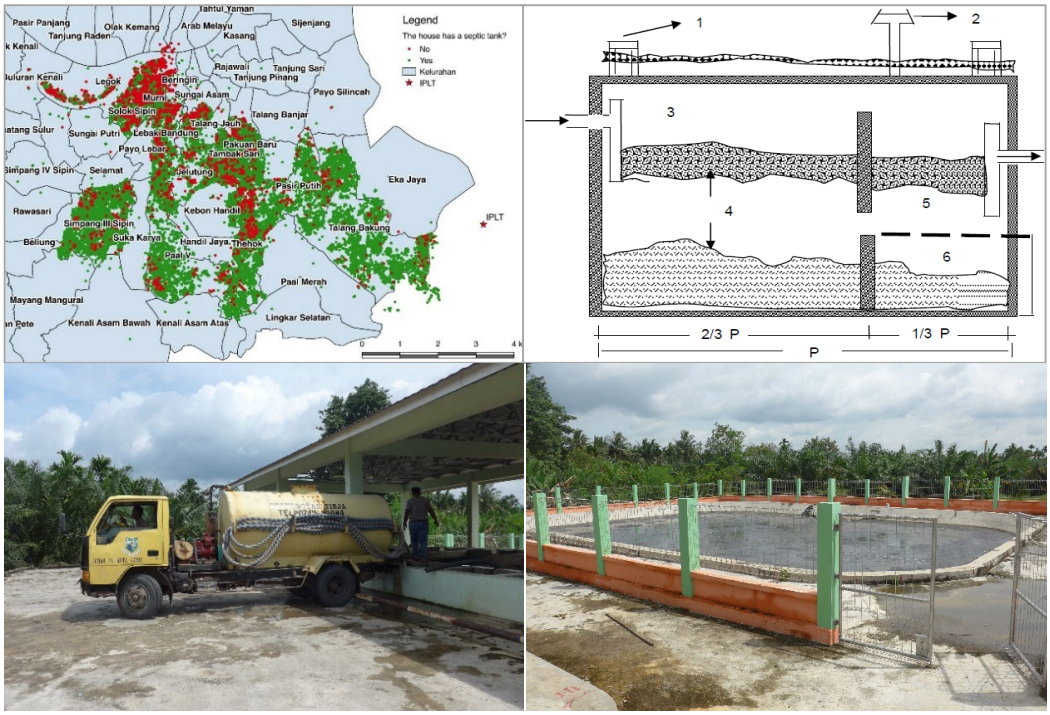
SIAP
Sustainable Infrastructure Assistance Program



COMPREHENSIVE SEPTAGE MANAGEMENT PLANNING IN INDONESIA

A Case Study in the City of Jambi

May 2019

TRTA-8666-INO – INDONESIA
Capacity Development Technical Assistance
Metropolitan Sanitation Management Investment Project

Australian Government
Department of Foreign Affairs and Trade

ADB

CONTENTS

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ABBREVIATIONS

ABR	Anaerobic Baffled Reactor
ADB	Asian Development Bank
BOD/BOD_5	(Five-Day) Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CDTA	Capacity Development Technical Assistance
CV	Commanditaire Vennootschap or Limited or Silent Partnership
DPUPR	Public Works and Spatial Planning Agency (Dinas Pekerjaan Umum dan Penataan Ruang)
GIS	Geographic Information System
IPAL	Wastewater Treatment Plant (Instalasi Pengolahan Air Limbah)
IPLT	Septage Treatment Plant (Instalasi Pengolahan Lumpur Tinja)
IT	Information Technology
IUWASH	Indonesia—Urban Water, Sanitation, and Hygiene
LLTT/L2T2	Scheduled Desludging Service (Layanan Lumpur Tinja Terjadwal)
MIS	Management Information System
MPWH	Ministry of Public Works and Housing
MSMIP	Metropolitan Sanitation Management Investment Project
O&M	Operation and Maintenance
PERDA	Local Regulation (Peraturan Daerah)
PERMEN	Minister's Regulation (Peraturan Menteri)
PPP	Public Private Partnership
PUPR	Ministry of Public Works and Housing (Kementerian Pekerjaan Umum dan Perumahan Rakyat)
RT	Neighbourhood Association (Rukun Tetangga)
SDB	Sludge Drying Beds
SDO	Service Delivery Organization
SIAP	Sustainable Infrastructure Assistance Program
SMP	Septage Management Plan
SNI	Indonesian National Standard (Standar Nasional Indonesia)
SOP	Standard Operational Procedure
SSC	Solids Separation Chambers
SS	Suspended Solids
TS	Total Solids
TSS	Total Suspended Solids
UPTD-PAL	Local Technical Implementation Unit for Wastewater Management (Unit Pelaksana Teknis Daerah – Pengelolaan Air Limbah)
WFPF	Water Financing Partnership Facility
WSP	Waste Stabilization Pond
WWTP	Wastewater Treatment Plant

1. Introduction

With a population of about 245 million people, Indonesia is the world's fourth most populous country. Almost half of the population lives in urban areas; with an urban growth rate averaging 2.5% per year in 2016, the proportion of urban dwellers and their need for wastewater management services are growing rapidly. According to the 2013 Riskesdas[1] results, 76.2% of the households have a private toilet facility, 6.7% are using a communal toilet, and 4.2% are using a public toilet. The remaining 12.9% of the households still do not use a toilet for defecation.

Historically, wastewater management in Indonesia has been viewed as a household or private sector responsibility; as a consequence, public investment in sanitation infrastructure or services was negligible. Following independence in 1945, the primary focus of government was on building the nation and achieving economic growth, while the provision of basic services was not a priority for public expenditure. Although in the 1970s concern about health and welfare impacts on economic development led to increased investment in health programs, with limited investment in top-down projects for sanitation infrastructure. Beginning in 2000, the central government, coordinated by BAPPENAS, embarked on a series of initiatives to reform water supply and sanitation sector policies. These reforms were aligned with decentralization which devolved responsibility for sanitation to the local government[2].

Despite the substantial investments supported by several international donors including the Asian Development Bank (ADB) during the past two decades, Indonesia has still one of the lowest rates of conventional off-site or centralized sewerage coverage in Asia. At the national scale, this coverage is around 1% of the total urban population and only 13 cities have some form of centralized sewerage network and, as seen below, four more are under implementation. Wastewater treatment and disposal are almost entirely managed in on-site systems, mostly in the form of what are commonly called as septic tanks, although in fact most of them are cubluk (i.e., one compartment, lined but open bottomed pits) that rely on wastewater absorption in the subsoil and overflow to water bodies.

The current status of these so-called septic tanks, however, leaves a great deal to be desired. An estimated 60% of septic tanks are located within less than 10 meters of water abstraction wells, either in the same premise or in that of the neighbor. It is estimated that less than 25% of human waste delivered to on-site systems is dealt with properly and about 80% of the country's greywaters (bathroom, kitchen, and laundry wastes) are passed directly to surface water drains, such as the effluents of those septic tanks that have an outlet. The lack of adequate sewerage systems, combined with inadequate solid waste management, is causing a high public health risk and a widespread contamination of both surface and groundwater.

Due to the lack of WWTPs and also to the lack of willingness or inclination to address the option of land application, the independent septage treatment plants, independent septage treatment plants, the so-called IPLT, have become the predominant solution in Indonesia so that there are roughly 170 plants of this kind all over the country. However, as can be seen in Figure 1, only 4% of the septage is treated in a septage treatment plant (IPLT) despite that almost 150 of such plants have been built during the past 20 years. The above-mentioned

[1] Kementerian Kesehatan (2013).

[2] World Bank (2013).

economic disadvantages were intended to be counterbalanced by adopting simple Waste Stabilization Pond (WSP) systems in most cities and regencies, which required relatively low investment costs and skilled labor. The result is, however, not very encouraging as more than 90% of these 170 IPLTs are currently out of operation (AECOM-EAWAG, 2010).

Confronted with this problem, the Ministry of Public Works and Housing (MPWH) has made septage management one of its priority programs as part of their efforts to increase access to appropriate sanitation, especially as to the implementation of scheduled desludging (LLTT) is concerned. In order to raise the awareness of local governments (LGs), the MPWH issued a guidance document on septage management in 2014[3], and, more recently, held a two-day workshop titled Assistance for the Technical Optimization of Septage Management and Implementation of Scheduled Septage Services[4], in Bandung, on 5-6 November 2016.

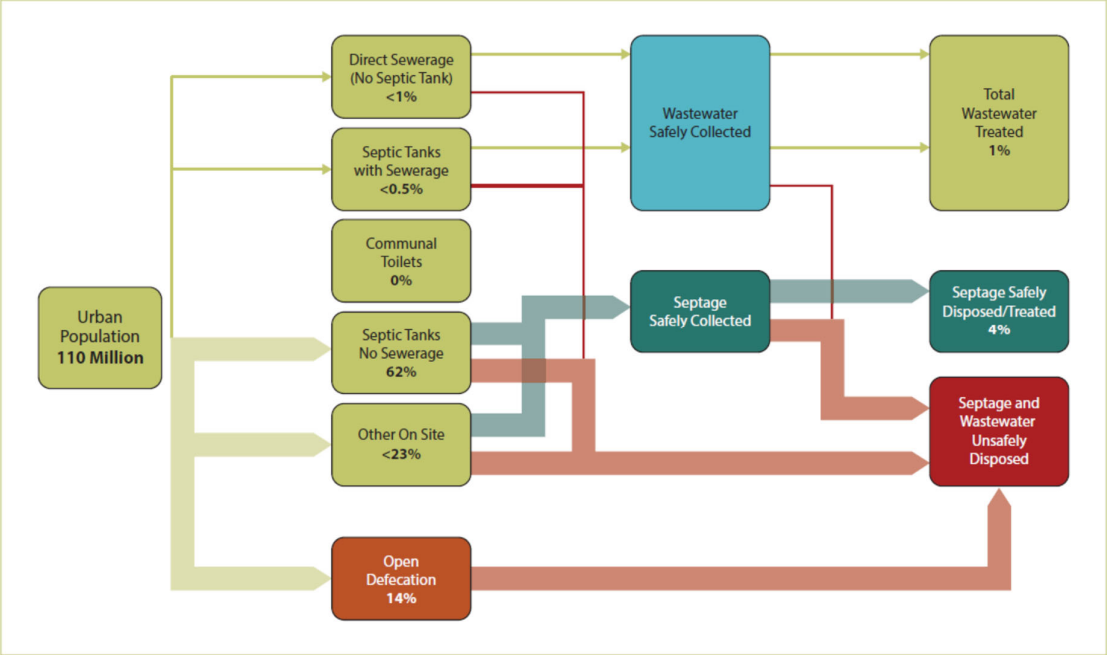


Figure 1: Wastewater and Septage Flow in Urban Indonesia[5]

2. Background

The Asian Development Bank (ADB) is implementing the INO 43251-025 - Metropolitan Sanitation Management Investment Project (MSMIP) to provide centralized (or off-site) sewerage and wastewater treatment facilities within the central districts of the cities of Jambi (Jambi Province), Makassar (South Sulawesi Province) and Pekanbaru (Riau Province) through a $120 million loan. Similar investments in Palembang (South Sumatra Province), also included in the MSMIP, will be financed through a separate grant from the Australian Government. Attached to the project was a technical assistance to support the government in

[3] Pedoman Layanan Lumpur Tinja Terjadwal (Guidelines on Scheduled Septage Services). Kementerian Pekerjaan Umum dan Perumahan Rakyat, Direktorat Jenderal Cipta Karya, Direktorat Pengembangan Penyehatan Lingkungan Permukiman, December 2014 (only in Indonesian).

[4] Bantuan Teknis Optimalisasi Pelayanan Lumpur Tinja dan Penyiapan Penerapan Layanan Lumpur Tinja Terjadwal.

[5] WorldBank (2013).

implementing the project, TA-8666-INO – INDONESIA Capacity Development Technical Assistance. The CDTA is a sub-project of the C-TA0013-INO: Sustainable Infrastructure Assistance Program (SIAP) that ADB's Board approved on 17 June 2013. The CDTA was to support long-term sustainability of the MSMIP loan and grant by providing expert advice to (i) help establish the relevant agencies and wastewater management, (ii) create an operational framework for sanitation services including tariff structures and billing, and (iii) provide training to ensure continued sustainability of the services.

The new off-site sewerage systems, however, will be available for less than 10% of the population in the ongoing Stage 1. This means that on-site systems and septage management will remain the predominant method of sanitation for many decades in these cities and elsewhere in Indonesia. Therefore, it is of crucial importance to regulate and develop an appropriate on-site wastewater management service at the local government level. The key element of such practices is an integrated septage management approach based upon scheduled desludging services (layanan lumpur tinja terjadwal or LLTT/L2T2), including regular collection, transport, treatment and adequate disposal and/or reuse of the extracted septage. The cost of the operation should be covered by a fee (or monthly rates) to be collected from all owners or occupiers of the premises equipped with on-site wastewater treatment facilities. Considering that the on-site wastewater service users constitute around 90% of the potential customers of the Service Delivery Organization (SDO), even after the implementation of the first stages of the new off-site sewerage systems, this service will make up the bulk of the SDO's activity and revenues.

With the support of the MPWH in the framework of the above-mentioned LLTT program, it was proposed to draft a Septage Management Plan for the City of Jambi (SMP) as an additional task of the CDTA, which could then serve as an example and a model for the rest of the MSMIP target cities and elsewhere in Indonesia. Accordingly, the City Government of Jambi requested ADB's assistance to prepare the plan based upon a detailed survey covering 40,000 households. The plan, one of the first of its kind in Indonesia, should include provisions for the establishment of scheduled desludging of septic tanks, in line with the above-mentioned MPWH policy. The task is financed with funds available from the Water Financing Partnership Facility (WFPF).

3. Rationale: What Is and Why Manage Septage

A septic tank is a primary settlement tank consisting of a watertight chamber with two or three compartments, made of concrete, brickwork, PVC or plastic, for the storage and treatment of wastewater, both blackwater and greywater, in which settling and anaerobic processes reduce solids and organics.

Septage is the settled solid matter, usually a mixture of solids and water, retained at the bottom of a septic tank. It is raw or partially digested sludge in a semisolid form. It results from the collection, storage or treatment of combinations of black water and excreta, with or without grey water. It has an offensive odor and appearance and is high in organics and pathogenic microorganisms.

There is a very slight difference between septage, generally used in relation to septic tanks in the narrow sense, and other outputs of on-site sanitation systems, such as cesspools or pit latrines, for which the terms faecal sludge or excreta are also used. The characteristics of

septage can differ widely from household to household, city to city, region to region, and country to country, and are influenced by the duration of storage, temperature, soil condition, and intrusion of groundwater or surface-water in septic tanks or pits, the performance of septic tanks, and the tank-emptying techniques and pattern.

There is, however, a fundamental difference between sewage (or wastewater) and septage. Sewage is untreated wastewater which contains feces and urine as well as greywater from the kitchen and bathroom and is discharged either into a centralized sewer system or into an on-site wastewater treatment facility. Generally, both biochemical oxygen demand (BOD) and total suspended solids content (TSS) of domestic sewage range from 200 to 350 mg/l and WWTPs are designed for this load. Septage is sludge or slurry, emptied out of septic tanks, cesspools or pit latrines, and is much more concentrated than sewage, its TSS being 10 to more than 100 times higher than that of municipal wastewater. Actually, in terms of solids content (TSS) it resembles to the sludge that is removed from the settling tanks of a WWTP, ranging from 2-10 g/l. This means that septage is sludge and not water, and should be treated as such, using the proper methods of the sludge treatment process, such as thickening, stabilization, dewatering and drying. The treatment process should be designed as a function of septage quality and quantity and, mainly, of its final disposal and/or end usage.

The main reasons to manage septage are as follows:

(i) On-site wastewater systems, such as septic tanks, pit latrines, dry latrines, MCK, or other types, accumulate septage or fecal sludge that needs to be removed periodically.

(ii) If septage is not properly managed, i.e. not removed regularly from the septic tanks and not treated and/or not disposed of adequately, it may cause highly negative impacts on public health and on domestic and urban environment caused by the presence of fecal matter in the surroundings of the habitations.

(iii) Improper handling of septage may cause risks of fecal matter re-entering the domestic environment and cause waterborne diseases, such as typhoid fever, gastroenteritis and all types of diarrhea, within the households.

(iv) Private septage haulers often discharge collected septage into drains, waterways, open land and agricultural fields, posing a threat to the environment and health.

(v) Despite the implementation of the new centralized off-site sewerage systems, on-site systems will remain the predominant method of sanitation for many decades in all Indonesian cities.

4. Purpose of this Document

This document is provided as an aid to help develop comprehensive septage management plans in Indonesian cities and regencies (kota or kabupaten). Therefore, it addresses all key activities involved in an SMP, such as the survey of existing on-site facilities, the assessment of the current situation, the design and construction and/or refurbishment of septic tanks, scheduled desludging, treatment and disposal of septage and all related institutional, financial and governance aspects, such as a new economic-financial model, socialization and participation of the private sector. Accordingly, the report describes succinctly all these activities and explain the ways how local governments should gradually control their city's on-site wastewater treatment and disposal facilities, organize and implement scheduled

desludging services and operate and maintain the septage treatment facilities and manage sludge disposal.

The document is conceived as a case study for septage management planning based upon the experience on the above-mentioned Septage Management Plan for the City of Jambi. This management plan is the first of its kind in Indonesia, because (i) it is designed based on an up-front, innovative, city-scale baseline survey of existing sanitation facilities that was carried out in collaboration with the local residents; and (ii) once the data was collected and processed, a comprehensive plan was developed − including an information management system − to provide the Jambi City Government with the tools to navigate all aspects and activities involved in septage management in the long term. It is believed that the assessment and planning exercise done for the city of Jambi and the tools developed could well set an example and be used in other cities in Indonesia.

5. Elements of a Comprehensive Septage Management Plan

The key elements of a Comprehensive Septage Management Plan for Indonesian cities are as follows:

(i) Survey of existing on-site wastewater collection and treatment facilities and data management:
   (a) Data collection on all or on a significant portion of septic tanks and other on-site facilities.
   (b) Development of a GIS-based Management Information System (MIS) for data management and update.

(ii) Amendment of the local government regulation for wastewater management:
   (a) Clear provision for the implementation of septage management as a public service within an overall wastewater management service.
   (b) Detailed legal and technical specifications regarding septage management, setting up the rights and obligations of both local government and service users.

(iii) Design and construction and/or refurbishment of on-site wastewater collection and treatment facilities:
   (a) Regulatory provisions and criteria for the design and construction of new septic tanks.
   (b) Refurbishment plan for non-complying septic tanks.
   (c) Guidelines for the inspection and monitoring of existing facilities and of the installation of the new ones.

(iv) Implementation of scheduled desludging of on-site facilities
   (a) Quantification of septage and provisions for the acquisition of desludging vehicles.
   (b) Scheduled desludging services planning.
   (c) Best practices for septic tank emptying and transport to the treatment plants and/or disposal sites.

(v) Septage treatment and disposal
   (a) Septage quantities, qualities and treatment options.
   (b) Refurbishment of existing septage treatment plants (IPLT).
   (c) Septage treatment at wastewater treatment plants (IPAL)
   (d) Final disposal and/or reuse of treated septage sludge.
   (e) Land application option of liquid septage.

(vi) Economic and financial model
   (a) Establishment of fees and/or rates.
   (b) Construction of a simplified model.
   (c) Financial analysis for cost recovery.

(vii) Private Sector Participation in Septic Tank Desludging
   (a) Legal framework.
   (b) Possible forms of private participation.
   (c) Licensing and cooperation agreement.

(viii) Social marketing
   (a) Increase consumer acceptability of septage management.
   (b) Socialization and marketing plan.
   (c) Monitoring.

6. The Planning Process

It is recommended to carry out septage management planning in the following three stages:

(i) Stage 1 – Preliminary Appraisal
The purpose of this Stage 1 is to set out the bases and the main elements of septage management planning so as to provide a framework for an in-depth discussion of the key concepts and issues of septage management, both technical and financial and institutional, with the local government and all relevant stakeholders. This stage includes the preparation of a Preliminary Report and concludes with a Preliminary Workshop to present and discuss the report with the above-mentioned authorities and stakeholders in the city or regency.

(ii) Stage 2 – Field Investigations and Assessment of the Current Situation
This second stage includes all the field and desk investigations necessary to assess the current situation and future development of on-site wastewater management in the city or regency. Thus, it is in this stage that the survey and field visits at the treatment plant(s) and possible sludge disposal sites as well will take place. The findings of these field works and other desk analyses should allow for the assessment of the current situation and for a proposal of the planning approach. The works carried out, the assessment and the planning approach will be the subject of an Interim Report presented and discussed with the local government and the stakeholders at an Interim Workshop.

(iii) Stage 3 – Development of the Septage Management Plan
In the last stage of the planning process, the above-mentioned key elements involved in the Septage Management Plan are to be addressed, such as the design and construction and/or refurbishment of septic tanks, scheduled desludging, treatment and disposal of septage and all related institutional, financial and governance aspects, such as a new economic-financial model, socialization and participation of the private sector. All these elements will be incorporated in the Final Report which is to be presented and discussed at a Final Workshop.

7. Survey of Existing On-Site Facilities and Data Management in the City of Jambi

7.1. Design and Scope of the Survey

The first task proposed for the development of the SMP was a detailed census of the existing on-site facilities throughout a representative area of the city. Consequently, a survey of 40,123 households (or 200,000 beneficiaries approximately) was carried out, covering roughly one-third of the City throughout 13 kelurahan and 5 kecamatan of the city (Figure 2). It excluded the districts that will be covered by the sewer network of the future MSMIP off-site project.

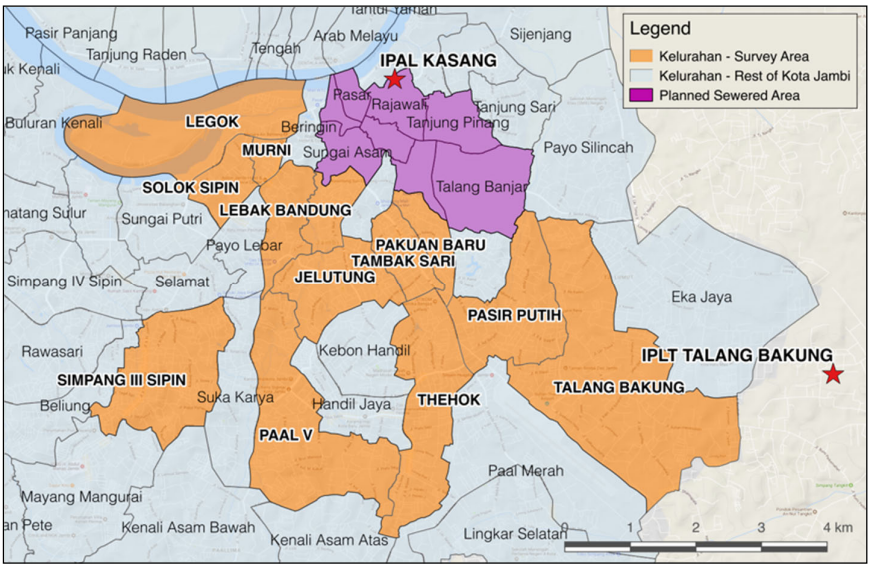
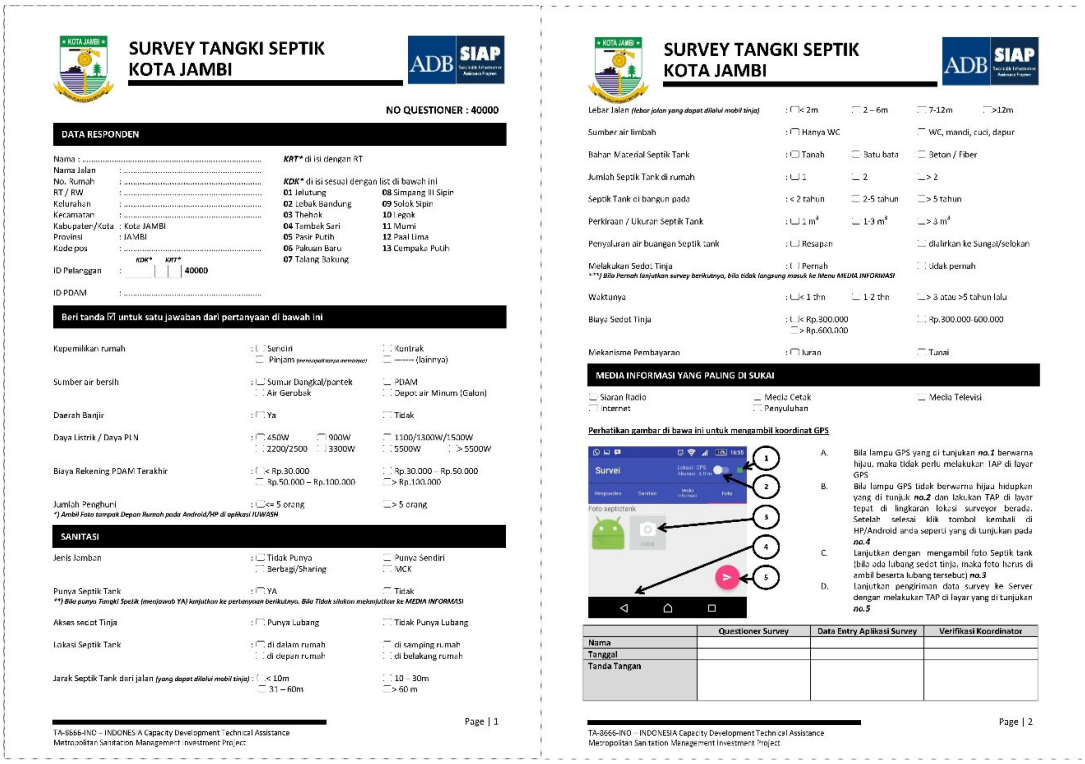


Figure 2: Survey Area

The survey is one of the first of its kind in Indonesia and hoped to establish a model for future surveys in Jambi and other Indonesian cities to support the strategies and decision-making in integrated urban wastewater management. The survey was based on a comprehensive questionnaire that included questions ranging from the physical location of the property and the septic tank, through socio-economic characteristics of the dwelling to technical features of the on-site facility.



SURVEY TANGKI SEPTIK
KOTA JAMBI

NO QUESTIONER : 40000

DATA RESPONDEN

Nama :
Nama Jalan :
No. Rumah :
RT / RW :
Kelurahan :
Kecamatan :
Kabupaten/Kota : Kota JAMBI
Provinsi : JAMBI
Kode pos :
ID Pelanggan : KDK* KRT* 40000
ID PDAM :

KRT* di isi dengan RT

KDK* di isi sesuai dengan list di bawah ini

01 Jelutung
02 Lebak Bandung
03 Thehok
04 Tembok Seri
05 Pasir Putih
06 Paksian Baru
07 Talang Bakung
08 Simpang III Sipin
09 Solok Sipin
10 Legok
11 Mumi
12 Paal Lima
13 Cempaka Putih

Beri tanda ☑ untuk satu jawaban dari pertanyaan di bawah ini

Kepemilikan rumah : Sendiri / Kontrak / Pinjam (pemanfaatannya permanen) / ------ (lainnya)

Sumber air bersih : Sumur Dangkal/pantek / PDAM / Air Gerobak / Depot air Minum (Galon)

Daerah Banjir : Ya / Tidak

Daya Listrik / Daya PLN : 450W / 900W / 1100/1300W/1500W / 2200/2500 / 3300W / 5500W / > 5500W

Biaya Rekening PDAM Terakhir : < Rp.30.000 / Rp.30.000 – Rp.50.000 / Rp.50.000 – Rp.100.000 / > Rp.100.000

Jumlah Penghuni : <= 5 orang / > 5 orang

*) Ambil Foto tampak Depan Rumah pada Android/HP di aplikasi IUWASH

SANITASI

Jenis Jamban : Tidak Punya / Punya Sendiri / Berbagi/Sharing / MCK

Punya Septik Tank : YA / Tidak

**) Bila punya Tangki Septik (menjawab YA) lanjutkan ke pertanyaan berikutnya. Bila Tidak silakan meloncat/lokasi ke MEDIA INFORMASI

Akses sedot Tinja : Punya Lubang / Tidak Punya Lubang

Lokasi Septik Tank : di dalam rumah / di samping rumah / di depan rumah / di belakang rumah

Jarak Septik Tank dari jalan (yang dapat dilalui mobil tinja) : < 10m / 10 – 30m / 31 – 60m / > 60 m

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SURVEY TANGKI SEPTIK
KOTA JAMBI

Lebar Jalan (lebar jalan yang dapat dilalui mobil tinja) : < 2m / 2 – 6m / 7-12m / >12m

Sumber air limbah : Hanya WC / WC, mandi, cuci, dapur

Bahan Material Septik Tank : Tanah / Batu bata / Beton / Fiber

Jumlah Septik Tank di rumah : 1 / 2 / > 2

Septik Tank di bangun pada : < 2 tahun / 2-5 tahun / > 5 tahun

Perkiraan / Ukuran Septik Tank : 1 m^3 / 1-3 m^3 / > 3 m^3

Penyaluran air buangan Septik tank : Resapan / dialirkan ke Sungai/selokan

Melakukan Sedot Tinja : Pernah / Tidak pernah
***) Bila Pernah lanjutkan survey berikutnya, bila tidak langsung masuk ke Menu MEDIA INFORMASI

Waktunya : < 1 thn / 1-2 thn / > 3 atau >5 tahun lalu

Biaya Sedot Tinja : < Rp.300.000 / Rp.300.000-600.000 / > Rp.600.000

Mekanisme Pembayaran : Kuras / Tunai

MEDIA INFORMASI YANG PALING DI SUKAI

Siaran Radio / Media Cetak / Media Televisi / Internet / Penyuluhan

Perhatikan gambar di bawa ini untuk mengambil koordinat GPS

A. Bila lampu GPS yang di tunjukan **no.1** berwarna hijau, maka tidak perlu melakukan TAP di layar GPS
B. Bila lampu GPS tidak berwarna hijau hidupkan yang di tunjuk **no.2** dan lakukan TAP di layar tepat di lingkaran lokasi surveyor berada. Setelah selesai klik tombol kembali di HP/Android anda seperti yang di tunjukan pada **no.4**
C. Lanjutkan dengan mengambil foto Septik tank (bila ada lubang sedot tinja, maka foto harus di ambil beserta lubang tersebut) **no.3**
D. Lanjutkan pengiriman data survey ke Server dengan melakukan TAP di layar yang di tunjukan **no.5**

	Questioner Survey	Data Entry Aplikasi Survey	Verifikasi Koordinator
Nama			
Tanggal			
Tanda Tangan			

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Figure 3: Questionnaire

The work was carried out from the beginning of December 2017 to the end of February 2018 and involved the mobilisation of more than 400 people who were trained about the purpose, importance and specific tasks of the survey. The survey team was composed of a City Coordinator and 20 kelurahan coordinators (assistant professional staff), each of whom managed on average another 20 surveyors, all of them residents of the respective kelurahan of the survey area. This organizational scheme allowed the Consultant's team to have a very direct approach to the communities affected by the survey and managed to involve the 13 lurah and 482 rukun tetangga (RT) heads. In order to increase the level of awareness and engagement of the public in the execution of the survey, a socialization workshop was held with the participation of the 5 camat, the 13 lurah and the 21 survey coordinators that would be involved in the field survey, as well as representatives of Dinas PUPR.

Figure 4: Socialization Workshop and Training of Surveyors

Furthermore, all survey team members received a training on the aims of the survey, on the items of the questionnaire and on the use of the software application. The training was delivered at two levels: in the first phase, the coordinators were trained by the central management team (the “training of trainers”) and, in the second phase, the coordinators trained their respective surveyor team members.

The surveyors used an Android mobile phone application to record the answers given by the respondents, including the recording of GPS position. The application used was originally developed and tested by IUWASH as part of recent projects and was consequently adapted specifically to the needs of the Jambi SMP survey in a collaboration exercise. The record of each property and septic tank surveyed included two pictures taken with the camera of the mobile phone used.

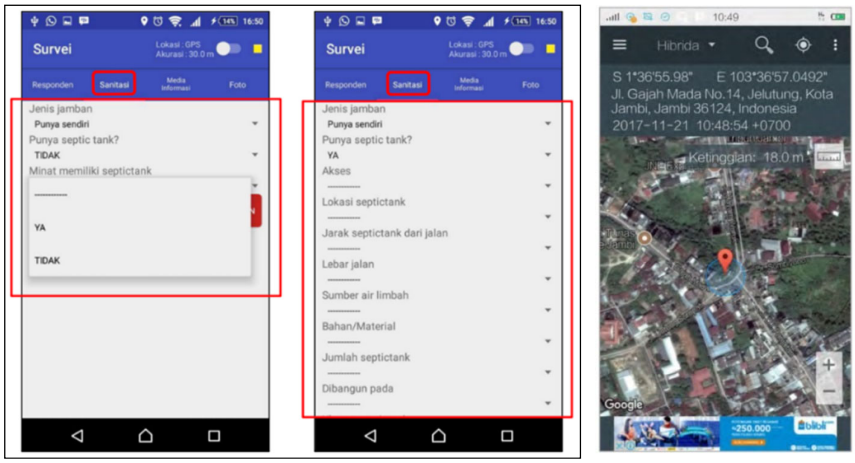


Figure 5: Sample Screenshots of the Android Application

Figure 6: Photos of Property and Septic Tank

7.2. Data Processing and Analysis

The data obtained by the surveyors were checked and verified daily by the coordinators and uploaded to a database hosted on a server managed by the CDTA consultant at its home office accessible via a web-based portal, also developed by IUWASH, for consultation and processing. Members of the consultan team carried out random checks on location to further ensure that data were valid.

Overall, the database contains 40,123 records with 42 properties each record, i.e. approximately 1.68 million data items. The data server has different user categories with distinct access, read and write rights. It also allows for editing of data (by high-level users) and exporting of selected records.

The processed data were input to a geographical information system (GIS) using the open-source client application QGIS for visual and spatial analysis. The use of spatial data visualisation was a fundamental aid for understanding and conveying a number of important insights about the existing condition of on-site sanitation facilities in the city.

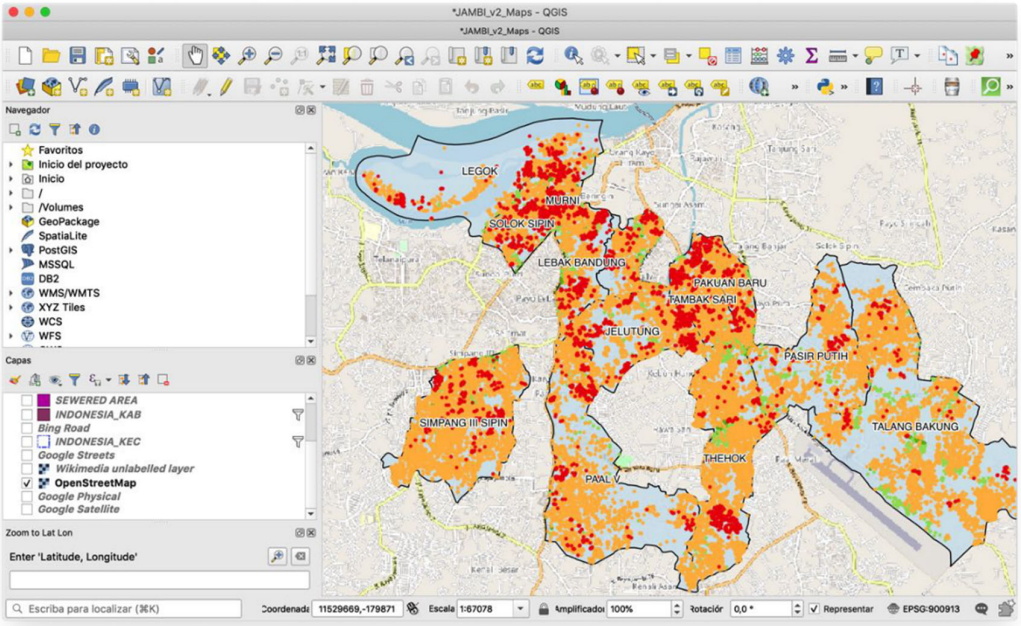


Figure 7: GIS Application

Furthermore, QGIS is a professional GIS application that is built on top of Free and Open Source Software (FOSS). The file formats operated by QGIS and used by the CDTA team in the context of the survey and the Jambi SMP are 100% compatible and interoperable with the majority of the free and proprietary GIS software.

7.3. Use of the Survey Data

The use of spatial data visualisation was a fundamental aid for understanding and conveying a number of insights about the existing condition of on-site sanitation facilities in the city.

The processed survey data is, in itself, valuable for a first round of analysis and extraction of insights about the existing condition of sanitation facilities. However, the most valuable

application is through its use on a management information system (MIS). The CDTA developed such a MIS based on previous models by and with the assistance of IUWASH. The City Government of Jambi will use this system to complete the survey and implement the Septage Management Plan, allowing the local office to:

- Build and manage customer databases
- Prepare the septic tank desludging schedules
- Send instructions to the truck operators
- Supervise & Monitor the desludging process
- Analyse desludging reports
- Financial management: payment registration, billing and accounting.

The web-based Portal application is used to manage the implementation process of customer desludging services as well as disposal of sludge at the IPLT. Features available in the web-based Portal application are: development of customer database, desludging truck operator database, work order system and accounting systems. This application can also be used to monitor truck movement by displaying it with maps on the application dashboard.

The MIS utilises Geographic Information System (GIS) technology that records the location of customers, the treatment plant and the vacuum truck through GPS devices. The truck routes can be planned, optimised and executed based on requests by the customers or mandatory, planned schedules. It also helps reinforce compliance.

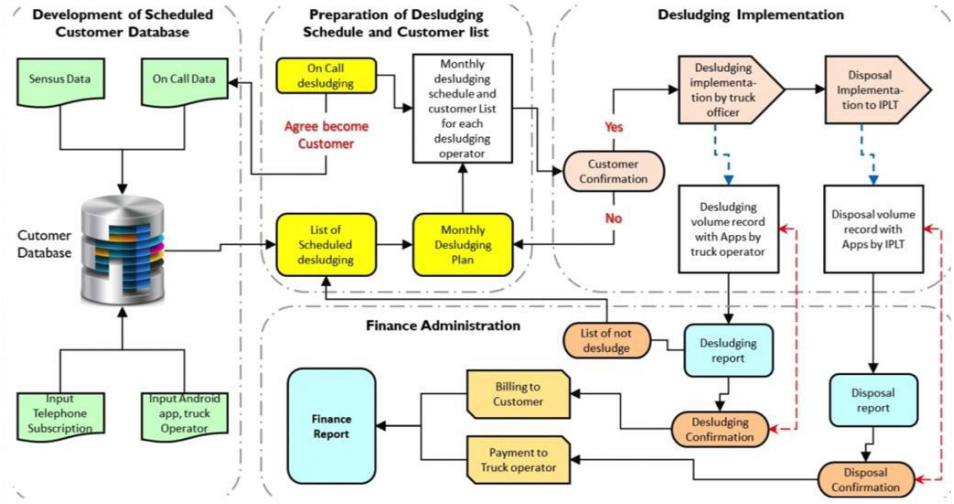


Figure 8: Management Information System

7.4 Key Lessons Learnt

The results of the survey were satisfactory in terms of i) how the survey was planned and executed, and ii) the consistency and sufficiency of the data for its purpose and considering the scale of the exercise.

Collaborate: Leverage on previous work

Some of the core tools used in the survey are adaptations of tools developed and used by IUWASH in previous projects in Indonesia. They had already been developed and tested precisely for the same problem, and it was a matter of approaching the institutions involved

and agreeing a collaborative effort. The Jambi project gained not only in efficiency, but also from building on previous knowledge. IUWASH will also be able to test their tools in further environments. This collaboration has proven essential in the outcome and will continue in the implementation stages.

Fully engage the local people

The surveyors were all residents of the districts covered while the coordinators responsible for training and supervising the surveyors were residnts of Jambi. The local leaders played a decisive role in encouraging the neighbours to participate, by actively learning the importance of the exercise first and later promoting it among the people who would ultimately respond to the questionnaires. This engagement has proven essential in creating a feeling of legitimacy among the people, who in most cases took part actively because they perceived the exercise will bring a genuine benefit to their lives.

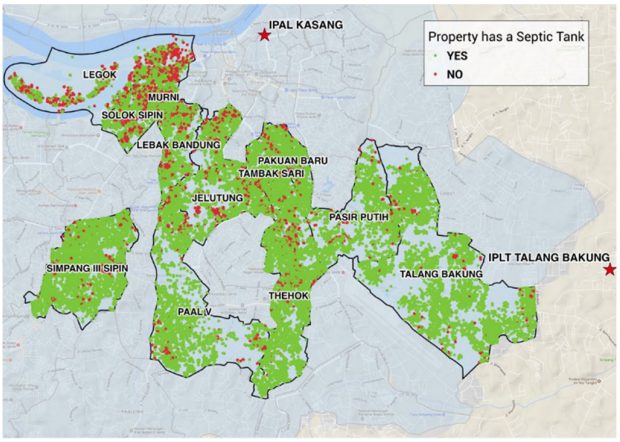
Dream big, act practical

The survey, unique in its kind and scale in Indonesia, was possible because of an innovative and bold approach that combines technology adapted ad-hoc, team building and collaboration, use of open source and free software, and management mechanisms designed specifically for the purpose. The use of spatial data visualisation was a fundamental aid for turning large volumes of data into useful information, and for conveying important ideas to the local decision makers. Training has been a core element in the planning and execution of the survey: all coordinators were trained before the surveyors were. Training covered not only the tasks related to the tools and questionnaires, but also collaboration and coordination aspects.

8. Assessment of the Current Situation of Septage Management in the City of Jambi

8.1. On-site Wastewater Treatment and Disposal Facilities

Most premises in Jambi (89%) are equipped with what the occupants consider a septic tank, which means that 11% of the households in the survey area still have no toilets (Figure 9). The facts that the majority of existing septic tanks are older than five years (83%), are rather limited in size (72% < 3 m^3), and have never been emptied (92%), suggest that they produce effluents and/or overflows that do not receive an appropriate treatment and cause a negative impact on the environment and a high public health risk (Figure 10). Actually, most septic tanks are in fact cubluk, i.e. one-compartment, lined but bottomless pits allowing wastewater to seep to the ground and to the groundwater. Accordingly, the vast majority of them is not in line with the Indonesian Standard SNI 03-2398-2002 concerning the Procedure for the Design of Septic Tanks with a Percolation System (Figure 11): practically none of them seems to comply with size requirements, three-quarters of them receive only blackwater from the associated buildings and practically none has an associated percolation area or a soak pit. As a consequence, most on-line facilities of the city produce overflows to drains and water bodies, and, actually, wastewater is omnipresent in the drains all over city.



DOES THE PROPERTY HAVE A SEPTIC TANK?		
DISTRICT/SUB-DISTRICT	**NO**	**YES**
DANAU SIPIN		
LEGOK	42,4%	57,6%
MURNI	22,4%	77,6%
SOLOK SIPIN	24,5%	75,5%
JAMBI SELATAN		
PAKUAN BARU	9,6%	90,4%
PASIR PUTIH	4,6%	95,4%
TAMBAK SARI	8,4%	91,6%
THEHOK	7,5%	92,5%
JELUTUNG		
CEMPAKA PUTIH	12,5%	87,5%
JELUTUNG	12,4%	87,6%
LEBAK BANDUNG	18,9%	81,1%
KOTA BARU		
PAAL LIMA	5,3%	94,7%
SIMPANG III SIPIN	4,1%	95,9%
PAAL MERAH		
TALANG BAKUNG	2,0%	98,0%
TOTAL	**11,2%**	**88,8%**

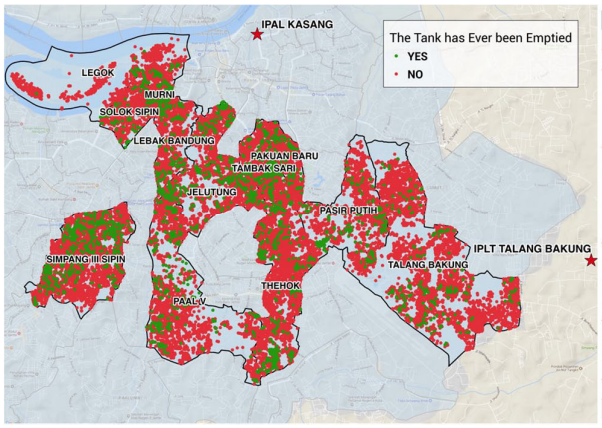
Figure 9: Presence of Septic Tanks[6]

8.2. Current Desludging Practices

The current desludging service in Jambi is a remedial system for overflowing tanks functioning exclusively on demand. Although the desludging equipment owned by the Public Works and Spatial Planning Agency (Dinas Pekerjaan Umum dan Penataan Ruang, DPUPR) is rather limited (only 3 vacuum trucks of 4 m^3 each), they are apparently under-utilized: less than three transports and discharges to the existing septage treatment plant (instalasi pengolahan lumpur tinja or IPLT) at Talang Bakung per day. There are also four private entrepreneurs providing the emptying of septic tanks, but they are not necessarily dump their loads to the IPLT. The lack of regular desludging contributes to increase the risks of fecal matter and pathogens

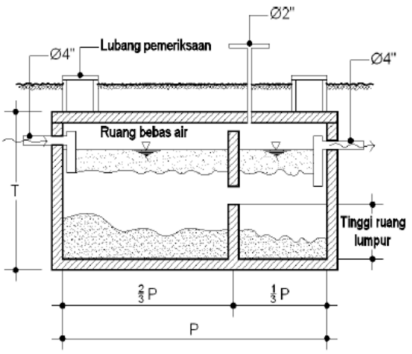
[6] Unless otherwise specifically stated, the images in this report have been prepared by the authors of the Septage Management Plan for the City of Jambi (SMPJ), Capacity Development Tecnical Assistance (CDTA), C-TA0013-INO - Sustainable Infrastructure Assistance Program (SIAP), Asian Development Bank.

remaining in the surroundings of the households and even re-entering the domestic environment causing waterborne diseases, such as diarrhea, infectious hepatitis, typhoid and paratyphoid fever, mainly among children. Furthermore, the uncontrolled discharge of greywater and septic tank overflows into drains, trenches, ditches and to the ground in general result also in a highly negative impact on the urban environment. Many on-site facilities have problems of access for emptying vehicles, and even a great number of them is situated under the buildings, mainly in case of the so-called ruko (rumah toko, i.e. dwelling and shop).

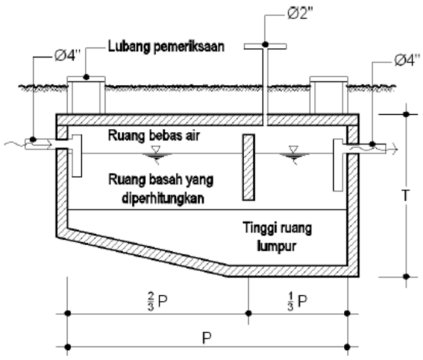


HAS THE TANK EVER BEEN DESLUDGED?		
DISTRICT/SUB-DISTRICT	**YES**	**NO**
DANAU SIPIN		
LEGOK	2,7%	97,3%
MURNI	10,9%	89,1%
SOLOK SIPIN	5,9%	94,1%
JAMBI SELATAN		
PAKUAN BARU	8,2%	91,8%
PASIR PUTIH	8,5%	91,5%
TAMBAK SARI	8,5%	91,5%
THEHOK	7,7%	92,3%
JELUTUNG		
CEMPAKA PUTIH	9,4%	90,6%
JELUTUNG	9,1%	90,9%
LEBAK BANDUNG	7,2%	92,8%
KOTA BARU		
PAAL LIMA	8,6%	91,4%
SIMPANG III SIPIN	8,3%	91,7%
PAAL MERAH		
TALANG BAKUNG	4,0%	96,0%
TOTAL	**7,3%**	**92,7%**

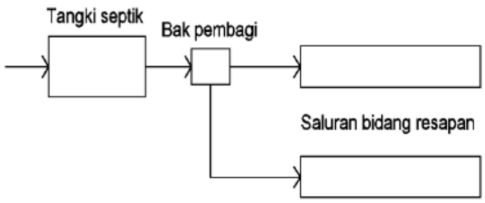
Figure 10: Septic Tank Emptying



a) Conventional Septic Tank



b) Modified Septic Tank



c) Percolation Area

Figure 11: Septic Tank Design According to the Indonesian Standard SNI 03-2398-2002[7]

[7] Drawings taken from Sudarmadji and Hamdi (2013).

Figure 12: Vacuum Trucks Owned by the Jambi DPUPR

8.3. Septage Treatment and Sludge Disposal

The Talang Bakung IPLT, located just outside the city's boundary to the east of the kelurahan of Talang Bakung (actually in the desa or village of Tangkit, kecamatan of Sungai Gelam, kabupaten Muaro Jambi), some 14 km away from the city center (Figure 13), consists of a waste pond stabilization (WSP) system preceded by a solids separation unit (Figure 14). The plant is in an acceptable physical state but is non-functional as a treatment facility. Although the septage input is very low, there is practically no dry sludge production due to the lack of solids removal and there is virtually no outflow. In consequence, the ponds that ought to treat the supernatant water separated from septage are only used for sludge storage (Figure 15). The main infrastructural deficiencies of the plant are the non-functional sludge removal at the so-called sludge separation chambers (SSC) due to design and maintenance problems (Figure 16), the total inadequacy and the consequent state of disuse of the sludge drying beds (Figure 17), the state of abandonment of the outlet pipe and the consequent complete lack of a plant effluent (Figure 18). Moreover, the problems of operation of the IPLT can be attributed essentially to the lack of understanding of the principle of septage treatment and sludge disposal and to the total absence of definition of sludge disposal options.

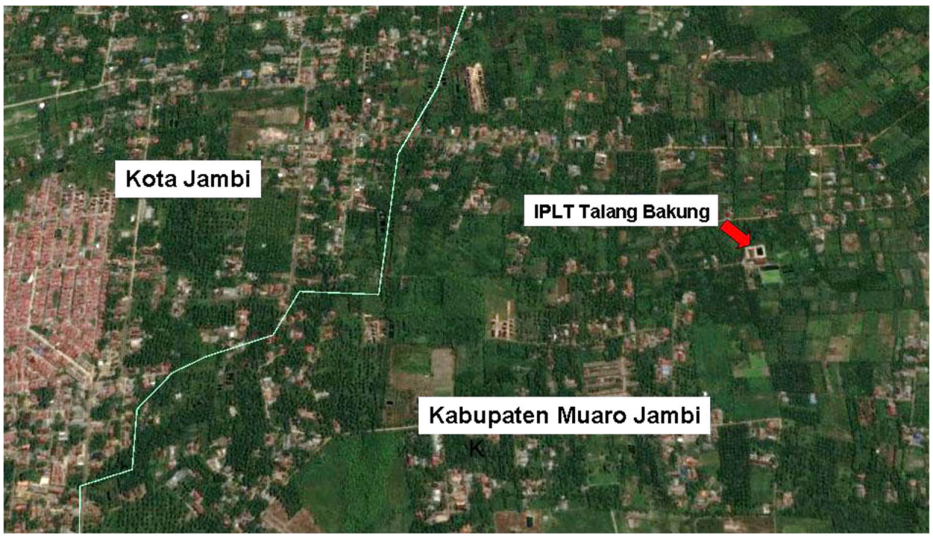


Figure 13: Location of the Talang Bakung IPLT

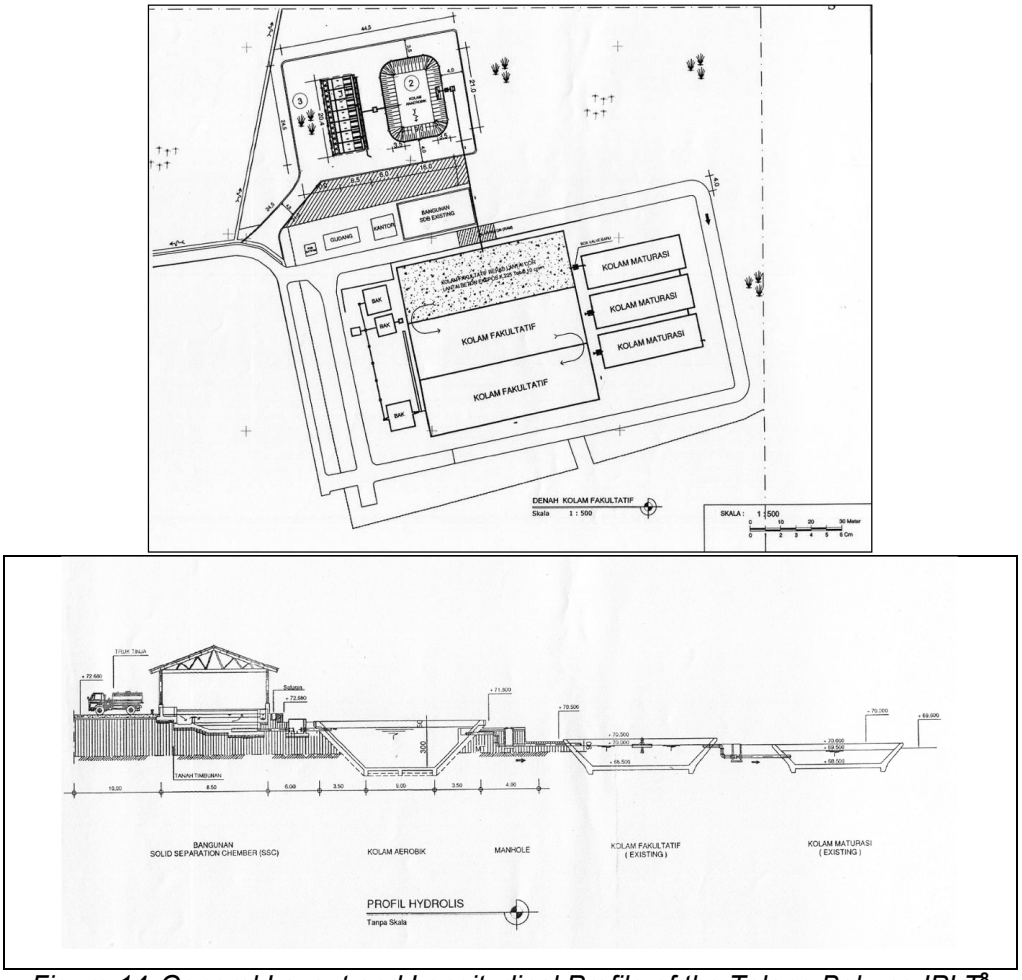


Figure 14: General Layout and Longitudinal Profile of the Talang Bakung IPLT[8]

a) Anaerobic Pond

b) Facultative Pond no. 1 and SDB

Figure 15: Waste Stabilization Ponds Used Only for Sludge Storage

[8] MPWH-SATKER Provinsi Jambi (2016).

Figure 16*: Solids Separation Chambers*

Figure 17: Sludge Drying Beds

Figure 18: Maturation Ponds and Outlet Area

9. Amendment of the Local Government Regulations for Wastewater Management

Most Indonesian cities and regencies (kota and kabupaten), such as the City of Jambi have a regulation on wastewater management (PERDA)[9]. These regulations generally cover the entire scope of wastewater management, both on-site and off-site, and contain even provisions for wastewater network planning and development. It is understood, however, that, in most of them, there are certain gaps in them that might be filled to allow the cities to improve their

[9] Kota Jambi (2015).

activity in all aspects of wastewater management and, in particular, in septage management, regarding certain technical, legal and financial aspects.

In the case of City of Jambi , the key concepts and criteria proposed for the amendment of the existing regulation were (based on Asian Development Bank, 2017):

(i) the introduction of the concepts of wastewater management service provision and service users;

(ii) clear distinction between domestic (household and other assimilable discharges) and non-domestic (industrial or commercial) effluents;

(iii) the obligation of treatment of all wastewaters issued from a property, both blackwater and greywater, (d) the specification of proper design and construction criteria for septic tanks based on the Indonesian Standard;

(iv) the implementation of scheduled desludging of on-site facilities;

(v) the mandatory nature of sewer connections, wherever available;

(vi) the implementation of the pretreatment obligation for industries before discharging into sewers, including prohibitions and effluent standards;

(vii) the establishment of the right to enter private properties for local government;

(viii) the setting up of permitting arrangements and financial provisions and

(ix) the establishment of enforcement procedures.

10. Design and Construction and/or Refurbishment of On-Site Wastewater Treatment and Disposal Facilities

10.1. Design and Construction Considerations for Septic Tank Systems

The septic tanks need to be designed and constructed as per the norms set out in:

(i) Indonesian Standard SNI 03-2398-2002 concerning the Procedure for the Design of Septic Tanks with a Percolation System.

(ii) Regulation of the Minister of Public Works and Public Housing No. 04/PRT/M/2017 on the Implementation of Domestic Wastewater Management Systems, Appendix II: Domestic Wastewater Management System Planning, Jakarta, 21 March 2017, pp. 38-81.

(iii) Guidelines for Scheduled Desludging Services. Ministry of Public Works and Public Housing, General Directorate General Cipta Karya, Directorate of Environmental Sanitation Development, May 2015.

The Indonesian Standard SNI 03-2398-2002, in force since 2002, allows the implementation of a septic tank for a maximum of 50 people (10 KK or households) and requires a two-chamber rectangular septic tank (Figure 11) for the so-called mixed wastewaters (blackwater and greywater), although it admits small cylindrical tanks for small households (1 KK). The only criterion set out for the two chambers is that the proportion between the first and the second should be 2/3 and 1/3.

Based on the above standard and regulations, a septic tank is a primary settlement tank consisting of a watertight chamber with one, two or three compartments, made of concrete,

brickwork, PVC or plastic, for the storage and treatment of wastewater, both blackwater and greywater, in which settling and anaerobic processes reduce solids and organics. The septic tank should be of sufficient volume to provide retention time for the settlement of the suspended solids (SS), while reserving an adequate volume for sludge storage. The volume required for sludge storage is the determining factor in sizing the septic tank, which depends on the potential occupancy of the building, estimated from the maximum number of people that the house can accommodate, and which determines also the desludging frequency of the tank. Septic tanks may be constructed on-site provided that they comply with the requirements specified in the standard and with the local wastewater management regulation, or pre-fabricated tanks may be installed if they are adequately designed and manufactured by a specialist company.

A septic tank should have at least two chambers unless it is small (less than 2 m^3, i.e. for less than 5 persons, practically inexistent in Jambi). The first chamber should be at least 50% of the total length, and when there are only two chambers, it should be two thirds of the total length. Most of the solids settle out in the first chamber. A septic tank divided into two chambers has the advantage that most of the sludge is accumulated in the first chamber and, as sludge is more confined, its emptying is easier. A one-chamber modified septic tank is, however, included in the SNI 03-2398-2002 standard (Figure 11). As can be seen, the floor is inclined towards the outlet, so sludge tends to accumulate in that part.

The floor of the tanks should be of cement concrete and, whenever possible, sloped towards the sludge accumulation area. Both the floor and sidewall shall be plastered with cement mortar to render the surfaces smooth and to make them watertight. The baffle, or the separation between the chambers, is to prevent scum and solids from escaping with the effluent. A T-shaped outlet pipe further reduces the scum and solids that are discharged. Accessibility to all chambers (through access ports) is necessary for maintenance. Septic tanks should be vented for controlled release of odorous and potentially harmful gases. Because the septic tank must be regularly desludged, a vacuum truck should be able to access the location. Often, as is also the case of Jambi septic tanks are installed in the home, under the building, which makes emptying difficult or even impossible. The design of a septic tank depends on the potential occupancy of the dwelling or building, the amount of water used per capita, the average annual temperature (in colder climates, their efficiency can be lower), the desludging frequency and the characteristics of the wastewater.

Improved forms of the septic tank consist in combining it with a filter, usually called biofilter, because it consists of a biological treatment based on a biomass adhered to a support medium. The system comprises two generally cylindrical compartments, the proper septic tank and the biofilter, in biological treatment of wastewater takes place. Actually, most of the compact prefabricated septic tank systems are of this kind, like the septic tank combined with an up-flow biofilter () promoted by IUWASH for small households (1 KK[10] = 5 persons)[11] and the other products available in Indonesia.

[10] Kepala Keluarga = Head of Family.

[11] MPWH (2016). Buku 2 - Sistem Pengelolaan Air Limbah Domestik-Setempat. Tangki Septik dengan Up-Flow Filter (Book 2 – On-Site Domestic Wastewater Management System. Septic Tank with an Up-Flow Filter). Ed. Lutz Kleeberg. Jakarta: Ministry of Public Works and Housing, 2016 (in Bahasa Indonesia). https://www.iuwashplus.or.id/cms/wp-content/uploads/2017/04/Buku-San1-SPALD-Setempat.pdf

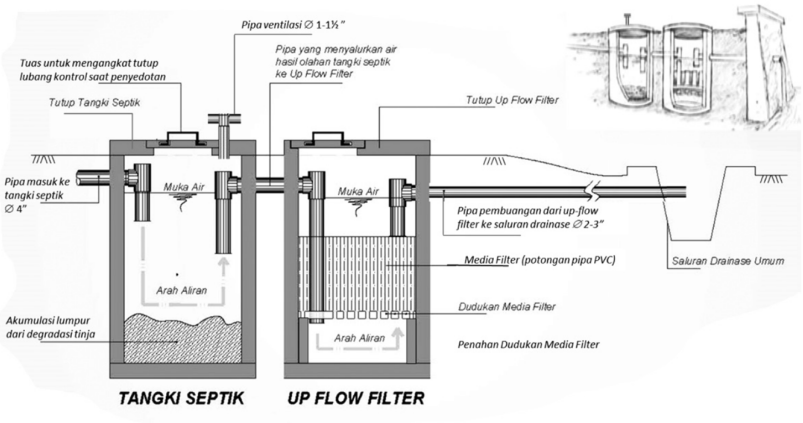


Figure 19: Cylindrical Septic Tank Combined with an Up-Flow Filter (IUWASH) [12]

Another improved form of the septic tank is the Anaerobic Baffled Reactor (ABR) which can be readily applied in small neighborhoods as the so-called communal septic tanks or for larger buildings (Figure 20). It is most appropriate where a relatively constant amount of blackwater and greywater is generated. This technology is suitable for areas where land maybe limited since the tank is most commonly installed underground and requires a small area. However, a vacuum truck should be able to access the location because the sludge must be regularly removed (particularly from the settler), which is not the case of some existing facilities in Jambi. The anaerobic baffled reactor (ABR) comprises a series of baffles under which the wastewater is forced to flow. The increased contact time with the active biomass (sludge) results in improved treatment. The up-flow chambers provide enhanced removal and digestion of organic matter. BOD may be reduced by up to 90%, which is far superior to its removal in a conventional septic tank.

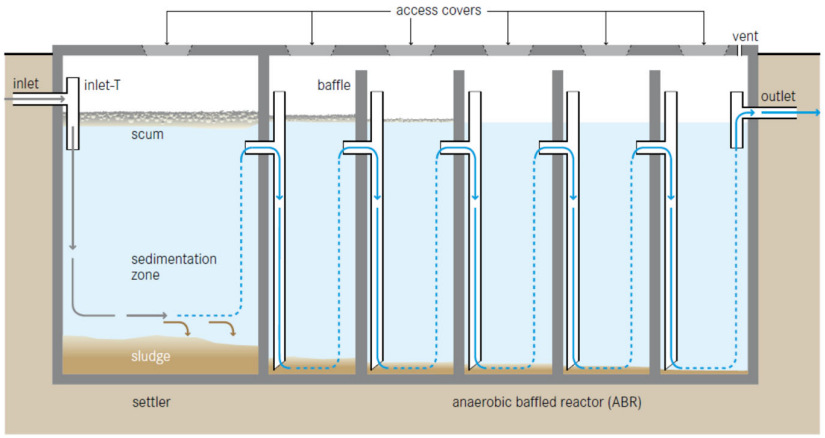


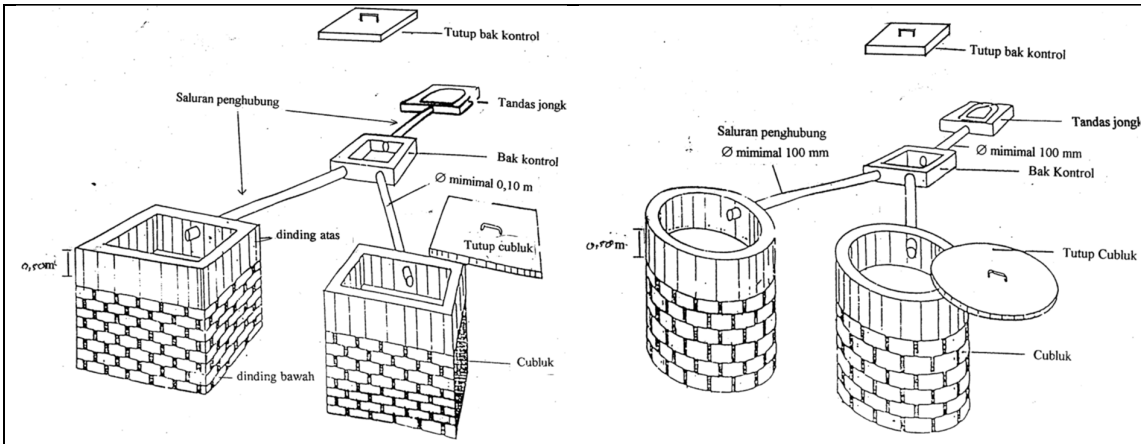
Figure 20: Anaerobic Baffled Reactor (ABR) for Communal Septic Tanks[13]

The twin cubluk system is the simplest type of on-site wastewater treatment unit (Figure 21). This technology consists of two alternating pits lined with pervious walls made of hollow bricks connected generally to a pour flush toilet. The blackwater (and in some cases greywater) is

[12] Kementerian Pekerjaan Umum dan Perumahan Rakyat (2016).

[13] Tilley et al. (2014).

collected in the pits where the feces are settled while water is allowed to slowly infiltrate into the surrounding soil. Over time, the solids are sufficiently dewatered and can be manually removed with a shovel. This simple facility might be appropriate for rural-type urban areas at the outskirts of Jambi but the PERMEN 04/PRT/M/2017[14] only admits it for areas with a density lower of 25 persons per hectare. Therefore, it is up to the City Government's approval to admit the construction of a twin cubluk for certain households in rural-type areas.



a) Square Type b) Cylindrical Type

Figure 21: Twin Cubluk Systems for Rural or Rural-Type Urban Areas[15]

The most important component of a septic tank system ought to be the percolation area (also called an infiltration area or leach field) as it provides most of the treatment of the wastewater effluent although it is not present in most existing septic systems in Indonesia. It is a network of perforated pipes that are laid in underground gravel-filled trenches to dissipate the effluent from an on-site wastewater treatment facility. Percolation areas require a relatively large area and unsaturated soil with good absorptive capacity to effectively dissipate the effluent. Due to potential oversaturation of the soil, leach fields are not appropriate (and sometimes not feasible) for dense urban areas. A percolation area will become clogged over time, although this may take 20 or more years, if a well-maintained and well-functioning septic tank or other primary treatment technology is in place.

In parcels with limited space, soak pits (also called seepage pits, leach pits or soakaways) can also be installed as means to dissipate the effluent from an on-site wastewater treatment facility. It is a covered, porous-walled chamber that allows water to slowly soak into the ground. Pre-settled effluent from a septic tank is discharged to the underground chamber from which it infiltrates into the surrounding soil.

[14] Kementerian Pekerjaan Umum dan Perumahan Rakyat (2017)

[15] Source: PERMEN 04/PRT/M/2017.

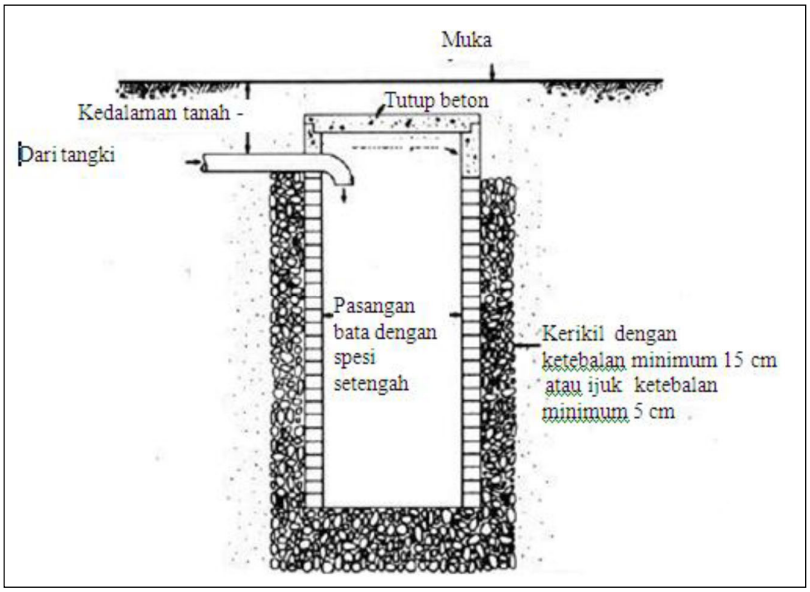


Figure 22: Typical Soak Pit[16]

It should be pointed out, however, the vast majority of the septic systems available in Indonesia, however, is not in line with the SNI 03-2398-2002 standard: practically none of them seems to comply with size requirements, three-quarters of them receive only blackwater from the associated buildings and practically none has an associated percolation area or soak pit. As a consequence, most on-line facilities of the city produce overflows or effluents to drains and water bodies, in general partially treated or not treated at all, which is why, actually, wastewater is omnipresent in the rainwater drains of the cities.

10.2. Refurbishment Plan of Non-Complying On-Site Facilities

To implement scheduled desludging in an Indonesian city, it is necessary that the deficiencies encountered in the survey should be remedied gradually in the future, which means, on the one hand, that all new septic tanks need to be designed and constructed according to the standard and, on the other, that the existing septic tanks will have to be gradually refurbished in a way that they approach as far as possible to the requirements of the standard.

As an example, the refurbishment plan for the city of Jambi is briefly outlined. In Jambi, as the total number of households is around 125,000, i.e. three times more than those surveyed, one of the first tasks the City Government of Jambi should do to start septage management is to complete the GIS database. Later, the android-based MIS application, to be used for day-to-day management, will ensure the regular update of the database. It is recommended, however, to carry out a specific upgrade of the database every 4 years and/or using other City Government surveys, such as local tax assessment.

The refurbishment of the non-complying on-site facilities should consist of, among others:
(i) the installation of access holes or manholes on the upper slab of the tanks;
(ii) the relocation of septic tanks to the front of the premises;
(iii) the reconstruction of clearly undersized septic tanks;

[16] Source: SNI 03-2398-2002, taken from Sudarmadji and Hamdi, 2013 (see footnote 11).

(iv) the connection of all wastewaters to the septic systems;
(v) the construction of proper outlets and percolation systems, such as percolation areas or leach fields (individual or communal);
(vi) the promotion of communal treatment and disposal systems to replace inappropriate individual facilities;
(vii) the installation of ventilation pipes on the upper slabs, wherever appropriate and
(viii) the promotion of flush toilets in those households that currently lack them.

Seen the current status of on-site facilities all over the City of Jambi and of most Indonesian cities, however, it goes without saying that there is a long way to go to attain the goals of an appropriate septage management and of proper septic tank design all over the city. Therefore, the implementation of the refurbishment plan is an objective-oriented process taking several years involving multiple decisions and activities, which means that the refurbishment of the existing facilities should be carried out gradually, in the framework of a long-term plan, for which, such as for the implementation of the other aspects of the septage management plan, a time horizon of ten (10) years appears to be reasonable.

The implementation process of the refurbishment plan should include three stages. The first stage, to be performed during the first year, should “set the framework” of the refurbishment plan, and include the amendment of the wastewater management PERDA, the setting up of the SDO (in Jambi, a UPTD-PAL), and the extension of the survey for the remaining two-thirds of the households of the city. The second stage, to be carried out during the second half of the first year, should “set the bases” of the plan, and include setting up inspection activities to be carried out by the SDO, the definition of funding sources and arrangements by the LG and the outline and classification of refurbishment works. Finally, the third stage, of nine years duration, should encompass the implementation of the works, including the definition of the necessary refurbishment works to be carried out and the setting up of funding arrangements on a yearly basis, the undertaking of the works proper by the owners and supervision and feedback to be performed by SDO staff.

11. Implementation of Scheduled Desludging of On-Site Facilities

11.1. Basic Criteria for the Introduction of Scheduled Desludging Services

The implementation of scheduled desludging services in Indonesian cities should be based on a pre-determined schedule replacing the current remedial on-demand practices. Scheduled desludging should be set up as a public service to be provided by the LGs, through their SDOs, by their own means or using those of licensed private septage haulers. The PERDA should be amended to ensure this regular desludging as a local government service. In case of private sector involvement, the LG should certify and license private septage transporters to desludge and transport septage to the designated treatment facility, preferably through a public private partnership (PPP) process, including a public tender arrangement. Awareness generation activities should educate households about the need for regular cleaning. Also, local fees should be levied by the City Government as per a specific PERDA or as part of a PERDA of fees for public services to recover the operating expenses for regular desludging.

Ideally, septic tanks should be emptied only when necessary, based on the volume of accumulated sludge. Yearly desludging of septic tank is desirable. But if it is not feasible or economical, smaller domestic tanks should be cleaned at least once in 1 to 3 years, with a

recommended average in most Indonesian cities (and, in particular, in Jambi) of 2 years, provided the tank is not overloaded. Since families generate varying volumes of sludge at different rates and have varying sizes of septic tanks, scheduled desludging programs should be adjusted to the real needs base on regular inspection. In any case, awareness generation activities should educate households about the need for regular cleaning.

The number of desludging vehicles should be based on the frequency of emptying, the distance of the location from the treatment facility and local conditions. Transportation to the treatment and/or disposal site should be done by larger vacuum trucks, so the transfer from the locally used small scale vehicle to the larger ones should be resolved adequately by means of transfer in each area.

11.2. Scheduled Desludging Services Planning

The cities and regencies should acquire additional trucks for the collection of septage and its transportation to the treatment and disposal sites. Vacuum trucks of different capacities can be used, from 2,000 to 12,000 liters, although the currently available 4,000-litre trucks in most cities seem to be appropriate due to the limited capacity of septic tanks.

In Jambi, the number of trucks required is 22. In case the City Government opted to provide the desludging service exclusively by their own means, they should acquire 20 more vehicles in addition to their existing three trucks (one of them in a rather bad state) and meet the related strong staff needs (one driver and one operator per vehicle) or to entrust the service substantially to licensed private waste hauler contractors, or again, as the most reasonable option, to implement a “mixed model”, including public and private service providers. In any case, the UPTD-PAL staff should ensure the planning, inspection and monitoring tasks.

Small scale, motorcycle-driven Vacutug-type devices are recommended for areas inaccessible to large vehicles (Figure 23). Transportation to the treatment and/or disposal site(s) should be done by larger vacuum trucks, so the transfer from the locally used small scale vehicle to the larger ones should be resolved by means of transfer stations located in each operational area of the service (Figure 24).

Figure 23: Vacutug-Type Desludging Vehicles for Septage Tanks with Difficult Access

c) Portable collection tanker *b) Portable reinforced plastic tanks*

Figure 24: Modular Transfer Stations[17]

For the operational planning of scheduled desludging services, it is recommended to divide the city into zones of roughly similar population and characteristics and prepare a yearly plan. In Jambi, a city with 13 kecamatan, it is proposed to establish 8 scheduled desludging zones comprising either individual kecamatan or the combination of two kecamatan (Figure 25). The number of desludging vehicles assigned to each zone is proposed to be roughly proportional to the population the zone while one Vacutug-type vehicle should be allocated to each zone. To operate with these, one transfer station per zone is also envisaged to allow the larger vehicles transport the collected septage to the treatment plant(s). To deploy scheduled desludging it the city, it was proposed to adopt a gradual implementation process over a time horizon of five (5) years.

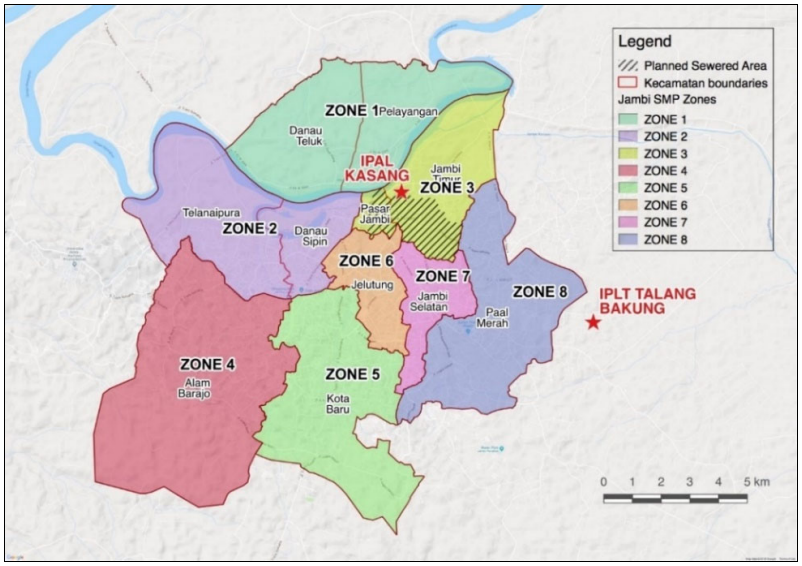


Figure 25: Septage Management Operational Zones in Jambi

[17] Mukheibir P. (2015).

11.3. Organization and Staffing of the Service Delivery Organization

Regular desludging activities will require a well-organized City Government, a specialist public SDO and the contribution of licensed private waste haulers. To establish and organize a wastewater SDO in an Indonesian city, the basic principle to consider is integrated management. This means that the future organization should undertake both off-site and on-site wastewater management as these are nothing but the two facets of an overall sanitation service aimed to adequately collect, treat and dispose of the wastewaters produced in the city. Such an arrangement would also enable the SDO to readily manage the transition from the on-site system to the future off-site system by promoting sewer connections. Furthermore, as the centralized off-systems will be of a rather limited scope for a long time, on-site wastewater management would ensure the financial feasibility of the organization by integrating the numerous on-site users. At the same time, this criterion implies that the structure needed for on-site wastewater management cannot be separated from the overall integrated management structure. In Jambi, a preliminary structure and staffing was proposed, envisaging 42 people at the outset and 87 people at a fully developed stage. The real needs, however, will greatly depend on how LGs decide to organize scheduled desludging and to what extent licensed private waste haulers will be integrated into the service.

12. Septage Treatment and Disposal

12.1. Septage Quantities, Qualities and Treatment Options

In order to envisage the septage treatment and disposal options and facilities, it is necessary to quantify the septage flows to be treated. In Jambi, on the assumption of a full deployment of scheduled desludging, the total quantity of septage to be treated and disposed of is 231 m^3/day. The existing Talang Bakung IPLT has a nominal capacity of 80 m^3/day. Although the current input is less than 10% of this capacity, around 7 m^3/day, and the plant is virtually non-functional despite the refurbishment works carried out in 2016, it is thought appropriate to upgrade it with relatively minor works that would allow to be put it into service. For the treatment and disposal of the remaining septage quantities, 151 m^3/day, the most rapid and cost-effective option would be undoubtedly their co-treatment with wastewater at the Kasang IPAL, to be completed, most likely, by 2021.

As regards septage quality, available characterization data should be used or, if appropriate, a sampling and characterization campaign should be carried out. In Jambi, in the absence of useable data, the key parameters to characterize the quality of septage were taken from a 2014 World Bank study (Mills, 2014), and are: total solids (TS) of 15,000 mg/l, total suspended solids (TSS) of 5,000 mg/l, BOD_5 of 1,000 mg/l, COD of 3,300 mg/l, BOD/COD of 1/3 and NH_3-N of 200 mg/l. The low BOD/COD ratio indicate very low and/or difficult biodegradability. Therefore, as also set out in specialized literature (Strauss et al., 2000), the type of septage available in Jambi might be highly mineralized and little digestive or not digestive at all and the anaerobic pond might not be required.

Septage treatment is not an aim in itself. Its main objective is to dispose of treated sludge without harming human and environmental health. Alternatives for the treatment and disposal of septage comprise the following categories:

(i) treatment at independent septage treatment plants;
(ii) co-treatment with wastewater at WWTPs and
(iii) land application.

When designing and operating a septage treatment facility, it is essential to consider the differences between septage and wastewater as designers and operators often fall into the trap of proposing treatment systems developed for wastewater. Septage is the settled solid matter, usually a mixture of solids and water, retained at the bottom of a septic tank or a pit latrine. It is raw or partially digested sludge in a semisolid form.

The characteristics of septage can differ widely from household to household, city to city, and country to country, but it is much more concentrated than sewage, its total solids or total suspended solids (TS or TSS) content being 10 to more than 100 times higher than that of municipal wastewater. This means that septage is sludge and not water, and should be treated as such, using the proper methods of the sludge treatment process, such as thickening, stabilization, dewatering and drying, always as a function of its final disposal and/or end usage.

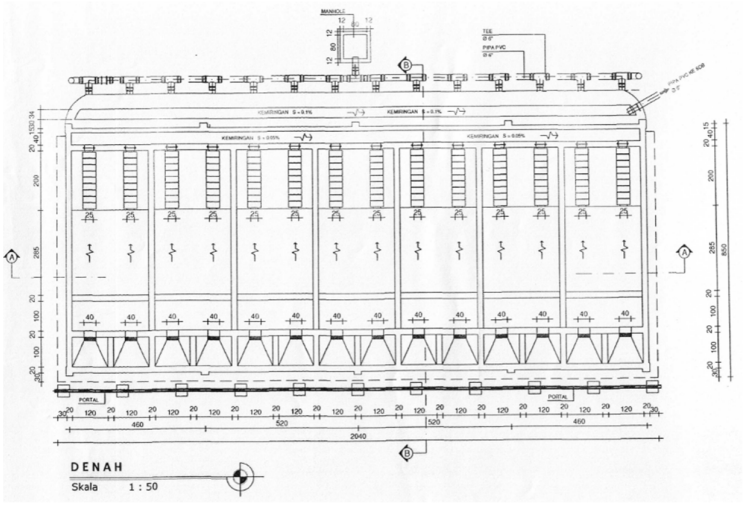
In consequence, the mean treatment objectives are thickening and dewatering of septage, as it contains a high proportion of liquid, and the reduction in this volume (or the increase of its dryness) will greatly reduce the cost of transporting water weight and simplify subsequent treatment steps. Environmental and public health objectives are achieved through pathogen reduction, stabilization of organic matter and nutrients, and the safe disposal or reuse of the sludge product.

12.2. Refurbishment of the Existing Talang Bakung Septage Treatment Plant

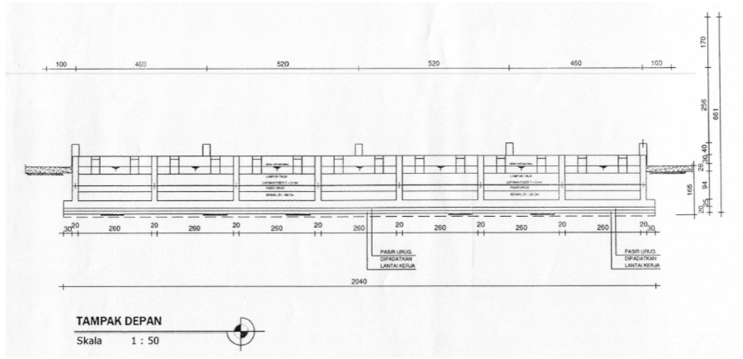
The waste stabilization pond system (WSP) available at the Talang Bakung IPLT consists of consists of an anaerobic pond and three trains of facultative and maturation ponds, preceded by solids separation chambers (SSC). As said above, the main infrastructural and operational deficiencies of the IPLT to be restored are (a) the non-existent solids removal at the SSCs due to design and maintenance problems, (b) the total inadequacy and the consequent state of disuse of the sludge drying beds, and (c) the state of abandonment of the outlet pipe and the consequent complete lack of a plant effluent.

WSP systems are essentially conceived to treat wastewater. Septage, however, typically exhibits total (TS) and suspended solids (TSS) contents, which are very high compared to wastewater. When treating septage in ponds, be it separately or in conjunction with wastewater, settleable solids must be separated in primary treatment units, such as the solids separation chambers (SSCs) described and analyzed above, in order to guarantee an undisturbed treatment of the liquid fraction (Strauss et al., 2000). It is therefore important to underline that only supernatant water should be admitted into the WSP. As this is not happening at the IPLT, the current treatment process is greatly disturbed.

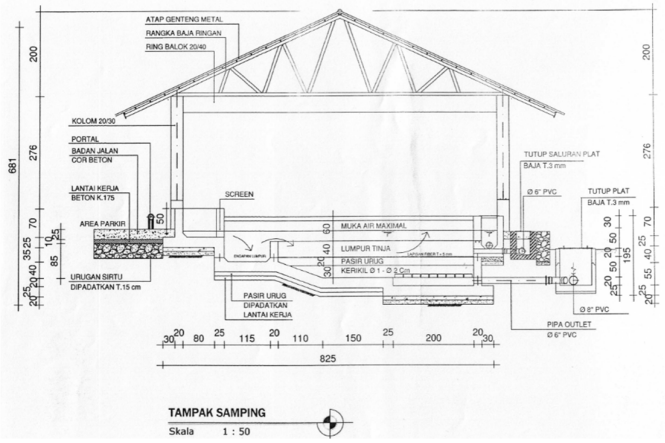
The SSCs are a modified version of a facility recommended in the PERMEN 04/PRT/M/2017 on wastewater management but the modification has not worked well (Figure 26). The proposed remodeling of the SSCs should consist basically in permanently removing the fiberglass plates and setting up the arrangement recommended in the PERMEN: collect thickened sludge at the bottom through the pipes that were to convey water and, vice versa, collect supernatant water at the upper part through the holes, canal and pipes that were to convey sludge according to the original design (Figure 27). It is understood that the suggested refurbishment is relatively simple to perform, as it would require only minor plumbing and masonry works to be defined at the detailed design stage. Thickened sludge will be conveyed to new sludge drying beds to be situated ca. 1.50 m below the SSC bottom which should allow gravity feed.



a) Layout Plan



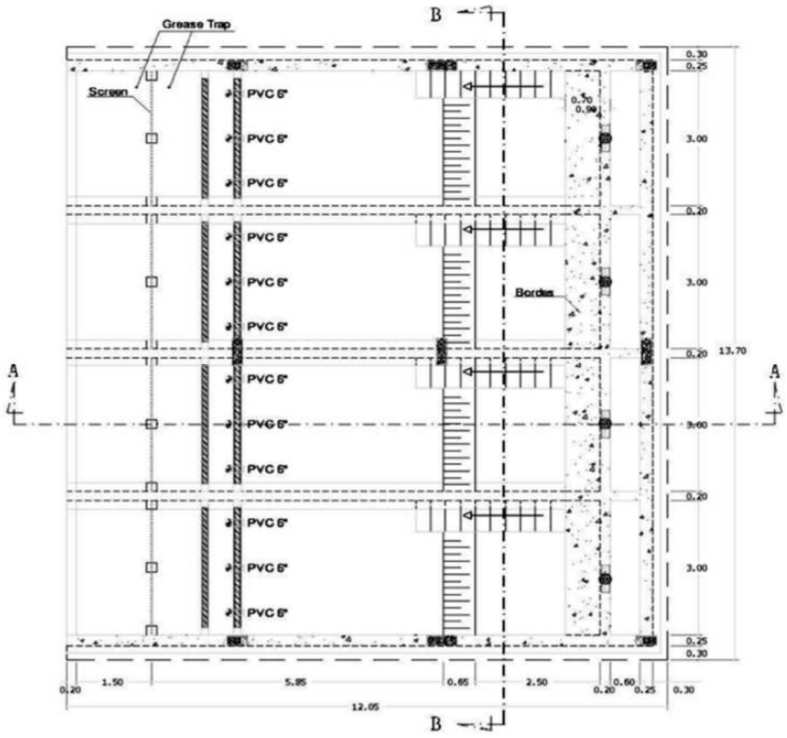
b) Longitudinal Section



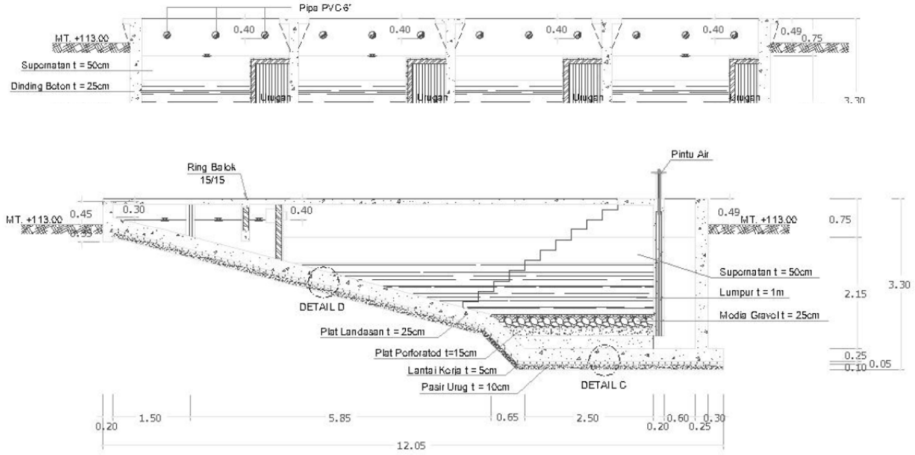
c) Cross Section

Figure 26: Solids Separation Chambers at the Talang Bakung IPLT[18]

[18] MPWH-SATKER Provinsi Jambi (2016).



a) Layout Plan



b) Longitudinal and Cross Sections

Figure 27: Solids Separation Chambers According to PERMEN 04/PRT/M/2017[19]

After the solids settling and thickening at the Solids Separation Chambers (SSCs) further treatment of the supernatant water is performed in a waste stabilization pond system (WSP) comprising three trains of facultative and maturation ponds preceded by an anaerobic pond. These ponds, relined in 2015-2016, are capable of providing the treatment of the supernatant water released from the SSCs but it is important to underline that only this water (and no thickened sludge) should be admitted into the pond system. It is, however, necessary to restore the water effluent outlet pipe lengthening it some hundred meters until the nearest channel or

[19] Kementerian Pekerjaan Umum dan Perumahan Rakyat (2017).

watercourse, most likely a tributary of the nearest significant watercourse of the region, Sungai Terap, affluent of Sungai Kumpeh, which is at a distance of about 2 km.

The sludge drying beds (SDBs) of the Talang Bakung IPLT are too small, practically inaccessible with machinery and, as a matter of fact, completely out of service. Nevertheless, the SDBs are one of the most, if not the most, important link of the septage treatment chain for they are the last one before the final product, the dried sludge, leaves the plant for its final disposal and/or its reuse on agricultural land. It is considered that the current undersized and ill-conceived facility cannot readily be refurbished and therefore it is proposed to build new and appropriate SDBs on a land of roughly 40x60 m, i.e. an area of 2,400 m^2, available within the IPLT parcel between the anaerobic and the waste treatment ponds (Figure 28). It is proposed to implement unplanted SDBs based on drainage of liquid through the sand and gravel to the bottom of the bed, and evaporation of water from the surface of the sludge to the air (Figure 29).

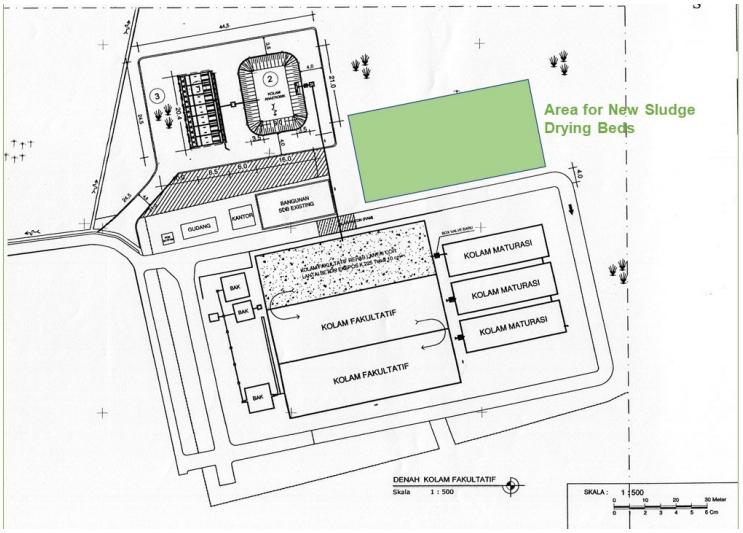


Figure 28: Location of New Sludge Drying Beds at the Talang Bakung IPLT

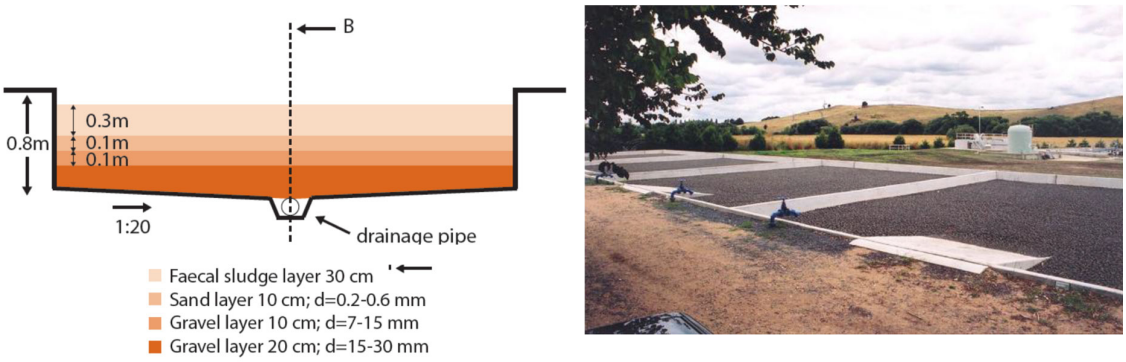


Figure 29: Typical Cross Section and View of an Unplanted Sludge Drying Bed[20]

[20] CEPT University (2015).

12.3. Septage Treatment at the Future Kasang Wastewater Treatment Plant

Co-treatment of septage with wastewater at a WWTP is an option which can be considered in Indonesia: since as most WWTPs are underutilized, adding septage into existing WWTPs can be a quick solution to the safe management of septage. provided the characteristics of the septage are known, it is diluted with sewage to avoid shock load, and the STP has enough capacity to take the extra load. Essentially, co-treatment can be carried out in two ways:

(i) Septage directly mixed with sewage, incorporating it into the so-called water train, i.e. co-treatment with sewer-based wastewater treatment technologies.
(ii) Septage treated with the sludge of a WWTP, incorporating it into the so-called solids handling or sludge train.

It is, however, common knowledge that many wastewater treatment plants in low-income countries have failed, and improper co-treatment with septage has even been the cause of some failures. WWTPs are typically not designed for septage loadings, and process disruptions and failures are frequently observed. Common problems with co-treatment of septage in WWTPs range from the deterioration of the treated effluent quality to overloading tanks and inadequate aeration (Strande et al., 2014, p. 178). Despite the potential operational problems, certain guidelines indicate that low volumes of septage can be co-treated in municipal WWTP water trains.

Thus, the Handbook of the Water and Sanitation Operator of the large French private water and environmental utility Lyonnaise des Eaux, now Suez Environnement (Valiron, 1987, p. 444), recommends that a maximum 20% of the total pollutant load, i.e. roughly 2% of the total influent flow can be admitted to the water train of a wastewater treatment plant.

In Jambi, according to the septage quantification above, an additional 150 m^3/day of septage could be co-treated with wastewater at the Kasang WWTP by incorporating this flow into the water train, provided that the plant inflow does not exceed 50% of the design flow. It is assumed that this will not happen at least during the first 4-5 years after the start-up of the WWTP, which means that the lacking septage treatment capacity could be resolved at the WWTP. A better and more sustainable option would be to incorporate septage to the solids handling train of the plant by installing a specific solids separation unit at the receiving station, including a screening and/or grit removal unit, a thickening unit usually consisting of a mechanical device that provides a solid fraction above 4% dryness and a system of conveyors or sludge pumps to transport the solid fraction directly to the drying beds (Figure 30). It is to be noted that such an equipment, seen on the picture, a Rotamat ® Ro32 by Huber is currently installed at the Bekasi IPLT.

Figure 30: Typical Septage Pretreatment Equipment for a WWTP[21]

12.4. Final Disposal and/or Reuse of Treated Septage Sludge

Septage and/or treated sludge must be disposed of in manner that poses no threat to public health and the environment. The most common and economical disposal of septage and wastewater sludge has been to apply it to agricultural fields, forest land and reclamation sites as a soil conditioner and organic fertilizer, since excreta contain essential plant nutrients and organic matter that increases the water retaining capacity of soils. The use of septage as a soil conditioner can range from untreated septage to bagged compost that is sold as a commercial product for household level use in horticulture. The most common form of reuse, however, is dried sludge produced in sludge drying beds (or by more sophisticated electromechanical dewatering equipment in WWTPs).

In the specific conditions of Jambi, this is the type of sludge both the Talang Bakung IPLT and the Kasang IPAL are expected to produce. Therefore, land application of dried sludge, i.e. its disposal and/or reuse on nearby agricultural lands seems to be the most appropriate, if not the sole, option. The agricultural lands available are oil palm and perhaps (only for highly stabilized dried sludge) also pineapple plantations located at a distance of a few km in kecamatan Sungai Gelam of kabupaten Muaro Jambi and the reuse of dried sludge may be feasible for both crops being, obviously, subject to agronomic considerations and restrictions (Figure 31).

[21] https://www.huber.co.uk/products/screens-and-fine-screens/sewage-sludge-screens/huber-sludge-acceptance-plant-rotamatr-ro3.html

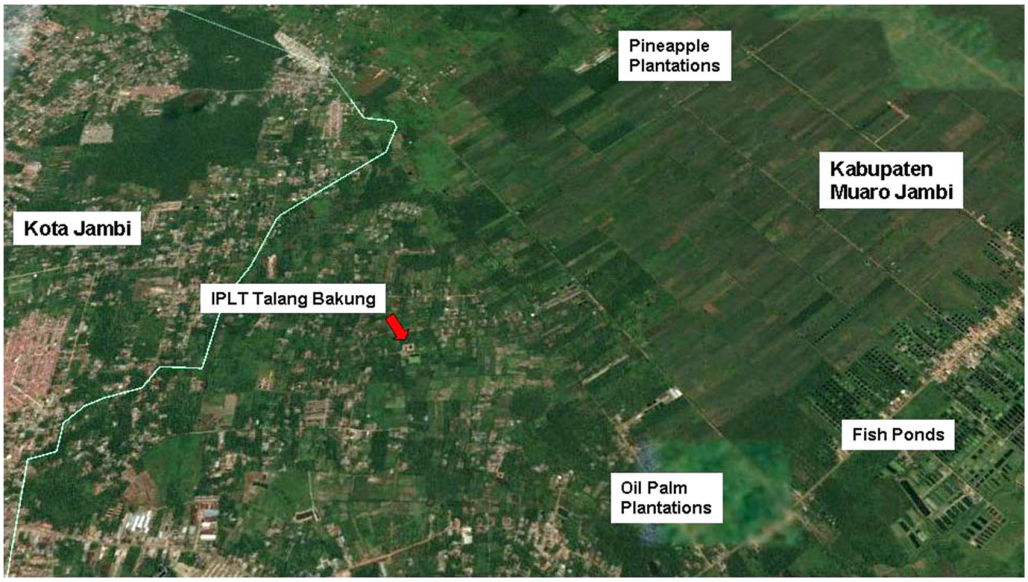


Figure 31: Location of the Talang Bakung IPLT and Nearby Farmlands

12.5. Land Application Option of Liquid Septage

The current lack of sludge disposal options and practices all over Indonesia can give rise to another reflection: septage treatment is not an aim in itself. The aim is safe and environmentally friendly disposal of septage. The difference between liquid and dry septage is mainly water (and the die-off of pathogens), so if the UPTD-PAL has no means to extract and transfer dry sludge to trucks and transport it to the final disposal sites, they might opt for the land application of liquid septage. Land application of septage is currently the most commonly used disposal method in many countries, mostly in the United States. It is relatively simple and highly cost-effective, uses minimal energy, and recycles organic material and nutrients to the land. As already said, with proper management, domestic septage is a resource that contains nutrients that can condition the soil and decrease the reliance on chemical fertilizers for agriculture. Appropriate septage disposal should maximize these benefits of septage while protecting public health and the environment. Septage can be incorporated into the land basically by three methods: surface application, subsurface incorporation or burial[22]. From among the surface application methods, the so-called ridge and furrow method is well suited to tree crops and could be recommended for possible septage application in the tree plantations near Jambi City, some of them within reasonable distance from the Talang Bakung IPLT. The other methods require specific equipment. It is to be noted that, in any case, land application of septage should involve an intensive cooperation with local agricultural agencies and the farmers themselves (Figure 32).

[22] US Environmental Protection Agency (1999).

a) Surface Application of Septage Waste *b) Subsurface Application of Septage*

Figure 32: Land Application of Septage[23]

13. Economic and Financial Model

13.1. Basic Model Characteristics

To help evaluate the fundamental economic and financial issues affecting the development of the septage management plan, it is recommended to develop a simplified economic and financial model. This simplified model is intended for an initial estimation of economic magnitudes and for scenario-building purposes, therefore should not be taken as a definite, detailed financial model for the operation of the septage management service. Such a model should be developed once the SDO has been established.

In the meantime, the preliminary model may be a decision-support tool in the definition of the implementation strategy for the SMP, to be used, among others, to evaluate aspects such as the zoning strategy for the implementation of regular desludging, the estimation of user tariffs and potential subsidies, the capital investment requirements for the establishment and development of the desludging service, the operational budget requirements, the potential benefits of collaboration with the private sector in different scenarios, the estimation of the impact of introducing potential savings in the septage management chain, such as intermediate transfer stations, etc.

The model should assume a certain progression of human and material resources to be deployed during a 5-year septage program implementation to achieve the target user figure[24], the organization and staffing recommended for the SDO and the equipment requirements and consider the desludging fee adopted. In Jambi, based on a separate CDTA study, a fee of Rp240,000 per service has been applied. The investment cost for the upgrade of existing septic tanks and installation of new septic tanks was not included in the model.

[23] Michigan Department of Environmental Quality (2015).

[24] In Jambi, 42,432 users, in addition to 10,300 off-site system users (sewer connections), in accordance with the scheduled desludging service established in the MSMIP Loan Agreement, Major Change in Project (ADB, 2016),

13.2. Financial Analysis

The main conclusion that follows from the Jambi model is that the septage service is marginally financially viable in the long term with the user fees assumed (Rp240.000 per desludging service and/or a monthly flat rate of Rp10,000 per month) and the investment and operating costs modelled. EBITDA (Earnings Before Interest, Tax, Depreciation and Amortization) becomes positive only in year 5; when depreciation of the assets is taken into account (EBIT) the service is in long-term deficit.

Furthermore, the estimated capital needed for buying the additional trucks to cover the service targets is Rp2,400 million. The total funding needs to implement the 5-year SMP amount to Rp9bn, i.e. Rp1.8bn/year, equivalent to approximately 0.1% of the local government budget for the year 2017[25], including a subsidy of Rp6.7bn million over the same 5-year period to cover the operating costs -compensating the difference between service costs and fees collected- and make the service sustainable. The resulting wastewater service coverage at the end of year 5 would be 40% of the city, including 10.300 off-site users.

14. Private Sector Participation in Septic Tank Desludging

14.1. Current Situation

The possible involvement of the private sector in the septage chain is mainly in (i) supply and installation of septic tanks (masons and plumbers); and (ii) collection and transport of septage using vacuum trucks (septage haulers). Septic tanks are sold (prefabricated) at building material stores and installed by small contractors or, more frequently, directly built in situ (wood, brick, concrete). Bearing in mind that the majority of existing septic tanks do not comply with the national standard, the potential for business opportunities in the forthcoming years is notable. In the business of collection and transport of septage, there is a small number of companies, all of them owning one vacuum truck.

Interviews with private desludging companies revealed that the key challenges that these entrepreneurs face in their businesses are:

(i) the uncertainty about demand, largely due to weak public awareness and enforcement;
(ii) (the lack of skilled labor, both in technical and customer relation aspects;
(iii) problems performing the service and even getting payment from the user; (iv) high variable costs, mainly fuel and oil;
(iv) difficult access to affordable commercial loans; and
(v) the licensing process is cumbersome.

In Jambi, the private trucks usually have a capacity of 4 m^3. The firms are microenterprises (less than 5 employees) registered as CVs (*Commanditaire Vennootschap* or Limited or Silent Partnership) or sometimes cooperatives, most of them less than 10 years old, and many of them even less than 3 years old. As for the current desludging practices in the city, private operators perform 2-3 services per day on average, reaching 4 services per day on busy days during the rainy season.

[25] Equal to Rp1,671bn as per Jambi City in Figures.

The operators are expected to discharge the septage at the treatment plant but IPLT registers indicate that much of the septage is being dumped elsewhere illegally. Altogether, it can be stated that these businesses operate at marginal levels of profitability while facing significant commercial risks. Therefore, given the high uncertainty about demand and the relatively fixed cost structure of operators (except for fuel and oil), from the financial perspective there seems to be a greater need for demand certainty, regulatory coherence and good governance of the service.

14.2. Legal framework

Concerning the legal framework of private sector participation, Law 25/2009 on Public Services[26] establishes that the administration may cooperate with other parties for the purpose of improving and accelerating the provision of the service, given the limited resources available to the LG. Furthermore, the PERMEN PUPR 16/2008[27] states in its mission the objective to improve and develop alternative sources of funding in the operation of wastewater management systems establishing several policies along with strategies and associated actions, including the promotion of public-private partnerships (PPP) in the implementation of wastewater facilities and infrastructure. In the case of septage management, PUPR's L2T2 guidelines establish that LGs must address cost recovery for service sustainability, including the cost of surveys, operation and maintenance, administrative costs, capacity building, socialization campaigns, promotion and collaborations that improve the access to sanitation. As for payments from the LG to a private company for the provision of a service must follow the public procurement regulation, PERPRES 54/2010 on Procurement of Government Goods and Services[28] and its latest amendment PERPRES 4/2015[29]. The law allows to appoint service providers directly (pengadaan lansung), without the need for a competitive tender, when (i) the contract value is below Rp300million; (ii) only small companies or cooperatives are involved; (iii) the service is required for operational needs; (iv) simple technologies and low risk are involved.

14.3. Possible Forms of Private Participation

The level of private participation depends mainly on the size of the market (potential number of customers and tariff), the expected growth, the cost to enter the market (investment required), how payment is received, the guarantees on payment and the operating costs.

The possible forms of participation in wastewater management are many, with a wide range of levels of complexity in the arrangement (technical, administrative and financial) and different requirements to ensure the arrangement delivers the expected results, including, from most to least suitable, the following: (i) empty and transport, business as usual; (ii) empty and transport, regular desludging; (iii) installation of septic tanks, emptying and transport; (iv) operation of IPLT, with or without construction.

[26] Republik Indonesia (2009).

[27] Kementerian Pekerjaan Umum (2008).

[28] President of the Republic of Indonesia (2010).

[29] President of the Republic of Indonesia (2015).

All of these options require companies to obtain a business license and an environmental permit from the LG, as determined by the applicable local regulations. The licensing process can be cumbersome and expensive in some cases but not difficult to streamline. It is important to note that UPTDs are not allowed to enter into cooperation agreements. This is an obstacle to the participation of the private sector in regular desludging. The most effective option is to use a BLUD or a BUMD. As a matter of fact, the only current examples of cooperation between LGs and private haulers in Indonesia for scheduled desludging are those with BUMDs, as in the case of Bandung and Surakarta. Therefore, option (ii) is considered the most viable for private sector participation in the short and medium term.

A successful cooperation between the private sector must be based on a clear understanding of the objectives, the roles, rights, obligations and working arrangements for all parties involved, arranged ultimately for the benefit of the people of Jambi. These issues should be reflected in a cooperation agreement endorsed by the City Mayor.

The recommended process for preparing the agreement should include (i) a detailed study of the existing private firms operating in Jambi; (ii) the identification of those companies that are in a position to deliver the service in cooperation with the LG in a responsible, transparent, competent and sustainable manner; (iii) a definition of the areas that can served by each operator, in line with the zoning of the SMP, including a detailed estimation of the collection and transport costs to the IPLT in each area and sub-area; (iv) the definition of the subsidies that must be allocated for each operator, since those that serve the populations farther away from the IPLT will have higher costs associated, but the users will still pay the same tariff; (v) the definition of the payment mechanism; (vi) the definition of the minimum standards of operation; (vii) the definition of the incentive/penalty arrangements to ensure that the operators fulfill their obligations; and the design of the monitoring and evaluation mechanisms to measure the performance of the service and the benefits of the cooperation. These considerations above should be established in a cooperation agreement, to be signed collectively or individually with each operator.

15. Social Marketing Plan

Community participation as a service target is the key to the success of the SMP. The main factor of the current low interest in desludging in the community is the lack of public knowledge about good and proper sanitation, especially knowledge of septic tanks that are in accordance with the standards and the importance of managing septage well. Another factor is the condition of on-site facilities that are difficult to access by vehicles, and often under the building which requires demolition of the building floor to access the septic tank. Besides that, cultural factors and habits inherited from generation to generation are not conducive to managing septage properly, because it is something dirty and disgusting.

There are three determinants of whether someone is willing or not to be an LLTT customer: (i) the availability of LLTT service infrastructure, (ii) LLTT promotion factors, and (iii) supporting environmental factors. These factors are interrelated: if the service infrastructure is adequate, a regulation already exists, but the promotion is not on target, the intervention has to be a promotional program; if the LLTT infrastructure is inadequate, then there must be an intervention to improve the infrastructure before promotion.

The socialization and marketing plan of the SMP should be carried out in the following seven stages: (i) organizing a social marketing team, (ii) determination of the budget, (iii) determination of marketing areas, (iv) determination of marketing targets, (v) target market analysis, (vi) product information development, and (vii) planning and implementation of socialization and promotion.

Monitoring (supervision) is an activity of monitoring program implementation while it is in progress, whereas evaluation is the measurement of program impact after the program is completed. The point is to ensure that every activity in the program is carried out in accordance with the plan. If ineffective activities are identified, they need to changed. The point is to assess whether the work program implemented is in accordance with the results envisaged. The monitoring results are analyzed as soon as possible with the aim of improving the program while running. The results of the monitoring analysis and improvements made are summarized in monthly, quarterly, or other periodical reports as agreed. The evaluation results are analyzed after a complete evaluation process is carried out and summarized in the annual report.

16. Conclusions and Recommendations

A comprehensive septage management plan builds on the analysis and conclusions from the survey and addresses institutional, legal, technical, organizational, social, economic and financial aspects. The key points of the plan are as follows:

1. In the current situation of wastewater management in Indonesia, it is high time local governments set up a public septage management service as part of an overall wastewater management service, together with the operation and maintenance (O&M) services of the centralized sewer network and the WWTP, wherever available. This service should cover the whole septage management chain, including mechanisms for the effective participation of private companies.

2. In this service, local government acts as wastewater management service provider (on the one hand, septage collection and treatment and, on the other, sewerage and wastewater treatment) and water users become service users (scheduled desludging and sewer use).

3. The local wastewater management regulation (PERDA) should be enhanced in order to clearly specify the establishment of this wastewater management service including all its legal, technical and financial aspects, and to govern the relationship between local government and service users, establishing the rights and responsibilities of both.

4. Wastewater management requires a well-organized and well-trained service delivery organization (SDO). Therefore, local governments should set up a specialist technical unit (UPTD) and gradually progress onto a unit with independent financial management (UPTD-PPK-BLU) and finally into a BLUD or BUMD as soon as possible. Transferring septage management to the local water company (PDAM) could also be a suitable option.

5. Septage management planning requires a comprehensive and detailed survey of all households and other premises of the city. The survey should use an IT application for field data collection, process data with a Geographical Information System (GIS) and,

finally, built into a Management Information System (MIS) to be used further for decision-making, day-to-day management and database updates.

6. Local governments have to set up septic tank design and construction criteria based on the national standard and include them in the wastewater PERDA. Moreover, as practically no existing septic tanks comply with the standard (actually, most of them are in fact cubluk, i.e. one-compartment, lined but bottomless pits allowing wastewater to seep to the ground and to the groundwater), the septage management plan should include a septic tank refurbishment plan of the non-complying on-site facilities. Seen their current status in Jambi, it goes without saying that there is a long way to go and will require a long-term refurbishment plan with an implementation process comprising three stages and ten activities and a duration of ten (10) years.

7. The current septic tank emptying practices in Indonesia consist in most cities of a remedial system for overflowing tanks functioning exclusively on demand (in Jambi 92% of septic tanks have never been emptied). This has to be transformed into a scheduled desludging and maintenance service to be provided by local governments as a public service using all resources available, public and private.

8. Based on the quantification of septage (230 m^3/day in Jambi), the SMP should include an estimate for the necessary equipment (vacuum trucks and Vacutug-type smaller devices for areas with difficult access) which local governments should gradually acquire and/or turn private waste haulers into wastewater service licensees in the framework pf a PPP. For the operational planning of scheduled desludging services, it is recommended to divide the city into operational zones of roughly similar population and characteristics and prepare yearly plans. In the Jambi 8 septage operational zones were proposed, the total number of vacuum trucks to carry out the service was estimated at 22 and a time horizon of five (5) years was considered for the gradual deployment of the desludging plan.

9. To avoid negative impacts on human and environmental health, septage should be adequately treated and disposed of. Options for the treatment and disposal of septage are: (a) treatment at independent septage treatment plants (IPLT), (b) co-treatment with wastewater at wastewater treatment plants (IPAL) and (c) land application. The septage quantity to be treated in Jambi being 230 m^3/day, the Talang Bakung IPLT of 80 m^3/day nominal capacity should be completed on the long run by an additional capacity of 150 m^3/day at the Kasang WWTP. Moreover, the existing Talang Bakung IPLT is non-functional as a treatment plant despite its relatively good physical status and should be refurbished in order to enhance its solids separation and sludge drying capacity. Septage treatment at the future Kasang WWTP could be performed in the water train until the plant is below 50% capacity. A more sustainable solution could be achieved by installing a specific electromechanical equipment for grit removal and sludge thickening.

10. Septage treatment, however, is not an aim in itself. Its main objective is to dispose treated sludge on land without harming human and environmental health. Local governments have therefore to identify and implement sludge disposal options, the lack of which underlies the problems of operation of most Indonesian IPLTs. The most common of these is application of sludge to agricultural fields, forest lands and reclamation sites as a soil conditioner and organic fertilizer. As for the Jambi management plan, disposal sites should be explored in cooperation with Kabupaten Muaro Jambi, farmers and agricultural experts.

11. Local governments should set up an economic and financial model for septage management adopting appropriate fees and/or monthly rates to cover the operational costs of scheduled desludging and septage treatment and remunerate private service providers. These fees and/or rates should be levied by the LGs as per a specific PERDA or as part of a PERDA of tariffs for public services. In Jambi, based on a separate CDTA, a desludging fee of Rp240,000 per service has been proposed (equivalent to an average monthly rate of Rp10,000 for a desludging service every two years). Based on these tariffs, it can be it can be concluded that the septage service is marginally financially viable in the long term with the user fees assumed. EBITDA (Earnings Before Interest, Tax, Depreciation and Amortization) becomes positive only in year 5; when depreciation of the assets is taken into account (EBIT) the service is in long-term deficit.

12. The possible involvement of the private sector in the septage chain is mainly in supply and installation of septic tanks (masons and plumbers); and collection and transport of septage using vacuum trucks (septage haulers). In Jambi, there is a small number of recently set up companies (microenterprises) involved in the business of collection and transport of septage currently in Jambi, all of them owning only one vacuum truck. The private operators perform 2-3 services per day on average, reaching 4 services per day on busy days during the rainy season, and are expected to discharge the septage at the treatment plant but IPLT registers indicate that much of the septage is being dumped elsewhere illegally. The level of private participation depends mainly on the size of the market (potential number of customers and tariff), the expected growth, the cost to enter the market (investment required), how payment is received, the guarantees on payment and the operating costs. To carry our scheduled desludging, the companies should obtain a business license and an environmental permit from the LG, as determined by the applicable local regulations in the framework of a cooperation agreement endorsed by the City Mayor and signed collectively or individually with each operator.

13. Local governments should organize appropriate commercial management based on a Management Information System and perform billing and collection of wastewater rates and assist communities on the development of communal systems as a means to improve and refurbish obsolete on-site facilities.

14. Community participation as a service target is the key to the success of the LLTT program. The main factor of the current low interest in desludging in the community is the lack of public knowledge about good and proper sanitation, especially knowledge of septic tanks that are in accordance with the standards and the importance of managing septage well. Therefore, to support the septage management plan, local governments should set up and conduct a social marketing plan to trigger behavior change with respect to sanitation and scheduled desludging. The socialization and marketing of the septage management plan should be carried out in the following seven stages: (i) organizing a social marketing team, (ii) determination of the budget, (iii) determination of marketing areas, (iv) determination of marketing targets, (v) target market analysis, (vi) product information development, and (vii) planning and implementation of socialization and promotion.

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