

**Philippines**  
**Small-Scale Wastewater Treatment Systems for 3 Markets**  
**USAID Philippine Sanitation Alliance Projects in the Philippines**

Project Owner(s)	<ul style="list-style-type: none"> <li>▪ 1) Muntinlupa City Government, Metro Manila</li> <li>▪ 2) San Fernando City Government, La Union</li> <li>▪ 3) Manila City Government, Metro Manila</li> </ul>
Project Partner(s)	<p>1) <b>Funding Agency:</b> Muntinlupa City Government  <b>Executing Agency:</b> USAID LINAW  <b>Cooperating Agencies:</b> local barangay council, market vendors association, League of Cities of the Philippines, and the DENR</p> <p>2) <b>Funding Agency:</b> City Government of San Fernando, La Union  <b>Executing Agency:</b> USAID PSA &amp; City Government of San Fernando, LU  <b>Cooperating Agencies:</b> Department of Environment and Natural Resources (DENR) Region 1, Bongar Co. (contractor), local barangay council, and market vendors association</p> <p>3) <b>Funding Agencies:</b> USAID-Philippine Sanitation Alliance (PSA) and Rotary International District 3810  <b>Executing Agencies:</b> Metro Manila Development Agency (MMDA) and City of Manila  <b>Cooperating Agencies:</b> Lola Grande Foundation, local barangay council, Solid Waste Management Association of the Philippines (SWAPP) and market vendors association</p>
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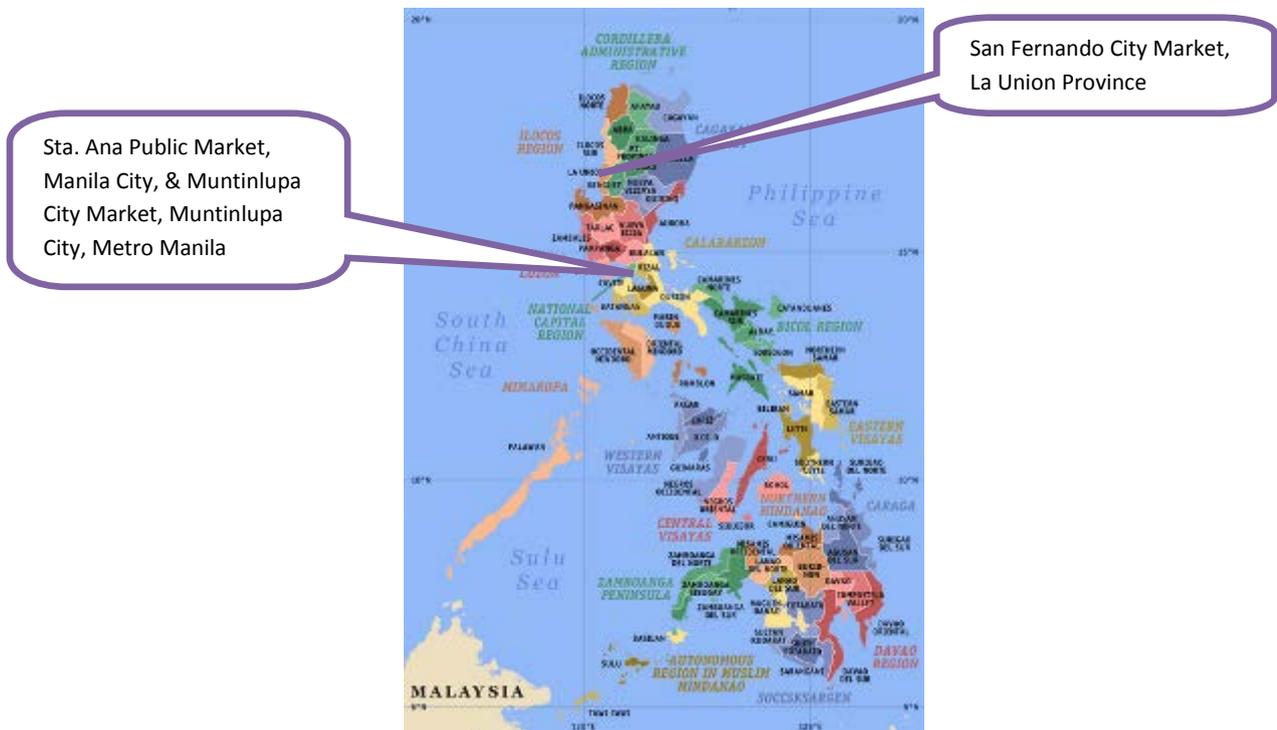
**Introduction and Background**

Lack of access to improved sanitation and lack of sanitation treatment infrastructure is a major issue facing the Philippines and other Southeast Asian countries. 2008 data estimated that 24% of the Philippine population still did not have access to personal improved sanitation, 15% of which rely on shared sanitary facilities and 9% of which rely on open defecation or the use of unimproved sanitation. Given the large population of the Philippines, this means that around 10 million Filipinos still defecate in the open on a daily basis, with serious consequences to their local environment and their health, dignity, and human development. In addition, even those people that have access to improved sanitation are very likely using a ‘basic’ form of improved sanitation – such as a septic tank-connected toilet – since only 4% of the country’s residents/businesses are connected to a sewerage system with proper treatment. Since septic tanks, even at their very best, do not in themselves provide adequate wastewater treatment, this means that the Philippines is grappling with a serious problem of groundwater and surface water pollution, with all of the resulting health consequences that this entails. It is estimated that 55 Filipinos die every day as a result of poor sanitation and that it poses economic losses exceeding \$1.4 billion yearly.

Recognizing this, the USAID Philippine Sanitation Alliance (PSA) project, implemented by AECOM International Development, was established to facilitate compliance with the 2004 Clean Water Act

of the Philippines. The law calls for all sources of water pollution to be connected to a sewerage system or septage management be employed. The PSA grew from a previous USAID project called LINAW (Local Initiatives for Affordable Wastewater Treatment) and focuses on designing and implementing decentralized sanitation systems and septage management programs at the local level for all types of facilities or cities in the country. Through these programs, the PSA estimates to have already provided 400,000 people with access to improved sanitation facilities.

Three of the PSA’s most prominent and recent projects will be outlined here, though the organization has undertaken many more, including large scale decentralized wastewater treatment systems for places like the SM group of malls, small scale systems for selected markets, slaughterhouses, hospitals, resorts, etc. across the country, and a variety of septage management programs. The organization’s primary role in all of these projects is as technical consultant and project initiator, with the partner government, water utility or company funding the construction of infrastructure.



The first project is the small-scale wastewater treatment system for the Muntinlupa City Public Market, in Muntinlupa City, Metro Manila. As a major market of 1,445 stalls, it was a foul-smelling place that was discharging all of its sewage, grease, and washings from the meat and fish areas to a septic tank. The partially treated wastewater then flowed into a nearby creek, which flows to Laguna Lake – a vital inland water body and source of drinking water and freshwater fish for much of Manila. To reduce the amount of pollution flowing into the lake, the city government and PSA’s precursor, LINAW, undertook to construct a sewage treatment system for all of this market’s wastewater that would meet the government’s discharge standards.

The second project is the small-scale wastewater treatment system for the San Fernando Public Market, in San Fernando City, La Union. As the main city market with about 700 stalls (up to 900 on the ‘market days’ of Wednesday/Saturday/Sunday), it was discharging all of its sewage, grease, and washings from the meat and fish areas to a septic tank and then to a drainage canal. This was posing

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a significant threat to the City's coastline (the City borders the ocean), as the wastewater was polluting the nearby beaches and threatening the health of nearby citizens. With technical assistance from the USAID-funded Environmental Cooperation-Asia project, the City constructed a sewage treatment system for all of the market's wastewater to clean up the City's coastline.

The third project is the small-scale wastewater treatment system for the Sta. Ana Public Market, in Manila City, Metro Manila. Situated alongside the Pasig River, known infamously as one of the world's most polluted rivers, the bustling market of 220 stalls was discharging all of its wastewater, including sewage, grease, and washings from the meat and fish areas, into an inadequate and rarely desludged septic tank, which then proceeded to discharge this partially treated effluent directly to the river. Inputs like these all along the river, in addition to domestic wastewater, are the reason why the river is considered "biologically dead." Thus, as part of a larger effort to start cleaning up the river, the PSA and Rotary worked with the city government and MMDA to construct a sewage treatment system for all of the market's wastewater, as a model for other markets and facilities along the river's length.

### **Project Purpose and Objectives**

These three projects were implemented using the following process: 1) initial consultations and outreach, 2) IEC (information, education, communication) activities on the project and on improving hygiene and sanitation in general, 3) construction of the facilities, and 4) follow-up IEC and training on O&M responsibilities. The purpose of these tasks was to build effective wastewater treatment systems for the markets that would positively impact the sanitation situation of the establishment and its surrounding community. Another objective was for all three markets to meet the national government's effluent discharge standards, which was not possible with septic tanks.

The specific objectives for the Muntinlupa City Market project were to reduce pollution to Laguna Lake, to clean up the market and its surroundings, and to build a model small scale wastewater treatment plant that could be replicated in other markets and establishments throughout the Philippines.

The specific objectives for the San Fernando City Market project were to reduce pollution inputs to the City's coastline and contribute to the City's overall goal of becoming a leader in the Philippines for effective sanitation management (the City has also implemented several other sanitation projects).

The specific objectives for the Sta. Ana Public Market project were to reduce pollution flowing into the Pasig River and to build a model wastewater treatment plant that can be replicated in other establishments along the river.

### **Partners and Funding Distribution**

For the Muntinlupa City Market project, the Muntinlupa City Government provided approximately 6.7 million pesos (~130,000 USD) for the construction, which was done by city staff. About P4.5 million was allotted for materials, P890,000 for labor, P220,000 for administration, P270,000 for excavation, and P760,000 for mark-up. USAID LINAW initiated the project by conducting a stakeholder workshop, developing an action plan and organizing a study tour to DEWATS projects in Indonesia. LINAW provided technical advice before, during and after construction and helped the

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city conduct an IEC campaign. Other decision-making and cooperative groups included the League of Cities of the Philippines, the DENR, the local barangay council, and the market vendor's association.

For the San Fernando City Market project, the City Government of San Fernando, La Union, provided approximately 5 million pesos (~116,000 USD) for the construction. The USAID ECO-Asia project worked with the city to develop the project, conduct an IEC campaign, and provided technical advice before, during and after construction. Other cooperative groups included the local barangay council, the market vendor's association, Bongar Co. (the construction contractor), and the Regional Office of the Department of Environment and Natural Resources (DENR).

The Sta. Ana Public Market project was initiated by the USAID-Rotary Pasig River Improvement Project, which is one of five projects in the Philippines supported by the USAID-Rotary International H2O Collaboration. A memorandum of agreement was signed among the project partners to provide the following: USAID Philippine Sanitation Alliance provided technical assistance, Rotary International District 3810 purchased most of the construction materials, MMDA supplied in-kind labor and equipment for the construction, and the City of Manila provided in-kind engineering services and are now operating and maintaining the system. The PSA led the preparatory work, designed the facility, and oversaw the construction and support activities. Other cooperative groups included the Solid Waste Management Association of the Philippines (SWAPP) – who was contracted to develop a solid waste and grease management program for the market's barangay – the local barangay council, the market vendor's association, and a community group called the Lola Grande Foundation, which provided day-to-day support, coordination and facilitation services and carried out IEC activities on sanitation and hygiene.

### **Project Activities**

The Muntinlupa City Market project ran from 2004 until 2006. Due to the innovative nature of the wastewater treatment system, the planning and design phase took nearly a year and construction lasted from July to December 2005. The project activities included: 1) Stakeholder workshop to develop an action plan for addressing wastewater in the city, 2) Study tour to Indonesia to learn more about DEWATS technology employed by BORDA, 3) Consultation with stakeholders and formation of a technical working group, 4) Design of the facility, 5) Carrying out an IEC campaign involving AV materials, posters, leaflets, comics, and news features on the need for wastewater management and proper sanitation; 6) Construct the facility, and 7) Determination of O&M responsibilities, training and promotional follow-up.

The San Fernando City Market project ran from March 2005 until Dec. 2005. The project activities included: 1) Consult with the City of San Fernando and stakeholders to develop an action plan for addressing water pollution in the city, 2) Design the treatment system for the market and associated infrastructure, 3) Consult with market vendors and other stakeholders to determine how to fund the project (a 10% increase in rent per stall, but not technically a 'users fee'), 4) Renovate the toilet facilities of the market, 5) Undertake IEC in cooperation with the market vendor's association to promote the project and promote overall hygiene improvements among the vendors and local community, 6) Construct the facility, and 7) Determination of O&M responsibilities and training.

USAID-Rotary assistance to the Sta. Ana Public Market began in mid-2009 and the wastewater treatment plant was constructed from March to October 2010. The project activities included: 1) Consult with project stakeholders to obtain funding and in-kind support, namely from the City of Manila, the Metro Manila Development Authority (MMDA), USAID and Rotary (the Foundation and

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International District 3810), 2) Hold focus group discussions and workshops for market vendors, local officials, neighboring schools and churches, and other neighboring establishments, to inform and involve them in project activities, 3) Undertake education campaigns, via a local community organization (the Lola Grande Foundation), on improving hygiene and sanitation in the market and surrounding communities, 4) Decide on treatment technology and prepare the design, 5) Undertake the construction, and 6) Follow-up IEC on the project and determine O&M responsibilities. To ensure that garbage and grease would not clog up the treatment plant, the USAID-Rotary project hired the Solid Waste Management Association of the Philippines (SWAPP) to help the vendor's association develop and implement a solid waste management program and a grease management program. The project also repaired the public toilets and sinks in the market, encouraged the local barangay to pass an ordinance requiring soap in all public restrooms and is currently developing a system that will pipe treated water to the restrooms to address water shortages.

### **Sanitation Technology / System**

Each of these three projects utilized a similar technology package, with minor differences adapted to each local situation.

The system installed in Muntinlupa City Market consists of the following sections – all located entirely underground (excavated under the parking lot / loading bays due to lack of above-ground space) – in order of wastewater flow: bar screen, lift station, equalization tank, anaerobic baffled reactor (ABR), upflow anaerobic sludge blanket (UASB), sequencing batch reactor, lamella clarifier, cocopeat filter, recycling to toilets for flushing. This system was designed to treat up to 210m<sup>3</sup> of wastewater per day.

The system installed in the San Fernando City Market consists of the following sections, in order of wastewater flow: bar screen, lift station, equalization tank, upflow anaerobic sludge blanket (UASB), sequencing batch reactor, clarifier and chlorination tank (combined), and discharge.

The system installed in the Sta. Ana Market consists of the following sections, in order of wastewater flow: grease trap, bar screen, lift station, equalization tank, upflow anaerobic sludge blanket (UASB), sequencing batch reactor, clarifier, chlorine contact chamber, and discharge.

A grease trap is a simple tank, one or two chambers, with influent and effluent pipes positioned fairly deep below the anticipated water level. Since grease (oil) floats on water, influent grease rises to the surface and is trapped there, while the remaining wastewater exits through the sunken effluent pipe.

Bar screens are located at each main inlet area to the equalization tanks, in order to filter out any large floatable debris, such as garbage, meat/fish trimmings, or other solids that could clog the rest of the treatment system. These screens are manually cleaned on a regular basis.

The lift station is a simple chamber containing paired automatic pumps that serve to pump the collecting wastewater to the equalization tank of the system. The pumps switch on as the chamber fills up because of floats that rise with the water level and trigger the pump switch. They likewise switch off as the floats lower with the falling water level.

The equalization tank serves as a wastewater retention point and an area for control of influent fluctuations, and allows a relatively constant flow of wastewater to proceed to the subsequent

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chambers (rather than having high flows during peak hours and no flow during nighttime). This unit is single-chambered for these projects.

The anaerobic baffled reactor (ABR) (Muntinlupa project only) is one of the main treatment technologies used in DEWATS. As the name implies, this multi-chambered tank is closed from the air and anaerobic. Wastewater flows slowly up (and back down through pipes) through its several identical chambers, each time entering the chamber at its bottom, where it passes through the accumulated sludge. This allows solids to settle out into the sludge and anaerobic bacteria living in the sludge to degrade much of the harmful organic and chemical components of the wastewater. The number of chambers can vary depending on available land area, wastewater strength, and funds – this project uses a 4 chamber ABR.

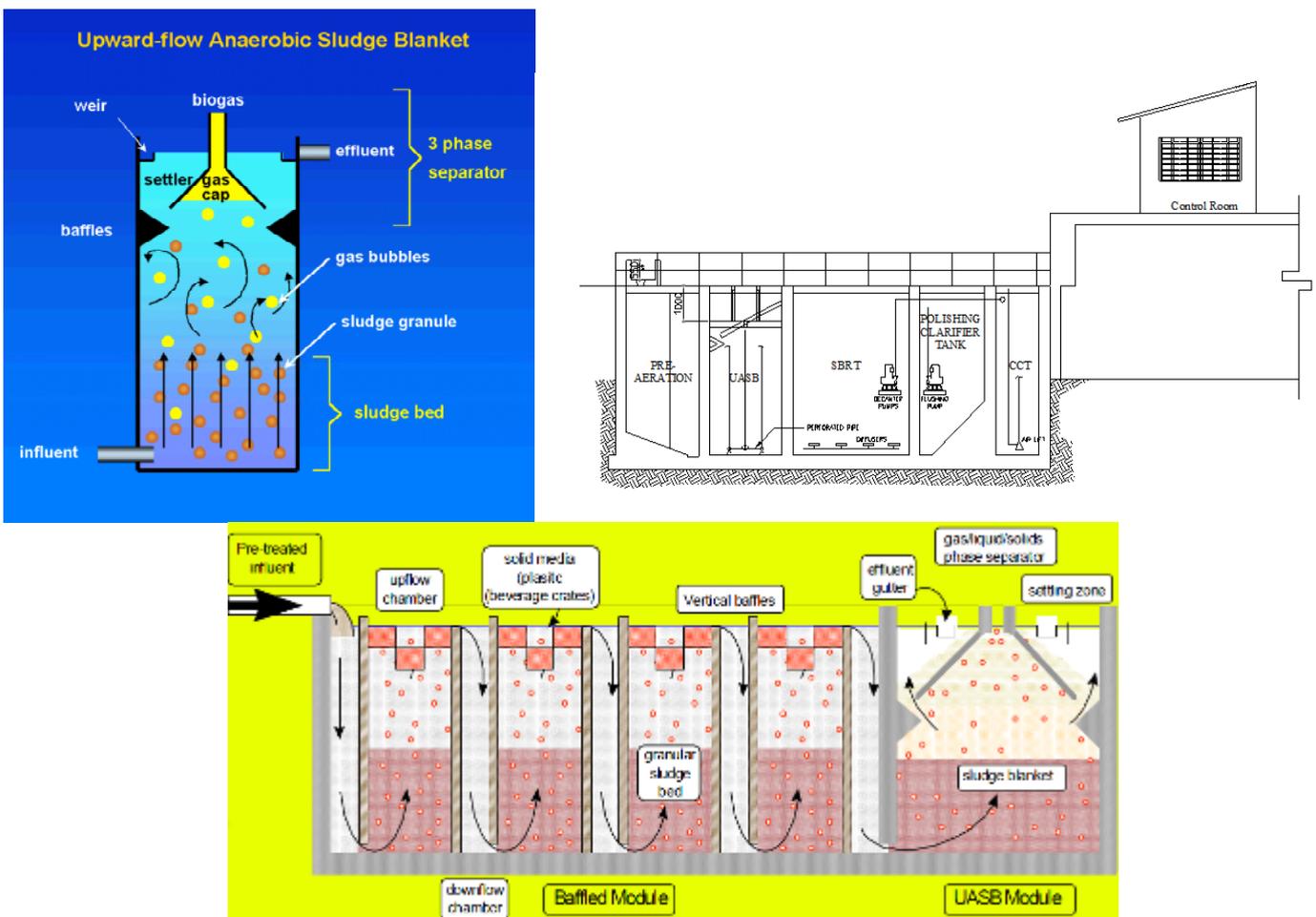
The UASB is a single-chambered tank with a baffled configuration near the top of the water level. Anaerobic wastewater is introduced along the bottom of the tank at evenly spaced inlets. It then flows upward through (once established) an layer of anaerobic sludge that has accumulated there, during which time anaerobic bacteria established in the sludge decompose much of the organic and chemical compounds of the wastewater. This degradation generates biogas (mainly composed of methane and carbon dioxide gases), the bubbles of which rise upward in the tank and provide natural mixing to the liquid above the sludge layer. The baffles then direct the gas bubbles toward the top and center of the tank, where there is situated a ‘three-phase separator’ / ‘gas cap’. The biogas mainly enters this cap and can be harnessed for use in lighting or cooking. Meanwhile, the baffled nature of the gas cap prevents much of the remaining solids from continuing on with the liquid effluent to the next tank. The liquid, though, is able to move around the baffles and continue upward to the top of the tank, where it spills over into weirs that carry it to the next tank. This tank can provide 50-70% treatment of the wastewater, especially in terms of BOD, COD, and TSS values.

The sequencing batch reactor (SBR), as the name implies, is a chamber that treats wastewater in batches, not continuously, using an activated sludge process. The activated sludge process consists of an open-air tank that is vigorously aerated from air injection pipes located at the tank’s bottom. When aeration like this is controlled at a certain rate, the environment created is very favourable for the growth of aerobic bacteria. These bacteria clump together in groups known as ‘flocs’ – staying suspended in the tank due to the aeration – and consume the organic compounds and nutrients (such as ammonia) present in the wastewater. These organic compounds are primarily responsible for the magnitude of the wastewater’s BOD and COD (biological oxygen demand and chemical oxygen demand) values. These are two of the main values measured when treating wastewater, since, if untreated, these organic compounds degrade in the water body they are disposed into and can reduce or eliminate oxygen in the water and cause the death of much of the marine or river life that was present. For SBRs, the stages of this cycle are: 1) Filling: the SBR is filled with pre-treated wastewater from the UASB, 2) Reaction: the filled tank is aerated vigorously, prompting the growth of flocs; length of time aerated depends on tank volume and desired treatment level, 3) Settling: aeration is then stopped and flocs are allowed to settle for around 1 hour, leaving clear effluent on top of a sludge blanket, 4) Decanting: effluent is pumped out of the tank through a pump that draws out the effluent from the top of the water level in a manner so as to not disturb the sludge blanket at the bottom, 5) Idling: the SBR idles until it is time for the next cycle, and 6) Sludge Wasting: excess sludge is periodically removed from the tank (automatically through the base), which maintains floc growth and effluent quality; the sludge can be recycled back through the system or dried and composted separately. The decanted effluent then passes to the clarifier.

The clarifier tank consists of an open-air tank that can be simply an open tank for gradual settling or can be filled with baffles (a lamella clarifier), which encourage the settling of any remaining flocs and solids.

The chlorination tank or contact chamber (Sta. Ana and San Fernando only) consists simply of a tank and device that applies chlorine to the wastewater at a fixed rate, to kill any remaining pathogens or bacteria in the water. After a resting period for the chlorine to again dissipate, the effluent can then be discharged or recycled for toilet flushing.

In Muntinlupa, a cocopeat filter was built for demonstration purposes and used for about one year. Treated wastewater dripped through a box containing cocopeat, which is the dust left over when coconut husks are processed to remove the coco coir or fibers. It is normally discarded as waste material. This material functions as an efficient filter to polish the wastewater before the effluent is either reused or discharged. The treated wastewater was reused for toilet flushing for about a year, then the flushing system in the restroom broke down (due to undisciplined use) and the market management decided not to repair it. Treated wastewater is currently used for cleaning the streets within the market complex.



**Figure 1.** A typical UASB system (top left), the schematic of the Sta. Ana Market treatment system, showing the equalization tank, UASB, SBR, clarifier, and chlorine contact chamber (top right), and the ABR and UASB of the Muntinlupa Market treatment system.

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## Number, Type, and Location of Beneficiaries

For the Muntinlupa Market project, the wastewater generated from the 1445 stalls, their vendors, and their customers are now covered by the project. In addition, the IEC activities performed by the project partners educated many people of the market and surrounding community on the benefits of proper hygiene and sanitation.

For the San Fernando Market project, the wastewater generated from the 700-900 stalls, their vendors, and their customers are now covered by the project. In addition, the IEC activities performed by the project partners educated many people of the market and surrounding community on the benefits of proper hygiene and sanitation.

For the Sta. Ana Market project, the wastewater generated from the 220 stalls, their vendors, and their customers are now covered by the project. In addition, the IEC activities performed by the project partners, especially the Lola Grande Foundation, educated many more people of the surrounding community on the benefits of proper hygiene and sanitation.

## Impacts and Challenges

These projects are now complete and being operated and maintained by market staff. All three are still functioning properly and serving as models for small-scale wastewater treatment in the Philippines. Muntinlupa Market, especially, is serving as a significant model, as it was the first plant of its kind in the Philippines, and also had the innovative feature of being built entirely underground due to space constraints at the project site.

These treatment systems are also low cost for O&M compared to conventional systems, as they utilize mainly non-mechanized processes (other than the pumps and SBRs) that are low maintenance. As an example of the O&M costs, the Muntinlupa Market – the project with the largest wastewater load – incurs approximately 27,000 pesos (~ 620 USD) a month in O&M fees, which includes the salary of its two maintenance personnel. Considering the volume of wastewater treated (210m<sup>3</sup> per day), this is a very reasonable sum. As well, the Muntinlupa Market implemented – with the agreement of the market vendors – a users fee of 5 pesos per stall per day, which allowed the City to recover its costs for the project in merely 3 to 4 years. By reusing the effluent for toilet flushing (for one year) and street cleaning, the Muntinlupa Market also saves money on water bills. The San Fernando Market also implemented an indirect cost-recovery measure by increasing rental rates for stalls by 10%, though the additional revenue collected also goes to other market maintenance and initiatives in general. In both cases, the IEC performed by the project teams allowed market vendors to be engaged in the projects and agree to paying these additional fees in exchange for doing their part to clean up their surrounding waterways and meet national government regulations.

All of the projects faced challenges. In Muntinlupa, several pumps broke down and needed to be replaced, which took time. As mentioned earlier, the reuse system for the public toilets broke down and was not repaired. In San Fernando, the system quickly got clogged up with trash and grease due to poor design and construction. This was remedied, and the lesson was incorporated into the design and management of the Sta. Ana system.

As for water quality, these combinations of anaerobic and aerobic treatment processes allow these plants to be very effective at reducing BOD, COD, and TSS values of the wastewater, and the

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chlorination/filtration steps also help to remove pathogens. For example, at the San Fernando Market project, influent BOD/COD/TSS averages around 153, 439, and 148mg/L, respectively, with DENR national standards of 100/200/150mg/L for markets. After treatment, these values fall drastically to averages of around 11/27/11mg/L, respectively – far below the national requirements. The same applies for Muntinlupa, which reduces its BOD from more than 300mg/L to below 30mg/L (with a DENR standard for discharge to Laguna Lake at 50mg/L). These plants are therefore being very successful in treating the water of these markets.

Overall then, these projects are successfully contributing to the improvement of the sanitation situation in the Philippines, by essentially eliminating some of the largest and highest strength inputs of wastewater into important water bodies like the Pasig River, Laguna Lake, and the country's coastlines. While they have only a small impact in the overall picture (Pasig River is still biologically dead), their positive examples provide the groundwork for many more projects like these in the future.

**Photos**



**Figure 2.** The San Fernando Market wastewater treatment plant (left) and its SBR and UASB (foreground/background, right)



**Figure 3.** The Muntinlupa Market wastewater treatment plant under construction (left) and one of the IEC ads made by the project team as part of social outreach for the project (right)

### DAILY CHECKLIST

1.  All mechanical equipment should be on and operating.
2.  Remove all solid wastes such as grease, trash, plastics, sticks, rags, rubber, rocks, etc. from trash/grit/grease traps and bar screens. Properly dispose of all removed solid waste and do not throw waste into the other treatment chambers.
3.  Aeration tanks must have uniform bubbling and equal distribution of mixing and aeration.
4.  Check the dosing tank and centrifugal pumps.
  - a.  Lift pumps in equalization tanks and decant pump in aeration/reactor chamber.
5.  Chlorination unit should be operating properly.
  - a.  Add solution when necessary.
  - b.  Unit container must have adequate supply of solution at all times.
6.  Daily monitoring of sludge level at SBR tank.



**Figure 4.** The daily checklist for operators of the Sta. Ana Market wastewater treatment plant, as part of the operations manual provided to them by the project team (left) and visitors touring the Sta. Ana plant (right)

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