | | * | | |

** costs not eligible for external loan financing
*** system expansion only

### 8.1.3 Identification of available funding services

The following sources of funding will likely be available for financing wastewater sector investments in the short and medium-term (Table 8.3).

- **Central, provincial and city government budgets.** DGHS, East Java province and Surabaya City itself may allocate funds from their own budgets to co-finance investments. Because the wastewater sector competes for scarce funding with other sectors, it is not possible to forecast available funds.
- **Foreign Loans.** DGHS plans to utilise US$ 400 million of ADB loan funds to finance eligible costs of off-site systems in 16 metropolitan and large secondary cities, including Surabaya City. DGHS is also currently mobilising foreign loan funds to finance SANIMAS facilities in East Java and other provinces (a lump sum of Rp 350 million would be made available for each facility). Until such loan funds become effective, DGHS will use its own budget (APBN) to finance SANIMAS facilities for which there is a demonstrated demand.

Table 8.3: Investment Costs for Wastewater Services in Surabaya City 2011-2030 (Rp Billion, Indicative)

| Service | DGHS | Province | City | Private |
|---|---|---|---|---|
| Off-Site | | | | |
| Private toilet | | | | Own funds<br>Micro-credit |
| Sewer connections<br>Tertiary sewer pipes | | | APBD-City<br>OBA | |
| Primary and secondary sewer pipes, WWTP | APBN - foreign loans as grants | APBD - Prov | APBD-City,<br>Municipal bonds | |
| Intermediate | | | | |
| Communal sanitation | APBN - foreign loans as grants | | APBD-City<br>OBA | |
| On-Site | | | | |
| Private toilet | | | | Own funds<br>Micro-credit |
| Vacuum truck | | | APBD-City<br>Bank loans | |
| IPLT | | APBD-Prov | APBD-City | |
| Land Acquisition and Resettlement | | | APBD-City | |
| Capacity Building | APBN - foreign grants | | | |

Source: Ministry of Public Works, DGHS

- **Foreign grants (including OBA).** IndII is expected to have a budget available for output-based aid (OBA). Under this scheme, a city government would be reimbursed for installation of sewer connections or communal sanitation facilities financed from its own resources. Foreign grants may also be used for capacity building.
- **Own funds.** Households and businesses will finance part of the investments (toilet, septic tanks, internal plumbing) from their own savings.
- **Bank loans (including micro-credit)**. The track record of domestic banks, both state-owned and private, in providing finance for regional government long-run infrastructure services has been dismal to date, notwithstanding exhortations from Ministry of Finance and Bank Indonesia. Contractors have been more successful than regional governments in obtaining this kind of finance, but only at high interest rates and short loan tenors, the costs of which eventually have to work their way into tariffs. It would be optimistic to expect a change of policy on the part of the domestic banks any time soon, At present, domestic banks can finance investments with relatively short economic life cycles (5-7 years), the costs of which can be fully recovered from user charges. At present, only vacuum trucks meet these criteria. Low-income households may have difficulties to finance sewer connections or septic tanks from their own, often very limited savings, and the city government may wish to encourage the use of micro-credit to enable borrowers to pay for such services in instalments.
- **Municipal bonds.** Ministry of Finance regulations (PP No 30/2011 and PMK No 147/2006) allow regional governments to issue bonds for financing revenue-generating public infrastructure delivery services. PMK No 147/2006 does not require full cost recovery from the services, with payment of interest and repayment of bond principal being supported by the issuer's general cash flows. No such bonds have yet been issued in Indonesia, but DKI Jakarta and East Kalimantan Province plan to do so. One of the four (4) projects to be funded from the DKI bond issue is an expansion of the sewered system in the Central Business District at estimated cost of Rp 253 billion.

## 8.2 Physical investment programme - Phase I (2011-2015)

### 8.2.1 Project costs

The total cost of the Phase I programme for Surabaya City is estimated at Rp 460.7 billion in nominal prices, or about US$51.2 million equivalent (Table 8.4). This amount excludes investments in on-site wastewater facilities (such as the procurement of toilet bowls and indoor plumbing), which will be undertaken and financed by households and businesses without an active involvement of the city government.

Table 8.4: Costs of Phase I Programme, Surabaya City, 2011-2015 (Rp Billion)

| Cost Item* | Cost Estimate (Rp b) | | Expected Outcome |
|---|---|---|---|
| | Base Costs** | Current Costs | |
| Physical Investment | 270.8 | 350.7 | |
| Construction of the Kali Asin off-site system ("embryo") | 113.8 | 144.2 | Construction of 9,200 new off-site sewer connections |
| Rehabilitation and expansion of intermediate systems | 157.0 | 206.5 | Construction of small-scale sewerage and community-based wastewater systems for 22,900 households, rehabilitation of community-based systems for 10,800 households |
| Supporting Programmes | 93.8 | 110.0 | |
| "Software" activities | 69.9 | 86.0 | Improved capacity of city government, wastewater services providers and communities to manage wastewater services |
| Capacity building programme | 22.7 | 22.5 | |
| Establishment of regulator | 1.2 | 1.5 | Independent regulation of wastewater charges and public service obligations |
| **TOTAL** | **364.5** | **460.7** | |

* Excluding on-site systems (to be financed by households and businesses)
** Base cost in mid-2011 prices (excluding physical contingencies, price contingencies, and taxes)

### 8.2.2 Financing plan.

The total nominal cost of the proposed Phase I investments, which is estimated at Rp 460.7 billion, will be financed from the following sources (Table 8.5):

- central government grants, likely to be financed by ADB or other foreign lenders (Rp 240.6 billion);
- grants from bilateral donors, to co-finance the software activities and the capacity building programme (Rp 43.3 billion);
- the city government's own resources, APBD-Kota (Rp 130.8 billion), and
- private sector investments (Rp 46.0 billion).

Table 8.5: Financing Plan of Phase I Programme, Surabaya City, 2011-2015 (Rp Billion)

| Cost Item* | Funding Source | | | | | | |
|---|---|---|---|---|---|---|---|
| | Foreign Loan | Foreign Grant | APBN | APBD-Prov | APBD-City | Private Sector | TOTAL |
| Physical Investment Programme | 240.6 | - | - | – | 110.1 | - | 350.7 |
| Construction of the Kali Asin off-site system ("embryo") | 87.2 | - | – | – | 57.0 | - | 144.2 |
| Rehabilitation and expansion of intermediate systems | 153.4 | - | – | – | 53.1 | - | 206.5 |
| Supporting Programme | - | 43.3 | – | – | 20.7 | 46.0 | 110.0 |
| "Software" activities | - | 20.8 | – | – | 19.2 | 46.0 | 86.0 |
| Capacity building programme | - | 22.5 | – | – | - | - | 22.5 |
| Establishment of regulator | - | - | – | – | 1.5 | - | 1.5 |
| TOTAL | 240.6 | 43.3 | - | – | 130.8 | 46.0 | 460.7 |
| **% Total** | **52%** | **9%** | **0%** | **0%** | **28%** | **10%** | **100%** |

* Excluding on-site systems (to be financed by households and businesses)

### 8.2.3 Flow of funds

The proposed subprojects will be financed from four different sources of funds:

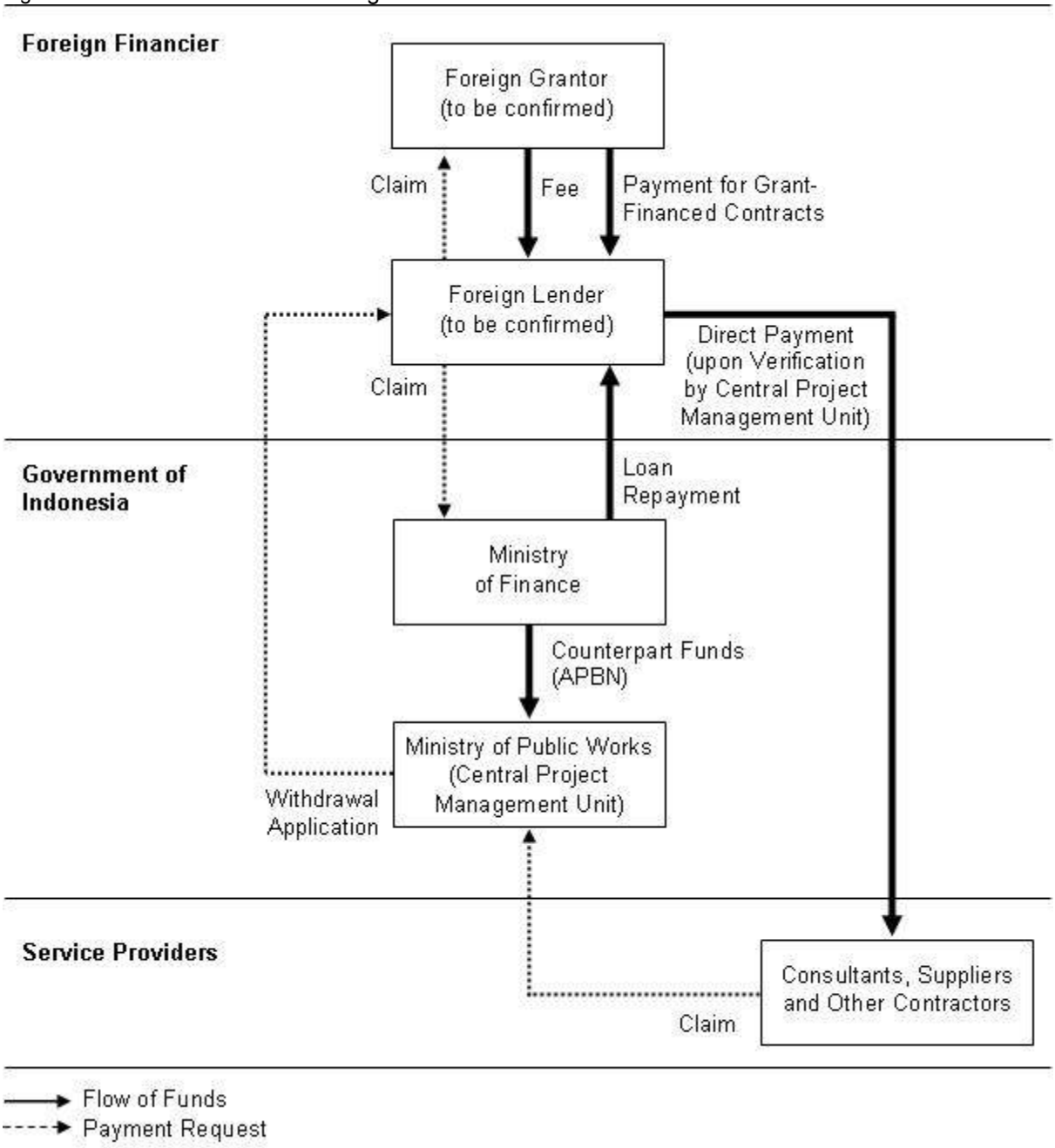
- foreign loans
- foreign grants
- city government budgets (APBD)
- private sector investments and contributions.

**Foreign funds**

Over 50% of the estimated project cost will be financed from the proceeds of foreign loans. In addition, it is anticipated that foreign grants will finance the full cost of the proposed capacity building programme, as well as a major portion of the cost of the software component, and possibly a portion of the cost of community-based sanitation systems (SANIMAS). It is assumed that foreign grants will be managed by the prospective foreign lender in return for an administration fee. This is a common practice whereby a central project management unit (CPMU), probably located in MPW, approves payment requests and submits a claim to the grantor for reimbursement.

The funds channelling arrangements for foreign loan and grant funds are summarised in Figure 8.1 below.

Figure 8.1: Indicative Flow of Foreign Loan and Grant Funds




**Domestic funds**

The balance of the project costs will be financed off the national budget (APBN) and city government budget (APBD) and by means of private sector investments and contributions. The APBN will fund the rehabilitation and expansion of the Kali Asin off-site system. The APBD will fund civil works, goods and service contracts not financed from foreign sources. Private sector investments include the purchase of sludge vacuuming vehicles and environmentally acceptable septic tanks. Private sector contributions consist of two types: (i) contributions towards the operations and maintenance of community-based

sanitation systems, and (ii) donations of private enterprises to finance selected software components, as part of the corporate social responsibility (CSR) programme of such enterprises.

## 8.3 Tariff policy for off-site, conventional and intermediate sewered systems

Commercial and industrial customers should be required to pay full O&M cost recovery tariffs. The city government will decide whether social organisations (schools, hospitals, places of worship, etc) and city government offices should also pay the full rate. However, it is not possible to apply the full O&M cost recovery principle to households in view of the DGHS policy that monthly household sewered wastewater charges should not exceed 2% of monthly household income. This limitation is likely to result in total revenues being insufficient to fully cover O&M expenditures; in which case, a subsidy in the form of an annual public service obligation will be required. Potential sources for funding the PSO are discussed in Chapter 8.7.

The operator/manager, expected to be in the form of an embryo BLU-D or the UPTD Plus on behalf of the incoming embryo BLU-D, will prepare a tariff policy as part of the business plan. It is recommended that tariff policy is based on limiting the number of interventions by the city government executive (mayor) and legislature (DPRD) to a minimum. This could be achieved by having the initial tariff approved, based on investment and annual recurrent costs, with usage in cubic metres estimated at 80% of piped water consumption. This arrangement would be accompanied with an agreement that the tariff (plus related connection maintenance fees and administrative charges) would be allowed automatic annual increases for the following four (4) years based on official inflation statistics. After five (5) years, the tariff would be rebased as a function of fixed asset values and recurrent costs, and would again require the approval of the mayor and DPRD, with the same arrangements for annual adjustments. The operator/manager will draft a *perda* to this effect.

The initial tariff calculation will be based on full O&M cost recovery. Weights would be attached to the basic tariff (low-income households) and applied to other household categories, as well as social, commercial and industrial customers. The weighting system used by PDAM would probably be suitable, at least as a proxy indicator. Ability-to-pay factors of 2% of average household income would then be applied to the weighted tariff based on full O&M cost recovery and the subsidised tariff calculated accordingly. This will allow the operator/manager to calculate the total PSO required for inclusion in the annual APBD.

Non-payment of water supply and electricity bills is sanctioned by disconnecting supply, but without financial or other penalties. Failure to pay the wastewater tariff cannot be met by cutting the supply, and therefore means to enforce payment, or otherwise to oblige the defaulting customer to face legal proceedings, must be incorporated in the *perda*.

## 8.4 Connection installation fee policy for off-site, conventional and intermediate sewered systems

Connection installation fees will be based on the same pricing principles as the tariff in terms of customer category. Installation fee costs and monthly maintenance fees will be incorporated in the same *perda* policy and tariff schedule as per Chapter 8.3.

Whilst it is likely that the first sewered mains and, probably, most subsequent sewered installations during the master plan period will be along city protocol streets, which are usually lined with commercial establishments and high-income households with strong ability-to-pay, the operator/manager may wish to consider introducing a credit scheme for connection installations by low-income families. This could be a scheme administered by the operator/manager, or a bank specialising in micro-credit arrangements, such as Bank Rakyat Indonesia (BRI), could be invited to manage the initiative.

BAPPEKO will co-ordinate city government policy on whether to subsidise household connections in whole or in part or not at all. The same consideration will apply to connections for social agencies (e.g. schools, clinics, hospitals, places of worship). It is expected that commercial establishments and light industrial premises will pay the full connection installation fee.

BAPPEKO will also ensure that all subsidy arrangements are appropriately funded on the annual city government budgets.

## 8.5 Compulsory connection policy for off-site, conventional and intermediate sewered systems

Results from the household survey indicate a low willingness-to-connect to off-site conventional and intermediate sewered systems in Surabaya City. Government at all levels is prepared to invest significant sums in improving wastewater service and the environmental health of communities. It is therefore recommended, irrespective of the nature of the policy decision on subsidising connection installation fees, that the city makes it compulsory for all households and other establishments with premises which have access to the sewered pipe line alignment to have the connection installed.

The operator/manager will draft a *perda* on the capital levy one (1) year before the first off-site sewered system becomes operational. The levy should comprise a connection maintenance charge, service charges, plus a monthly retribution based on an assumed wastewater discharge. Enforcing sanctions should be incorporated on the *perda* for owners of premises who are non-compliant.

## 8.6 Billing and collection procedures

In the early years of off-site conventional and intermediate sewered systems operation, the number of monthly bills issued will be relatively small. It would therefore not be cost-effective for the BLU-D to have its own billing, bill delivery and collection system. It is therefore recommended that this process be outsourced to the PDAM which would include charges as a separate item to its own water supply bills. This solution is

particularly appropriate since sewered system user charges are linked to piped water consumption and almost all users will be connected to the PDAM system (the PDAM has a 67% household coverage).

The alternative would be to ask the provincial office of the state electricity company to bill these charges as a separate item. The advantage is that PLN has an almost 100% coverage; however, this is outweighed by the fact that PLN would need access to PDAM bills in order to calculate the wastewater usage charges. Furthermore, PLN would almost certainly be unwilling to entertain such a proposal and, since it is a state-owned enterprise, the city government has little leverage in the matter.

The operator/manager should negotiate an agreement with PDAM before the first small bore sewered off-site system becomes operational. The general practice in other cities where PDAM incorporates the bills of other organisations (e.g. solid waste) into its monthly bills is to make an administrative charge of 5% on the value billed and to deduct this amount before passing on the revenue proceeds to the PDAM.

## 8.7 Other revenue sources to fund wastewater services

In addition to the PSO to cover any shortfall in O&M full cost recovery, as discussed in Chapters 8.4, a sustainable wastewater management service is going to require significant financial inputs from the city government in order to provide for technical support to intermediate community systems, on-site systems and tertiary (grey water disposal) drainage operations. This will be especially important in high-density, low-income areas where improved environmental health and control is so crucial to the success of overall wastewater management.

The most appropriate sources of funds would be either to levy a specific wastewater retribution, to be applied to occupiers of all premises in the city, or an allocation from the two property taxes which are now within the administrative control of regional governments; or a mix of contributions from both sources. These are discussed below.

### 8.7.1 Wastewater retribution

The rationale for introducing a universal wastewater retribution, except for those already paying the sewered system tariff or the capital levy, is known as the “polluter pay” principle, i.e. that all households and other establishments discharge wastewaters which, to varying degrees, contribute to environmental degradation, and, therefore, that they should all be required to make a financial contribution towards the proper disposal of such wastes.

The earliest feasible target date for introduction of the wastewater retribution is 2013. In early 2012, the entity responsible for wastewater management, proposed to be a UPTD IPAL+IPLT, should calculate the cost of technical support required to support non-sewered wastewater services (sewered systems are not expected to enter into service until 2015).

The cost information calculated by the UPTD Plus would be passed to the Revenue Department (*Dinas Pendapatan*) which would draft a *perda* for the retribution, including a methodology for assessment of the tax. The retribution could be graduated, depending on typology and/or area of the building, or it could be calculated as a factor against the property tax assessment. The method of collection could be as an addition to the property tax (PBB) bill; this would be much more equitable an easier than using the PDAM as the billing agent because of the efficiency of property tax coverage and collection.

### 8.7.2 Property taxes

These consist of the land and buildings annual property tax (PBB) and the land and buildings property transfer tax (BPHTB). Until recently, both were administered by the Directorate of Taxation at the Ministry of Finance, with receipts allocated to the various levels of government as shown below in Table 8.6.

Table 8.6: Distribution of property tax receipts

| Tax | % MOF (for admin) | % Province | % Kab/Kota (specific) | % Kab/Kota (general) | Incentives |
|---|---|---|---|---|---|
| PBB | 9.0% | 16.2% | 64.8% | 6.5% | 3.5% |
| BPHTB | - | 16.0% | 64.0% | 20.0% | - |

In the latest revision to the law on regional government taxes (Law No 28/2009), both taxes were devolved in their entirety to city/regency (*kota/kabupaten*) regional governments. All regional governments are required to begin administering these taxes by January 2014 at the latest. Surabaya City has already taken over the administration of both taxes as of January 2011.

Although the PBB revenue yield and its contribution to GDP are low when compared internationally, it is highly efficient in terms of tax object identification and revenue collection. Surabaya City's income from this source will rise by at least 40% as a result of the re-allocation of tax proceeds. The increase from the BPHTB is 56%. Both taxes have considerable scope for growth, especially the BPHTB, as the property market develops and matures, and truer property sales transactions will be registered.

### 8.7.3 Allocation of property taxes to fund wastewater management services

The practice in Indonesia for funding specific activities is to nominate a generic source, e.g. APBD and APBN revenues. However, in many countries, property tax legislation contains provisions for allocating stipulated percentages of annual property tax receipts for investments in and O&M of specific urban delivery services such as street lighting and wastewater and solid waste collection and disposal. In addition, any need for incremental wastewater services, such as payment by the city government for the compulsory desludging of septic tanks, could be funded by absorption of the costs into the next round of property tax valuations (*nilai jual obyek pajak* – NJOP). It would be more difficult to do this through an adjustment to the wastewater retribution.

In early 2012, the entity responsible for wastewater management, proposed to be a UPTD Plus, should calculate the cost of technical support required to support non-sewered wastewater services (sewered systems are not expected to enter into service until 2015 at the earliest). As in the case for the wastewater retribution, the revenues allocated from PBB and BPHTB receipts would be used towards funding the following wastewater services:

- Provision of a regular technical service to households equipped with on-site septic tanks. All septic tanks (at least those which can be located) would be registered with the wastewater management office. After 2014, private vacuum truck operators would be licensed and contracted by the city government to empty tanks at specific periods and paid against proof that the sludge had been delivered for treatment at the IPLT;
- Setting of standards and periodic inspections of intermediate communal systems and of small bore sewered systems and treatment facilities on private residential housing estates;

- Provision of family toilets (*jamban*) and septic tanks to poor households through a micro-credit system, with seed money provided to a bank;
- Inspection of tertiary drainage systems and provision of advice to community heads on repair and grey water disposal procedures;
- Co-ordination with the Health Department in terms of providing public health and hygiene education to the community ;
- Vetting technical standards of provisions for wastewater disposal as a requirement for the issue of new building permits.

When off-site conventional and small bore sewered systems are operational, there will be calls for additional funding, such as:

- A PSO for any shortfall in the ability of tariffs to fully recover O&M;
- A credit system for low-income household purchasing the sewer connection, unless the city government decides to subsidise the cost of the connection

It will be the responsibility of BAPPEKO, in collaboration with other agencies, such as the Revenue Department (*Dinas Pendapatan*), to determine the sources of funding, or the mix of sources of funding (i.e. retribution and property taxes) required to fund the non-revenue generating technical support services, the PSO and any other approved arrangements. This will require a calibrated approach to annual APBD budgeting, e.g. the pace at which septic tanks will be desludged at the expense of the city government will be determined by the availability of revenues which can be applied such expenditures.

## 8.8 Regulatory requirements

The schedule of *perda/perwali* required to authorise the various financial issues discussed above is given in Table 8.7 below.

Table 8.7: Schedule of Regulatory Requirements for Finance-Related Issues

| Proposed Actions | Target Date | Regulatory Action |
|---|---|---|
| Provisions for wastewater capital and operating budgets | December 2011 | APBD Perda |
| Wastewater Retribution (if required) | December 2012 | Perda required |
| Provisions for wastewater capital and operating budgets | December 2012 | APBD Perda |
| Approval of tariff policy and schedule for wastewater usage, connection fee and connection maintenance and administrative service charges. Sanctions and enforcement | December 2014 | Perda required |
| Provisions for wastewater capital and operating budgets | December 2013 | APBD Perda |
| Introduction of capital levy | December 2014 | Perda required |
| Provisions for wastewater capital and operating budgets, including PSO for domestic tariff | December 2014 | APBD Perda |
| Approval of 5-year business plan | December 2014 | Perwali required |
| Provisions for wastewater capital and operating budgets, including PSO for domestic tariff | December 2014 | APBD Perda |

# 9. Capacity building

## 9.1 Capacity building initiatives in the community

A number of specific capacity-building initiatives to provide an enabling environment for the community have been built into the first phase of the Master Plan in order to assist the community to improve their existing wastewater systems. These are products of the technical support to the community, private sector support to the community, revising building permits and micro-credit schemes described above as specific tasks, and accompanied by FOPIP and LIDAP implementing requirements, and will require a blend of city government support together with the active assistance of community-based organisations (CBOs), NGOs and environmental cadres). These initiatives are summarised below, with detailed frameworks, which set out the aims and objectives, targets, activities results, means of verification and critical assumptions: Appendix I.1 for on-site systems; Appendix I.2 for intermediate systems, and Appendix I.3 for capacity-building through city government institutions

**A. On-Site Systems**

- Study performance of existing on-site systems
- Development of new low-cost on-site systems
- Dissemination of results of new low-cost on-site systems within the community
- Marketing of low-cost on-site systems
- Community-based organisations/NGOs, environmental cadres for on-site systems
- Training sanitarians to market on-site systems
- Backstopping community initiatives for on-site systems

**B. Intermediate Systems**

- Study of existing practices of intermediate systems
- Development of intermediate system pilot projects
- Dissemination of results of intermediate system pilot projects within the community
- Marketing of intermediate systems
- Community-based organisations/NGOs, environmental cadres for intermediate systems
- Backstopping community initiatives for on-site systems

**C. Capacity-Building through Institutions**

- Establishment of a mobile wastewater information centre
- Exposure to sanitation and hygiene at school
- Exposure to sanitation and hygiene at clinics (*Puskesmas*)
- Exposure to sanitation and hygiene at other government institutions
- Backstopping commercial enterprise initiatives for improved wastewater management
- Sanitation campaigns/persuasion

## 9.2 Institutional capacity building

As a complement to the capacity-building initiatives to provide an enabling wastewater environment for the community, similar initiatives are required to ensure sustainable institutional arrangements. These are as follows:

### 9.2.1 Institutional capacity building for on-site wastewater system desludging

Specific tasks have been designed with the objective of creating an efficient and effective private sector septic tank desludging service which would be regulated by the wastewater operator/manager, with the sludge delivered for disposal at the city-government managed sludge treatment plant (IPLT). The objective is to improve the quality of ground and surface water, and hence, environmental health. The activities proposed are:

- Study of existing practices of septage removal
- Organising septage removal and environmentally correct disposal

Details of objectives, activities, results, performance, means of verification and critical assumptions are provided in Appendix I.4.

### 9.2.2 Institutional capacity building for off-site sewerage systems

The aims of this capacity-building component are to use an embryo small bore sewered system and treatment plant (“embryos”) as a platform for the management and operation of conventional sewered systems and wastewater treatment plants at a later stage. The major target of the component is to have 9,000 households and commercial establishments committed to connect to the embryo system in the Kali Asin area of Surabaya. The activities proposed, are in synthesis:

- Marketing the embryo
- Organisational set-up for O&M of the embryo off-site sewered system and wastewater treatment plant

Details of objectives, activities, results, performance, means of verification and critical assumptions are provided in Appendix I.5.

### 9.2.3 Institutional capacity building for the *Pokja*

During the wastewater master plan period (WWMP), the dedicated city government working group (*kelompok kerja* or *Pokja*) has played an important role as a facilitator and stakeholder. As a result, it has by now acquired a considerable knowledge base. This role should now be made formal so that the *Pokja* is transformed from an ad hoc working group into a recognised player in the wastewater sector. It should take the lead in organising the training of city government staff so that they are aware of the need for improved wastewater management and can disseminate information to their communities.

- Formalising the role of the *Pokja*
- Training city government staff in sanitation

Details of objectives, activities, results, performance, means of verification and critical assumptions are provided in Appendix I.6.

### 9.2.4 Institutional capacity building and management cooperation workshops

During the first phase of the Master Plan, it is proposed to hold a series of workshops, with two themes: strengthening of institutional capacity and strengthening management cooperation for wastewater services.

Appendix I.7 provides details of the course, number of days per course, the course operator and related city government institutions, number of participants and their organisation and the time frame. Workshop topic summaries are given below.

**Institutional Capacity Building**

- Public service organisation (attended by the mayor, city government officials, DPRD, district and community heads, university leaders and representatives of the private sector
- Management training for wastewater services
- Performance training for wastewater services
- Wastewater infrastructure and facilities assets management
- Financial Management
- UPTD PLUS Comparative Management Study
- Embryo BLU-D Comparative Management Study

The first workshop is an orientation course of one (1) day. The other six (6) workshops are of three (3) days duration each, specifically related to the principal facets of wastewater management and therefore with more restricted audiences in terms of numbers attending. Three (3) sets of these workshops will be held in 2011, 2012 and 2014 for the UPTD-IPLT, UPTD Plus and the embryo BLU-D respectively, each being progressively more focused as the services to be provided by the operator/manager increase in scope.

**Strengthening Wastewater Services Management Partnership Co-operation with the Community**

- Wastewater operator partnership training
- Training of community group wastewater operators
- Sewer pipes and lateral household pipe connections training
- Wastewater channel pipe use and maintenance training
- Monitoring and supervision training for wastewater management services implementation

The first workshop is a community course of one (1) day for neighbourhood community heads (RW/RT), youth organisations, CBOs/NGOs, environmental cadres, university leaders and representatives from the private sector. There will be three (3) such courses (2011, 2012 and 2014) for each of three (3) institutional arrangements (UPTD-IPLT, UPTD Plus and embryo BLU-D) to be made during the first phase of the Master Plan. There will also be a further four (4) workshops within the same time and institutional arrangements framework with community organisation cadres working in partnership with the wastewater services operator/manager.

Large meeting rooms will be required for some of these workshops, for which attendances will range between 150 and 300. Five (5) representatives from each sub-district (*kelurahan*) will be invited.

# 10. Private sector development

The strategic objective in developing customer and community relations in all aspects of wastewater services management is to ensure that necessary wastewater services are provided efficiently, effectively and economically, even though not necessarily by the city government itself directly.

## 10.1 Legal and regulatory framework

Within the regional government context, the legal basis for private sector partnership in infrastructure service deliveries is Law No 32/2004. The cross–sector regulatory framework at all levels of government is defined by Presidential Decree (PerPres) No 67/2005 (as amended by PerPres No 13/2010), concerning PPP in Infrastructure. Its objectives are:

- Meeting financial requirements in a sustainable manner in providing infrastructure through the mobilisation of private sector funds;
- Improving the quantity, quality and efficiency of service through fair competition;
- Improving the quality of management and maintenance in the provision of infrastructure;
- Encouraging the principle of users paying for services received, taking into account ability-to-pay in certain cases.

The guidelines applicable to the preparation and procurement of private sector infrastructure services are determined by the source of funding. If the funding is sourced from the central/regional budget (APBN/APBD), PerPres No 54/2010 on Procurement, superseding KepPres No 80/2003, will generally apply whilst the wastewater management institution is a UPTD, a UPTD Plus or an embryo BLU-D. When the embryo becomes a full BLU-D, it is able to exercise its own discretion as to whether apply PerPres 54/2010 in whole or on part or not at all, provided always that procurement arrangements are efficient and effective (ref (i) elucidations to Section 20, Sub-Section 1 of PP No 23/2005 on Financial Management of BLU and Section 100, Sub-Sections 1 and 2, of Ministry of Home Affairs Decree No 61/2007 on Technical Guidelines for Management of a BLU-D. If, however, the funding comes from the private sector, the procurement process of PerPres No 67/2005 (as amended) will apply. This is relevant for concession/build-operate-transfer (BOT) agreements and, to some extent, operations and maintenance (O&M) contracts.

There are various externalities which influence the decision of the private sector whether or not to participate in a project, all of which impinge upon the project's ability to generate a satisfactory return on investment. These include demand (take-or-pay), tariffs, land availability, security of contract and other political risks. The government contracting party is encouraged to provide guarantees against these risks, although not operational risks. Central government has now established PT Penjaminan Infrastruktur Indonesia (Indonesian Infrastructure Guarantee Fund) to issue such guarantees in order to compensate a private sector party if there is a failure on the part of the government host agency to meet its commitments in these respects.

Engagement of the private sector in the delivery of wastewater services is one of the key policy objectives of MPW Decree No 16/2008, which sets out the National Policy and Strategy for the Development of Domestic Wastewater Management.

## 10.2 Privatisation of desludging septic tank services

Septic tank emptying by vacuum trucks is already a privatised activity (except for emptying MCK and SANIMAS tanks which is done by a city government vacuum truck). The trucks should then transport the sludge to the treatment plant, where a tipping fee is paid. The truck operators must be licensed by the Cleansing and Parks Department (*Dinas Kebersihan dan Pertamanan – DPK*) and any trucks not licensed are turned away from the IPLT. However, the service is not regulated, with the result that much of the human waste sludge is almost certainly not transported to the city-owned treatment facility (IPLT), but is disposed of by methods which are environmentally unacceptable (water courses, storm drains, fields, etc). It is proposed that the service should remain in the private sector but with the principal objective that it should be regulated in such a way that all human waste sludge disposal is handled in an environmentally correct manner.

It is therefore proposed that the procedure should be changed whereby the contract is no longer an arrangement between private sector operator and household, but a service contract between the wastewater operator/manager (UPTD, UPTD Plus, embryo or full BLU-D) and the private sector operator for which the city government will pay. The private sector operator could be the owner of a vacuum truck, or a motor cycle with vacuum equipment for tanks located in areas difficult to access with a truck. The desludging schedule will be determined by periodic inspections of septic installations carried out by the wastewater operator/manager. The private sector operator will receive authorisation for payment only upon presentation of receipt of the sludge at the treatment facility, signed by the IPLT manager.

The funding of this arrangement will need significant financial inputs from the city government. Chapter 8.8 recommends that this could be provided through a city-wide specific waste water retribution or, preferably, through the two (2) property taxes recently transferred from central government to the city/regency governments through the latest revision to the law on regional government taxes (Law No 28/2009).

The same procedure of septic sludge transportation and disposal should be followed for commercial premises, except the service would not be free of charge but would be billed to and paid for separately by the customer. In the case of social service premises (schools, hospitals, government offices, etc), payment or a free-of-charge service would be at the discretion of the city government.

Consequently, there is a need for enabling decrees concerning the operational licensing of vacuum tanker operators, as well as tariffs based on volume and distance to the IPLT and the mode of payment to operators by the city government, as provided for in the regulatory requirements. No specific compliance with PSP/PPP or procurement regulations is required, as the service will be non-competitive, with service contracts being awarded to licensed operators based on regulated published fees.

The process for establishing this arrangement should include the following sequential steps:

- The city government should determine the stages by which the service is developed. This will depend primarily on the availability of subsidy funding. However, in the event of funding constraints, it is recommended that low-income, high-density population areas be given priority as these constitute the greatest environmental risk. The service would be expanded as a function of more subsidised funds becoming available.
- The necessary regulations to establish the privatised service would include a new *perda* for licensing private sector operators and establish desludging and transport fees, payable by the city government, based on volume and distance. The *perda* should contain provisions for payment only on production by the private sector operator of a receipt acknowledging delivery of the sludge at the

IPLT and applying sanctions for unlicensed operators and illegal tipping. Enforcement would be a duty of the wastewater operator/manager. *Perda* No 04/2000, which stipulates the tipping fee, should be cancelled.

- The city government, through the operator/manager, will advertise for private sector operators and license only a number sufficient to service the designated areas, on the basis of, say, a septic tank being emptied every four (4) years.

## 10.3 Privatisation of septic tank inspection services

The inspection service for septic tanks, community intermediate facilities and tertiary (grey water) drainage should begin in 2012 before the privatisation of septic tank desludging is authorised. It is unlikely that the UPTD located within DPK will have sufficient qualified personnel to undertake these services. It is therefore proposed that a private contractor be hired to assist in the preparation of registers for septic tanks, community intermediate facilities and tertiary drainage and train UPTD personnel in inspection procedures.

It is estimated that a contract of one (1) year should be sufficient for the required training. Septic tank manufacturers would probably be able to provide suitably qualified inspectors. However, the city government may find it more efficient and economic to continue the privatised service after one year, or tender a multi-year contract, rather than employ additional permanent civil service staff with their attendant overhead

The inspection service should be competitively tendered in accordance with PerPres No 54/2010.

## 10.4 Future privatisation initiatives

Research carried out during the Master Plan phase suggested little enthusiasm by the private sector in participating in activities on a larger scale, such as construction and management of wastewater/sludge disposal facilities under BOT or concession arrangements through competitive tendering under PerPres No 67/2005 (as amended). It is possible that some interest may be shown in operations and maintenance of an IPLT, but not until the second stage of the Master Plan (2015-2020) at the earliest.

In conclusion, it may be said that the central government has provided a fair regulatory framework and guarantee incentives which could make privatisation for BOT and concession agreements feasible; however, regional governments have shown little interest to date in making the most of the opportunities presented. Until this outlook charges, the private sector will not be very willing to engage in investment in urban infrastructure, especially the wastewater sector which is still in the early stages of development.

Table 10.1: Schedule of Regulatory Requirements for PSP Proposals

| Proposed Actions | Target Date | Regulatory Action |
|---|---|---|
| Funding for privatisation of septic tanks, community intermediate facilities and tertiary drainage inspection service | December 2011 | FY 2012 APBD |
| Revised conditions for licensing of private sector operators for desludging service, together with tariff schedule | June 2012 | Perda required |
| Cancellation of IPLT Keputih tipping fee | June 2012 | Perda 04/2000 to be cancelled |

# 11. Conclusion

## 11.1 Primary Benefits

Referring to the strategic objectives of the Master Plan in Section 1.5, we conclude that by implementing the activities proposed in the Master Plan, Surabaya can meet its 3 main aims:

- Reach ODF status by 2020 by using a mix of on-site and intermediate facilities;
- Improve the areas with relatively unhealthy living conditions by a mix of on-site and intermediate solutions by 2020;
- Half the pollution load in 2030 compared to the load in 2010, at a total investment cost of Rp 4.5 trillion (US$ 500m) between 2010-2030,

## 11.2 Reduction of the BOD load of the City

With the planned investment included in the masterplan by 2030, the BOD load produced in Surabaya is expected to reduce to be around 21 ton BOD/day, compared with the current 59 ton BOD per day. The investment costs per kg BOD removed are around Rp 34m by 2030. Besides the new infrastructure, the improvement and upgrading of existing on-site systems is also crucial to the success of reducing the BOD load to this level by 2030.

See Table 11.1 for the forecast decrease of pollution loads over the masterplan period.

Table 11.1: Forecast decrease in pollution load for Surabaya for the period 2010 to 2030

| Calculation pollution load | | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|
| BOD load-non served households | kg BOD/day | 13 060 | 7 268 | 0 | 0 |
| Treatment efficiency Sewage Treatment Plant | % BOD removal | 0% | 95% | 95% | 95% |
| BOD load off-site | kg BOD/day | 0 | 80 | 489 | 1 223 |
| Treatment efficiency acceptable intermediate facilities | % BOD removal | 60% | 75% | 90% | 95% |
| BOD load acceptable intermediate systems | kg BOD/day | 1 136 | 2 126 | 1 468 | 1 541 |
| Treatment efficiency unacceptable intermediate facilities | % BOD removal | 20% | 20% | 20% | 20% |
| BOD load unacceptable intermediate systems | kg BOD/day | 1 515 | 0 | 0 | 0 |
| Treatment efficiency acceptable on-site facilities | % BOD removal | 80% | 80% | 80% | 80% |
| BOD load acceptable on-site facilities | kg BOD/day | 11 269 | 14 428 | 19 569 | 16 966 |
| Treatment efficiency unacceptable on-site facilities | % BOD removal | 20% | 20% | 20% | 20% |
| BOD load unacceptable on-site facilities | kg BOD/day | 24 272 | 19 238 | 0 | 0 |
| Treatment efficiency acceptable treatment facilities commercial enterprises | % BOD removal | 80% | 75% | 90% | 95% |
| BOD load acceptable facilities commercial enterprises | kg BOD/day | 1 892 | 3 483 | 1 974 | 1 132 |

| Calculation pollution load | | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|---|
| Treatment efficiency unacceptable treatment facilities commercial enterprises | % BOD removal | 20% | 20% | 20% | 20% |
| BOD load unacceptable commercial enterprises | kg BOD/day | 6 191 | 3 715 | 0 | 0 |
| Total BOD load | kg BOD/day | 59 336 | 50 339 | 23 499 | 20 862 |
| **Pollution load** | **% BOD produced** | **49%** | **38%** | **17%** | **13%** |

## 11.3 Identification of the 20 year investment requirements for wastewater infrastructure

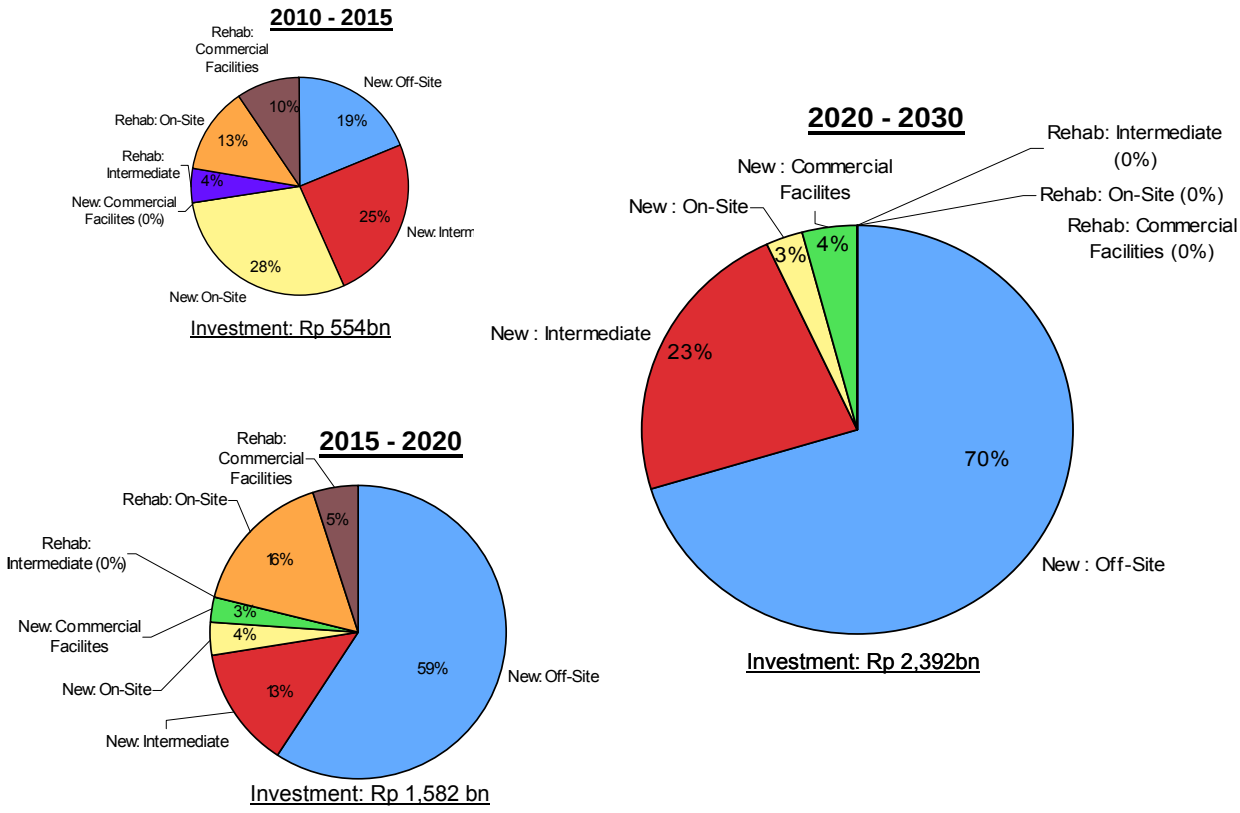
Table 11.2 contains a summary of the total investment costs required for masterplan implementation.

Table 11.2: Investment program Surabaya 2010-2030

| COST ESTIMATE (IDR m) (engineer's base costs) | Cost Ph1 | Cost Ph2&3 | 2010-2015 | 2020-2020 | 2020-2030 | Total | |
|---|---|---|---|---|---|---|---|
| - new off-site house connections: hc+lateral sewers | Rp9.4m | Rp10m | Rp87 000m | Rp468 000m | Rp840 000m | Rp1 395 000 m | 31% |
| - new off-site house connections costs for trunk sewers | Rp0.6m | Rp5m | Rp6 000m | Rp234 000m | Rp420 000m | Rp660 000m | 15% |
| - new off-site house connections costs for STP | Rp1.2m | Rp5m | Rp11 000m | Rp234 000m | Rp420 000m | Rp665 000m | 15% |
| - rehabilitation off-site facilities | Rp15m | Rp15m | Rp- | Rp- | Rp- | Rp- | 0% |
| - new intermediate facilities' | Rp5.9m | Rp6m | Rp136 000m | Rp210 000m | Rp549 000m | Rp895 000m | 20% |
| - rehabilitation intermediate facilities | Rp2.5m | Rp2.5m | Rp27 000m | Rp- | Rp- | Rp27 000m | 1% |
| - new on-site facilities | Rp3m | Rp3m | Rp162 000m | Rp60 000m | Rp63 000m | Rp285 000m | 6% |
| - rehabilitation on-site facilities | Rp2m | Rp2m | Rp72 000m | Rp256 000m | Rp- | Rp328 000m | 7% |
| - new treatment facilities commercial enterprises | Rp- | Rp20m | Rp- | Rp40 000m | Rp100 000m | Rp140 000m | 3% |
| - rehabilitation treatment facilities commercial enterprises | Rp10m | Rp10m | Rp53 000m | Rp80 000m | Rp- | Rp133 000m | 3% |
| **Total investment cost** | | | **Rp554 000** | **Rp1 582 000** | **Rp2 392 000** | **Rp4 528 000** | **100%** |
| Cumulative investment cost | | | Rp554 000 | Rp2 136 000 | Rp4 528 000 | | |
| Cumulative investment cost US$ (m) | (@ $1USD = Rp9 000) | | $62m | $237m | $503m | | |
| Total investment cost per kg BOD removed (m) | Rp/kg BOD removed | | Rp7m | Rp18m | Rp32m | | |

The graphical distribution of investment costs year by year on a system by system basis is shown below in figure

Figure 11.1:Graphical Representation of the Distribution of Investment Costs




## 11.4 Additional masterplan components

### 11.4.1 Commencement of the development of the City-wide sewerage system

Two main sewer lines have been identified that will be part of the long-term (2030) city wide sewerage system: one running in a 1700 ha sewerage area west from Kali Mas from the Surabaya Zoo to the Morokrembangan Boezem and one in the east from Jembatan Merah to the Suramadu Bridge covering 1400ha. This will allow decisions on spatial reservations for the facultative aerated ponds required to treat the wastewater at the Morokrembangan STP, the area required will be at least 11 ha and at the Suramadu Bridge STP, with an area of at least 6 ha and allow spatial reservations for the routes of the trunk sewers;

A ‘starter’ (embryo) off-site wastewater systems has been identified in the commercial area of Kali Asin Wastewater from this area is to be pumped to a temporary UASB (or RBC) installation on the banks of the Kali Mas River.

When the city wide sewerage systems become available, the presence of the trunk sewers will facilitate the start-up of an SMS : Septage Management Service. The proposed SMS is a septage collection system that will be unique to Surabaya, it will facilitate the easy receive of septage waste into the “embryo” sewerage system. The households wanting the septic tank emptying sends an sms text to the entrepreneurs ( who at present empty the leaching pit/septic tank manually ), they will remove the septage with a vacuum

motorcycle in an environmentally sound way and discharge it to the septage discharge station on the trunk sewers. The discharge point can be legally accessed and used for discharging septage and sludge directly into the sewer for treatment.

### 11.4.2 Identification of the operator of the improved wastewater systems

The city has decided in principle (awaiting formal confirmation from the mayor) to establish a regional government services agency (BLU-D) to be the operator and provider of integrated wastewater services. The BLU-D will manage the off-site wastewater systems, operate the IPLT, co-ordinate the activities of the private sector septage removal operators, to ensure that sludge is disposed of in an environmentally friendly manner and to provide guidance for the operation and maintenance of on-site septic tanks and intermediate wastewater systems as well as grey water drainage systems.

### 11.4.3 Identification of proposals for financing the improved wastewater systems

It is recommended that financial support in the form of a public service obligation be made available by the City for domestic wastewater services. Proposals are made that the funding source could be from the property taxes which the city now manages in its own right, or from targeted retribution, or from both sources.

# 12. Priority projects, follow up actions and implementation schedule

## 12.1 Priority projects

The following projects have been identified for inclusion during the first five years ( period 1) of the Master Plan, see Table 12.1. The projects have been included in the June WWMP Final Feasibility Study report.

- Embryo off-site system “Kali Asin” , sewerage and STP (Rp 103 bn).
- On-site systems, rehabilitation and new (Rp 234 bn).
- Intermediate systems, rehabilitation and new (Rp 163 bn). It is suggested to start with a pilot SBS/SS in Peneleh.
- Non domestic systems, rehabilitation and new (Rp 153 bn).

Table 12.1: Unit rates and costs of the projects in the first period of the masterplan

| Programme 2010-1015 | Number of households | Price per household | 2010-2015 Cost | |
|---|---|---|---|---|
| Kali Asin Embryo | 9 200 | Rp11.2 | Rp103,000m | 19% |
| On-site systems (new and rehabilitation) | 90 000 | Rp2.3 | Rp 234,000m | 42% |
| Intermediate systems (new and rehab) | 33 700 | Rp4.8 | Rp163,000m | 29% |
| Commercial enterprises | 5 300 | Rp10.0 | Rp53,000m | 10% |
| **Total** | | | **Rp554,000m** | **100%** |
| **Total (US $)** *(@ $1USD = Rp 9000)* | | | **$61m** | |

## 12.2 Follow up actions - interventions and studies

To overcome the present shortcomings of the wastewater systems in Surabaya, to sustain the interventions and to arrive at healthy living conditions in Surabaya, we recommend that the following actions are needed:

- Motivation of the population, commercial enterprises and institutes to implement, operate and maintain adequate wastewater facilities;
- Development at the same time of physical, financial and technical capabilities regarding wastewater improvements
- Work with all levels of city organisations at the same time: government, institutes, commercial enterprises, neighbourhood and community;
- Implementation of the motivational and capacitating activities identified in Chapter 6 and focus on:
  - Education of responsible government staff;
  - The implementation of a WRC: Wastewater Resource Centre, where contractors and the general public can obtain information on appropriate technologies (models, construction drawings, etc.);
- Development of pilot/models of the on-site and intermediate systems suited to Surabaya conditions, with displays at government offices, hospitals, schools, Puskesmas;
- Execute a number of studies to back-up and refine the planned interventions by:

  - Studies, monitoring and evaluation of the performance of communal treatment systems such as the ABR;
  - Studies into the reasons and causes of the present low coverage of formal septage collection services: is there no demand for services or is the present demand served by illegal/informal practices?
- Publish the effluent quality of all licensed wastewater treatment facilities in Surabaya on the internet (Wiki-leaks for Surabaya);
- Award and reward for the best working wastewater treatment facility, visit by the mayor and generate publicity.
- Start a joint venture with other (foreign) sewage treatment entities to facilitate peer visits and learning-on-the job;
- Start the construction of sewers only after land has been purchased for sewage treatment plants;
- Subsidise the purchase of on-site and intermediate systems for the urban poor;
- Develop micro-credit schemes to assist in the purchase of on-site and intermediate systems for the medium-level income groups and/or develop “Arisan” schemes to purchase on-site systems
- Consider and implement legislation to ensure that 100% of the neighbourhood connects to the off-site and neighbourhood intermediate systems;
- Consider and implement legislation to ensure that all properties pay a wastewater fee, whether they are connected to off-site and intermediate systems or not.

## 12.3 Implementation schedule

The implementation schedule is presented in Table 12.2.

Table 12.2: Implementation schedule

| Nr. | Description | Period 1 | | | | | Period 2 | | | | | Period 3 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| | | | | | | | | | | | | | | | | | | | | | |
| **1.000** | **STUDIES** | | | | | | | | | | | | | | | | | | | | |
| 1.010 | Masterplan and Feasibility Study | ■ | | | | | | | | | | | | | | | | | | | |
| 1.020 | Detailed Engineering Design Pilot Intermediate Systems | ■ | | | | | | | | | | | | | | | | | | | |
| 1.030 | Detailed Engineering Design Embryo | ■ | | | | | | | | | | | | | | | | | | | |
| 1.040 | Env. Man. (UKL) & Mon. (UPL) Plan Embryo and STP Kayun | ■ | | | | | | | | | | | | | | | | | | | |
| 1.050 | AMDAL STPs Morokrembangan (Surabaya West) | | | | ■ | | | | | | | | | | | | | | | | |
| 1.060 | AMDAL STPs Suramadu (Surabaya East) | | | | | ■ | | | | | | | | | | | | | | | |
| 1.070 | AMDAL Sewerage Surabaya West | | | | ■ | | | | | | | | | | | | | | | | |
| 1.080 | AMDAL Sewerage Surabaya East | | | | | ■ | | | | | | | | | | | | | | | |
| 1.090 | Detailed Engineering Design STP & Sewerage Surabaya West | | | | | | ■ | | | | | ■ | | | | | | | | | |
| 1.100 | Detailed Engineering Design STP & Sewerage Surabaya East | | | | | | | ■ | | | | | ■ | | | | | | | | |
| **2.000** | **MILESTONES** | | | | | | | | | | | | | | | | | | | | |
| 2.010 | Acceptance Masterplans and Feasibility study | ■ | | | | | | | | | | | | | | | | | | | |
| 2.020 | Presentation Bappenas/'Blue Book' | ■ | | | | | | | | | | | | | | | | | | | |
| 2.030 | Land acquisition STP Kayun (Embryo Kaliasin) | ■ | | | | | | | | | | | | | | | | | | | |
| 2.040 | Land acquisition STP Intermediate pilot system Peneleh | ■ | | | | | | | | | | | | | | | | | | | |
| 2.050 | Land reservation STPs City Morokrembangan and Suramadu | | ■ | | | | | | | | | | | | | | | | | | |
| 2.060 | Land acquisition STPs Morokrembangan and Suramadu | | | | | ■ | | | | | | | | | | | | | | | |
| 2.070 | Release of Loan ADB/Hibah Surabaya | | ■ | | | | | | | | | | | | | | | | | | |
| **3.000** | **PHYSICAL IMPLEMENTATION (HARDWARE)** | | | | | | | | | | | | | | | | | | | | |
| **3.100** | **Off-site** | | | | | | | | | | | | | | | | | | | | |
| 3.101 | - Construction STP Kayun | | ■ | | | | | | | | | | | | | | | | | | |
| 3.102 | - Construction sewerage system Embryo Kaliasin | | 9,200 conn. | | | | | | | | | | | | | | | | | | |
| 3.103 | - Construction STP Morokrembangan (Surabaya West) | | | | | | | ■ | | | | | | | | | | | | | |
| 3.104 | - Trunk sewer/sewerage system Surabaya West | | | | | | | 30,800 conn. | | | | 50,000 connections | | | | | | | | | |
| 3.105 | - Construction STP Suramadu (Surabaya East) | | | | | | | | ■ | | | | | | | | | | | | |
| 3.106 | - Trunk sewer/sewerage system Surabaya East | | | | | | | | 16,000 conn. | | | 34,000 connections | | | | | | | | | |
| 3.107 | - Connection intermediate systems to trunk sewers | | | | | | | | | | | | | | | ■ | | | | | |
| **3.110** | **On-site systems** | | | | | | | | | | | | | | | | | | | | |
| 3.111 | - Pilot projects low-cost Surabaya fit system (100 hh) | | ■ | | | | | | | | | | | | | | | | | | |
| 3.112 | - Rehabilitation existing on-site systems | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 3.113 | - Implementation new on-site systems | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | | | | | | | | | | | | | | | | | | | | | |
| **3.210** | **Intermediate systems** | | | | | | | | | | | | | | | | | | | | |
| 3.211 | - Preparation & DED 1 pilot 'community sewerage modules | ■ | | | | | | | | | | | | | | | | | | | |
| 3.212 | - MoU with the community for O&M | ■ | | | | | | | | | | | | | | | | | | | |

| Nr. | Description | Period 1 | | | | | Period 2 | | | | | Period 3 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| 3.213 | - Construction of 1 pilot 'community sewerage module' | | 3,300 hh | | | | | | | | | | | | | | | | | | |
| 3.214 | - Preparation & DED 'community sewerage modules' | | | 3*3,300 hh | | | | | | | | | | | | | | | | | |
| 3.215 | - MoU with the community for O&M | | | | | | | | | | | | | | | | | | | | |
| 3.216 | - Construction 'community sewerage modules' | | | | 3*3,300 hh | | | | | | | | | | | | | | | | |
| 3.217 | - DED & Construction of 8 'community sewerage modules' | | | | | | 8 * 3,300 hh | | | | | 28 * 3,300 hh | | | | | | | | | |
| 3.218 | - Implementation MCKs | 70 * 100 hh | | | | | 50 * 100 hh | | | | | | | | | | | | | | |
| 3.219 | - Implementation Communal Treatment Systems | 20 * 100 hh | | | | | 20 * 100 hh | | | | | | | | | | | | | | |
| **3.310** | **Septage collection and treatment** | | | | | | | | | | | | | | | | | | | | |
| 3.311 | - Construction of Septage Discharge Stations in Trunk Sewers | | | | | | | | | | | | | | | | | | | | |
| 3.312 | - Purchase of vacuum motor cycles | | | | | | | | | | | | | | | | | | | | |
| 3.313 | - Improving O&M IPLT Keputih | | | | | | | | | | | | | | | | | | | | |
| **4.000** | **SOFTWARE** | | | | | | | | | | | | | | | | | | | | |
| **4.100** | **Off-site** | | | | | | | | | | | | | | | | | | | | |
| 4.101 | - Marketing embryos | | | | | | | | | | | | | | | | | | | | |
| 4.102 | - Organisation set-up for Operation sewerage & stp | | | | | | | | | | | | | | | | | | | | |
| 4.103 | - Legislation, Law Enforcement | | | | | | | | | | | | | | | | | | | | |
| **4.200** | **On-site systems** | | | | | | | | | | | | | | | | | | | | |
| 4.201 | - Study performance existing on-site systems | | | | | | | | | | | | | | | | | | | | |
| 4.202 | - Develop Surabaya fit system | | | | | | | | | | | | | | | | | | | | |
| 4.203 | - Dissemination results | | | | | | | | | | | | | | | | | | | | |
| 4.204 | - Marketing on-site systems | | | | | | | | | | | | | | | | | | | | |
| 4.205 | - Community organisation/ NGOs | | | | | | | | | | | | | | | | | | | | |
| 4.206 | - Training sanitarians | | | | | | | | | | | | | | | | | | | | |
| 4.207 | - Backstopping community initiatives | | | | | | | | | | | | | | | | | | | | |
| **4.300** | **Intermediate systems** | | | | | | | | | | | | | | | | | | | | |
| 4.301 | - Study performance existing intermediate systems | | | | | | | | | | | | | | | | | | | | |
| 4.302 | - Pilot projects (sbs, ss) subsidy | | | | | | | | | | | | | | | | | | | | |
| 4.303 | - Dissemination results | | | | | | | | | | | | | | | | | | | | |
| 4.304 | - Marketing intermediate systems | | | | | | | | | | | | | | | | | | | | |
| 4.305 | - Community organisation/ NGOs | | | | | | | | | | | | | | | | | | | | |
| 4.306 | - Backstopping community initiatives | | | | | | | | | | | | | | | | | | | | |
| **4.400** | **Septage collection** | | | | | | | | | | | | | | | | | | | | |
| 4.401 | - Study existing practices | | | | | | | | | | | | | | | | | | | | |
| 4.402 | - Develop alternative manual desludging | | | | | | | | | | | | | | | | | | | | |
| 4.403 | - Marketing septage collection | | | | | | | | | | | | | | | | | | | | |
| 4.404 | - Organising septage collection | | | | | | | | | | | | | | | | | | | | |

| Nr. | Description | Period 1 | | | | | Period 2 | | | | | Period 3 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| 4.405 | - Law Enforcement | | | | ■ | | | | | | | | | | | | | | | | |
| **4.500** | **Enabling Environment** | | | | | | | | | | | | | | | | | | | | |
| 4.501 | - Formalising role Pokja | ■ | | | | | | | | | | | | | | | | | | | |
| 4.502 | - Wastewater Information Centre (mobile) | | ■ | | | | | | | | | | | | | | | | | | |
| 4.503 | - School Sanitation | | | ■ | | | | | | | | | | | | | | | | | |
| 4.504 | - Puskesmas Sanitation | | | | ■ | | | | | | | | | | | | | | | | |
| 4.505 | - Sanitation at institutes | | | | | ■ | | | | | | | | | | | | | | | |
| 4.506 | - Training government staff on sanitation | | | ■ | | | | | | | | | | | | | | | | | |
| 4.507 | - Blame and shame / Ombudsman / Grievance procedures | | | | ■ | | | | | | | | | | | | | | | | |
| 4.508 | - Backstopping commercial enterprises | | | | | ■ | | | | | | | | | | | | | | | |
| **5.000** | **IMPLEMENTATION LIDAP** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **6.000** | **IMPLEMENTATION FOPIP** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **7.000** | **MONITORING AND EVALUATION** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 7.010 | M&E Embryo Kaliasin | | | | ■ | | | | | | | | | | | | | | | | |
| 7.020 | M&E Pilot on-site sanitation | | | | ■ | | | | | | | | | | | | | | | | |
| 7.030 | M&E Pilot intermediate system | | | ■ | | | | | | | | | | | | | | | | | |
| 7.040 | M&E Off-site | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 7.050 | M&E On-site | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 7.060 | M&E Intermediate | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 7.070 | M&E Septage collection and treatment | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **8.000** | **IMPLEMENTATION SUPPORT** | | | | | | | | | | | | | | | | | | | | |
| 8.100 | TA Implementation | | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
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