

Fourth Regional 3R Forum in Asia

“3Rs in the Context of Rio+20 Outcomes – The Future We Want”

Ha Noi, Viet Nam, 18-20 March 2013

Country Analysis Paper

(Draft)

< Fiji >

This country analysis paper was prepared by Fiji as an input for the Fourth Regional 3R Forum in Asia. The views expressed herein do not necessarily reflect the views of the United Nations.

Brief Country Analysis Paper for the 4th Regional 3R Forum in Asia, Ha Noi, Viet Nam, March 18 – 20, 2013

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1.0 General Country Information and Waste Management in Fiji

The Fiji archipelago is located between 174° East and 178° West and latitudes 12° and 22° South comprising of 332 islands scattered over 18,270 km² of the South Pacific Ocean. The population of Fiji is over 835, 230 (2007 census) and these are mainly concentrated in coastal towns and cities of the major islands. The urban sector population is around 412,425 whilst the rural sector population is about 424, 846.

Fiji has ratified and acceded total of nine (9) International and Regional treaties relating to waste management and pollution prevention. At the national level, Fiji's strategy in relation to overall waste management aspect is guided by the Fiji National Solid Waste Management Strategy 2011 – 2014 with the vision being “informed and responsible communities to sustainable solid waste management”.

The Department of Environment has the primary function of developing, implementing, monitoring and enforcement of legislations and policies in partnership with all municipalities, Ministry of Health and other relevant agencies. Waste management is addressed under several legislations including but not limited to Public Health Act Cap 111, Fijian Affairs Act (Cap 120), Environment Management Act 2005, Environment Management (EIA Process) Regulations 2007, Environment Management (Waste Disposal and Recycling) Regulations 2007, Litter Promulgation 2008 and Biosecurity Promulgation 2008.

Fiji with a population of over 835,230 (2007 Census) largely depends on the importation of goods and materials from the developed countries. Over the last decade, urbanization, population growth, increasing prosperity, commercial and industrial development, tourism, and most other forms of development have all contributed in varying ways to increasing quantities of solid wastes in Fiji. Due to its geographical isolation and relatively small recycling market, it becomes very difficult to recycle waste in Fiji. In addition, finding suitable landfill sites is quite difficult considering the land issues like customary rights over the use of land and reluctance by landowners to lease land for use as disposal sites due to fear of negative environmental, social and economic impacts.

Fiji being one of the small island countries in the Pacific Region is particularly concerned with Solid Waste Management with the potential to cause negative impacts on the fragile environment, tourism, trade, food supplies, public health and severely place constraint on the existing limited resources.

2.0 Waste Minimization and 3R promotion Initiatives

Government of Fiji recognized the need to introduce waste minimization and implemented on the number of 3Rs initiatives and formulated Guidelines/Policies as follows:

- a. **“Waste Minimization and Recycling Promotion Project in the Republic of Fiji islands”** or referred to as the **“3R Project”**.
- b. **Project on “Promotion of Shibushi Model (Waste Minimization without incineration) from the Republic of Fiji to Pacific Island Countries”** with the purpose of raising awareness on the concept of “Mixture produces waste, separation produces resources” at household level in Pacific Island Countries in order to reduce waste and improve waste disposal.
- c. **Japanese Technical Cooperation Project for Promotion of Regional Initiative on Solid Waste Management in Pacific Island Countries (J-PRISM).**
- d. **The United Nations Development Programme (UNDP)** funded project to introduce Container Deposit Legislation (CDL) in Fiji.
- e. **The formulation of 3R Guideline and 3R Manual.** The objective of the 3R Guideline is to reveal the National Policy on 3R promotion and the 3R Manual was developed as a tool to provide technical and practical information as guidance to other municipalities to promote the 3Rs in their jurisdictions.
- f. **The formulation of Solid Waste Management Plan** by Lautoka City Council and Nadi Town Council which highlights the necessity to promote the 3Rs including the systems. SWM Plan also provides the roadmap for expansion of 3R Promotion to the entire LCC and NTC jurisdiction area by year 2017.

The “Waste Minimization and Recycling Promotion Project in the Republic of Fiji islands” (“3R Project”) was implemented under the technical cooperation of the Japan International Cooperation Agency (JICA) for a term of three and half years commencing October 2008. The project was implemented to strengthen the capacity of two municipalities, which are Lautoka City (population of 45,000) and Nadi Town (population of 12,700), and Department of Environment (DOE) to promote waste minimization.

Since the 3R Project was a technical cooperation project with JICA, the emphasis was on building capacity of the Lautoka City Council (LCC) and Nadi Town Council (NTC). This was achieved by identifying project Counterparts in both Councils to work side-by-side with JICA Technical Experts. Funding for the project activities was provided by JICA whilst LCC/NTC/DOE also allocated some budget for implementation of the project.

The scope of the project included (i) conducting baseline surveys to grasp the existing situation and issues relating to SWM, (ii) developing Solid Waste Management Plans for the two municipalities based on baseline data, (iii) implementing pilot projects to examine the applicability, sustainability and expandability of waste minimization practices such as home-composting, market waste composting, clean schools program, separate collection for recyclables, and green waste

collection and chipping, (iv) improving the operation and management of the Vunato Disposal Site, (v) developing a wide range of educational tools, which were utilized for extensive awareness raising to citizens through house to house visits, community meetings etc., and (vi) expanding viable pilot projects to other areas based on the validity and lessons learnt from the pilot projects.

The following Specific 3R Activities were implemented under the 3Rs Project and has been sustained by the LCC and NTC under the J-PRISM Project upon the completion of 3Rs project in March 2012:

a. Separate Collection of Recyclables

Separate collection of recyclables was conducted in the residential and commercial areas of both municipalities. Target recyclable items for separate collection was limited as it depends on the items which recycling company can accept, including PET beverage bottles, plastic shopping bags, hard plastics, metals including tin cans, paper (newspaper, magazines, office paper), cardboard, cloth (textiles) and glass. Councils provided collection service on fortnightly basis in residential and on weekly basis for commercial areas.

Council visited each household and business to provide a specific nylon bags with the “3R” logo imprinted, and a recycling leaflet with calendar, which provides guidance on participating in the system. At the same time, people are requested to separate waste into recyclables and non-recyclables at source and to discharge at the curbside on designated times and days, which are indicated in the leaflets.

The Council-owned truck in LCC collects recyclables using unique appealing music announcements to remind the citizens of the collection day. NTC has reduced garbage collection frequency from three (3) days/week to two (2) days and same contractor conducts recyclable collection without any additional costs to council. The collection workers monitor the quality of the recyclables being discharged and record the number of households participating in the initiative. Non-recyclables and unclean materials are rejected and the workers provide necessary guidance for the discharger. The recyclables collected are then taken to the recycling company where they are sorted by category, weighed, baled, and exported overseas for recycling.

The results of monitoring of the pilot project implemented in LCC and NTC revealed the average discharge rate of recyclables as **6.2 g/person/day** at households and **217 g/BE/day** at business establishments (BE).

b. Promotion of Home Composting of Organic waste

LCC and NTC are of the view that it is crucial to decrease the amount of organic waste which accounts for around 60% of household waste generated. Therefore, both municipalities established a “Home compost subsidy programme” in July 2010 to encourage their ratepayers to use compost bins which are manufactured locally in Fiji and sold at costs of FJD 55. Council provides a subsidy of FJD 25 when ratepayers purchase a bin from the Councils. Each Council also conducted various

advertising and awareness activity to promote this noble initiative.

The Pilot Project proved that home composting using compost bin was very effective. Three hundred and eighty (380) households in LCC and NTC are practicing home composting under the pilot programme, and the amount of kitchen waste being recycled is estimated to be **107 g/person/day**, or about 20% of the household wastes being generated. It is also expected that composting will reduce the costs for the municipality because it lessens the amount of garbage going into the waste stream. Thus, LCC and NTC positioned the promotion of home composting as a core activity in the Solid Waste Management Master Plan.

c. Market Waste Composting

The market waste composting pilot was undertaken by both LCC and NTC. Both Councils provided separate bins in the Vegetable Markets for discharge of green waste and other waste that cannot be composted. Awareness was also created among the market vendors regarding segregation of compostable waste. In the case of LCC, total market waste generated is 3.3 tons/day. An average of 800 kg/day of compostable waste is segregated and transported to the composting yard located at Vunato Disposal Site (VDS) to be composted.

The “heap method” of composting has been established under the project whereby the dry organic waste (e.g., old wood chips, saw dust) is used for the base material and also for covering which assists in moisture regulation, controlling odors, flies and birds, and introducing microorganism to catalyze the compost. The compost heap is also covered with plastic sheet to retain moisture or protect from excessive moisture during heavy rainfall. The pile is then left to ferment for 3 weeks and then turned over every week by an excavator. Each compost heap is also monitored for moisture content, temperature and pH.

Once the compost is fully matured (about four to five months), it is sieved, weighed and packed in 10 kg bags for sale at price of FJD3.00 whilst the production cost is FJD2.64/10kg. The compost is purchased by the citizens as flower and vegetable gardening is popular in Lautoka and response from citizens has been encouraging. The analysis of the compost quality revealed nutrient content as Nitrogen: 1.3(%), Phosphorous: 2.1(%), and Potassium: 1.2%, with a carbon to nitrogen ratio of 7.2.

d. Clean Schools Programme

The aim of the Clean Schools Pilot Programme was to spread the message of good waste management practices to schools, particularly to students who are regarded as effective agents of change and influence, and to create awareness among children about waste minimization in the home and community. This initiative began in July 2010 and participating schools (14 schools in NTC and 26 schools in LCC) were required to implement 3R activities through three sets of activities: environmental awareness activities, school composting, and recycling.

Key factor for success was that 3R Project counterparts in LCC and NTC monitored the Clean

Schools Pilot Programme and also conducted awareness sessions with students during school visits. Competitions were also organized where all participating schools were rewarded with certificates of participation and other awards by the Minister of Environment during a special award ceremony. Both Municipalities are now working with Ministry of Education to expand the concept to all other schools from other municipalities in the Western Region.

e. Green Waste Collection and Recycling

The Green Waste Collection and Recycling Pilot commenced in October 2009 as an initiative to prevent the accumulation of such waste in backyards, minimize open burning and littering in public places, reduce the amount of waste going to the dumpsite, and reduce the collection and transportation cost of green waste.

A wood chipper is used to reduce green waste to wood chips which can be effectively recycled as mulching material in gardens, used in market waste composting for moisture control, used as base material for home composting, or sold as fuel for industrial boilers.



Figure 1: Citizen using plastic home composter



Figure 2: Recyclable collection



Figure 3: Market composting



Figure 4: Visit by JICA President, Ms Ogata.



Figure 5: Green waste chipping at public place



Figure 6: Clean School Awards Function

3.0 CONCLUSION

The applicability, sustainability and expandability of above 3R activities were proved to be viable based on the result of good practices and lessons gained from the pilot projects and the

encouraging response from the participating communities. It was realized that house to house visits and community meetings were effective tools in promoting 3R.s. Thus considering the limited resources of councils, the promotion of the 3Rs has been expanded gradually to 32% of the Lautoka City population and 100% of the Nadi Town population.

As a result of the 3R Project, the recycling rate was increased from 5.9% to 12.8 % in Lautoka City and from 2.8 to 22.3% in Nadi Town, whilst the disposal rates from 2008 to 2011 have decreased by 10.4% in Lautoka City and 25.8 % in Nadi Town.

One of the major challenges of the project has been the relatively small recycling market and low value for recyclables. Thus, it becomes very difficult to recycle waste in Fiji. Bringing about behavioral change amongst citizens is also a challenge since 3Rs is a new concept and requires voluntarily participation of the citizens to embrace 3R practices. Hence, 3R legislation is highly needed to compel the citizens to engage and practice 3Rs.

It has been realized that implementing 3Rs require significant investment in terms of human resource, training, equipments and other costs. However, it has been realized that implementation of 3R activities shall be seen as municipality's public responsibility towards preserving the environment. The active engagement and participation of citizens is indispensable towards implementing successful 3Rs initiatives.

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Waste Minimization and Recycling Promotion Project in the Republic of the Fiji Islands



SOLID WASTE MANAGEMENT (SWM) MASTER PLAN (MP) FOR LAUTOKA CITY COUNCIL

TARGETING YEAR 2009-2017



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Abbreviations

AP	Action Plan
CA	Capacity Assessment
DOE	Department of Environment
EIA	Environmental Impact Assessment
FIRR	Financial Internal Rate of Return
GRDP	Gross Regional Domestic Products
GW	Green Waste
JICA	Japan International Cooperation Agency
LCC	Lautoka City Council
M/P	Master PPlan
MLGUD	Ministry of Local Government and Urban Development
M/M	Minutes of Meeting
MOH	Ministry of Health
MRF	Material Recovery Facility
NGO	Non-Government Organization
NTC	Nadi Town Council
POS	Public Opinion Survey
P/P	Pilot Project
PR	Public Relations
SWM	Solid Waste Management
3R	3R (Reduce, Reuse, Recycle/Return)
3RPP	3R Pilot Project
The Project	Waste Minimization and Recycling Promotion Project

1 Current Situation of Solid Waste Management

1.1 Waste Flow

Development of a waste flow is very important to grasp the current solid waste management. Japanese Expert Team (hereinafter referred as “JET”) for the Waste Minimization and Recycle Promotion Project (hereinafter referred as “the Project”) has developed a waste flow based on the results of four baseline surveys out of six.

Table 1: Baseline Surveys and Analysis for Development of a Waste Flow

Surveys	Implementation period	Analysis
1. Waste amount and composition survey (WACS)	Dry: Mid. Nov. 2008 – Mid. Dec. Rainy: Mid. Jan. 2009 – Mid. Feb.	Dry: Mid. Dec. 2008 – End Jan. 2009 Rainy: Early Feb. 2009 – End Feb. 2009
2. Final disposal amount survey (FDAS)	Dry: Mid. Nov. 2008 – Mid. Dec.	Dry: Mid. Dec. 2008 – End Jan. 2009
3. Public Opinion Survey (POS)	Mid. Dec. 2008 – Mid. Feb. 2009	Mid. Feb. 2009 – Mid. Mar.
4. Recycling Activities Survey (RAS)	Mid. Dec. 2008 – Mid. Feb. 2009	Mid. Feb. 2009 – Mid. Mar.

Therefore, the waste flow was developed based on the conditions mentioned below.

- Household waste: The generation amount is estimated by multiplying the population in 2008 and a generation rate obtained by WACS. The generation rate is the weighted average of the ratio of population in commercial areas and residential areas.
- Waste from business establishments: This was estimated by the sum of waste generated from restaurants, shops and hotels, etc. surveyed in the WACS. The number of generation sources was obtained from the data of business licenses in 2007. The generation amount is estimated by the generation rates given in WACS and the number of generation sources.
- Waste from public areas: The generation amount is estimated based on the results of FDAS and the data of incoming waste recorded by LCC at the Vunato disposal site.
- Green waste (GW): The disposal amount of the GW generated from the households and business establishments was obtained from the results of FDAS. And the generation amount was estimated by the ratio (23.6%) of households which paid collection fee obtained by the interview survey carried out in the POS and the disposal amount mentioned above.

(Estimate of green waste generation amount)

Disposal amount (3.0ton/day) / 0.236 = Generation amount (12.7 ton/day).

- Recycle rate: According to the questionnaire survey GW treatment carried out through POS, 89 out of 100 households GW and 29 are composting it. However, this answer is overlapped with that of self disposal. Therefore, it is assumed that the half of 29 households compost the garden waste and the recycle rate of the GW generated from the household and business establishments is estimated as 16.3%

($29/2/89=0.163$) On the other hand, the valuables such as plastic bottles (PET), and metals, etc. is assumed to be 1.0% based on the results of a questionnaire survey conducted in the WACS and POS (household).

- Rate of self-disposal: The self-disposal rate of GW adopted 60.1% which was estimated as taking 23.6% of collection and 16.3% of recycling off GW generation amount. The self-disposal amount of kitchen waste of household and business establishment are estimated as 1.1ton/day and 0.3ton/day respectively based on the results of questionnaire survey carried out in the WACS and POS.
- As there was no big differences between the results of WACS carried out in the rainy season and dry one, the generation rates adopted the average values.

2008: Before Project

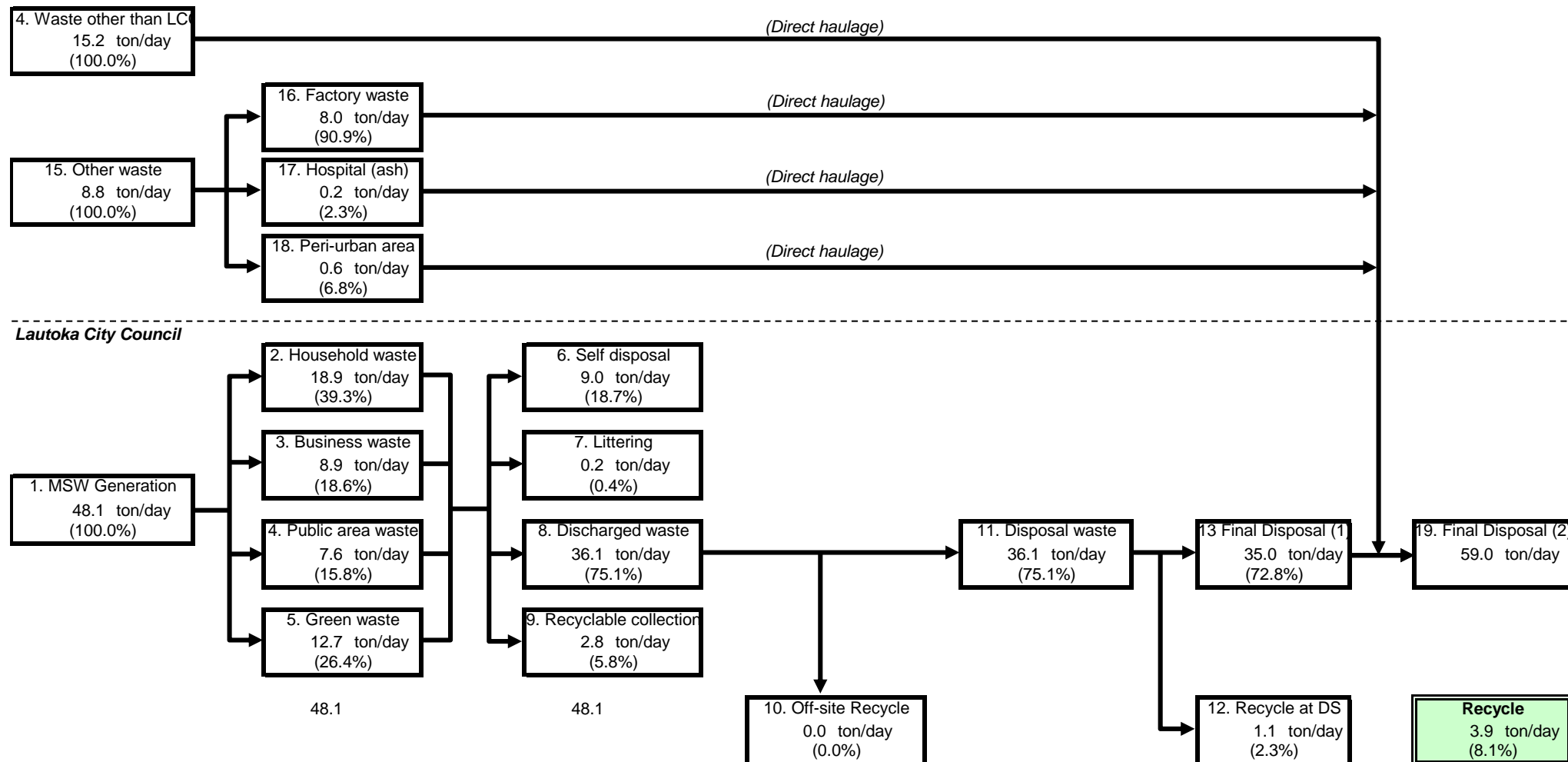


Figure 1: Waste Flow in Lautoka (2008)

1.2 Current Situation and Problems Regarding SWM

The situation of the current solid waste management (SWM) in Lautoka and its problems are summarized in the following table.

Table 2: Situation and Problems of the Current SWM in Lautoka

Items	Current situation	Problems
1. Technical system		
1.1 Generation	<ul style="list-style-type: none"> Population: 43,473 (in 2008) Area: 1,439 ha Generation amount of MSW: 48.1 ton/day^{*1} Generation rate of MSW: 1,098 g/person/day Generation amount of HH waste: 18.9 ton/day Generation rate of HH waste^{*2}: 432 g/person/day 	<ul style="list-style-type: none"> As the collection service of green waste is charged, almost 40% of green waste is self-disposed. Including self-disposed green waste, daily waste generation rate of MSW per person exceeds 1.1kg.
1.2 Waste composition	<ul style="list-style-type: none"> HH waste: Kitchen waste (52.5%), Plastic (PET)(1.9%), Plastic (Films & others)(11.7%), Paper (11.8%) MSW: Green waste^{*3} (37.4%), Kitchen waste (30.7%), Recyclables^{*4} (5.2%) 	<ul style="list-style-type: none"> Green waste rate of 37.4% is highest of all MSW. The recyclables rate, 5.2% of MSW, is very low.
1.3 Storage and Discharge	<ul style="list-style-type: none"> Each area sets its own discharge rules (collection day, container, etc.). The frequency of the collection service for residential areas is twice a week. It is divided into 3 areas according to the service days, Mon & Thu, Tue & Fri, Wed & Sat. Collection is from 7:00 to 15:00; Residents discharge waste on the day the service is provided. By-law stipulates the waste container should be steel or plastic with a lid and have a capacity of 0.042 ~ 0.085m³. 	<ul style="list-style-type: none"> Discharge rules are generally kept by public. Plastic bags are commonly used for discharging waste, meaning animals are able to scavenge and scatter the waste. As the collection time is not fixed, (1) waste is scattered in areas where collection is provided in the afternoon, and (2) waste is put out after collection has finished in areas where the service is early in the morning.
1.4 Collection & transport (Nr is the actual expenditure in 2008 and () is the rate against the total SWM cost)	<ol style="list-style-type: none"> Municipal waste other than bulky waste: <ul style="list-style-type: none"> Curbside collection service is free (covered by tax) and has 100% coverage. Contracted out (one private company has the contract to collect MSW and Lautoka market waste) 6 days a week in commercial areas 2 days a week in residential areas Collection/transport amount: 25.3 ton/day Contract amount: 240,460 FJ\$/year (22.7%) Unit cost of collection and transport: 26.0 FJ\$/ton Green waste / Bulky waste <ul style="list-style-type: none"> charged service due to a request from the discharger: Green waste = 22.0 FJ\$/trip, 	<ul style="list-style-type: none"> As residents living outside the city boundary discharge waste on the streets belonging to LCC, LCC has to provide collection service free of charge. Waste collection workers rarely collect recyclables on their route. As there is a charge for the green waste collection service, residents who do not want to or can not pay the service fee, self-dispose their green waste. Some green waste is treated inappropriately (burnt or left on the roadside). Green waste is generated in large quantities. It is also bulky

Items	Current situation	Problems
	<p>Bulky waste =24.0 FJ\$/trip</p> <ul style="list-style-type: none"> Private contractor (1) Major portion is the collection of green waste <p>Green waste: 821 trips/year Balky waste: 10 trips/year</p> <ul style="list-style-type: none"> Collection and transport amount: 3.0ton/day Total contract amount: 52,000 FJ\$/year (4.9%) Unit collection/transport cost: 47.5 FJ\$/ton 	<p>meaning transport efficiency is low. And it is difficult to compact at the disposal site.</p>
1.5 Public area cleaning (Nr is the actual expenditure in 2008 and () is the rate against to the total SWM cost)	<p>3. Street sweeping:</p> <ul style="list-style-type: none"> Total sweeping length: 47.6 km (56.7% of total street length 83.9km) Collection & transport amount: 4.1ton/day 2 contractors Contract price: 170,880 FJ\$/year (16.1%) Unit cost: FJ\$3,590/km/year, 114.2 FJ\$/ton <p>4. Park cleaning</p> <ul style="list-style-type: none"> Total cleaning area: 71.2 ha Collection & transport amount: 2.8ton/day Branch cutting is carried out by direct operation and grass cutting of the park is commissioned (contractor for drain cleaning and grass cutting) Contract price (included in the drain & grass cutting); Direct operation cost: 20,000 FJ\$/year (1.9%) Unit cost for park cleaning: 19.6 FJ\$/ton <p>5. Drain cleaning and grass cutting</p> <ul style="list-style-type: none"> Total length of drain cleaning: 556 km (100% of all municipal drain) Area of grass cutting: 66.6 ha Collection & transport amount: 0.7ton/day 15 contractors Contract price: 372,397 FJ\$/year (35.2%) Unit cost for drain cleaning & grass cutting: 1,457.5 FJ\$/ton 	<ul style="list-style-type: none"> The cost for public area cleaning, which is two times as much as that of MSW collection service, accounts for more than half (53%) of the total cleaning service cost. Street sweeping covers 56.7% of total municipal road extending for 83.9km. Drain cleaning service covers the entire municipal drain network, extending 556km. Therefore, the cleaning cost including grass cutting service accounts for 35% of total cleaning service cost.
1.6 Intermediate treatment	<ul style="list-style-type: none"> No intermediate treatment except incineration of the medical waste at Lautoka hospital (incinerator, 80 kg/3hours capacity), imported from New Zealand Incinerator in Lautoka Hospital treats infectious medical waste except sharp objects generated by the major councils in the western region. Sharp objects generated in the western region are treated in Suva separately from the other infectious medical waste. 	<ul style="list-style-type: none"> The incinerator in Lautoka hospital is operated appropriately, but the exhaust gas is emitted without treatment. The ash is disposed at the Vunato disposal site.
1.7 3R Activities	1. Reuse and Recycling facilities	<ul style="list-style-type: none"> LCC does not have any reuse or

Items	Current situation	Problems
	<ul style="list-style-type: none"> There is no reuse recycling facility targeting recyclables. Therefore, FSC collects and uses the waste oil which is generated in and around the Lautoka area as fuel for a boiler. The waste oil is traded free of charge. Sugar factory (FSC: Fiji Sugar Corporation) has a generator with boiler using bagasse as a fuel and sell the electricity generated to the Fiji Electricity Authority. Mill mud also generated in the FSC is supplied to the farmer free of charge. South Pacific Fertilizer Ltd. is studying a possibility for composting of mill mud and bagasse generated in the factory of FSC. Pig farm (Vuda Piggeries Ltd. produces compost by using dung and sawdust generated in sawmill nearby. The compost products is sold as F\$25.0/m³. <p>2. 3Rs Activities</p> <ul style="list-style-type: none"> LCC supported recycling activity targeting the paper generated in the city hall and schools. Other than LCC, Coca Cola conducts recycle campaign for plastic bottles. 	<p>recycling facilities.</p> <ul style="list-style-type: none"> Reuse and recycling activities are carried out privately. Besides the end users in Lautoka, there are very few in the rest of Fiji. There are no 3R activities promoted by LCC of its own initiative, and there are very few promoted privately. Although the price of the chemical fertilizer consists of a grant from the government, F\$25.0/ton given by the Vuda Piggeries Ltd. may be a target price of the compost. Most of the farmers have never used compost so the PR is needed to rouse the compost demand.
1.8 Final disposal	<ul style="list-style-type: none"> Site: Vunato disposal site Area: 20ha Disposal method: Controlled tipping (sanitary landfill level 1) Landuse of the surrounding area: Mangrove, grave yard Distance from the city: 2.0km from Lautoka market Operation staff: Engineering department 6 under director of DOH Final disposal amount: 58.9 ton/day MSW of LCC: 34.8 ton/day, other than MSW: 8.8 ton/day, MSW other than LCC (NTC, etc.): 15.3 ton/day Operation cost: Total expenditure 255,908 FJ\$/year, for LCC=156,204 FJ\$/year (14.3%) in 2008 Income from tipping fee: 143,000 FJ\$/year Unit disposal cost: 11.9 FJ\$/ton 	<ul style="list-style-type: none"> The area of the disposal site has been decided but the boundary is not defined. Securing soil (15FJ\$/m³) for covering waste is difficult so sanitary landfill operation is not carried out. On the other hand, Vunato disposal site is operated by control tipping, so the tipping fee is rather expensive compared other insufficiently operated sites. Therefore, private waste collectors dispose waste at the Sigatoka disposal site if the total cost including transportation is cheaper than Vunato. Since the tipping fee is established according to size of truck, it seems unfair.
1.9 Maintenance	<ul style="list-style-type: none"> The equipment for cleaning work which LCC has are one open truck for garden waste collection and one bulldozer (D6) for landfill only. LCC has a depot for parking but maintenance is contracted out privately. 	<ul style="list-style-type: none"> LCC rents equipment necessary for the cleaning work except one open truck and one bulldozer. As maintenance of the equipment is contracted out privately, the maintenance capability of the council is very

Items	Current situation	Problems																																
		limited.																																
2. Institutional system																																		
2.1 Laws and regulations	<div>1. Central government<ul style="list-style-type: none">“Environment Management Act” was issued in March 2005.Environment Management (Waste Disposal and Recycling) Regulations was in force according to the Environment Management Act.</div> <div>2. Lautoka City Council<ul style="list-style-type: none">Lautoka (Garbage Disposal) By-Law was enacted to complement the “Public Health Act (Cap.111)” and “Local Government Act (Cap 125).”</div>	<div>1. Central government<ul style="list-style-type: none">Standards and guidelines for planning and designing of waste disposal and recycling facilities are not prepared yet.A legal support system for establishment of economic instruments for 3R promotion is not prepared.</div> <div>2. LCC<ul style="list-style-type: none">By-Law(s) to promote 3Rs is not prepared yet.</div>																																
2.2 Administration and management system on SW	<div>1. Central government<ul style="list-style-type: none">Department of Environment (DOE), Ministry of Local Government and Urban Development & Housing and Environment is in charge of SWM.DOE worked out National Solid Waste Management Strategy & Action Plans 2008 – 2010 (NSWMSAP) according to the Environment Management Act.</div> <div>2. LCC<ul style="list-style-type: none">Department of Health (DOH) is in charge of SWM. Total number of DOH staff is 10.Most of the cleaning work (78.5% of total cleaning cost) is contracted out to the private companies, except park cleaning and landfill operation. Management system to control the private companies (tender, selection, contract and supervision) is sufficiently established.</div>	<div>1. Central government<ul style="list-style-type: none">Number of DOE staff in charge of the SWM is only 5 and budget is limited.Implementation system for the NSWMSAP is insufficient. Especially, the implementation system in the local authority is very week.</div> <div>2. LCC<ul style="list-style-type: none">Most of the cleaning work is contracted out so that the staff and equipment of DOH is limited.Due to the limited staff and equipment of DOH, it may take some time to commence cleaning work in an emergency, 3R campaign, etc.</div>																																
2.3 Financial situation (Nr is the actual expenditure in 2008 and () is the rate against to the total SWM cost)	<div><ul style="list-style-type: none">Cost of cleaning work in the total council expenditure<table><tr><th>Items</th><th>Unit</th><th>2007 Actual</th><th>2008 Estimation</th></tr><tr><td>LCC Total Income</td><td>F\$</td><td>5,526,839</td><td>5,504,800</td></tr><tr><td>LCC Total Expenditure</td><td>F\$</td><td>5,465,670</td><td>5,853,600</td></tr><tr><td>Surplus (Deficit)</td><td>F\$</td><td>61,169</td><td>-348,800</td></tr><tr><td>SWM Total Income</td><td>F\$</td><td>275,064</td><td>231,110</td></tr><tr><td>SWM Total Expenditure</td><td>F\$</td><td>1,089,347</td><td>1,163,645</td></tr><tr><td>Surplus (Deficit)</td><td>F\$</td><td>-814,283</td><td>-932,535</td></tr><tr><td>Ratio of SWM Expenditure in LCC Total Expenditure</td><td>%</td><td>20.00%</td><td>20.00%</td></tr></table>Sources of revenue are municipal tax, tipping fee, green and bulky waste fee and market waste fee.</div>	Items	Unit	2007 Actual	2008 Estimation	LCC Total Income	F\$	5,526,839	5,504,800	LCC Total Expenditure	F\$	5,465,670	5,853,600	Surplus (Deficit)	F\$	61,169	-348,800	SWM Total Income	F\$	275,064	231,110	SWM Total Expenditure	F\$	1,089,347	1,163,645	Surplus (Deficit)	F\$	-814,283	-932,535	Ratio of SWM Expenditure in LCC Total Expenditure	%	20.00%	20.00%	<div><ul style="list-style-type: none">Cost of cleaning work accounts for 20% of the council budget.80% of the revenue for cleaning work is covered by municipal tax; however the council levies a tipping fee to outsiders, and a green and bulky waste fee.The collection cost of the municipal waste accounts for only 27.6% of all cleaning cost. The cost of public area cleaning accounts 53.2%.LCC does not promote 3Rs actively at present. LCC is required to secure additional budget if LCC promotes 3Rs independently. LCC is also required to secure budget to improve landfill operation and environment.</div>
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Items	Current situation				Problems																																																			
	<table><tr><th>Items</th><th>Unit</th><th>2008 Estimation</th><th>Portion to Total (%)</th></tr><tr><td>1. Income from SWM Fee</td><td>F\$</td><td>231,110</td><td>19.9</td></tr><tr><td>1.1 Fee from green waste collection service</td><td>F\$</td><td>22,000</td><td>1.9</td></tr><tr><td>1.2 Tipping fee from dump site operation</td><td>F\$</td><td>143,000</td><td>12.3</td></tr><tr><td>1.3 Market waste collection fee</td><td>F\$</td><td>66,110</td><td>5.7</td></tr><tr><td>2. Income from LCC Budget</td><td>F\$</td><td>932,535</td><td>80.1</td></tr><tr><td>Total Income for SWM</td><td>F\$</td><td>1,163,645</td><td>100</td></tr></table>				Items	Unit	2008 Estimation	Portion to Total (%)	1. Income from SWM Fee	F\$	231,110	19.9	1.1 Fee from green waste collection service	F\$	22,000	1.9	1.2 Tipping fee from dump site operation	F\$	143,000	12.3	1.3 Market waste collection fee	F\$	66,110	5.7	2. Income from LCC Budget	F\$	932,535	80.1	Total Income for SWM	F\$	1,163,645	100	<ul style="list-style-type: none">Measures to secure the budget shall be considered.<ul style="list-style-type: none">increase the allotment for cleaning services from the council budgetraise the service feereview of service quality (i.e. reducing service frequency)																							
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	<table><tr><th>Service Items</th><th>ton /day</th><th>LCC Cost F\$/year</th><th>Share</th></tr><tr><td>1. MSW Collection</td><td>26.2</td><td>292,460</td><td>27.6</td></tr><tr><td>1.1 MSW Others than 1.2/1.3</td><td>19.9</td><td>174,350</td><td>16.5</td></tr><tr><td>1.2 Market Waste</td><td>3.3</td><td>66,110</td><td>6.2</td></tr><tr><td>1.3 Green Waste</td><td>3.0</td><td>52,000</td><td>4.9</td></tr><tr><td>2. Public Area Cleansing</td><td>7.6</td><td>563,277</td><td>53.2</td></tr><tr><td>2.1 Road Sweeping</td><td>4.1</td><td>170,880</td><td>16.1</td></tr><tr><td>2.2 Park Cleaning</td><td>2.8</td><td>20,000</td><td>1.9</td></tr><tr><td>2.3 Drain & Grass</td><td>0.7</td><td>372,397</td><td>35.2</td></tr><tr><td>3. Final Disposal</td><td>57.1</td><td>151,483</td><td>14.3</td></tr><tr><td>Cleansing Services Total</td><td></td><td>1,007,220</td><td>95.1</td></tr><tr><td>Administration, Education, Others</td><td></td><td>52,000</td><td>4.9</td></tr><tr><td>Total</td><td>57.1</td><td>1,059,220</td><td>100.0</td></tr></table>				Service Items	ton /day	LCC Cost F\$/year	Share	1. MSW Collection	26.2	292,460	27.6	1.1 MSW Others than 1.2/1.3	19.9	174,350	16.5	1.2 Market Waste	3.3	66,110	6.2	1.3 Green Waste	3.0	52,000	4.9	2. Public Area Cleansing	7.6	563,277	53.2	2.1 Road Sweeping	4.1	170,880	16.1	2.2 Park Cleaning	2.8	20,000	1.9	2.3 Drain & Grass	0.7	372,397	35.2	3. Final Disposal	57.1	151,483	14.3	Cleansing Services Total		1,007,220	95.1	Administration, Education, Others		52,000	4.9	Total	57.1	1,059,220	100.0
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2.4	Public education and cooperation	LCC carries out the following activities.		<ul style="list-style-type: none">Public education and cooperation conducted by LCC is currently very limited in terms of budget and manpower.																																																				
		<ul style="list-style-type: none">Environmental education: holding clean up campaign, execution of “the Greener and Litter-free Programs” based on the Polluter Pays Principle, and publishing a newsletter (once)Activities in collaboration with the community: LCC carried out “waste discharge container installation project” in collaboration with a neighborhood watch group which was organized by the police for crime prevention.																																																						

(Footnotes)

- *1: The municipal waste in Lautoka is defined as the waste generated in the council area excluding (1) waste which factories and hospitals take to the disposal site directly, and (2) waste from out of its jurisdiction (i. waste collected by LCC in the peri-urban area, ii. the waste collected by other local authorities)
- *2: As green waste is generated in large quantities, it was not included in the waste discharged in WACS. Therefore, the generation rate and composition of household waste does not include green waste.
- *3: Measuring the volume of green waste was very difficult. It was estimated using the record of the green waste collection service. Therefore, the proportion of green waste to municipal waste was estimated by the ratio of green waste weight, estimated by collection records, and other municipal waste generation amount, estimated based on the results of WACS.
- *4: The proportion of valuable recyclables (PET, Metal, Bottles and Glass) currently collected as municipal waste. Paper recycling is excluded, as although some paper is collected, it only makes up a small percentage, and whether it is recycled is effected by fluctuations in international prices.

2 Planning Framework

2.1 Socio economic framework

2.1.1 Population projected

Population in whole Fiji and Lautoka City council was projected as in the table below based on the census in 2007 by “Statistical News, No.45, 2008, Census 2007 Results : Population size, Growth, Structure and Distribution” published by Fiji Islands Bureau of Statistics on 15th October 2008”.

Table 3: Population Forecast in the Project Area

Year	Whole Fiji	Lautoka city	Ratio (2008=1)
2007 (Census)	837,271	43,473	0.992
2008 (Projected)	843,847	43,814	1.000
2012 (Projected)	872,800	45,317	1.034
2017 (Projected)	912,300	47,367	1.081

2.1.2 Economic growth

Fiji Island Bureau of Statistics & Macroeconomic Committee has estimated a GRDP growth rate of Fiji from 2008 to 2011 as 1.93%. The M/P adopts this rate as a local economic growth in Lautoka area. Furthermore, M/P adopts 2.0% for the economic growth rate after 2012 considering the projected rate.

2.1.3 Financial conditions

The portion of budgets for cleansing services accounted for the total municipal one from 2005 to 2007 were at a constant rate of 20%. Therefore, it is presumed that the future rate would not to be changed until 2017. The growth rate of the municipal budget is estimated considering population growth rate (0.8%) and economic growth rate.

Table 4: Budget Projection for Cleansing Works

Year	LCC Expenditure	Rate of SWM Expenditure (%)	SWM Expenditure
2007 (Actual)	5,465,670	20	1,089,347
2008 (Estimated)	5,853,600	20	1,163,645
2012 (Projected)	6,538,000	20	1,307,600
2017 (Projected)	7,556,000	20	1,511,200

2.2 Forecast of Future Waste Flow

2.2.1 Future Municipal Solid Waste Amount

Formula of forecast:

The future Waste Generation Amount (WGA_x) is calculated by multiplying the future Number of waste Generation Source (NGS_x) and the future waste Generation Rate (GR_x).

$$WGA_x = GR_x \times NGS_x$$

Future Number of waste Generation Source (NGS_x):

The future Number of waste Generation Source (NGS_x) for household waste, which means population, is forecasted based on the Population Forecast in the Project Area (Table 3). The future Number of waste Generation Source (NGS_x) for school waste, which equals with number of school students, is relative to the figure of the Population Forecast. Apart from the household and school waste, the future Number of waste Generation Source (NGS_x) will increase in proportion with the increase of economic growth rate, i.e. 1.93-2.00 % per annum.

Future waste Generation Rate (GR_x):

The future waste Generation Rate (GR_x) of each generation source will increase according to the economic growth rate. Based on the Japanese case, the future GR_x in Lautoka City was calculated based on the relationship between the GR_x and economic growth rate as follows;

- 1) The Japanese statistics, which were recorded from 1963 to 1988, show the following trend of the GR_x in accordance with economic growth rate:

At the time of developing economy (1963-1970): Increase of GR_x = 0.55 of GDP growth rate

At the time of developed economy (1975-1988): Increase of GR_x = 0.29 of GDP growth rate

*Note: After 1990, generation rate has been constant about 1.1 kg/person/day due to 3R promotion

- 2) GR_x will increase according to the economic growth rate. The coefficient of 0.55 for GR_x/GDP growth rate obtained from the above Japanese statistics is applied to the forecast of future GR_x in Lautoka City.
- 3) The increase of economic growth rate in Lautoka City is 1.93-2.00 % per annum. Consequently, GR_x of wastes other than Public Area Cleansing (PAC) and Green Waste (GW) will increase 1.1 % per annum.

$$1.93 - 2.00 \times 0.55 = 1.062 - 1.100 \rightarrow 1.1$$

However, it is presumed that GR_x for PAC and GW would not change.

According to the above formula and conditions, the future Municipal Solid Waste (MSW) Generation Amount is forecasted shown in the following table.

Table 5: Forecasted Municipal Solid Waste (MSW) generation amount

Unit: Ton/day					
Waste Generation Sources		Unit	2008	2012	2017
Household		ton/day	18.9	20.4	22.5
Commercial	Restaurant	ton/day	1.3	1.4	1.7
	Other shop	ton/day	3.7	4.2	4.8
Hotel		ton/day	0.04	0.05	0.05
Public and Private office		ton/day	0.5	0.5	0.6
School		ton/day	0.1	0.1	0.1
Market		ton/day	3.3	3.7	4.3
Street sweeping		ton/day	4.1	4.1	4.1
Park		ton/day	2.8	2.8	2.8

Waste Generation Sources	Unit	2008	2012	2017
Drain	ton/day	0.7	0.7	0.7
Green waste	ton/day	12.7	12.7	12.7
Total	ton/day	48.1	50.7	54.4

2.2.2 Future Waste Composition:

The future waste composition is forecasted by comparing the results of the Waste Amount and Composition Survey (WACS) with other countries. In Lautoka case, the forecast is mainly based on the following assumptions:

- The generation rates(amount) of wastes used for containers and package, e.g., paper, plastics, bottles and glass, metals, are assumed to increase in accordance with economic growth rate (GRDP= 2%).
- The generation amount of textile, leather and rubber which are extremely low in the current generation amount, are also assumed to rise in accordance with the economic growth rate. However, the growth rate is supposed as half that of the above mentioned waste.
- On the other hand, the generation amount of grass and wood (green waste and grass), ceramic and stone, soil, and others will not change.

Based on the above assumptions, the future waste composition in Lautoka City as forecast is shown in the following table.

Table 6: Municipal Solid Waste (MSW) Composition

Category of Waste	2008 (%)	2012 (%)	2017 (%)
Kitchen Waste	30.1	31.5	36.1
Paper	12.9	13.5	15.4
Textile	1.5	1.4	1.1
Plastic (PET)	1.2	1.4	1.6
Plastic (Film)	6.7	7.1	8.0
Grass and Wood	37.4	35.8	30.0
Rubber and Leather	0.2	0.2	0.2
Combustibles Sub-total	90.0	90.9	92.4
Metal	2.5	2.6	3.0
Bottle and Glass	1.5	1.6	1.9
Ceramic & Stone	2.7	2.4	1.4
Others	3.3	2.5	1.3
Non-Combustibles Sub-total	10.0	9.1	7.6
Total	100.0	100.0	100.0

2.2.3 Future generation amount of Industrial and Medical waste

The future generation amount of industrial wastes coming to Vunato disposal site (VDS) is forecasted to be based on the data recorded at the generation sources. Medical waste, which

consists of the general waste and ash of infectious/hazardous wastes incinerated at Lautoka Hospital and coming to VDS, is also forecasted.

The forecast is mainly based on the following assumptions:

- Generation Rate (GR_x) will not change
- Industrial waste will increase in accordance with economic growth rate.
- Medical waste will increase in accordance with population growth rate.

Based on the above assumptions, the Industrial and Medical Waste Generation Amount in Lautoka City is forecast as shown in the following table.

Table 7: Forecast of Industrial and Medical Waste Generation Amount

Year	Unit	Industrial waste	Medical waste			Total
			General	Infectious	Total	
2008	ton/day	8.0	0.16	0.04	0.2	8.2
2012	ton/day	8.6	0.16	0.04	0.2	8.8
2017	ton/day	9.5	0.16	0.04	0.2	9.7

2.2.4 Future Waste Flow

The future Waste Flow without 3Rs implementation is forecasted based on the following assumptions.

- Public sectors will not own any recycling facilities, and will not implement any 3R activities. Private sectors will continue with recycling activities based on economic principles.
- Waste generated in NTC will come to Vunato disposal site (VDS) during target years of the M/P, from 2009 till 2017. When NTC will find its own disposal site, the M/P shall be modified.

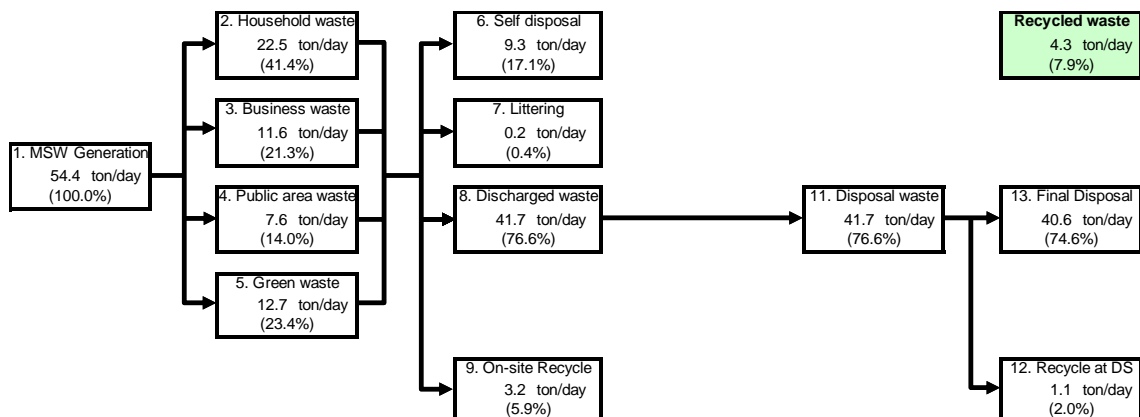


Figure 2: Future Waste Flow in the year 2017 without Improvement (M/P implementation)

The above figure shows that the following matters should be taken into consideration for developing the M/P;

- In case of without M/P implementation, the VDS will receive 273,500 ton of wastes by the end of 2017 in total. It means that total disposal volume required will be 300,800 m³ (with 10% of cover soil). Consequently the VDS is required to mount up 2.2 m higher than present level.
- The future waste recycling amount against the MSW generation amount in 2017 is forecasted as 7.9%, however, it is decreased by 0.5% comparing with that of 2008 as 8.5 %. It means that maximum rate of recycling done by private and informal sectors would be approximately 8.0%.

3 Selection of Appropriate Technical System

3.1 Policy of selection

Technical System

An SWM technical system consists of the following technical subsystems:

- Discharge and Storage system;
- Collection and Transport system;
- Public Area Cleansing system
- Intermediate Treatment and Recycling system; and
- Final Disposal system

Considering the current Solid Waste Management situation in the target area and the numerous targets of the M/P, policy of selecting appropriate technical system is set as follows:

- Technical system is required to contribute to the realization of the vision of the M/P.
- LCC and its citizen can afford to implement the system which will change along with socio-economic conditions and the system should be practical in terms of regional economy.
- The systems and technologies to be adopted should be simple so that operation and maintenance will be easy and inexpensive.
- The additional inputs acquired through foreign aid should be minimized by making the most of locally available materials and services.
- The proposed technical system should be consistent with the existing conditions and practices to have LCC and its citizen easily cope with.

3.2 Basic Policy on Appropriate Technical System

a. Discharge and Storage System

- Improper self-disposal (such as open burning, discharge to open space) of MSW shall be eliminated.
- Waste separation at generation source into the following four categories is promoted:
 - Kitchen waste
 - Green waste
 - Recyclable waste
 - Other wastes
- Kitchen waste shall be separated from other waste at kitchen, and be self disposed appropriately by using the composter etc. placed at backyard. Technical and financial support system shall be established to promote home composting since it has already verified its practicability and effectiveness from the experiences of the Pilot Project undertaken in FY2009.
- Vegetable waste shall be separately stored at the municipal market for composting.
- Green waste from parks, street pruning, residents etc shall be discharged on a request basis.
- Recyclable waste shall be separately stored at generation source and discharged by using appropriate container such as nylon sack on the day specified for recyclable collection.
- Other waste shall be discharged for LCC waste collection services the same as present one. However, discharge rules (day, time, container, etc.) shall be strictly applied to.
- Kitchen waste generated in the commercial area, whose quantity is comparatively large, should be separated at the kitchen and stored. LCC promotes use of this for the pig farming as much as possible.

b. Collection System

- Vegetable waste generated from the market is collected by the LCC and composted at the MRF to be constructed in the VDS.
- Chipping of Green Waste will be conducted by setting collection schedule by area to increase the efficiency of collection and chipping.
- Bulky and green waste collection service is charged to the service user.
- Recyclable waste will be collected by private recyclers or LCC service.
- Current collection system (mixed collection, curb-side collection, etc.) with strict enforcement of discharge rule will be continued.

c. Public Area Cleansing System

- Public area cleansing service cost share more than half expenditure of SWM, it is possible to reduce in cost by public cooperation.
- LCC will conduct environmental education to obtain public cooperation.

d. Intermediate Treatment and Recycling System

- Recyclable waste from household and business establishment shall be collected for recycling as follows:
 - On-site recycling of Kitchen and Green waste by composting, what is called proper self disposal will be promoted by LCC.
 - Recyclable waste will be separately stored at generation sources and be collected by private recyclers or LCC service.
 - Vegetable waste will be collected separately from the market waste and be used as raw materials for composting by windrow system.
- Green waste collected by LCC service shall be recycled by following methods:
 - Chipping (on-site and VDS) by the shredder;
 - Chips will be used for mulching on public gardens and composting, and also will be sold to the private company such as the Fiji Sugar Corporation as fuel for boiler.
 - Surplus chips will be used as a cover material at VDS.

e. Final Disposal System

- VDS will be available to use as the final disposal site for more than 10 years.
- To prolong the life of VDS, LCC will promote 3R activities as much as possible. Especially composting organic waste will be prioritized as a primary component of the solid waste management plan. It will contribute to the reduction of the disposal amount and the improvement of leachate quality.
- Considering various constrain for the realization of Sanitary Landfill (SLF), M/P is aiming at further improvement of VDS up to the Strictly Controlled Landfill (SCL) which will minimize adverse affects by VDS as much as possible by using available resources.
- For realization of the SCL, the following improvement works shall be achieved:
 - Boundary of VDS shall be defined physically by embankment, buffer zone, etc.
 - Strict/fair controlled dumping fee system for incoming wastes shall be established by utilizing a weighbridge.
 - Mitigation measures such as periodical soil covering for waste scattering prevention, etc. shall be taken.
 - Environmental monitoring system and measures should be established

3.3 Appropriate Technical System

Considering the above basic policy, the following technical system is examined as appropriate methods.

Table 8: Appropriate Technical System

Sub-system	Planned system
Storage/Discharge	<ul style="list-style-type: none"> Separation at generation source: Separation by four (4) waste types; Kitchen waste, Green waste, Recyclable and Other waste, shall be implemented on a gradual basis in the area where home composting and recyclable collection is already available. Container for storage and discharge: <ul style="list-style-type: none"> [Residential area] Recyclable waste shall be discharged by nylon sack. Other waste shall be discharged by plastic-made container with lid. (Plastic shopping bag will be gradually eliminated.) [Commercial area] Recyclable and Other waste shall be discharged by separate containers. Home composting: Home composting of kitchen waste shall be promoted.
Collection	<ul style="list-style-type: none"> Frequency: <ul style="list-style-type: none"> [Residential area] General waste: twice a week, Recyclable waste: once a week [Commercial area] General waste: daily, Recyclable waste: X a week Method: <ul style="list-style-type: none"> [Residential/Commercial area] Curbside collection Time: Daytime Vehicle: <ul style="list-style-type: none"> [Residential area] Compactor for General and Recyclable waste [Commercial area] Container truck to be dispatched for large Recyclables generators Transportation: Direct transport to the disposal site
Public area cleansing	<ul style="list-style-type: none"> Park <ul style="list-style-type: none"> Green waste to be pruned by LCC. Chipping of pruned waste by shredder will increase in transport efficiency. Grass cutting in the park to be conducted by private contractors. Drain cleaning and Grass cutting <ul style="list-style-type: none"> Drain cleaning to be conducted by private contractors. Grass cutting around compounds by residents to be promoted. Road sweeping <ul style="list-style-type: none"> Road sweeping to be done by LCC
Recycling	<p>The following recycling system with administrative involvement shall be established;</p> <ul style="list-style-type: none"> Recyclable waste to be separately stored at generation and to be collected for recycling. Recyclable collection done by recyclers to be supported. Assistance scheme to promote home composting such as subsidy programme to be implemented. Market waste composting is implemented under direct operation by LCC. Garden waste to be put to good use.
Intermediate treatment	<ul style="list-style-type: none"> Material Recovery Facility (MRF) to be constructed at Vunato disposal site for composting, and sorting and storage of recyclables.
Final disposal	<ul style="list-style-type: none"> Vunato disposal site to be improved as Strictly Controlled Landfill. Appropriate dumping fee to be applied using weighbridge.
Maintenance of equipments	<ul style="list-style-type: none"> Garage facility to be constructed for daily maintenance. Extensive repair to be contracted out to the private companies.

4 Solid Waste Management Master Plan (SWM M/P)

4.1 Basic Policy of the SWM M/P

Vision of the SWM M/P for Lautoka City is;

“To establish an Environmentally Sound SWM System in LCC by 2017”

The establishment of such a system will:

- Maintain the urban environment and public health of the Lautoka City, which is the center of economic and industrial activities of the western region in Fiji, and contribute to the sustainable development.
- Motivate investment whereby the economic development of the western region of Fiji can be promoted.

In the environmentally sound SWM system, the 3Rs (Reduce, Reuse and Recycle) of waste are promoted and the following situation should be established;

- Waste reduction is encouraged at the generation source such as households and business establishment.
- Waste generated after the attempt of waste reduction is reused or recycled as much as possible.
- Only after the effort of waste reduction, reuse or recycling, waste is properly collected, treated, and finally disposed of in a proper manner without negative environmental impacts.
- Such a SWM system will be established by requiring the governmental sector, private sector and general public to bear adequate responsibilities under a transparent and fair rule.

4.2 Target Year

The above vision will be achieved step by step. The target of the Master Plan of Solid Waste Management for Lautoka City is shown by each phase as below.

Phase 1: 2009 - 2012 Establishment of 3Rs systems

Phase 2: 2012 – 2017 Expansion phase of 3Rs to achieve the M/P)

4.3 Numerical Target of the SWM M/P

The numerical targets are shown in the Table 9 and the break down of each target is shown in the Table 10.

Table 9: Numerical Target of the M/P

Items	Present (2008)	TCP (2012)	M/P (2017)
Collection Rate	100.0%	100.0%	100.0%
Self disposal rate to the waste generation	9.0%	6.7%	3.1%
Appropriate self disposal	2.4%	2.7%	3.1%
Inappropriate self disposal	6.6%	4.0%	0.0%
Recycle rate of MSW to the waste generation	8.1%	19.7%	25.1%
Disposal rate to the waste generation	72.3%	67.9%	62.6%
Final Disposal	Controlled Landfill	Strict Controlled Landfill	

Table 10: Breakdown of the Target of the SWM M/P

Components	Phase Present (2008)	Startup (2009)	Phase 1 (2012)	Phase 2 (2017)
1. MSW generation amount				
Population 人口				
Veitari ward:	14,550	14,664	15,049	15,730
Simula ward:	9,102	9,173	9,415	9,841
Waiyavi ward:	8,108	8,171	8,386	8,766
Tavakunbu:	12,053	12,147	12,467	13,030
Total	43,814	44,155	45,317	47,367
MSW generation amount	48.1ton/day	48.7ton/day	50.7ton/day	54.4ton/day
Waste characterization (%)	100.0%	100.0%	100.0%	100.0%
• Kitchen waste	30.1%	30.3%	31.5%	36.1%
• Recyclables waste	26.3%	26.4%	27.6%	31.0%
• Green waste	37.4%	37.3%	25.8%	20.0%
• Others	6.2%	6.0%	5.1%	2.9%
2. Waste collection and transportation				
Waste collection rate to population (%)	100.0%	100.0%	100.0%	100.0%
Self disposal (%)	18.7%	18.7%	13.3%	5.7%
• Appropriate self disposal	5.0%	5.0%	5.4%	5.7%
• Inappropriate self disposal such as open burning	13.7%	13.7%	8.0%	0%
Frequency of general waste				
• Residential area	2 times/week	2 times/week	2 times/week	2 times/week
• Commercial area	Daily	Daily	Daily	Daily
Service provider	Private contractors	Private contractors	Private contractors	Private contractors
Supervision	Health Department of LCC	Health Department of LCC	Health Department of LCC	Health Department of LCC
Unit cost for collection and transportation	26.0F\$/ton	29.3F\$/ton	29.2F\$/ton	32.2F\$/ton
3. Recyclable separate collection				
Recyclable collection				
• Collection amount	0.4 ton/day	0.4 ton/day	1.6 ton/day	2.5 ton/day
• Collection rate	0.8%	0.8%	3.2%	4.6%
Frequency of recyclable collection	Once/week	Once/week	Once/week	Once/week
Transportation system	Direct transportation	Direct transportation	Direct transportation	Direct transportation
Service provider		Direct operation under Health Department of LCC	Private contractors	Private contractors

Components	Phase	Present (2008)	Startup (2009)	Phase 1 (2012)	Phase 2 (2017)
4. Public cleansing					
Park cleansing					
• Cleansing area		71.2ha	71.2ha	71.2ha	71.2ha
• Service provider		LCC: pruning and chipping Private contractors: grass cutting	LCC: pruning and chipping Private contractors: grass cutting	LCC: pruning and chipping Private contractors: grass cutting	LCC: pruning and chipping Private contractors: grass cutting
Unit cost for park cleansing		19.6F\$/ton	20.2 F\$/ton	22.5 F\$/ton	27.4 F\$/ton
Drain cleansing/ Grass cutting					
• Length of drain cleansing		556 km	556 km	556 km	556 km
• Area size including Park		66.6 km	66.6 km	66.6 km	66.6 km
• Service provider		Private contractors(15)	Private contractors(15)	Private contractors	Private contractors
Unit cost for drain cleansing and grass cutting		1,457.5 F\$/ton	1,499.8 F\$/ton	1,456.0 F\$/ton	1,346.4 F\$/ton
Road sweeping					
• Length of road sweeping		47.6 km	47.6 km	47.6km	47.6 km
• Service provider		Private contractors(2)	Private contractors(2)	Private contractors(2)	Private contractors(2)
Unit cost for road sweeping		114.2 F\$/ton	117.5 F\$/ton	127.6 F\$/ton	147.7 F\$/ton
5. 3R Promotion					
Home composting					
• Total number of composters to be set		-	50	500	3,000
• Coverage of composters against household numbers		-	0.6%	5.4%	30%
• Recycling rate through home composting		0.6%	0.6%	0.9%	1.9%
Market waste composting					
• Amount of market waste to be put into composting process		0.0	0.5ton/day	0.6ton/day	1.3ton/day
• Recycling rate through market waste composting		0%	1.0%	1.1%	2.4%
Recyclables separate collection					
• Amount of recyclables to be collected		0.4 t/day	0.4 t/day	1.6 t/day	2.5 t/day
• Recycling rate through recyclables separate collection		0.8%	0.8%	3.2%	4.6%
Green waste recycle					
• Recycling amount (On-site)		2.1 t/day	2.1 t/day	2.1 t/day	2.1 t/day
• Recycling rate (On-site)		4.4%	4.4%	4.1%	3.9%
• Recycling amount (Off-site)		0 t/day	2.4 t/day	4.5 t/day	6.6 t/day
• Recycling rate (Off-site)		0%	4.9%	8.8%	12.2%
Recyclable picking at VDS		1.1 t/day	1.1 t/day	0.7 t/day	0.0 t/day
Recycling rate		2.3%	2.3%	1.4%	0.0%
Total recycling rate		3.9 t/day	6.8 t/day	10.0 t/day	13.5 t/day
Total recycling rate to generation amount		8.1%	14.0%	19.7%	25.1%
6. Final disposal					
Landfill site		Vunato	Vunato	Vunato	Vunato
Landfill method		Controlled landfill	Controlled landfill	Strict controlled LF	Strict controlled LF
Distance from the city center		2 km	2 km	2 km	2 km
Implementation body		LCC Engineering Department	LCC Engineering Department / Health Department	LCC Health Department	LCC Health Department
Final disposal amount of LCC		34.8 t/day 72.3%	34.9 t/day 71.6%	34.4 t/day 67.9%	34.1 t/day 62.6%
Final disposal amount incl. others		58.9 t/day	71.1 t/day	72.3 t/day	76.0 t/day
Number of workers		7	7	7	7
Unit cost for final disposal		11.9 F\$/ton	- F\$/ton	15.5F\$/ton	15.5F\$/ton
7. Maintenance system of the equipments and facilities					

Components	Phase	Present (2008)	Startup (2009)	Phase 1 (2012)	Phase 2 (2017)
Existing equipments					
(1) Landfill equipment	- Bulldozer:	1	- Bulldozer D6: 1 - Excavator: 1	- Bulldozer D6: 1 - Excavator: 1	- Bulldozer D6: 1 - Excavator: 1
(2) Equipments for collection	-		- MPT: 1	- MPT: 1	- MPT: 1
(3) Equipments for intermediate treatment	-		- Shredder: 1	- Shredder: 1	- Shredder: 1
(4) Facilities for landfill management	-		- Weighbridge: 1	- Weighbridge: 1	- Weighbridge: 1
Preventive maintenance	by Operator		by Operator	by Operator	by Operator
Extensive repair	by Commission		by Commission	by Commission	by Commission
Implementation body	Engineering Dept.		Health Dept.	Health Dept.	Health Dept.
8. Financial management					
City budget (1,000F\$)		932.5 (80.1%)	1,023.1	1,111.5	1,284.5
Income (F\$1,000)		231.1 (19.9%)			
• GW collection service		22.0	22.0	22.0	22.0
• Market waste collection		66.1	66.1	74.0	86.0
• Tipping fee		143.0	156.0	287.3	314.5
• Sales of GW chips		-	-	40.6	60.3
• Sales of composter		-	-	4.9	11.7
Total revenue (F\$1,000)		1,163.6	1,267.2	1,540.3	1,779.0
Investment (F\$1,000)				74.3 (5.1%)	133.3 (8.1)
• Recyclable collection				65.3	113.0
• Procurement of composter				9.0	20.3
Waste Collection cost: F\$1,000		292.5 (27.6%)	300.0 (25.2%)	341.0 (23.2%)	411.0(24.9%)
• MSW collection (F\$1,000)		174.4	179.0	196.0	226.0
• Market waste collection		66.1	68.0	74.0	86.0
• Vegetable waste separate collection from Market		0.0	4.0	4.0	9.0
• GW collection		52.0	49.0	67.0	90.0
Public cleansing cost and its proportion to total expenditure: F\$1,000 (%)		563.3(53.2%)	78.0 (48.6%)	586.0(39.9%)	593.0(35.9%)
• Park cleansing 公園清掃		20.0	21.0	23.0	28.0
• Drain cleansing and grass cutting		372.4	381.0	372.0	344.0
• Road sweeping		170.9	176.0	191.0	221.0
Final Disposal: F\$1,000		255.9 (24.2%)	258.8 (21.7%)	402.0(27.4%)	437.0(26.5%)
Administration: F\$1,000 (%)		52.0(4.9%)	53.5 (4.5%)	65.0(4.4%)	76.0(4.6%)
Total expenditure for SWM: F\$1,000 (%)		1,059.2(100%)	1,190.0(100%)	1,468.3(100%)	1,650.3(100%)
SWM cost per person		24.2FJ\$/person	27.0FJ\$/person	32.4FJ\$/person	34.8FJ\$/person
9. Medical waste					
Generation amount (ton/day)					
• General medical waste:		0.16(ton/day	0.16(ton/day	0.16(ton/day	0.16(ton/day
• Infectious medical waste such as ash:		0.04(ton/day	0.04(ton/day	0.04(ton/day	0.04(ton/day
Treatment of infectious medical waste at source	Incinerated at Lautoka Hospital		Incinerated at Lautoka Hospital	Incinerated at Lautoka Hospital	Incinerated at Lautoka Hospital
Final disposal					
• General medical waste:	- Landfilled at VDS		- Landfilled at VDS	- Landfilled at VDS	- Landfilled at VDS
• Infectious medical waste such as ash:	- Disposed at special area in VDS		- Disposed at special area in VDS	- Disposed at special area in VDS	- Disposed at special area in VDS
10. Industrial waste					
Generation amoun (ton/day)					
• General industrial waste:		8.0 ton/day	8.2 ton/day	8.7 ton/day	9.6 ton/day
• Hazardous waste:		NA	NA	NA	NA
Treatment of industrial waste					
• General industrial waste:	by private collector		by private collector	by private collector	by private collector
• Hazardous waste:	Unknown		Unknown	Unknown	Unknown
Final disposal					
• General waste:	Landfilled at VDS		Landfilled at VDS	Landfilled at VDS	Landfilled at VDS
• Hazardous waste:	Unknown		Unknown	Unknown	Unknown

Note: Rate means the portion to generation amount unless particular mention

*1: Inputs from JICA technical project (Procurement of 50 composters)

4.4 Strategy

To achieve the goal of the Master Plan, the following strategy is developed from technical and institutional aspects.

Table 11: Strategy to achieve the M/P

Item	Activity
First Phase (2009 - 2012)	
Technical aspect	<ul style="list-style-type: none"> • 3Rs to be recognized by the entire city. • Organic waste recycling to be promoted to the whole city area. • Recyclables separate collection to be carried out in the Veitali Ward.
T1. Source Separation	<p>Home composting:</p> <ul style="list-style-type: none"> • To promote organic waste composting to reduce waste amount generated from household and commercial area.
T2. Collection/Transportation	<ul style="list-style-type: none"> • To collect general waste by private contractors twice a week. • To establish GW collection system • To establish recyclables separation collection <ul style="list-style-type: none"> • To carry out collection and sorting work separately since sorting work on the collection truck is inefficient. • To contract out recyclables collection work to private contractors (recycling companies or general private contractors).
T3. Public area cleansing	<ul style="list-style-type: none"> • To continue the manual public area cleansing • To discourage the Public from littering through awareness campaign and the enforcement of related regulations.
T4. Intermediate treatment/Recycling	<p>Recycling:</p> <ul style="list-style-type: none"> • To transport collected recyclables to the Material Recovery Facility (MRF), and sort out by workers such as waste pickers. • To clarify each role and responsibility between the Council and private companies for MRF operation and maintenance. • To promote 3Rs system (waste reduction at generation source, composting and waste separation for recycling). • To establish an assistance framework to encourage private sectors to implement their recycling activities.
	<p>Promotion of market waste composting:</p> <ul style="list-style-type: none"> • To construct MRF at Vunato Dump site. • To conduct awareness activity for market waste separation targeting market vendors and the public.
	<p>Promotion of Green Waste recycling GW:</p> <ul style="list-style-type: none"> • To chip green waste from parks, street pruning, residents etc using shredder. Chips are used for mulching on public gardens, composting and also sold to the private company as fuel for boiler.
T5. Final disposal	<p>Final disposal:</p> <ul style="list-style-type: none"> • To improve landfill operation from Section 1 until Section 5 gradually after the completion of the partial landfill improvement Pilot Project at Section 6. • To establish appropriate landfill operation and maintenance system at Vunato disposal site.

Item	Activity
	<ul style="list-style-type: none"> To impose fair tipping fees on dumping users based on weight(tonnage) to be gained from weighbridge and the necessary cost for appropriate landfill management. Council to make calculation process for the public to obtain user's understanding.
T6. Medical waste/Industrial waste	<p>Medical waste management:</p> <ul style="list-style-type: none"> To enforce separation and treatment at generation source, and separate discharge and collection. To strictly control medical waste at landfill site. Inappropriate disposal shall be prohibited. General waste generated from medical center is collected and disposed by the same, as current procedures. <p>Hazardous industrial waste management:</p> <ul style="list-style-type: none"> To conduct survey on the present situation on how hazardous industrial waste is generated, treated and disposed. To develop an inventory of hazardous industrial waste and legislative measures for management. To develop the proper management plan targeting medical waste and hazardous industrial waste. Some hazardous industrial waste could be treated at cement factory. To secure necessary budget, and to construct required treatment and disposal facility for hazardous industrial waste. By then, these wastes shall be strictly controlled by enforcing separation and treatment at generation source.
Institutional aspect	<p>To establish necessary institutional system to promote 3R to whole city area.</p> <ul style="list-style-type: none"> To establish 3R-centric waste management system to make it possible to implement proposed 3R technical system. Council also needs to clarify a role and responsibility of each stakeholder (Lautoka City Council, residents, private contractors, recycling companies, etc). To strengthen the capacity of Health Department of Lautoka City Council to enable them to implement 3R activities to the whole city area. <p>Promotion of home composting:</p> <ul style="list-style-type: none"> To establish a subsidy system to assist the public in purchasing composters. To train particular people to be composting instructors. To promote private companies' involvement in proposed 3Rs activities considering their capacity, and an appropriate contract system to be developed. To establish systematic monitoring and information management system for proper waste management. <ol style="list-style-type: none"> To calculate unit cost of implementation for cost analysis (cost to profits, cost to efficient and cost to effect). To develop a database related to all SWM activities. It will make it possible for the Council and private sectors to monitor the quality and cost of cleansing service continuously. To strengthen the capacity of Health Department staffs through JICA Project. To amend related laws, regulation and rules if necessary. To reduce current expenditure on cleansing service remaining high-quality service by obtaining public cooperation to secure the budget for 3R Promotion activities.
Second Phase (2012 - 2017)	
Technical	3Rs is implemented in the whole area of Lautoka City.

Item	Activity
aspect	<ul style="list-style-type: none"> • To eliminate inappropriate disposal (illegal dumping and improper self-disposal) by 2017. • To reduce waste generation amount at source, and increase waste separation rate for composting and recycling. • To recycle 9.0% of waste generation amount through home composting promotion and the expansion of recyclables separate collection. • To supervise sorting work of collected recyclables under supervision of LCC • To control inappropriate hazardous and medical waste, and establish proper treatment and disposal system with Department of Environment.
Institutional aspect	<p>Appropriate institutional system is established to implement 3R activities at whole area of Lautoka City.</p> <ul style="list-style-type: none"> • To strengthen the capacity of organizations responsible for waste management for not only municipal waste but hazardous and industrial waste. • To develop and maintain a database on waste management. Based on the database, the efficiency of each service will be examined for further improvement. • To raise citizen's awareness through environmental education and awareness campaign.

4.5 Future waste flow

Future waste flows of Lautoka City in 2012 and 2017 are shown as below.

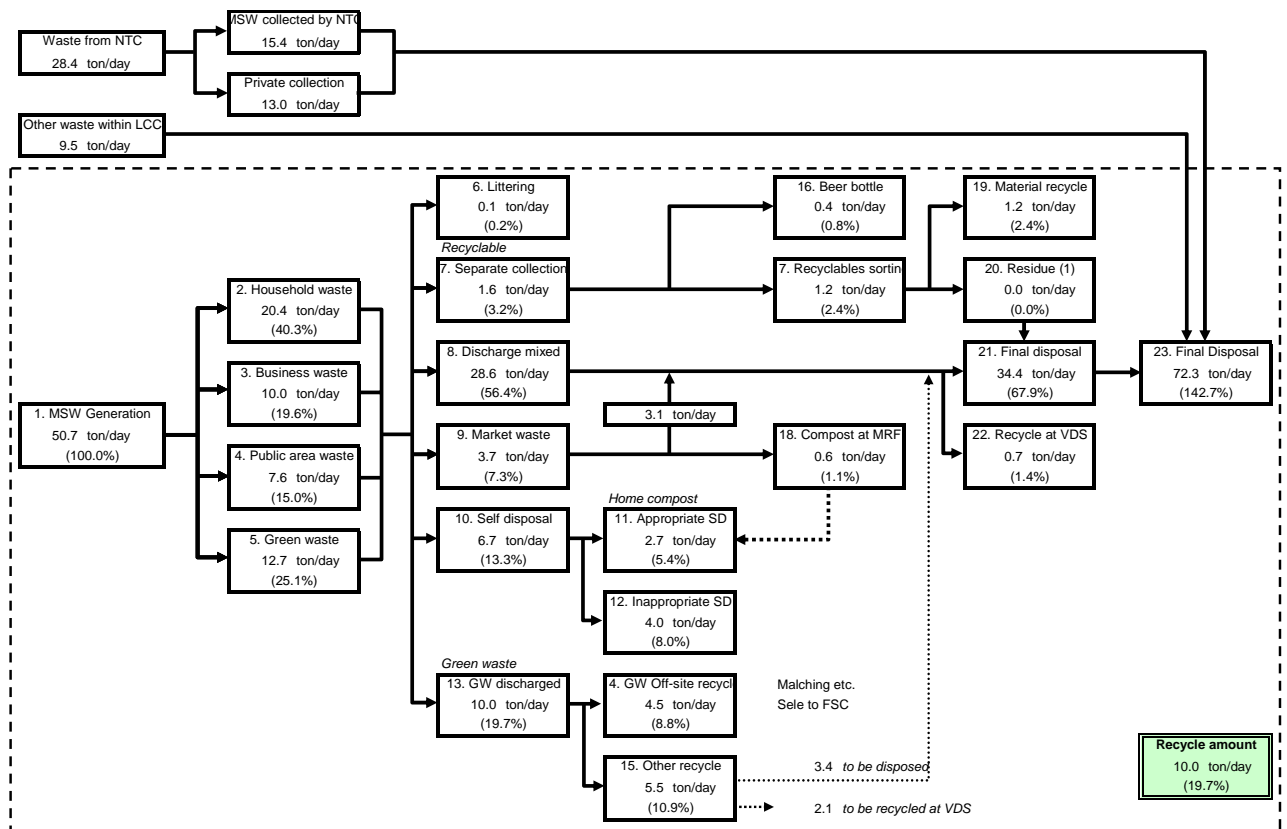


Figure 3: Future waste flow in 2012

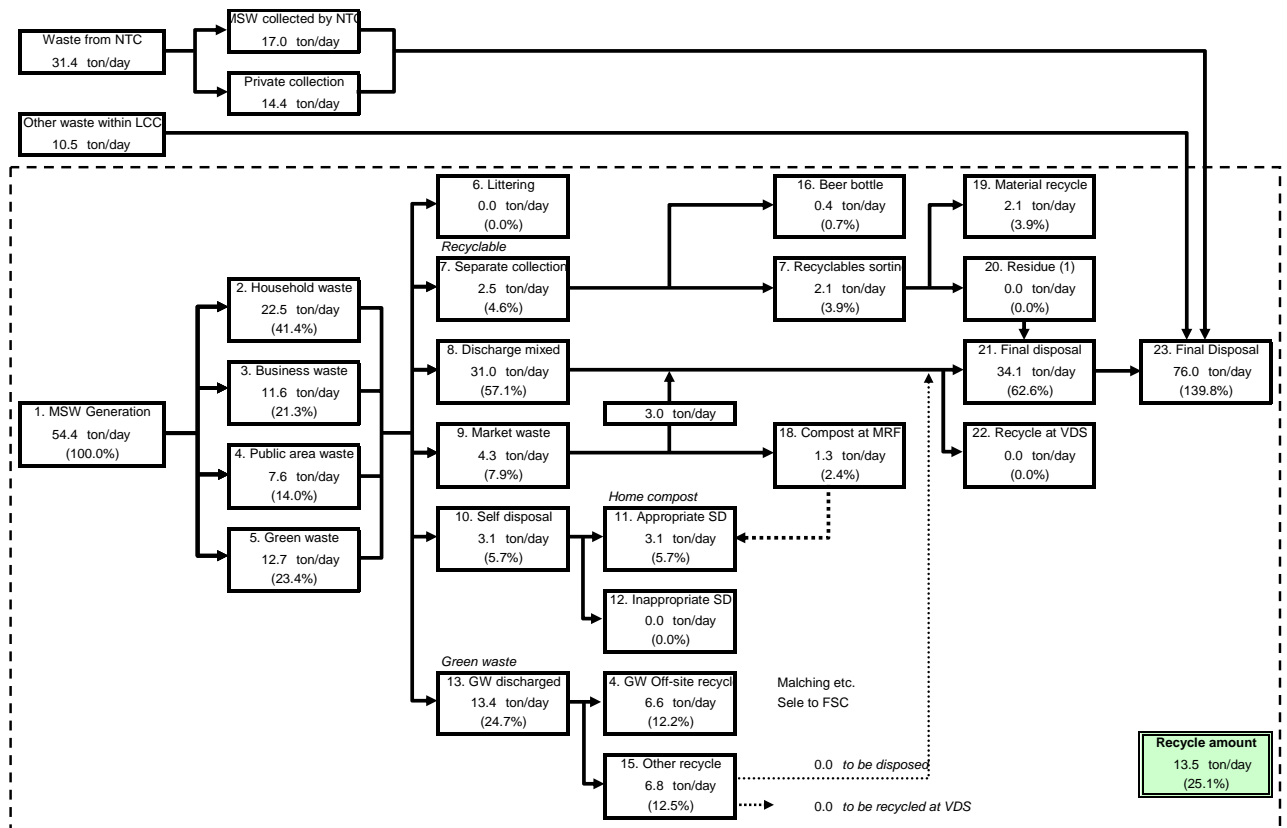


Figure 4: Future waste flow in 2017

5 Implementation plan of the SWM M/P

The following activities will be mainly implemented according to the Master Plan of Solid Waste Management for Lautoka City.

5.1 Waste Storage and Discharge

To achieve the target of the M/P, the council will promote source separation of the waste according to the expansion of the 3R activities. Therefore, the council will educate the citizens to separate and store the waste appropriately at the generation source through campaign and/or media such as radio and newspapers, etc.

5.2 Waste Collection and Public Area Cleansing

The Council has currently implemented the following SWM services; General waste collection, Market waste collection, Green waste collection, Bulky waste collection, Park cleansing, Drain cleansing and grass cutting, Road sweeping and Recyclables collection.

The Council has contracted out these services to the private contractors, however, the increase of contract fees is getting bearded severely on the Council budget in proportion to the increase in waste generation amount. Therefore, the 3R-centric M/P was developed to reduce waste generation amount, negative environmental impacts and financial burden.

To achieve the goal of M/P, the current implementation system of cleansing service shall be modified as follows;

Table 12: Modification of Waste Collection & Public Area Cleansing service

Cleansing service		Current service provider	Proposed service provider
1. General waste collection		Private contractor	Private contractor under HD
2. Market waste collection	Residue	Private contractor	Private contractor under HD
	Vegetable waste		Health Department of LCC
3. Green waste collection		Private contractor	Health Department of LCC /Private contractor
4. Bulky waste collection		Private contractor	Private contractor under HD
5. Park cleansing		Health Department of LCC /Private contractor (grass cutting only)	LCC ED/ Private contractor (grass cutting only)
6. Drain cleansing and grass cutting		Private contractor	LCC DE with Public cooperation
7. Road sweeping		Private contractor	Private contractor
8 . Recyclables collection		Health Department of LCC (Pilot area only)	Private contractor (after 2011)

HD: Health Department of LCC, ED: Engineering Department of LCC

a. Collection of Market Waste

Waste separation at source shall be implemented by placing wheelie bins for vegetable waste only in the market at strategic and easily accessible locations in the market. Collected market waste is collected daily by the Council using MPT and is transported to the Compost yard at Vunato Dump site.

The rest of waste is separated into recyclables waste and other waste, and residue is transported to disposal site by the private contractor.

b. Collection of Green Waste

To improve efficiency of Green waste collection, the Council shall set up collection schedule by area, and implement intensive collection on schedule. It will contribute to encourage residents to access service at lower cost, and reduce inappropriate self-disposal practices.

GW collection service will be implemented by private contractors by 2010. If large amount of GW generated, the Council shall dispatch shredder with MPT and carry out chipping work at the site, and transport chips to the Vunato composting yard. The Council shall establish the efficient collection system from 2011 downward based on the actual cost of GW collection service undertaken in FY 2010.

c. Park Cleansing

To reduce the SWM expenditure, park cleansing service has been shifted from contract to direct operation implemented Department of Engineering since 2010. Collected garden waste is shredded to make chips for recycling.

d. Drain cleansing and grass cutting

The total cost of the drain cleansing and grass cutting accounts for 35.2% (actual cost in FY2008) of total cleansing service, it has become huge financial burden for the Council. The current drain cleansing and grass cutting is being conducted twice a month, however, it is recommended to reduce the frequency to once a month by 2012. The frequency of grass cutting is determined according to weather permitting. The Council will implement additional grass cutting when received the residents complaints are received. Instead, the Council shall support the community beautification.

These modifications will contribute to reduce the cost of drain cleansing and grass cutting by up to 30% by the end of 2011, which enables the Council to allocate the saved budget to 3R activities.

e. Recyclables separate collection

Recyclables separate collection will be implemented by the Council using MPT by the end of 2010. From 2011 downward, the collection work will be contracted out to the private contractors since the larger volume of waste will be collected due to expansion. For better control of contractor's work, the Council will establish appropriate contract control system by the end of 2010.

5.3 3R Promotion

a. Recyclables separate collection

It takes a lot of time for residents to become accustomed to waste separation, so that Council needs to conduct continuous awareness activities steadily. For this reason, the recyclables separate collection shall be expanded gradually as follows;

Table 13: Expansion Plan of Recyclable Separate Collection

Stage	Period	Target area	Population
Stage 1	2009 – 2010	3R PP Area (Mutlah, Fultala, Berar in Field Forty)	513 (1.2%)
Stage 2	2010 –2011	Whole Field Forty Area, Namori Village Part of Commercial area	5,000 (11.5%)
Stage 3	2011 –2012	Whole of Veitari ward	15,000 (32.0%)
Stage 4	2012 –2017	Whole of Council area	47,000 (100%)

Collection works during Stage 1 and Stage 2 shall be implemented by the Council since various approaches will be tried out to establish appropriate recyclables collection system. After Stage 3 targeting wider area, collection work will be contracted out to the private contractors, while the Council will concentrate its efforts on awareness activities.

b. Organic waste composting

Organic waste accounts for 67.5% of total waste generated in Lautoka City. The breakdown is Kitchen waste (30.1%) and Green waste (37.4%). Organic waste causes odors and generates leachate and methane gas at Landfill. Organic waste composting is very vital in minimizing wastes and negative environmental impacts caused by landfill. The Council will implement the following three activities to promote organic waste composting.

b.1 Promotion of home composting

The effectiveness of home composting has been already verified from the experiences of the Pilot Project conducted in FY2009. Therefore, the Council is aiming to make residents to implement home composting by 30% of total household in the City by 2017. Home composters is procured and distributed as below.

Table 14: Promotion plan for home composting

	Unit	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Household	No.	50	100	150	200	500	500	500	500	500	3,000
Business	No.		50	30	20	20	20	20	20	20	200
Total installation		50	150	180	220	520	520	520	520	520	3,200

In addition, the Council will establish a subsidy programme to encourage residents to purchase composters. The Council will subsidize \$25.0 while composter is priced \$45.0 each. For the commercial area, the programme is not applied.

The Council shall promote the effectiveness of home composting through the publicity. Composter will be distributed on a first come, first-serve basis. Leaflet that gives necessary information for composting is also attached to composter. Besides, people belong to particular groups such as NGO, shall be trained as composting instructors.

b.2 Market waste composting

Vegetable waste accounts for 91.3% of total waste generated in the municipal market, so that it is possible to make a high-quality compost from market waste. The Council will collect vegetable waste separately at the market, transport it to the Compost yard at VDS and put it into composting process. It is also expected to produce “BOKASHI”, which is a high quality fermented compost accelerator and rich in beneficial microorganisms, by mixing with necessary materials such as Mill mud. BOKASHI will be also promoted as effective materials for composting.

Table 15: Plan for market waste separation collection

	Unit	2009	2012	2017
Market waste separate collection	ton/day	0.5	0.6	1.3

b.3 Green Waste

To increase efficiency of Green waste collection, the Council will improve current GW collection system by implementing by area on a request basis. If large amount of GW generated, the Council will dispatch shredder to the site, carry out chipping and transport chips to the Vunato composting yard. If little amount of GW generated, the Council just collect them from the site and make chipping at Vunato yard intensively.

The Council shall sell chips to the private company such as the Fiji Sugar Corporation as fuel for boiler. In addition, chips will be used for mulching on public gardens such as municipal Botanical garden. The rest of chipped GW could be used as soil covering materials at dump site.

Table 16: Plan for green waste composting Green Waste

	Unit	2009	2010	2011	2012	2013	2014	2015	2016	2017
Green waste generation	ton/day	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
Self disposal	ton/day	7.6	6.9	6.2	5.5	4.9	4.2	3.5	2.8	2.1
On-site Recycling (Proper)	ton/day	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Improper self disposal	ton/day	5.5	4.8	4.1	3.4	2.8	2.1	1.4	0.7	0.0
Green waste discharged	ton/day	5.1	5.8	6.5	7.2	7.9	8.5	9.2	9.9	10.6
Off-site recycling	ton/day	0.1	0.6	1.3	1.7	2.0	2.4	2.8	3.2	3.8
Other recycling	ton/day	5.0	5.1	5.2	5.5	5.8	6.1	6.4	6.7	6.8

5.4 Landfill Operation of Vunato Dump site

a. Improvement of Vunato Disposal site

Under the Pilot Project for partial improvement of Vunato Dump site undertaken in FY2009, the improvement of Vunato Disposal Site has been in progress with the construction of market green waste compost yard in Recycling area and the movable concrete slabs for approach into disposal area. The section 6 was leveled and enclosed with buffer zones, dividers and periphery banks. Environmental monitoring was conducted in August 2009 and February 2010. In addition, computerized weighbridge was constructed, and new dumping fees based on tonnage (weight) has been implemented since January 2010.

The Council will implement the following constructions;

- landfill improvement from Section 1 until Section 5 (including construction of periphery banks and drainage)
- Improvement of Special waste section (medical waste ash and condemned food to be disposed).
- Rehabilitation of access road
- Periphery bank and drain to identify the boundary



Figure 5: Improvement Plan of Vunato Disposal Site

5.5 Implementation Schedule

The above activities will be implemented on the following schedule;

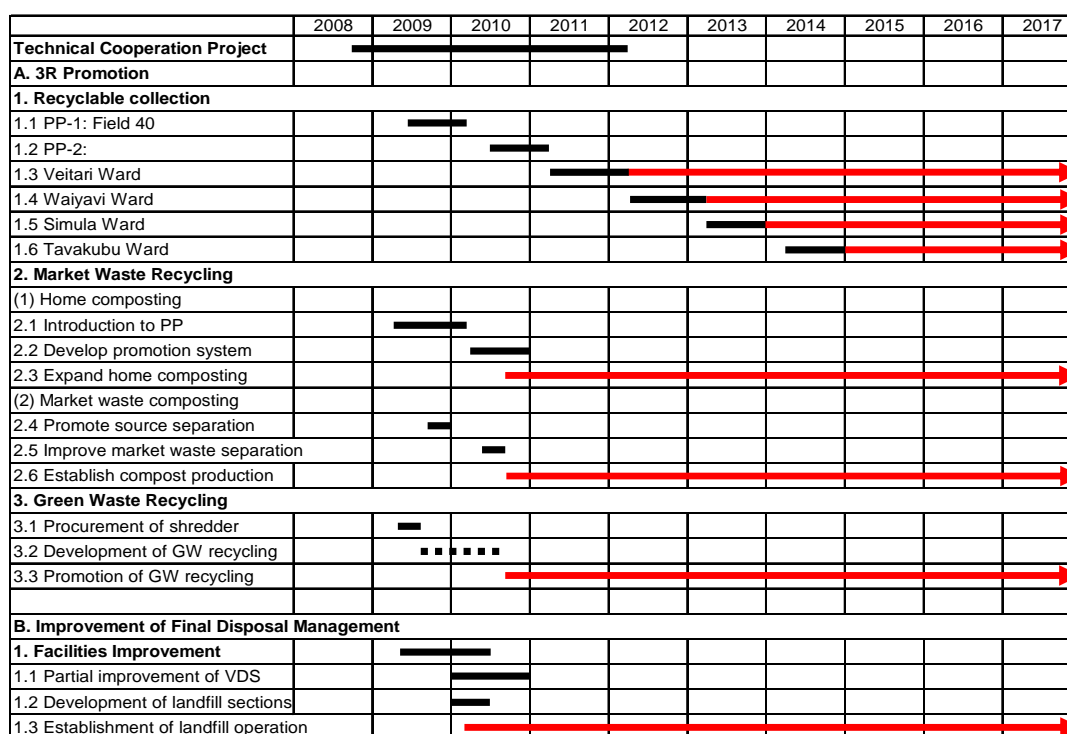


Figure 6: Schedule for implementation

5.6 Financial Analysis for Implementation of the M/P

5.6.1 Implementation Cost

The following table shows the annual implementation cost for the M/P.

Table 17: Implementation cost for M/P

Unit: \$1,000

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Investment	20.0	333.5	220.1	74.3	89.8	91.8	129.5	132.5	133.3
Recyclable collection	0.0	37.0	63.3	65.3	67.3	69.3	107.0	110.0	113.0
Procurement of composter	0.0	4.5	6.8	9.0	22.5	22.5	22.5	22.5	20.3
Construction of MRF	0.0	142.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement of VDS	20.0	150.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement of Bulldozer	0.0	0.0	150.0	0.0	0.0	0.0	0.0	0.0	0.0
O & M	1,190.3	1,358.0	1,374.0	1,394.0	1,421.0	1,446.0	1,473.0	1,493.0	1,517.0
Waste collection	300.0	315.0	328.0	341.0	355.0	370.0	384.0	397.0	411.0
Public area cleansing	578.0	582.0	585.0	586.0	590.0	591.0	593.0	593.0	593.0
Final disposal	258.8	399.0	397.0	402.0	409.0	416.0	425.0	430.0	437.0
Administration	53.5	62.0	64.0	65.0	67.0	69.0	71.0	73.0	76.0
Total Expenditure	1,210.3	1,691.5	1,594.1	1,468.3	1,510.8	1,537.8	1,602.5	1,625.5	1,650.3

5.6.2 Revenue

Revenue received from SWM is expected as follows;

- General budget
- Other income (GW collection, Market waste collection, Tipping fee, Sales of chips, Sales of composter)

a. General budget

It is assumed that 20% cap on the budget for SWM is allocated from general budget every year.

Table 18: SWM budget allocated from general budget

Unit: \$1,000

Items	2009	2010	2011	2012	2013	2014	2015	2016	2017
Council budget	6,018.0	6,187.0	6,360.0	6,538.0	6,730.0	6,928.0	7,131.0	7,340.0	7,556.0
SWM budget incl. Other waste	1,203.6	1,237.4	1,272.0	1,307.6	1,346.0	1,385.6	1,426.2	1,468.0	1,511.2

b. Other income

Other income from the implementation of M/P is estimated as follows.

Table 19: Estimated other income

Unit: F\$1,000

Items	2009	2010	2011	2012	2013	2014	2015	2016	2017
GW collection service	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Market waste collection service	66.1	70.0	72.0	74.0	76.0	80.0	82.0	84.0	86.0
Tipping fee	156.0	285.6	286.5	287.3	291.8	298.0	305.0	309.7	314.5
Sales of GW chips	0.0	28.8	37.1	40.6	44.1	47.5	51.0	54.6	60.3
Sales of composter	0.0	4.3	4.4	4.9	10.9	10.9	10.9	10.9	11.7
Total Income	244.1	410.7	422.0	428.8	444.8	458.4	470.9	481.2	494.5

(1) Revenue of Green waste collection

The Council has charged \$22.00 per trip for GW collection service. It is assumed that the actual annual revenue will maintain \$22,000 until 2017.

(2) Market waste collection service

A collection fee for market waste service has been charged from market vendors. The future collection fee is assumed considering population growth rate and economic growth (GDP).

(3) Tipping fee

The weighbridge makes it possible to calculate dumping fee based on weight (tonnage), so

that the dumping fee system has been amended and introduced since January 2010. The appropriate fee should also be calculated considering necessary cost for landfill operation however, the actual cost has not been obtained yet as of January 2010. Hence, it is temporarily assumed that the unit cost for dumping is \$17.0/ton which is calculated by dividing estimate cost for landfill operation (\$444,000) by estimate dumping amount in 2010 (77.66ton/day). The income from tipping fee is estimated based on the unit cost, and is applied to waste excluding one collected by the Lautoka City Council.

(4) Sales of GW chip

Sales price of GW chip is estimated based on the actual sales of Lautoka City (\$50/ton). It is assumed that sales amount of GW chip is gradually increased as 50% in 2010, 70% in 2011 and 80% in 2012 downward. It is presumed that the 80% of generated GW would be sellable and the rest would be disposed as residue.

(5) Sales of Composter

To promote home composting, the Council will subsidize \$25.0 while composter is priced \$45.0 each. The balance which is \$20.0, is paid by resident to the Council. Hence, sale of composter are also included in income.

5.6.3 Financial analysis

The Financial Internal Rate of Return (FIRR) from 2010 to 2017 is examined under the following three cases;

Case 1: In case of the fund is 20% of general account

Case 2: In case of that the SWM fund is covered by the special account which “Other income” is transferred and the 20% of general account.

Case 3: Trial calculation of the portion of general account necessary for the SWM to obtain more than 10% of FIRR under the condition that “Other income” is used for the SWM

a. Cash Flow and FIRR

In case 1, the balance will be in deficit during the implementation period since 10% of budget allocated from the general account is not enough evidently. In case 2, the balance in 2010 will be in deficit, however, it will become surplus in other years. According to the trial calculation in case 3, if the 17% of general account would be allocated to the SWM fund with the special account to which other income would be transferred, FIRR becomes 13.8%.

Table 20: Case 1: Cash Flow of the M/P

Unit: F\$1,000

	Total	2010	2011	2012	2013	2014	2015	2016	2017
General budget	10,954.0	1,237.4	1,272.0	1,307.6	1,346.0	1,385.6	1,426.2	1,468.0	1,511.2
Expenditure	12,680.8	1,691.5	1,594.1	1,468.3	1,510.8	1,537.8	1,602.5	1,625.5	1,650.3
Balance	-1,726.8	-454.1	-322.1	-160.7	-164.8	-152.2	-176.3	-157.5	-139.1

Table 21: Case 2: Cash Flow of the M/P

Unit: F\$1,000

	Total	2010	2011	2012	2013	2014	2015	2016	2017
General budget	10,954.0	1,237.4	1,272.0	1,307.6	1,346.0	1,385.6	1,426.2	1,468.0	1,511.2
Income	14,565.2	1,648.1	1,694.0	1,736.4	1,790.8	1,844.0	1,897.1	1,949.2	2,005.7
Expenditure	12,680.8	1,691.5	1,594.1	1,468.3	1,510.8	1,537.8	1,602.5	1,625.5	1,650.3
Cash flow	1,884.4	-43.5	99.9	268.1	280.0	306.2	294.6	323.7	355.4

Table 22: Case 3: Cash Flow of M/P

Unit: F\$1,000

	Total	2010	2011	2012	2013	2014	2015	2016	2017
General budget	9,311.0	1,051.8	1,081.2	1,111.5	1,144.1	1,177.8	1,212.3	1,247.8	1,284.5
Income	12,922.2	1,462.5	1,503.2	1,540.3	1,588.9	1,636.2	1,683.2	1,729.0	1,779.0
Expenditure	12,680.8	1,691.5	1,594.1	1,468.3	1,510.8	1,537.8	1,602.5	1,625.5	1,650.3
Cash flow	241.4	-229.1	-90.9	72.0	78.1	98.4	80.7	103.5	128.7

FIRR= 13.8%

b. Recommendation for financial plan

As a result of the above examination, it was presumed that M/P would be feasible if other income from SWM is allocated to a special account for the SWM (Case 2 and 3).

For instance, if all other income from SWM is allocated to the special accounts, a portion of the SWM budget to the council will decrease gradually as shown in Table 19. Hence, the Council will be able to allocate these saved budgets to other services like development and education as scheduled.

Table 23: Forecasted portion of SWM budget to Council budget

Unit: F\$1,000

	Total	2010	2011	2012	2013	2014	2015	2016	2017
Council Budget	TF\$	54,770.0	6,187.0	6,360.0	6,538.0	6,730.0	6,928.0	7,131.0	7,340.0
SWM cost	TF\$	12,680.8	1,691.5	1,594.1	1,468.3	1,510.8	1,537.8	1,602.5	1,625.5
Special account (Other income)	TF\$	3,611.2	410.7	422.0	428.8	444.8	458.4	470.9	481.2
Donation from General account	TF\$	9,069.6	1,280.9	1,172.2	1,039.5	1,066.0	1,079.4	1,131.6	1,144.3
Portion of SWM donation		16.6%	20.7%	18.4%	15.9%	15.8%	15.6%	15.9%	15.6%

5.7 Institutional Plan

In order to realize the M/P smoothly, it is necessary to strengthen the capacity development of organizations responsible for carrying out waste management and to improve implementation and financial system on SWM.

5.7.1 Strengthening of the Department of Health Service

As of January 2010, the Department of Health Service has a Director, a Secretary and five Health Inspectors (including two Senior inspectors). One of the Senior inspectors has been assigned as a Co-Project manager for the Waste Minimization and Recycling Promotion Project. These Health Inspectors are basically working by area not for specific fields, and are in response to whenever the occasion arises.

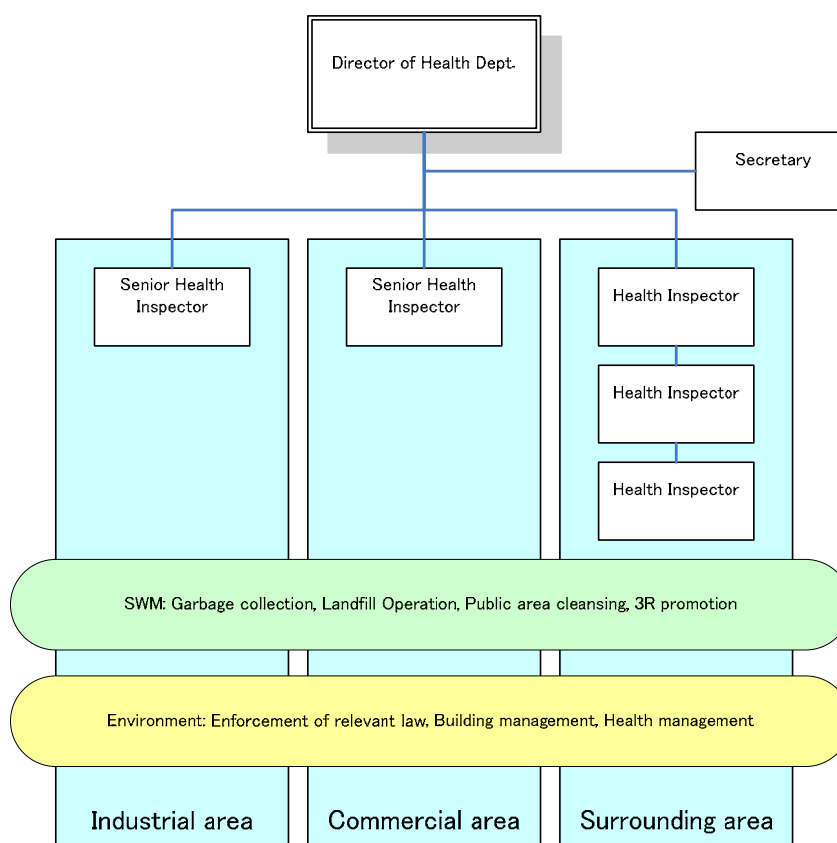


Figure 7: Current institutional structure of Department of Health

Through the implementation of 3R-centric waste management, the volume of their services are obviously increased since various activities like 3R Promotion, recyclables separate collection, landfill management etc will be implemented under the direct control of the Department of Health.

For this reason, it is necessary to supplement their increased services with two more Inspectors in FY2010.

5.7.2 Landfill Operation System

a. Strengthening of the landfill management

The Council shall improve the institutional system for the operation of Vunato disposal site which is capable of implementing strict controlled landfill. Three weighbridge operators shall be assigned to monitor incoming waste, and two operators shall be permanently stationed at disposal site to operate two equipments; bulldozer and excavator.

Four workers will assist as security in the landfill operation work and work around the clock at maintaining facilities and preventing illegal dumping and unauthorized recyclables collection. A handyman shall be in charge of the market waste composting works (picking up other waste, turning over compost, moisture control, etc).

Lastly, some operators for the Multi Purpose Truck (MPT) and shredder are also stationed at Dump site, and shall implement chipping of Green Waste.

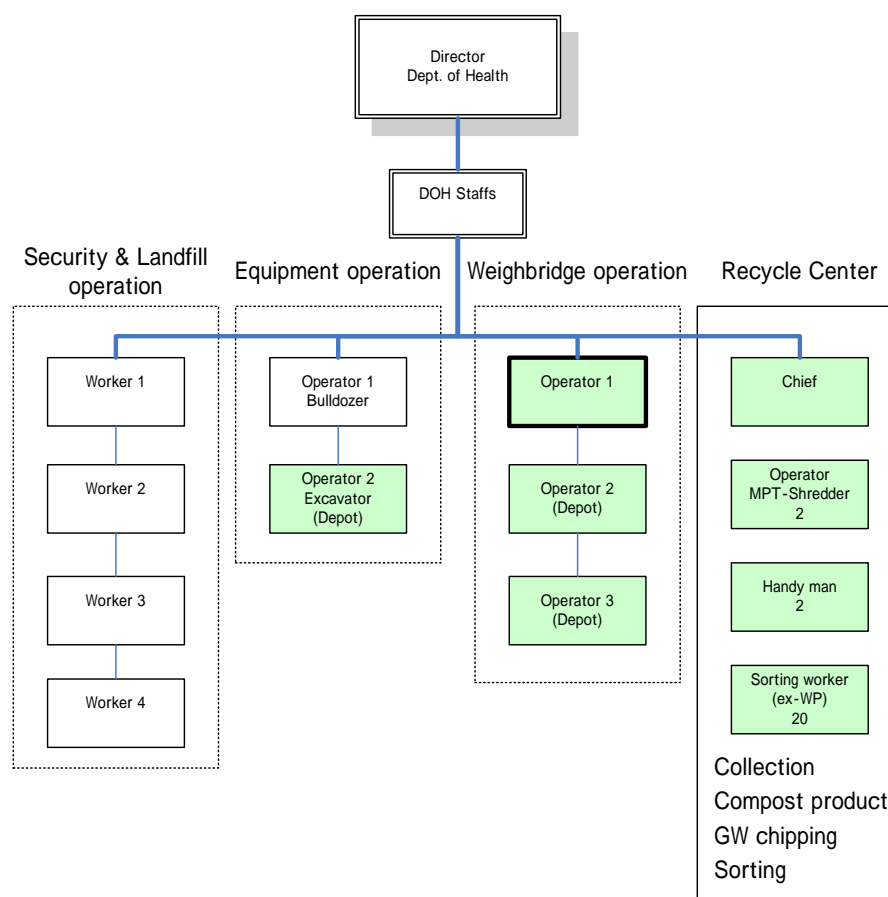


Figure 8: Organization of for the Vunato landfill management

b. Replacement of Landfill Equipment

The Council is carrying out landfill management with existing bulldozer which is very old and frequently breaks down, so that dumped waste is sometimes heaped on the access road since bulldozer is unavailable due to mechanical trouble. The Council has managed to lease extra bulldozer, however, it is becoming a challenge for the Council considering huge cost for lease. Therefore, the existing bulldozer shall be replaced by 2011 for better operation, and management of the landfill.

5.7.3 Establishment of 3R Promotion system

The waste minimization and recycling promotion should take priority over all other matters for the Solid Waste Management in Lautoka City Council. Community involvement is indispensable for the implementation of 3R activities, so that Council shall conduct continuous awareness activities with various approaches. The staffs of Health Department need to gain more knowledge and experience of environmental education through the Project.

In addition, the 3R Task force which consists of resident representatives, NGO and other stakeholders, shall be established as a supplement to the Council's capacity. It will also contribute to promote 3R activity to be carried out by the community.

5.8 Financial System

5.8.1 Establishment of special accounts for cleansing service

All cleansing service expenditure has been currently disbursed from general revenue, and has accounts for 20% of all municipal one from 2005 until 2008 in the last four years. The current budget allocation process for cleansing service had been unplanned and just allocated as to the need, and strategic approach to achieve the goal had not been taken so far. On the other hand, the cleansing service covers a large proportion of total municipal expenditure, so that it has impacted severely on other services like education and social development.

Implementing the M/P will need additional financial sources, however, the current budget system does not guarantee against sufficient allocation for 3Rs Promotion and landfill improvement. Therefore, it is strongly recommended that special accounts to be utilized just for waste management and should be established using income from SWM. It will enable to secure a budget for the implementation of the M/P, and it will contribute to reducing the portion of SWM expenditure on total municipal one. It will enable the Council to allocate more budgets for other services intentionally.

Therefore, the Council shall establish the special account for SWM which consists of all income from cleansing services and to be utilized just for cleansing services. Besides, the portion of SWM expenditure should be reduced from 20% cap of all municipal one.

5.8.2 Income from cleansing service

Total income from cleansing service is already mentioned in the Financial Analysis section. In this section, it is explained about expected income through 3R Promotion (sales of composter, sales of GW chips, garbage fee, etc)

a. Expected income through 3R Promotion

a.1 Sales of Composters

To achieve the goal of M/P, the Council will procure composters at \$45.0 each. Then residents will pay \$20.0, and the Council subsidy the balance of \$25.0. The future total

number of household in the year 2017 is forecasted as 9,746 households, so that 3,000 composters, which accounts for one third of forecasted household number, should be procured and distributed to city residents by 2017.

According to the above estimation, the number of composter to be procured by the Council is from 100 to 500 every year. For that reason, the Council needs to secure the budget for the procurement of composter.

On the other hand, the Council will receive the sales of composters. As shown in Table 21 below, it will become to \$2,000 in 2010 and \$10,000 from 2013 to 2017. These sales shall be brought forward to the procurement of composter in next FY as a part of special account for SWM.

Table 24: Expected Sales of Composter

		2009	2010	2011	2012	2013	2014	2015	2016	2017
Composters installed (HH)	No	50	100	150	200	500	500	500	500	450
Composters installed (BE)	No		50	30	20	20	20	20	20	60
Total composters installed	No	50	150	180	220	520	520	520	520	510
Sale	F\$		4,250	4,350	4,900	10,900	10,900	10,900	10,900	11,700
Carried forward	F\$		0	4,250	4,350	4,900	10,900	10,900	10,900	10,900
LCC budget required	F\$		6,750	3,850	5,550	18,500	12,500	12,500	12,500	12,050

a.2 Sales of Green Waste chip

Lautoka City Council has promoted GW chipping using JICA funded shredder since September 2009. Chips is used for mulching on public gardens, composting and also sold to the private company such as the Fiji Sugar Corporation as fuel for boiler by \$50/ton. Previously all green wastes was just disposed and it took up considerable amount of space at the disposal and also costly to manage.

If Lautoka City Council continues to carry out chipping and sell to the private company, the following sales are expected;

Table 25: Expected sales of Green Waste Chip

	Unit	2009	2010	2011	2012	2013	2014	2015	2016	2017
GW collected	t/day	3.7	1.6	2.0	2.2	2.4	2.6	2.8	3.0	3.3
Sales of GW chips	F\$		28,800	37,100	40,600	44,100	47,500	51,000	54,600	60,300

b. Tipping fee

As a result of calculation done by computerized weighbridge, it has emerged that unfair dumping fees had been given to dump users by previous system. Therefore, Lautoka City Council revised dumping fees in January 2010.

However, it has not still covered the necessary budget for proper landfill operation and maintenance. Hence, the Council will review the tipping fees based on actual cost to be estimated through the Pilot Project for partial improvement of the Lautoka landfill which has been currently implemented with JICA Expert Team.

The tipping fees shall be revised annually based on the actual result of previous fiscal year, and the Council shall make it known to the public and dump users through circular and/or mass media for a need for greater transparency in revising process.

5.9 Contract Supervision

Lautoka City Council has contracted out of most of waste management services, so that these contracts should be strictly supervised by the Council. The following are matters to be considered;

a. Basic background

The valid reasons for contract-out are as follows.

- Through fair and transparent tender, service will be provided to city residents at low cost.
- The service provided by contractors will be monitored and supervised by the Council, so that the quality of service will be maintained.
- Contractors have a responsibility for services to be provided to the Council and city residents, and the service and its price are determined to gain resident's satisfaction from services. If the service provided by contractors does not meet the terms of the contract, the contractors should be fine. Therefore, the contractors need to provide service following the terms of reference.
- The authorized and independent Board of Audit will officially examine the business and financial records of contractors, so that the quality of being fair and transparency are maintained.

b. Contract supervision

The waste management service should be contracted out through fair and transparent procedure, and its service needs to be provided under the condition with competitive principles. The roles and responsibility of contractors are clearly determined in the contract and related regulations. In the tender document, the following terms should be included;

- Governing law; Regulations and rules such as By-laws related to waste management
- Scope of work; Target area, Target items, Service population, Road length, Frequency
- Terms of payment, Events of default
- Other matters if necessary

If the above contract is made, the Council needs to establish the monitoring system to inspect whether the contractors is implementing work based on the contract.

5.10 Capacity Development

Staffs of Health Department of Lautoka City Council seem to have sufficient capacity, however, they need to gain more knowledge and experience for 3R-oriented Solid Waste Management and proper landfill operation to achieve the goal of Master Plan. Especially, the following capacity needs to be developed as below.

- Capacity for setting waste discharge rules, and imposing it on residents.
- Capacity for planning of waste separation system, and its implementation.
- Capacity for working in cooperation with recyclers.

The above capacity shall be developed in individual, institutional and social aspect with their ownership through the Waste Minimization and Recycling Promotion Project.

3R Promotion Action Plan

for

Lautoka City Council

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3R Promotion Action Plan for Lautoka City Council

3R Promotion Action Plan clarifies necessary activity items to be done in order to promote 3R smoothly, role of the stakeholders, necessary expenses for 3R promotion and promotion schedule. It outlines promotion schedule of the term of 2010 to 2017 (seven years). Following describes the items to be done in the 3R promotion and policy for promotion.

1. Separate collection of recyclables

Separation and regular collection of recyclables will be introduced step by step to the whole household and business districts in Lautoka City. As the council bears in mind that the collection work will be contracted out to the private collector, it needs considering the council's budget when doing expansion of the separate collection of recyclables. It also needs considering that it should be conducted so that discharger may not be confused. In the business district there are some business establishments contracting out recyclables collection to recycling company. As the capacity of collection vehicle is limited, such business establishments will be not targeted. They will be instructed about other measures to reduce amount of waste (e.g. provision of information of recycling companies).

2. Reduction and recycling of organic waste

- ① Promotion of use of home composter: to promote use of home composter to the households that have concern in composting by introducing subsidy system. (The cost of home composter will be FJD 30 for ratepayers only. FJD25 of the cost will be subsidized by council.)
- ② Composting of organic waste generated at the market place: to enhance separation of waste at the market place and promote composting of organic waste, moreover, to promote use or sale of composted products as well as composting of organic waste.
- ③ Chipping of green waste as well as the pruned branches generated at public space, and recycling: to segregate (collect waste and take out green waste) and chip it for effective use

3. 3R promotion at school: cooperation with the Ministry of Education (MOE)

The Clean School Programme, started in June 2010 will be conducted continuously. Basically, MOE shall conduct regular monitoring of this activity and LCC shall give technical advice to MOE.

1. Separation and collection of the recyclables

1.1 Policy for expansion

The activity of the separation and collection of recyclables is expanded step-by-step to the following target areas.

Table1-1 Activity term, target area and population for each step

Step	Period		Target area	Target population (accumulation) 2012
	Preparation/ awareness	Start Collection		
Step 1	Apr.-Aug. 2009	Sep.2009-	3R PP Area (Mutlah, Fultala, Berar in Field Forty + Andhra)	513 (1.1%)
Step 2	Apr.-Jun 2010	Jul.2010-	Whole Field Forty Area, Namoli Village Part of CBD and All schools	5,000 (11.0%)
Step 3	Nov.2010 – Feb. 2011	Mar.2011-	Whole of Veitari ward	16,940 (37.4%)
Step4-1	Jan.-Mar.2012	Apr.2012-	Whole of Tavakuvu ward	29,672 (65.5%)
Step4-2	Jan.-Mar.2013	Apr.2013-	Whole of Simula ward	39,599 (87.4%)
Srep4-3	Jan.-Mar.2013	Apr.2014-	Whole of Waiyavi ward	45,317 (100%)

BE: Business Establishment

Table1-2 Schedule for the activity to expand the separation and collection of recyclables

Year/ Month	2009			2010				2011				2012				2013				2014	
	2 nd	3 rd	4 th	1 st	2 nd	3 rd	4 th	1 st	2 nd	3 rd	4 th	1 st	2 nd	3 rd	4 th	1 st	2 nd	3 rd	4 th	1 st	2 nd
Step																					
Step 1																					
Step 2																					
Step 3																					
Step 4-1																					
Step 4-2																					
Step 4-3																					



Preparation



Commencement of Separate collection

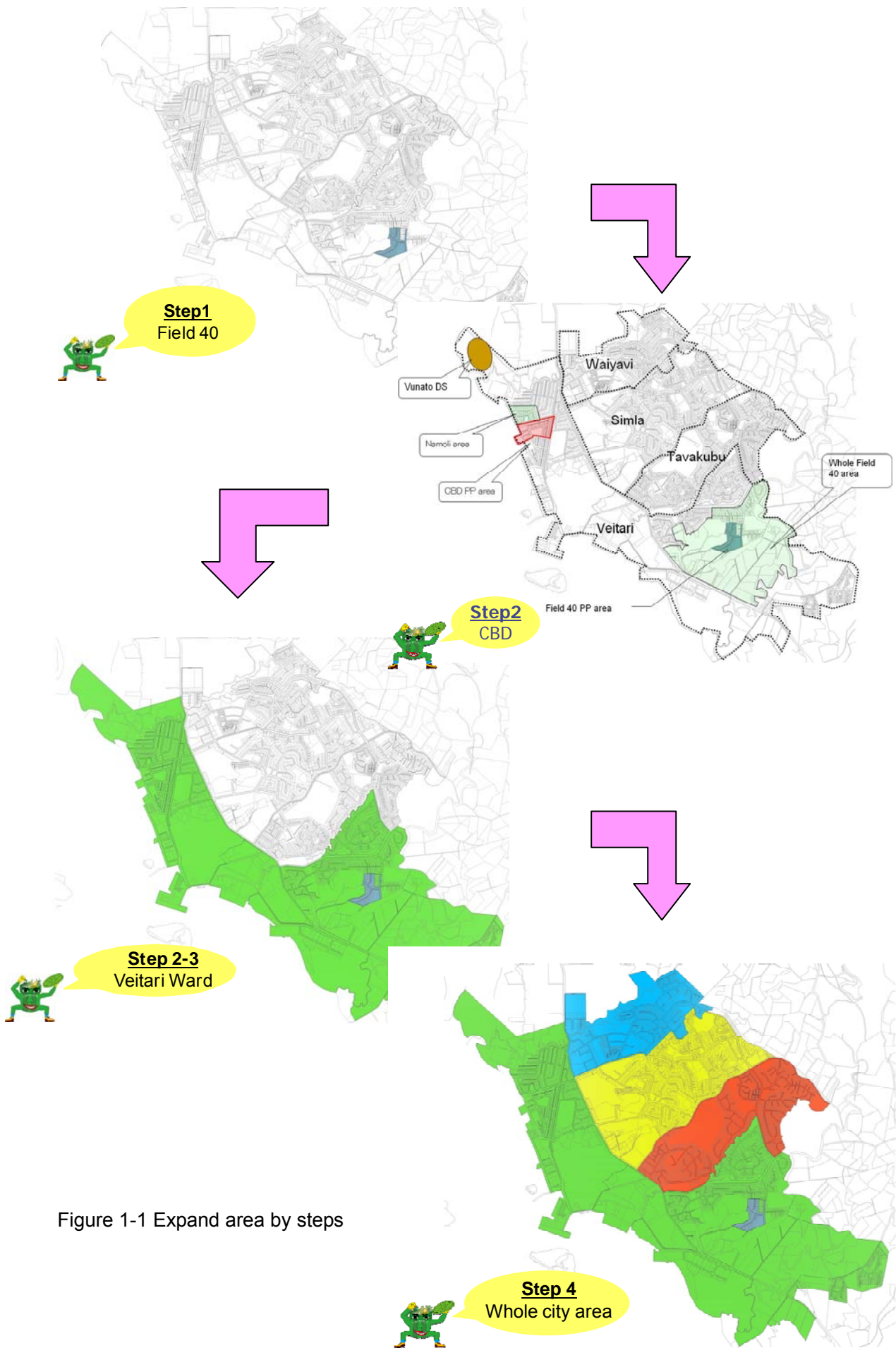


Figure 1-1 Expand area by steps

1.2 Implementation Schedule for the Separation and Collection of Recyclables

The Activity of the separation and collection of recyclables will be expanded to the whole area of council step by step. And, following methods, which was verified in Step 2, are applied. The main points of the activity items are as shown below.

- ☐ Awareness and promotion activity
- ☐ Establish the separate collection system
- ☐ Establish the unit to supervise and instruct (monitoring) the separate collection
- ☐ Establish promotion schedule for the separate collection

1.2.1 Promotion activity for the separation and collection of recyclables

a Preparation of promotion tools and distribution by home visit

a) Promotion tools

The promotion tools are prepared as shown below. They are listed in the table below by residential and commercial districts.

- Recyclables separation and collection calendar (leaflet)
- Nylon sack for storing/discharging recyclables (Residential and commercial districts)
- Sticker for the container used in the commercial district (A large amount of recyclables would be discharged at hotel, restaurant, etc. It would be attached to only wheelie bin. It may be permitted to discharge using plastic bag, if the discharger have to use.← Purchase of wheelie bin is promoted to the business establishment that discharge a large amount of recyclables.)
- Notice of Community meeting (Circular)

Table1-3 List of the promotion tools to be distributed

Material	Residential district	Commercial district
1. Leaflet (Recyclables separation and collection calendar)	✓	✓
2. Nylon sack	✓	✓
3. Sticker		✓
4. Leaflet (Home compost subsidy programme)	✓	✓
5. News letter	✓	✓
6. Circular for community meeting	✓	✓

b) Necessary copies of the 3R promotion tools and cost for preparation

Following shows the target number of households and business establishments to which 3R promotion is conducted. It is listed by step. The target numbers of Step 2, 3, and 4 are 955, 3,600 and 5,800 units, respectively. Necessary expenses for preparing promotion tools for were estimated based on this plan for expansion. The estimation was FJD 2,600 (Step 2), 8,000(Step 3), and 12,400 (Step 4).

Table1-4 Number of households and business establishments to be disseminated

Ward	Residential or commercial	Household (HH)	Business establishment (BE)	Number of HH and BE targeting in each step		
				Step2 (including Step1)	Step3	Step4 -1,2,3
Veitari	Residential	3,356	-	757	2,600	-
	Commercial (CBD)	-	1,200	198	1,000	-
Waiyavi	Residential	1,113	-	-	-	1,200
Simla	Residential	2,092	-	-	-	2,100
Tavakubu	Residential	2,460	-	-	-	2,500
Total	Residential	9,021	-	757	2,600	5,800
	Commercial	-	1,200	198	1,000	-

Table1-5 Amount and cost for 3R promotion tools for LCC

Item	Amount	Unit cost	Cost(\$)			
			Total	Step2 (including step1)	Step3	Step4- 1,2,3
Leaflet (residential + commercial)	11,500	1,000F\$/ 1,000 leafles	11,500	1,100	4,000	6,400
Nylon sack for household	10,000	1\$/sack Including spray ink	10,000	1,000	3,000	6,000
Sticker for business establishment	1,500	100F\$/ 100stickers	1,500	500	1,000	-
Total			23,000	2,600	8,000	12,400

*Materials will be prepared actual required numbers plus 10% more.

c) Distribution by home visit and promotion activity

3R promoter visits every household or every business establishment and give leaflet to them. If they are absent, the 3R promoter revisits them.

- In Step 2, 3R promoters were employed. They were youth volunteers whose workplace was in the council. They worked jointly with C/P in the council for 3R

promotion. As they worked at satisfactory level, their experience would be applied for expansion (further dissemination).

- 8 promoters of 4 groups will work for further activities of 3R promotion under supervision of C/P.
- Following shows the estimates of necessary days and expenses for the 3R promotion. It was estimated based on experience in Step 2. It may take 34 days to complete whole steps. It may take 10 and 19 days to complete Step 3 and Step 4. Total cost necessary for employing 3R promoters was estimated FJD 6,800. The costs for Step 3 and Step 4 were estimated FJD 2,000 and FJD 3,800, respectively.

【Ground for calculation】

Household: 3R Promotion (4days, 4Group(2 promoters per group), 1,150 household)=

80 households/day/group

Business establishment(BE): 3R Promotion (1days, 4Group(2 promoters per group), 220 BE=

60 BE/day/group

Table1-6 Necessary number of 3R promoters and cost

Ward	Household (HH) or Business establishment BE)	Required day			
		Total	Step2	Step3	Step4- 1,2,3
Veitari	3,356 HH	10	4	6	0
CBD	1,200 BE	5	1	4	0
Waiyavi	1,113 HH	4	0	0	4
Simla	2,092 HH	7	0	0	7
Tavakubu	2,460 HH	8	0	0	8
Total	9,021 HH	29	4	6	19
	1,200 BE	5	1	4	0
		34	5	10	19
Cost: 25\$/day/promoter x 8 promoters x days		6,800	1,000	2,000	3,800

b Community meeting

It is desired to have community meeting within about one week after having distributed leaflet. Before the community meeting, it needs explaining main points of the meeting to the community leader or representative and fixing meeting date and place. When distributing leaflet, it also needs distributing a guide specifying meeting date and place. It needs reducing the number of working days for 3R

promotion activity as much as possible. Following works are necessary before community meeting.

a) Division of community

- Basically, community meeting is implemented by area.
- If the area was assumed to be too large for residents to come to meeting, it would be subdivided.

b) Discussion with community leaders

- Briefing of the system
- Request of cooperation
- Fixing of meeting date and place

c) Community meeting

- Preparation of presentation

d) Preparation of the whole schedule

Meeting date will be fixed based on the distribution date for the 3R promotion materials. Fixing of the meeting date will be discussed with community leaders and other representatives. It will be coordinated prior to the meeting.

Table1-7 schedule of meeting with representative in the community, distribution of leaflet and community meeting

Area	Representative (Group, Association etc.)	Schedule		
		Meeting with representative	Distribution of leaflet (Day time)	Community meeting (Night time)
VEITARI				
NATABUA	-Natabua Prisons	-Prisons Officer Incharge	Day time	Night time
	-PRB	-Supervisor of PRB		
	-Golden Age Homes	-Medical Officer Incharge		
	-Natabua Housing Stage 1 and Natabua Housing stage 2 Neighborhood committee	-Committee President/Secretary		
NATABUA SEASIDE	House to house visits only	-	Day time	-
FIELD 40	Andhra, Oriana, Captain Withers street and f/40 road Neighborhood	-Committee President/Secretary	Day time	Night time

	committee			
RIFLE RANGE	-Rifle, range, Rifle range B, Chenab/Santhia and Howrah Crescent Neighborhood	-Committee President/Secretary	Day time	Night time
	-Rifle range temple.	-President		
	-Chandmari Mosque	-President		
BALAWA	-Balawa Estate and Balawa Subdivision Neighborhood Committee	-Committee President/Secretary	Day time	Night time
VUNATO	Land Owner	Rt Jo Naini	Day time	Night time
NAVUTU	-Navutu, Nasinu and Nasoata village.	-Turaga in Koro	Day time	Night time
CENTRAL BUSINESS DISTRICT	Lautoka chamber of Commerce and Ltk retailers association	President/Secretary	Day time	Day time
FIJI SUGAR CORPORATION	Management	Mill Manager	Day time	Day time
NAMOLI VILLAGE	-Village representative.	-Turaga Ni Koro	Day time	Night time
	-Women and youth group	-President/secretary		
SIMLA				
DRASA VITOGO	-Vomo st, upper sandalwood, upper Hollander, Adam st/Marau pl/Tanoa pl, Evans st, Pickering place/Marlow st , Kula Pl, Lower Sandalwood st, Mid Vomo st, Jamuna st, upper vomo st, Corbet st, poona Pl, Nasir Pl neighborhood committee.	-Committee President/Secretary	Day time	Night Time
	-Vomo st Mosque	-President		
SIMLA	-Kama /Ragg st,Covuli st and Phlугers Avenue/Tokoriki pl/Kiwi place, Razak rd/Mandarine Pl	--Committee President/Secretary -Property	Day time	Night time

	neighborhood committee. -PRB	supervisor.		
WAIYAVI				
WAIYAVI STAGE 1	Sulua st/Chameli st/Taj Pl neighborhood committee	-Committee President/Secretary	Day time	Night time
WAIYAVI STAGE 2	Sakoor pl, Sukanaivalu rd/Maharaj pl neighborhood committee	-Committee President/Secretary	Day time	Night time
WAIYAVI STAGE 5	-	-	Day time	-
TAVAKUBU				
TOPLINE	-Topline neighborhood committee	-Committee President/Secretary	Day time	Night time
BANARAS	Banaras neighborhood committee	-Committee President/Secretary	Day time	Night time
NATOKOWAQA	-Natokowaqa neighborhood committee. -PRB	-Committee President/Secretary -PRB Supervisor and youth group president/secretary	Day time	Night time
GOLF LINK CRESENT	-Golf Link Crescent -PRB	-Committee President/Secretary --PRB Supervisor and youth group president/secretary	Day time	Night time
TAVAKUBU STAGE 1	-	House to house visits only-	Day time	-
TAVAKUBU STAGE 6	-	House to house visits only	Day time	-
TAVAKUBU STAGE 2-5 KASHMIR	-	House to house visits only	Day time	-

c Melody and announcement at collection time

As melody and announcement at collection time is very effective for residents to make them reminding collection timing, a system of sounding melody and making announcement is introduced. The system is introduced for first one or two months after the collection service have started. When contracting out collection service to

private sector, in the contract with the contractor, it needs specifying use of collection vehicle with the melody prepared by council, sounding the melody and making announcement.

d Media campaign

a) Media

- Radio
- Newspaper (①Fiji Sun (Lautoka Sun)), ②Community Paper (CITY STAR)
- TV (① Local news (Fiji One News), ②Documentary (through DOE))

b) Timing

- Timing of expansion (dissemination)
- Timing of the event such as workshop, seminar, etc. which is concerned on 3R
- Timing of publication of the council's gazette, event (Sugar Festival)

c) Expenses

1.2.2 Separation and Collection System

The followings technical systems for separate collection are shown in below;

- Storage and discharge system at residential area
- Storage and discharge system at commercial area
- Collection and haulage system
- Collection schedule
- Sorting and storage system
- Monitoring system

a. Storage and discharge

Table1-8 Collection system for residential districts of LCC

Target items	Regular garbage collection	Recyclables collection
Target items	Except recyclables	PET bottle (for beverage), Plastic shopping bag Hard plastic, Metal including tin cans Paper (newspaper, magazines, office paper) Cardboard, Cloths, Glass
Collection Frequency/collection day of the week	Twice a week Monday/Thursday Tuesday/Friday Wednesday/Saturday	Fortnightly collection Wednesday Monday Friday
Discharge container	Containers with lid	Nylon sack (with 3R logo) distribute only first time Bulky cardboards should be discharged by tying it with string
Discharge time	by 7:00 a.m.	by 8:00 a.m.
Collection time	7:00am-5:00pm	8:30am-3:00pm
Discharge place	Curb side	Curb side

Table1-9 Collection system for commercial districts of LCC

Target items	Regular garbage collection	Recyclables collection
Target items	Except recyclables	PET bottle (for beverage), Plastic shopping bag Hard plastic, Metal Paper (newspaper, magazines, office paper) Cardboard, Cloths, Glass bottle
Collection Frequency/collection day of the week	Daily collection except Sunday	Once a week Every Monday
Discharge container	Containers with lid	Any type of containers basically Nylon sack (with 3R logo) distribute only first time Plastic-made container and wheel bin are promoted for discharge of recyclables Bulky cardboards should be discharged by tying it with string
Discharge time	by 9:00 a.m.	10:00-11:00am
Collection time	9:00-10:00 a.m.	11:00am-3:00 pm
Discharge place	Curb side or back lane of the shops	Curb side or back lane of the shops

b. Collection and haulage

a) Collection system

Table 1-10 Collection system

Items		Residential area	Commercial area
Collection	Implementation body	Contract out to private contractor	Contract out to private contractor (Business establishment discharging a large amount of waste, such as supermarket individually contracts with recycling company)
	Workers	One Driver At least two collectors	One Driver AT least two collectors
	Equipments	Collection truck belongs to contractor	Collection truck belongs to contractor
	Profits	All profits to be paid to the council.	All profits to be paid to the council.

b) Collection schedule

Table 1-11 Collection schedule (1)

Existing garbage collection day		Proposed collection day of the week						
		Recyclables	Weekly schedule					
Mon	Thu	Wed	Mon	Tue	Wed	Thu	Fri	Sat
Tue	Fri	Mon	Mon	Tue	Wed	Thu	Fri	Sat
Wed	Sat	Fri	Mon	Tue	Wed	Thu	Fri	Sat
Daily		Mon	Mon	Tue	Wed	Thu	Fri	Sat

Table 1-12 Collection schedule (2)

Ward	Population		Collection weeks
Veitari	15,734	21,055	2 nd and 4 th week
Waiyavi	5,321		
Simla	9,178	21,025	1 st and 3 rd week
Tavakubu	11,847		
Commercial area (CBD)			Every week

➤ Residential are

Recyclable amount estimated based on the PP: 19.2g/day/person (Sep.2009 – Mar.2010)

Estimation of collection amount per each collection day:

$19.2\text{g} \times 21,000\text{person} / 3 \text{ divisions of collection day} \times 14\text{days} = 1,88\text{t/collection day} / \text{division}$

➤ Commercial area

$0.3\text{t/day} \times 7\text{days} = 2.1\text{t/collection day}$

Table 1-13 Collection schedule (3)

Garbage collection day Ward	Tue/Fri	Mon/Thu	Wed/Sat
Simla/ Tavakubu	1 st and 3 rd week Mon.	1 st and 3 rd week Wed.	1 st and 3 rd week Fri.
Veitari/ Waiyavi	2 nd and 4 th week Mon.	2 nd and 4 th week Wed.	2 nd and 4 th week Fri.
CBD	Every week Monday		

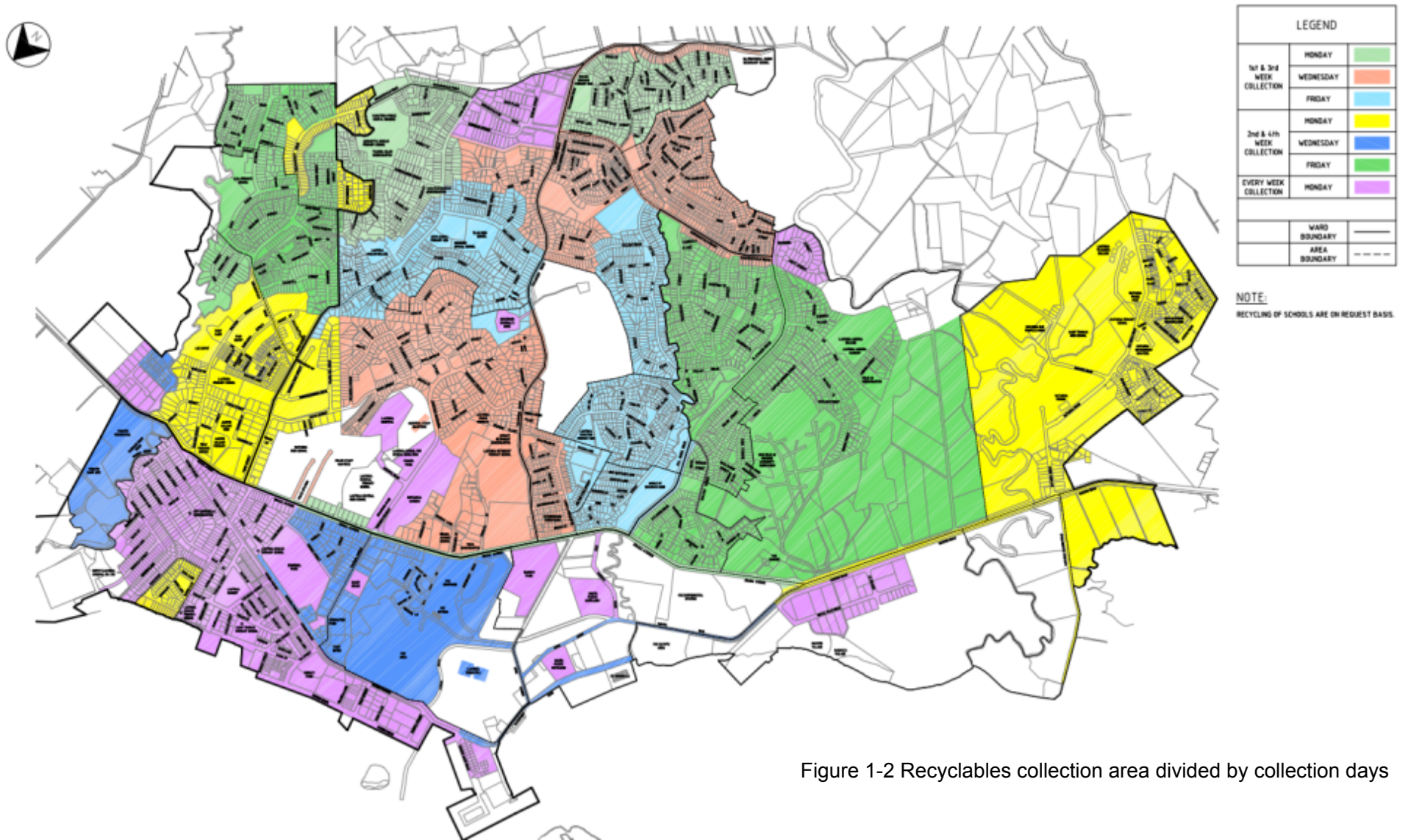


Figure 1-2 Recyclables collection area divided by collection days

c. Sorting and Storage

Table 1-14 Sorting and Storage for recyclables

Items	Residential area	Commercial area
Sorting	<ul style="list-style-type: none"> - Place: Recycler's depot - Staffs: Recycler's staffs 	Same as residential area

1.2.3 Monitoring system for separation and collection

Table 1-15 Monitoring for recyclables

Items	Residential area	Commercial area
Monitoring	<ol style="list-style-type: none"> 1) Collection crew counts the household discharged recyclables. 2) Collection crew refuses the mixed non recyclables and dirty recyclables. 3) C/Ps monitor the discharge manner at initial stage (at least 2 months) 4) Recyclers submits monitoring sheet filled up recyclables amount and profits. 	<p>(Same as residential area)</p> <ul style="list-style-type: none"> • Discharge container • Discharge day of the week • Discharge place • Other discharge manner • Amount of recyclables

1.2.4 Expenditure

Table 1-16 Expenditure for separate collection

Item	2011	2012	2013-2017
1. Contract fee	60,000	65,000+(6,000)	125,000/year
2. Awareness and promotion	9,500	17,400	2,000/year
3. Hiring 3R promoters	2,000	3,800	0
Total	71,500	86,200	127,000/year

1.2.5 Expansion schedule for the separate and collection of recyclables

Table 1-17 Expansion schedule for the separation and collection of recyclables

Table 1-1 Expansion schedule for the separation and collection of recyclables						
Item	FY 2010		FY 2011		FY2012	
	July	August to December	January to March	April to December	January to March	April to December
1. Awareness and promotion activity						
1.1 Distribution of leaflet	-	-	-	-		-
1.2 Community meeting	-	-	-	-		-
2. Separate collection system for recyclables						
2.1 Collection entity	Collection by WR	Collection by LCC. LCC uses MPT.	Private collector starts to collect recyclables with announcement and recycling melody			
2.2 Sorting of recyclables, management of benefit	Sorting by WR All benefits will be restored toWR.	Sorting by WR WR pay for benefit to LCC.	Sorting by WR WR pay for benefit to LCC.			
2.3 Announcement of collection service by sound system	LCC visits target areas and disseminates prior to collection service (i. One day before collection, ii. Early morning of the collection date, iii. at the time of collection)	LCC uses MPT and disseminates prior to collection service (i. One day before collection, ii. Early morning of the collection date, iii. at the time of collection)				
Step 3 Expansion of collection service toward (whole area of Veitary Ward)						
1. Awareness and promotion activity						
1.1 Distribution of leaflet	-	Distribution of leaflet by 3R promoter's home visit - Revise leaflet - Necessary period for distribution: 10 days - Labor cost for distribution: FJD 2,000 - Expenses for preparing leaflet: FJD 7,400	-	-		-
1.2 Community meeting	-	• Division of area • Fixing of community meeting date and meeting place • Community meeting	-	-		-
2.1 Collection entity	-	Preparation for fixing collection dates (twice a month) of recyclables at Veitary Ward	Private collector starts to collect recyclables with announcement and recycling melody			
2.2 Sorting of recyclables, management of benefit	-	-	Sorting by WR WR pay for benefit to LCC.			
2.3 Announcement of collection service by sound system	-	-	Private contractor announce to notify recyclables collection service at a same time of collection work by using sound system attached collection vehicles.			
Step 4-1 Expansion of collection service toward (Tavakubu Ward)						
1. Awareness and promotion activity						
1.1 Distribution of leaflet	-	-	-		Distribution of leaflet by 3R promoter's home visit • Revise leaflet • Necessary period for distribution: 19 days • Labor cost for distribution: FJD 3,800 • Expenses for preparing leaflet: FJD 12,400	-
1.2 Community meeting	-	-	-		• Division of area • Fixing of community meeting date and meeting place • Community meeting	-
2. Separate collection system for recyclables						
2.1 Collection entity	-	-	-		Preparation for fixing collection dates (twice a month) of recyclables at Waiyavi, Simla, Tavakubu Ward	Private collector starts to collect recyclables with announcement and recycling melody
2.2 Sorting of recyclables, management of benefit	-	-	-	-		Sorting by WR WR pay for benefit to LCC.
2.3 Announcement of collection service by sound system	-	-	-	-		Private contractor announce to notify recyclables collection service at a same time of collection work by using sound system attached collection vehicles.

Item		FY 2013		FY 2014		FY 2015
		January to March	April to December	January to March	April to December	
Step 4-2 Expansion of collection service toward (Simla Ward)						
1. Awareness and promotion activity						
	1.1 Distribution of leaflet	Distribution of leaflet by 3R promoter's home visit • Revise leaflet • Necessary period for distribution: 19 days • Labor cost for distribution: FJD 3,800 • Expenses for preparing leaflet: FJD 12,400				
	1.2 Community meeting	• Division of area • Fixing of community meeting date and meeting place • Community meeting				
2. Separate collection system for recyclables						
	2.1 Collection entity	Preparation for fixing collection dates (twice a month) of recyclables at Waiyavi, Simla, Tavakubu Ward	Private collector starts to collect recyclables with announcement and recycling melody			
	2.2 Sorting of recyclables, management of benefit		Sorting by WR WR pay for benefit to LCC.			
	2.3 Announcement of collection service by sound system		Private contractor announce to notify recyclables collection service at a same time of collection work by using sound system attached collection vehicles.			
Step 4-3 Expansion of collection service toward (Waiyavi Ward)						
1. Awareness and promotion activity						
	1.1 Distribution of leaflet		-	Distribution of leaflet by 3R promoter's home visit • Revise leaflet • Necessary period for distribution: 19 days • Labor cost for distribution: FJD 3,800 • Expenses for preparing leaflet: FJD 12,400		
	1.2 Community meeting		•	• Division of area • Fixing of community meeting date and meeting place • Community meeting		
2. Separate collection system for recyclables						
	2.1 Collection entity			Preparation for fixing collection dates (twice a month) of recyclables at Waiyavi, Simla, Tavakubu Ward	Private collector starts to collect recyclables with announcement and recycling melody	
	2.2 Sorting of recyclables, management of benefit				Sorting by WR WR pay for benefit to LCC.	
	2.3 Announcement of collection service by sound system				Private contractor announce to notify recyclables collection service at a same time of collection work by using sound system attached collection vehicles.	

2. Home composting

It is crucial to decrease the amount of organic waste which accounts for 60% of household waste generated. The Pilot Project proved that home composting using compost bin was very effective way in reducing 20% of household wastes. It is also expected that composting reduces costs for the municipality because it lessens the amount of garbage going into the waste stream. Therefore, council has positioned the promotion of home composting as a core activity in the Solid Waste Management Master Plan (SWM M/P).

2-1. Goal

To decrease the amount of kitchen waste generated from household by ○○% by 2017.

2-2. Indicator

To make residents implement home composting by 30% of total household in the Lautoka City.

2-3. Promotion plan

To achieve the above goal, council will promote home composting to the whole area of Lautoka City as scheduled in the SWM M/P as follows.

Table 1: Promotion plan for home composting

	Unit	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Household	No.	50	100	150	200	500	500	500	500	500	3,000
Business	No.		50	30	20	20	20	20	20	20	200
Total number		50	150	180	220	520	520	520	520	520	3,200

2-4. Implementation

Home compost will be promoted according to the following steps.

- (1) Secure the budget to procure the necessary number of compost bins (every November-January)
 - Department of Health (DoH) submits the budget for the coming year to procure the necessary number of compost bins as scheduled in the SWM M/P.

By-law for the home compost subsidy programme

Lautoka City Council has established a “Home compost subsidy programme” to encourage their ratepayers to use compost bins in July 2010. Council has provided a \$25 subsidy when Lautoka ratepayers purchase a bin from Lautoka City Council. In order to make it sustainable programme and secure sufficient budget allocation for the compost bins, council will develop a by-law for the home compost subsidy programme by 2011.

- (2) Procure the compost bins (every June)

- Based on the amount of budget allocated, council orders the necessary number of compost bins to the manufacturing company in June. Delivery date to be confirmed when ordered.
- Some compost bins, approx.10, to be stored in the council office to hand it to residents who visited the council office to purchase a bin. Other compost bins to be stored properly at the council depot.

(3) Prepare the materials for advertising and awareness (every June)

- When the total number of compost bins and the delivery date are confirmed, council prepares for the following advertising and awareness materials;
 - ① Leaflet attached with application form
 - ② Sticker for compost bin
 - ③ Manual
 - ④ Poster (to be pasted at several municipal facilities)
- Some of the above materials have been already developed by the JICA Project, so that council just prints them out. Specific date and the number of compost bins will be amended if necessary.
- The necessary number of each material to be prepared is as follows;

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Leaflet with application	100	200	200	300	600	600	600	600	600
Sticker	100	200	200	300	600	600	600	600	600
Manual	100	200	200	300	600	600	600	600	600
Poster	-	50	50	50	50	50	50	50	50

(4) Conduct advertising and awareness activity (every June, and continuously)

- Using the above materials, council conducts advertising and awareness activity for the public using the following measures;
 - Setting up the booth nearby the council's cashier desk.
 - House-to-house visit for separate recyclable collection when expanded
 - Demonstration in the community meeting
 - Demonstration during the council's event (Sugar festival, Open day, etc)
 - Demonstration for schools
 - Advertising through newspaper
 - Radio programme (if possible)



Booth in the council office



House-to-house visit



Community meeting



Booth during council event



Float



School programme

(5) Distribute compost bins (annually)

- Ratepayers visit the council's cashier desk, submit an application form with \$30.00 and receive a compost bin at the same time.
- Council develops a database of the basic information of residents who purchased a bin (e.g. name and home address).
- If residents request council to deliver bins to their houses, council will consider giving a charge for delivery arrangement.

(6) Conduct monitoring (every month)

- Monitoring plan (staff in charge, schedule, etc) to be developed. It is preferable to check the implementation condition of compost bins **three times** at least after the distribution.

	Monitoring schedule	Matters to be checked
1 st monitoring	within a month after distribution	Installation, Location, etc
2 nd monitoring	after 3 months	Composting process (first)
3 rd monitoring	after 6 months	Composting process (second)

- Conduct monitoring through house-to-house visit. Items to be checked as follows;

Items to be checked	Resident's information
<ul style="list-style-type: none"> - Condition (color, odor, moisture, insects, temperature) - What kind of waste put into bin? - How full was bin? 	<ul style="list-style-type: none"> - Name - Household number/address - Family number - The day when bin was installed

- How often they have used bin for a week?	- Monitoring day
- How much waste they put into bin at once?	

- Council sets up the question desk in the council's for residents who purchased a bin, so that it makes necessary instructions available to residents anytime when needed.

(7) Report and review (every month)

- Council develops a database including the following information;
 - Information on resident who own a bin (name, the place where they live, etc)
 - Number of bins which were sold for a month (to estimate the number of bins are left)
 - Result of monitoring
- Based on the above database, DoH staff develops a monthly report, and submits it to the Director of DoH at the end of every month.
- Council reviews and re-examines the advertising and awareness strategy if council faced the following situations;
 - If not enough bins are sold, and cannot expect to achieve the target number of bins to be sold within a year.
 - If the results of monitoring shows that most of residents are using a bin improperly.

2-6. Implementation body

<u>1) Lead agency</u> - Department of Health (DoH), Lautoka City Council	<u>2) Partnerships and other related organization</u> - Manufacturing company; supplier of compost bins - Department of Environment; promotion at national level - Ministry of Agriculture; promotion at national level - NGO (OISCA); technical adviser
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2-7. Budget

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Compost bins	-	8,250	9,900	12,100	28,600	28,600	28,600	28,600	28,600
Leaflet with application	-	-	200	300	400	400	400	400	400
Sticker	-	-	300	400	600	600	600	600	600
Manual	-	-	300	400	500	500	500	500	500
Poster	-	-	500	500	500	500	500	500	500
Total	-	8,250	11,200	13,700	30,600	30,600	30,600	30,600	30,600
Returns from sales of bins	250	3,000	4,500	6,000	15,000	15,000	15,000	15,000	15,000
Actual expenditure	-	5,250	6,700	7,700	15,600	15,600	15,600	15,600	15,600

*Returns from sales of bins should be allocated to the special account for Solid Waste Management (SWM) for future purchase of bins. **A compost bin costs \$55.00 per bin as of June 2010. The above figures should be amended according to the change of the price.

Home Composting



Funded by the
Japanese
International
Cooperation Agency



Health Department
Lautoka City Council
P.O. Box 124, Lautoka
Phone: 666 0433
Fax: 666 3288



Health Department
Nadi Town Council
P.O. Box 241, Nadi, Fiji Island
Phone: 670 0133, 670 0503
Fax: 670 1202, 670 0131



How to use
distributed composters

We would like to thank OISCA, a Japanese non-profit organization, for providing us with BOKASHI.

What is happening in that pile?

The kitchen scraps and yard waste in your compost contain nitrogen and carbon. There are a number of different micro organisms, worms and beneficial insects that live on a diet of nitrogen and carbon-rich materials. The microorganisms will generate a lot of heat as they do their work - a compost pile regularly heats up after new material is put into it. During the process, the materials you put in are broken down into compost, or humus.



Step 1

- Decide where to compost

The backyard is usually a good place. Find a spot on bare ground that gets a fair amount of shade, so your pile is not dried out by the sun. A tree can provide some shelter from heavy rain storms. Put your composter for enough away from your back door or a spot that seems handy, maybe just near your garden where you will use the material.



Step 2

- Place the composter

Before placing the composter, dig the ground to a depth of 30cm. Then, put your composter at a 10cm-deep under the ground. Remain the soil generated by digging around the composter for water control.



Step 3 - Let's start home composting

It's a time to put your kitchen waste into the Composter.

1. Reuse and put an empty ice cream or any container of kitchen for storing kitchen waste for a day and making only one trip to the composter instead of disposing every time a kitchen waste is generated.
2. Cut kitchen waste into smaller pieces as much as possible before adding them to the composter; you will slow the faster compost process.
3. Squeeze the moisture out of kitchen waste as much as possible. With moisture, bad smell will be issued and the fermentation and decomposition processes are getting slowly!
4. Begin with a layer of branches first, this helps air circulate in your pile and slows water to drain, - and then add kitchen waste. Finish by covering with a layer of brown waste (i.e. soil, grass, shredded chips). Always cover with some leaves or other brown wastes when you put the kitchen waste into the Composter. It helps water control, and minimizes odors that may occur, and also promotes the fermentation process.



Step 4

- Maintain your pile

1. Turn the materials over with a shovel or pitchfork to send the air into the inside of materials. It promotes the fermentation and decomposition process done by microorganisms in the soil.
2. Sprinkle BOKASHI just on the top of pile once a week. BOKASHI contains a lot of nutrients and it serves as a catalyst/biocoaster for rapid fermentation and odor control.

What is BOKASHI?

- The general definition of the Japanese term "Bokashi" is "fermented organic matter".
- Bokashi is a byproduct of EM (Effective Micro-organisms), and is a high quality fermented compost accelerator, rich in beneficial micro organisms.

Step 5

- Use Compost

1. Compost can be produced in as little as a couple of months. It depends on the kinds and conditions of kitchen waste you put into.
2. Take the materials out from the bottom of Composter which is ready to use compost. If it is not ready, cover them by soil or plastic sheet until it gets ready.
3. Use compost for flower and vegetable garden.



TIPS FOR HOME COMPOSTING



What is the best location for your home compost site?

- In open area exposed to sun. Natural heat from the sunlight will boost the internal temperature of compost pile which will assist in decomposition. Heat will also eliminate maggots, fruit flies and other undesirable insects.
- At an elevated location to prevent surface water runoffs getting into the compost pile.

What materials should you add to a compost pile?

- Any organic matter including vegetable peelings, egg shells, partly dried grass, fallen leaves, leftover food lies in moisture content like bread, rice, root crops etc, garden trimmings/prunings, animal manure, shredded wood chips, saw dust etc.
- Adding chipped leguminous plants like bean plant is a bonus for the compost as it is an excellent source of nitrogen.

What materials should NOT be added to the compost?

- Any plastics, paper, oil and cardboard.
- Any liquid matter - left over liquid food like soup, dhal, tea, milk etc.
- Organic matter containing lot of water - to be squeezed to get rid of excess moisture.
- Raw or cooked meat and rotten/spoil eggs.

What should I do when I notice foul odor/smell, maggots, other insects or excess moisture in the compost?

- Do not get alarmed or disheartened (important!)
- Sprinkle a layer of soil or Bokashi if available on the surface.
- Add dry grass or fallen leaves or wood chips.
- Stir the pile at least once a week to introduce air into the compost pile.

What should I do when it rains?

- Ensure that the location has good drainage to prevent water getting into the composter.
- Cover the lid at all times.
- Add dry grass and soil or BOKASHI to control moisture and maggots.



Containers or buckets can be used as coposters. You can make a good composter from a used drum.

What can I do if my compost pile takes too long to break down?

- Compost pile needs large enough pile and enough air, so:
 - Add moisture-rich and nitrogen-rich fruit and vegetable scraps to speed up the process.
 - Add more fresh food scraps and water while stirring the pile.
 - Mix in materials that do not compact, such as green twigs and plant stems. *It will help to create more air spaces.

How can I judge when composting is finished?

- Signs of finished compost include:
 - A sufficient amount of time has passed since materials were last added to the pile.
 - The pile of compost has developed a dark brown color.
 - Odors are no longer a concern - could be earthy odor, no more ammonia or rotten odor.
 - Consistent crumbly texture except for pieces of wood, the compost shows very little evidence of the original yard trimmings and food scraps added to the pile.
 - The moist pile remains cool and does not become warmer after turning.

How long will it take to make finished compost?

- Compost can be produced in as little as 3 months or longer (in a year or more). It depends on how you maintain your heap.

What should I do with the final compost material?

- Leave in exposed area for at least a week to let dry properly. Turn pile whilst drying/storing.
- Add to your garden to improve soil fertility and act as soil conditioner.
- Can be used as base material before planting vegetables or flowers.
- Can be used as potting mix.
- Remember to keep a small portion and add to the new compost pile as the need arises to help eliminate foul odor, maggots, moisture. Compost is rich in micro organisms which help in the composting process.

Note : Organic fertilizer has good water retention capacity and can supply wide range of essential nutrients to plants for longer duration compared to costly artificial fertilizer.

3. Composting of market waste

3.1 Policy for expansion

Composting of organic waste generated at the market place is done by separating such waste at the market place. Recycling of organic waste for composting is promoted in accordance with following indicators.

Table 3-1 Plan for market waste separate collection

	Unit	2009	2012	2017
Market waste separate collection	ton/day	0.5	0.6	1.3

3.2 Basic system

Table 3-2 Outline of market waste composting

Item	Content
Instruction about how to separate waste to stall keepers at the marketplace, monitoring system	Regular activity for awareness-raising Regular activity on awareness-raising to collection workers in the market place
Separation and collection system in the market place	Organic waste: 120 liters wheel bin with sticker Other waste: Half cut drum
Collection and haulage of market waste	Organic waste: LCC Other waste: Garbage collection contractor
How to make compost	Solar evaporation (1 month) – Maturing (6 months)-Sieving-Bagging Regular component testing (N,P,K,C/N)
Equipment/ facility for making compost	Facility for solar evaporation and maturing
System for making compost	Driver (1 person), workers (2 persons)
Quality of compost and its use	Sale of compost to citizens Planting in the disposal site

3.3 Implementation Plan

Composting of organic waste generated at the market place is done in accordance with following methods.

3.3.1 Separation method, how to instruct about separation, and monitoring system

The status of mixing of organic waste including vegetable waste sorted at the market place as well as other waste is checked. If the status is judged not to be good in conditions, following awareness-raising activities shall be conducted.

- Cooperate with the management personnel at the market place as well as

vender association for promotion of waste separation

- Instruct to the collection workers in the market place regularly

	
Awareness rising to market vendors	Poster to promote separation of organic waste

3.3.2 Collection system, equipment

Table 3-3 Collection equipment, system

	Organic waste	Other waste
Container	120 liters wheel bin with sticker	Half cut drum
Collection entity	LCC	Garbage collection contractor
Collection vehicle	MPT	Compactor Truck

	
Wheel bin for organic waste with sticker	Sticker for organic waste

3.3.3 How to make compost

Composting of vegetable waste segregated at the market place has been done as an activity of the pilot projects since September, 2009. Following procedure for composting is based on the result of this activity.

a. Solar evaporation

- To pile vegetable waste carried into the compost yard, remove mixed inorganic substance such as plastic as much as possible before it is carried in, and chop into small pieces if a large chunk of vegetable waste is found.







- After 3 weeks
- fermentation
- | | 1 st Day | 2 nd Day | 3 rd Day | 4 th Day | 5 th Day | 6 th Day | 7 th Day |
|-------------|---|---|---------------------|---------------------|---------------------|---------------------|---------------------|
| Third week |  |  | | | | | |
| Second week |  |  | | | | | |
| First week |  |  | | | | | |

Figure 3-1 Drying schema



- To pile the vegetable waste which was dried for one month, water it, and mature using a sheet for keeping moisture
- To set the waste at an elevation of 1.5 meters using wooden frame, water it, and mature using a sheet for keeping moisture, if the compost yard is too small to do composting effectively
- To mature for approximately six months, measure temperature and moisture regularly, and keep moisture by watering if necessary



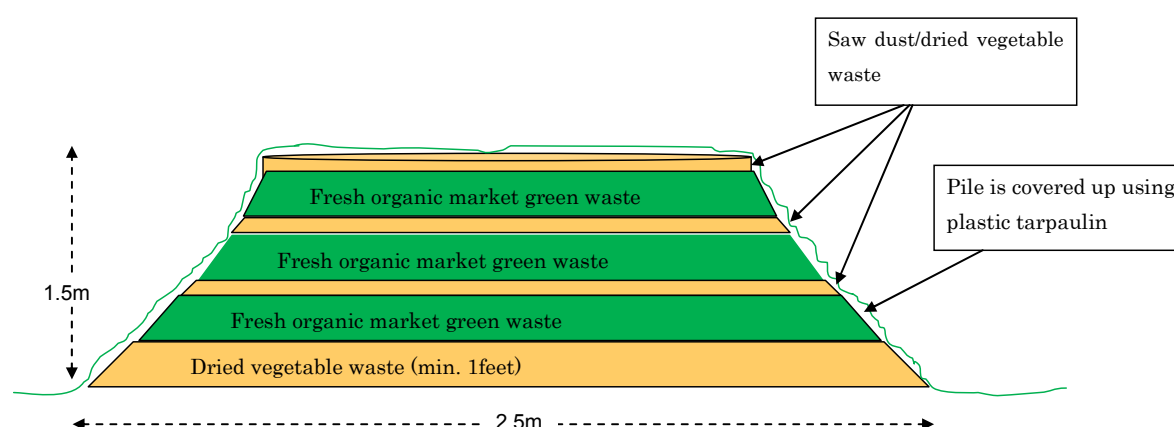
c. Sieving and bagging

- To do component testing of the compost once a year in order for them to be sold
- To sieve the compost once composting is completed, and pack in 10kg bags with labeling.

d. Market Green waste Composting System during Dry Weather

The Maturation yard shall be used for receiving fresh market green waste instead of the drying yard. Since dry weather hampers the composting by eliminating the needed moisture from the pile, it is essential to introduce other measures to retain moisture. It is vital that 50-60 % of moisture is required for optimum composting process. One such measure is using the fresh organic vegetable waste which is high in moisture content to supplement moisture to dried vegetable waste.

Hence, dried up vegetable waste shall form the base material at least 1 feet in height and in a round shape with approximately 2.5 metre diameter. Then the fresh organic waste is spread over this pile and covered immediately with saw dust/dried vegetable waste and the fresh organic waste is again spread over this pile and covered again immediately. This process shall be continued until the pile reaches the height of 1.5 metre. The pile is also covered with plastic sheet to retain moisture or protect from excessive moisture during heavy rain. The pile is then left to mature and turned over every fortnightly by excavator. Once the compost is fully matured, mill mud is added approximately at ratio of approximately 20% to the volume of the pile. the pile is then thoroughly mixed, sieved, weighed and packed in 10 kg bags for sale at cost of \$5.00.



3.3.4 Facility for producing compost, and production system

Following facility is necessary for producing compost of the waste generated at the market place.

a. Compost drying yard during rainy weather

- To estimate necessary area for composting. It is necessary for estimating the target amount of daily **throughput**. The specific gravity of vegetable waste carried in shall be 0.39 ton/m³ (this was estimated based on the result of WACS).
- To secure necessary space of land mentioned above, and mount up higher and level the land in consideration of discharged water if necessary

b. Compost maturation yard

- To use an open space provided in the north of compost drying yard (16m×9m), use a sheet for a while, although it needs to be kept in a structure with roof. Because it is indispensable to keep moisture for maturing.
- During dry weather, use old dried vegetable waste and mix with fresh vegetable waste to retain moisture.

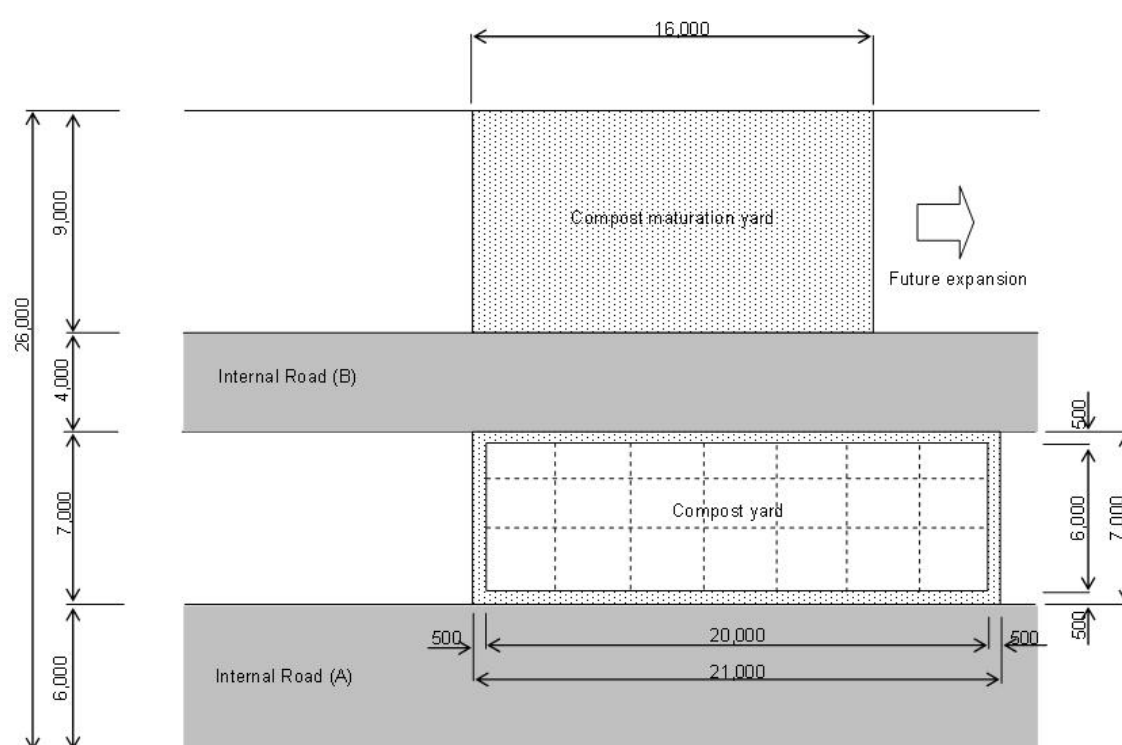


Figure 3-2 Layout of Composting Facility (Vunato Disposal Site)

c. Compost production system

- Production of compost of the market waste is continuously done by the compost production system which was established through the pilot project (one driver, two workers)

3.3.5 Use of the generated compost

The result of the component testing clarified that the generated compost contained high nutrient content. LCC intends to use the compost as mentioned below.

a. Sale to citizens

- To sell to citizens who is doing home gardening

b. Planting in the landfill site

- To use the compost as the material for assisting gardening and planting on the embankment

c. Others

- LCC cultivates vegetable experimentally using the compost produced in the Vunato Disposal Site and makes an effort to enhance quality of compost, and develop the most appropriate use of the compost (e.g. mixing with surface soil) and promote use of the compost.

3.3.6 Expenditure and income

Table3-4 Expenditure and income

Item		2011	2012	2013-2017
1. Expenditure		34,500	34,500	
	1.1 Implementation (transportation, labor cost etc.)	14,500	14,500	
	1.2 packing process (plastic bag, sealing, label etc.)	10,000	10,000	
	1.3 Advertising	10,000	10,000	
	1.4			
2. Income				
	2.1 Selling compost			

3.3.7 Implementation schedule

4. Green waste

4.1 Policy for expansion

The flow from generation of green waste originated from tree branches pruned in a public park and discharged from residents to recycling is shown below.

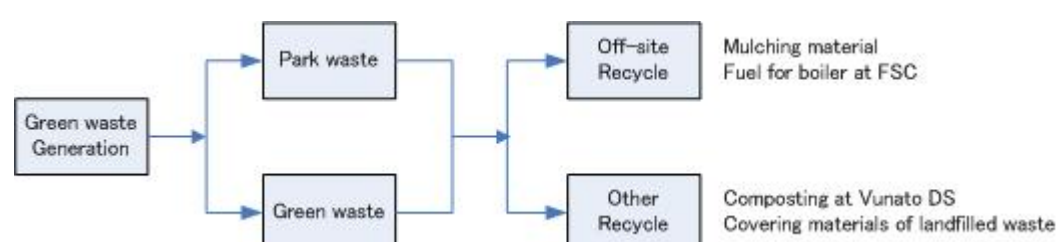


Figure 4-1 Basic concept of green waste recycling

Green waste is chipped by wood shredder. The chipped material is recycled in accordance with following target figures, and such recycling is promoted. As it is unclear whether the use as mulching and fuel for boiler is possible, 30 percent of the material is expected to be used for recycling at the time of 2017. However, the amount of other recycling would be reduced, if the demand of use of the chipped material is estimated more than expected after having negotiated with FSC and hotels.

Table 4-1 Plan for green waste recycling

	Unit	2009	2010	2011	2012	2013	2014	2015	2016	2017
Green waste generation	ton/day	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
Self disposal	ton/day	7.6	6.9	6.2	5.5	4.9	4.2	3.5	2.8	2.1
On-site Recycling (Proper)	ton/day	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Improper self disposal	ton/day	5.5	4.8	4.1	3.4	2.8	2.1	1.4	0.7	0.0
Green waste discharged	ton/day	5.1	5.8	6.5	7.2	7.9	8.5	9.2	9.9	10.6
Off-site recycling	ton/day	0.1	0.6	1.3	1.7	2.0	2.4	2.8	3.2	3.8
Other recycling	ton/day	5.0	5.1	5.2	5.5	5.8	6.1	6.4	6.7	6.8

4.2 Basic system

Table 4-2 Outline of green waste recycling

	GW generated at household and business establishment	GW generated at parks and streets
Storage and discharge	<ul style="list-style-type: none"> • Instruction about segregation at source of waste discharge • Request of collection • Reception at the council, advance payment corresponding to volume and kind, announcement of collection date (collection by area) • Segregate the collected waste, extract and discharge GW and discharge GW on designated date 	<ul style="list-style-type: none"> • GW will be generated in accordance with a plan for pruning tree branches at parks and streets • Pruning: Department of Engineering

Collection and haulage	<ul style="list-style-type: none"> • Private operator permitted by the council collects waste in accordance with the council's collection schedule. • Waste is segregated into GW and other waste as much as possible, and hauled. 	<ul style="list-style-type: none"> • Collection and haulage: Department of Engineering • Pruned at the site and chipped by shredder at same time in order to effectively work • Chipped material is hauled to Department of Engineering's depot.
Accumulation of GW, chipping, storing of the chipped material	<ul style="list-style-type: none"> • GW is unloaded on a designated area. • It is chipped at the time when a certain amount of the chipping material is collected or stored. • The chipped material is stored and used for mulching material for parks and cover soil for disposal site 	<ul style="list-style-type: none"> • The chipped material hauled is stored in accordance with regulations for recycling
Effective use of the chipped material	<ul style="list-style-type: none"> • Used as mulching for parks and cover soil for disposal site 	<ul style="list-style-type: none"> • The chipped material is recycled as fuel for boiler according to contract with sugar factory

4.3 Implementation plan

4.3.1 Improvement of GW collection service

a. Improvement of pay service for GW collection

The council already has a user pay collection service for garden waste arising from the private premises within the city boundary. Presently the collection service is contracted out to private contractor and the service caters for following categories of waste:

1. Garden refuse includes only organic waste like grass, tree pruning's, trunk, branches, leaves and any other green waste.
2. Commercial refuse (may include mixture of green waste)
3. Trade/industrial/construction refuse (may include mixture of green waste)
4. Motor body shell

Once the waste is brought to VDS, the garden refuse only is disposed at recycling area and is chipped once a reasonable pile is formed. The chips is then stored at recycling area. Other garden refuse mixed with other waste will be disposed at the general waste disposal area near the entrance and once a reasonable heap is formed, the MPT with chipper will be brought to this disposal area and green waste will be selectively chipped from the heap and the chip will be stored at recycling area ready for sale to FSC, covering material or used as mulching.

However, in the case of big amount of green waste, the members of public can request for hire of chipper at fee of \$75.00/hour and they can retain the chips. This also applies to commercial sector.

The other aspect is the need for stringent enforcement of relevant legislations like open fire bylaw, liter decree to control the inappropriate self disposal of green waste via burning, littering and accumulation in backyards.

b. Dissemination of the collection service for GW, enhancement of GW collection

- Leaflet, poster
- Public Relations

c. Segregation of GW

- Awareness-raising to residents (Instruction about segregation when discharging)
- Instruction to collection workers (how to segregate waste at the stages of collection, haulage, disposal)

4.3.2 Plan for pruning tree branches at parks and streets

Table 4-4 Estimated amount of GW to be pruned at target park and street, and timing to be pruned

Names of target park and street	Area (m ²), Total length (m)	Estimated amount of GW (m ³)	Timing to be pruned
Churchill park	m ²	m ³	
Tavewa Avenue	m	m ³	
Drasa Avenue			
Thompson crescent			
Adams place			
Corbet street			
Shirley park			
Botanical garden			
Furner park			
Covuli st.			
Oriara place			
Narara parade			

4.3.3 Storing of GW collected, chipping, storing of the chipped material

Table4-5 Storing of GW collected, chipping, storing of the chipped material

	GW generated at household and business establishment	GW generated at parks and streets
Collected GW	<ul style="list-style-type: none"> • Place of collection: Vunato Disposal Site • Area: 100m² • Facility: Same as general 	<ul style="list-style-type: none"> • On site chipping depending on location

	disposal area • Location: explain using figure •	
Chipping	• Place for storing: Vunato Disposal Site • Area: 300m ² • Volume: •m ³ • Facility: Recycling area next to compost facility • Location: explain using figure • Chipped when a certain amount of GW is collected or stored	• Place for storing: Department of Engineering's Botanical garden • Area: 400m ² • Volume: •m ³ • Facility: Botanical garden • Location: explain using figure
Management and maintenance	• Responsible department: Department of Health • System	• Responsible department: Department of Engineering • System

4.3.4 Effective use of wood chip

Table 4-6 Effective use of wood chip

	GW generated at household and business establishment	GW generated at park and street
How to use effectively	• Use as covering material for disposal site	• Recycling the chipped material for fuel for boiler in accordance with contract with the sugar factory
Recycling plan	• Plan for soil covering	• Plan for providing the chipped material
Quality control	• No special regulations	• The material needed by the sugar factory, how to make product needed by the factory and keep quality, and necessary facility

4.3.5 Operation for recycling GW and operation system

Table 4-7 Operation for recycling GW and operation system

	GW generated at household and business establishment	GW generated at park and street
Maintenance of shredder	1. System for maintenance <ul style="list-style-type: none"> • Responsible department: Department of Health • Maintenance system: (operation and maintenance) • Place of maintenance: Vunato Disposal Site 2. Operation: 3. Maintenance <ul style="list-style-type: none"> • Daily check: • Regular check: • Repair: 	
Operation and maintenance system for recycling GW at Vunato Disposal Site	•	-
Operation and maintenance system for recycling GW at Botanical garden	-	•

4.3.6 Expenditure and income

Table 4-8 Expenditure and income

Item	2011	2012	2013-2017
1. Expenditure	21,000	21,000	
1.1 Advertising	1,000	1,000	
1.2 Implementation (transportation, fuel etc.)	10,000	10,000	
1.3 O&M for shredder	10,000	10,000	
2. Income			
2.1 Selling to FSC as a fuel of boiler			

4.3.7 Implementation schedule

5. Activity for promoting 3R at school

Promotion of 3R at school is done jointly with the Ministry of Education

- ☐ Management system/ joint cooperation system
- ☐ Segregation of the recyclables
- ☐ Environment awareness raising
- ☐ Compost
- ☐ Others

6. Expenditure and income

Table6-1 Expenditure and income for 3R

Item		2011	2012	2013-2017
1. Expenditure		142,695	155,800	
	1.1 Separate collection for recyclables	71,500	86,200	
	1.2 Home composting	15,695	14,100	
	1.3 Market waste composting	34,500	34,500	
	1.4 Green waste recycling	21,000	21,00-0	
	1.5 3R promotion in school			
2. Income				
	2.1 Market waste			
	2.2 Green waste			

Japan International Cooperation Agency (JICA)

**Waste Minimization and Recycling Promotion Project
In the Republic of the Fiji Island**

3R Guideline

November 2011

Department of Environment

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Appendix

Intermediate Treatment Technologies and Resource Recovery Method

Abbreviation

JICA	Japan International Cooperation Agency
MSWM	Municipal Solid Waste Management
DOE	Department of Environment
LCC	Lautoka City Council
NTC	Nadi Town Council
M/P	Master Plan
JET	JICA Expert Team
LA	Local Authority ¹
RDF	Refuse Derived Fuel
GW	Green Waste
CDM	Crean Developemt Mechanism
3Rs	Reduce, Reuse, Recycle
EPR	Extended Producer Responsibility
PPP	Polluter-Pay-Principle
A/P	Action Plan
WACS	Waste Amount and Composition Survey
POS	Public Opinion Survey

¹ Local Authority in this 3R Guideline means Municipal Council.

3R GUIDELINES (DRAFT)

1 Introduction

1.1 Background

The Government of Fiji has advocated the "coexistence of a sustainable society and the environment" as one of its basic policies. Furthermore, in June 2008, the government published its "National Solid Waste Management Strategy and Action Plan, 2008 – 2010" which aims to minimize waste, establish appropriate solid waste management (SWM) and reduce their environmental footprint. To achieve these basic policies, the Fiji Government has conducted a "Waste minimization and recycling promotion project" from October 2008, working out of the Lautoka City Council (LCC) and Nadi Town Council (NTC).

The Department of Environment (DOE) decided to move ahead with waste minimization and recycling nationwide by promoting the 3Rs while building a sustainable Solid Waste Management (SWM), as stated in the National SWM Strategy 2011 – 2014 which was revised strategy endorsed by cabinet in 15th August, 2011. Therefore, the DOE prepared this 3R Guideline as a national policy to promote 3Rs.

1.2 Objective of the 3R Guidelines

The objective of the 3R Guidelines is to exhibit the national policy on 3R promotion to the persons in charge of SWM.

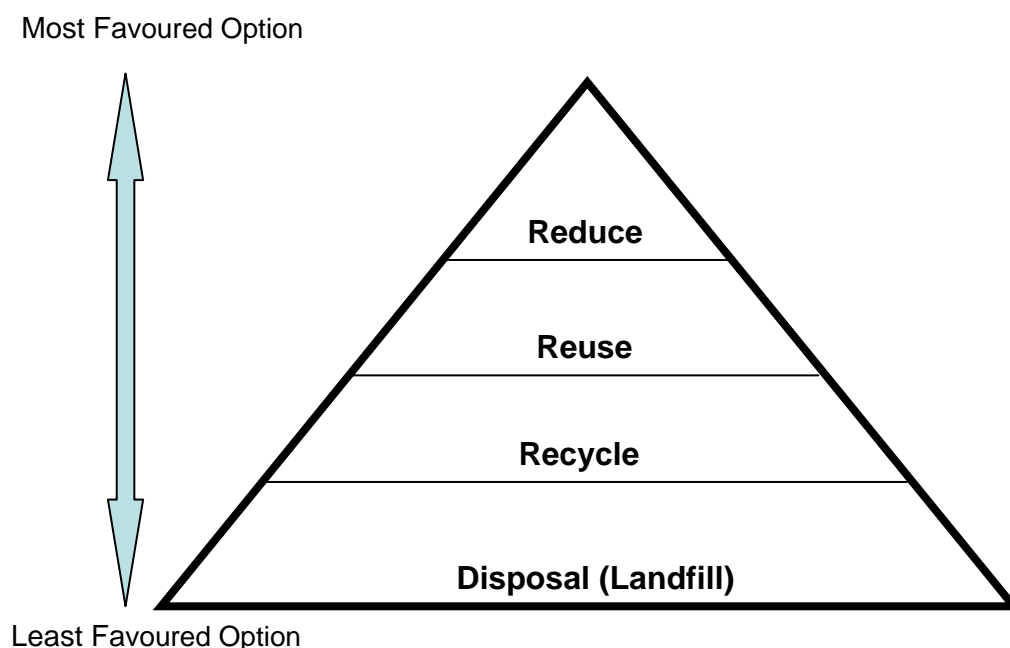
The persons in charge of SWM, especially the Local Authorities (LA), are required to take action to realize the national policy described in the guidelines within their jurisdiction.

2 3R Targets and Policy of Promotion

2.1 What is 3R (Reduce, Reuse and Recycle)?

2.1.1 Waste Hierarchy

The waste hierarchy refers to the 3Rs of Reduce, Reuse and Recycle, which classify waste management strategies according to their desirability. The 3Rs are meant to be a hierarchy, in order of importance.



(Source) JICA Expert Team

Figure 1: Waste Hierarchy

2.1.2 Vision of Solid Waste Management (SWM) and 3R

The vision of SWM for each local authority (LA) is:

To establish an environmentally sound SWM system, which aims at more efficient use of products and resources and reduction of adverse environmental impact by waste in the LA.

In the environmentally sound SWM system, 3R (Reduce, Reuse and Recycle) is promoted and the following situation should be established.

- Waste reduction is encouraged at the generation source, such as households and business establishments.
- Waste generated after reduction measures have been applied is reused or recycled as much as possible.
- Only after efforts have been made to reduce, reuse or recycle waste, it is then properly collected, treated, and finally disposed of in an appropriate manner without negative environmental impacts.
- Such a SWM system will be established by requiring the governmental sector, private sector and general public to bear adequate responsibilities under a transparent and fair rule.

2.1.3 Policy of 3R Promotion

Each element of 3R--Reduce, Reuse, Recycle--is interrelated, and the policies to promote each can not be treated independently.

To illustrate this, the table below shows the 3R promotion policy arranged into a table by JET. Here, "On-site Composting" is categorized under "3. Recycle" as item 3.1.1, but this measure also belongs under "1. Reduce" in item 1.2.4.

Table 1: 3R Promotion Methods

Item of 3R	Large Category	Detailed Method
1. Reduce	1.1 Governments establish policy and legal system	1.1.1 PPP (Polluter-Pays-Principle) 1.1.2 EPR (Extended Producer Responsibility) 1.1.3 Import tax on troublesome goods for SWM 1.1.4 Promotion of environmentally friendly products (product design for 3R at the manufacturing stage) 1.1.5 Promotion of simplified packaging 1.1.6 Green purchasing system (Eco-label system)
	1.2 Enhance public consciousness	1.2.1 Buy less and use less 1.2.2 Buy environmentally friendly products 1.2.3 “My bag” campaign (carrying reusable bags) 1.2.4 Reduction of waste discharge through reuse and recycling at waste generation sources
2. Reuse	2.1 Governments establish policy and legal system	2.1.1 Deposit system for reusable/recyclable products 2.1.2 Promotion of returnable containers and packaging
	2.2 Enhance public consciousness	2.2.1 Re-use and repair products 2.2.2 Buy goods with returnable containers and packaging 2.2.3 Sorting reusable goods at generation sources
3. Recycle	3.1 Material recycling	3.1.1 Composting (On-site and Off-site) 3.1.2 Sorting reusable/recyclable wastes (On-site and Off-site)
	3.2 Thermal recycling	3.2.1 RDF (Refuse Derived Fuel) production 3.2.2 Biomass fuel of chipped green waste (GW) 3.2.3 Incineration for power generation and heat supply 3.2.4 Biogas production

(Source) JICA Expert Team

As shown in the table above, reduce and reuse measures—most particularly, reduction--depends largely upon the central government to develop a policy (i.e. a guideline) and establish the necessary legal system to actualize policy. The National Government, through the Ministry of Local Government, Housing, Urban Development and Environment will take the necessary steps to prepare the legal system needed to strengthen the initiatives of LA's to progressively promote and sustain 3R activities based on the 3R Guidelines.

It is also important to raise public awareness for 3R promotion, especially concerning reduce and reuse. Concerning these measures, the LA will be requested to take positive action.

The 3R Promotion Manual will be utilized by each LA to implement national policy shown in the 3R Guidelines. The manual primarily deals with recycling techniques, and it is important that LAs will promote recycling by developing policy, preparing bylaws to realize the policy and take actions to raise public awareness.

2.2 Municipal Solid Waste Management and 3R

2.2.1 Municipal Solid Waste management

3R promotion is closely linked to Municipal Solid Waste Management (MSWM). The technical system in MSWM consists of 3 main systems which are: 1) Collection System, 2) Intermediate Treatment System, and 3) Final Disposal System, as shown in the next figure.

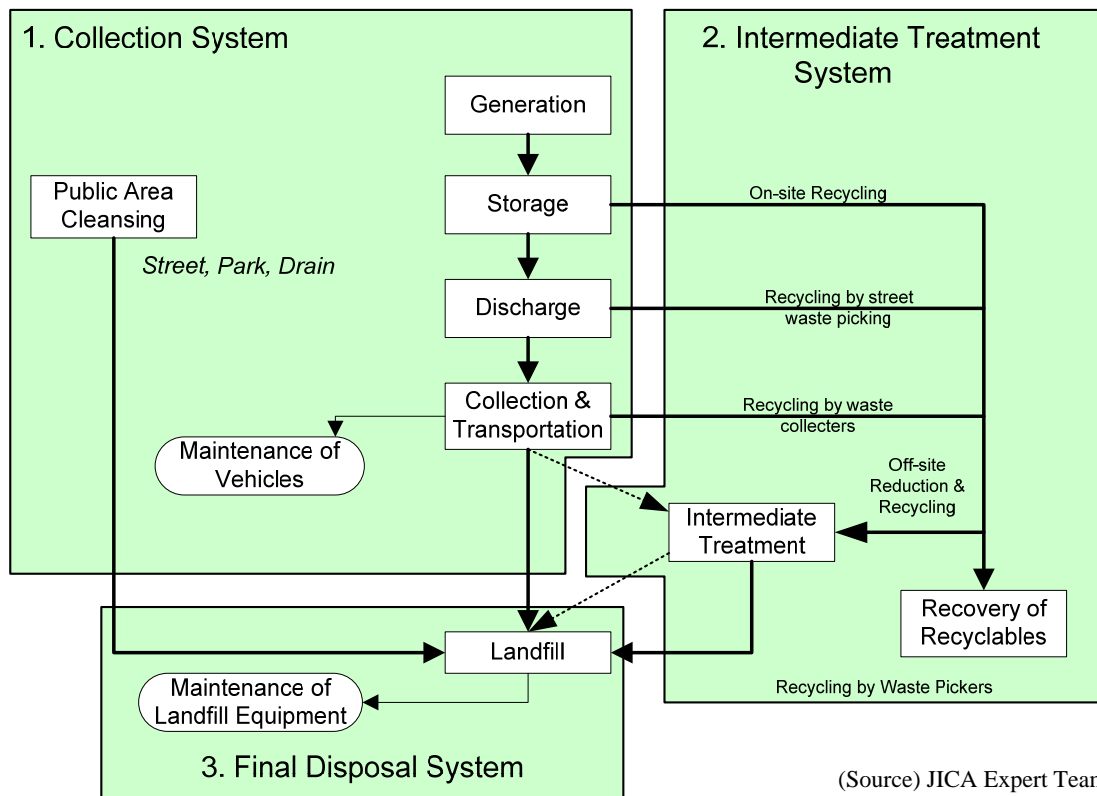
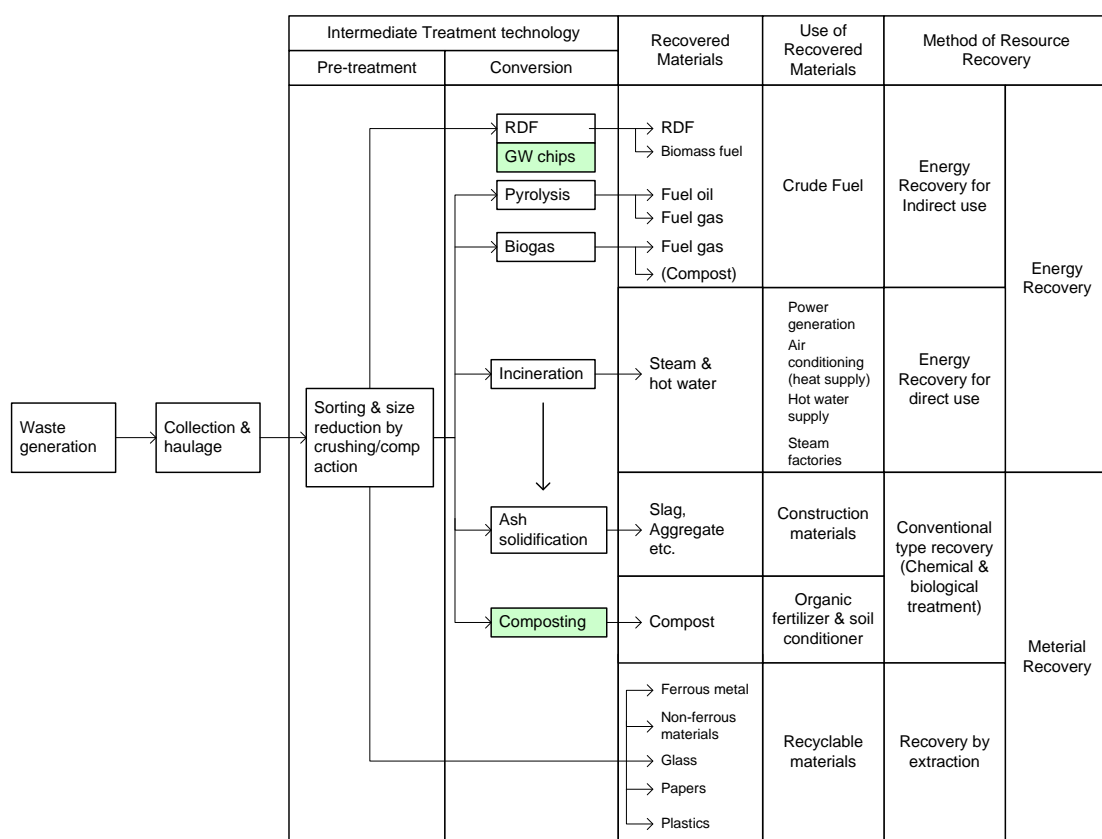


Figure 2: MSWM Technical System

2.2.2 Intermediate Treatment Technologies and Resource Recovery Method

Reuse and recycling of MSW are classified under the “Intermediate Treatment System” as shown in Figure 2. Intermediate treatment has a large variety of technologies and many technologies are being operated all over the world.

The following figure shows a relation between intermediate treatment technologies and methods of resource recovery.



(Source) JICA Expert Team

Figure 3: Intermediate Treatment Technologies and Resource Recovery Method

Green waste chipping can be useful for biomass fuel and composting, however typical intermediate technologies as introduced in the appendix, and explained below are alternative intermediate technologies in Fiji.

a. Green Waste (GW) Chipping as Biomass Fuel

GW Chipping as Biomass Fuel is a recycling system which converts green waste generated largely in the LA into chips which are then used as a biomass fuel. The combustion of these chips does not require a special facility such as an RDF incinerator, so the existing combustion system can be employed. In Lautoka, Fiji Sugar Corporation (FSC) uses the chips as fuel for the boiler at their factory. GW fuel is renewable so it can be promoted as a CDM project. In addition to utilization as a fuel, wood chips also serve as a bulky material to keep the compost heap under aerobic conditions and act as moisture control.

Therefore, GW chipping is an adoptable intermediate treatment technology. Details of wood chipping are explained in the “3R Promotion Manual”.

b. Composting

Waste composting is a method used to achieve microbiological degradation of organic matter (household and vegetable wastes, garden waste, etc.), to produce a recycled organic product for use in agriculture, gardens, parks, and so forth. The most important technical issue related to composting concerns the precise nature of the product. Compost is not a fertilizer but a soil conditioner. It does contain some plant nutrients, but its value lies primarily in that it improves the soil structure by introducing humus, promotes microbial activities, and can help to retain fertilizers and moisture in the soil. Most essential for achieving success when

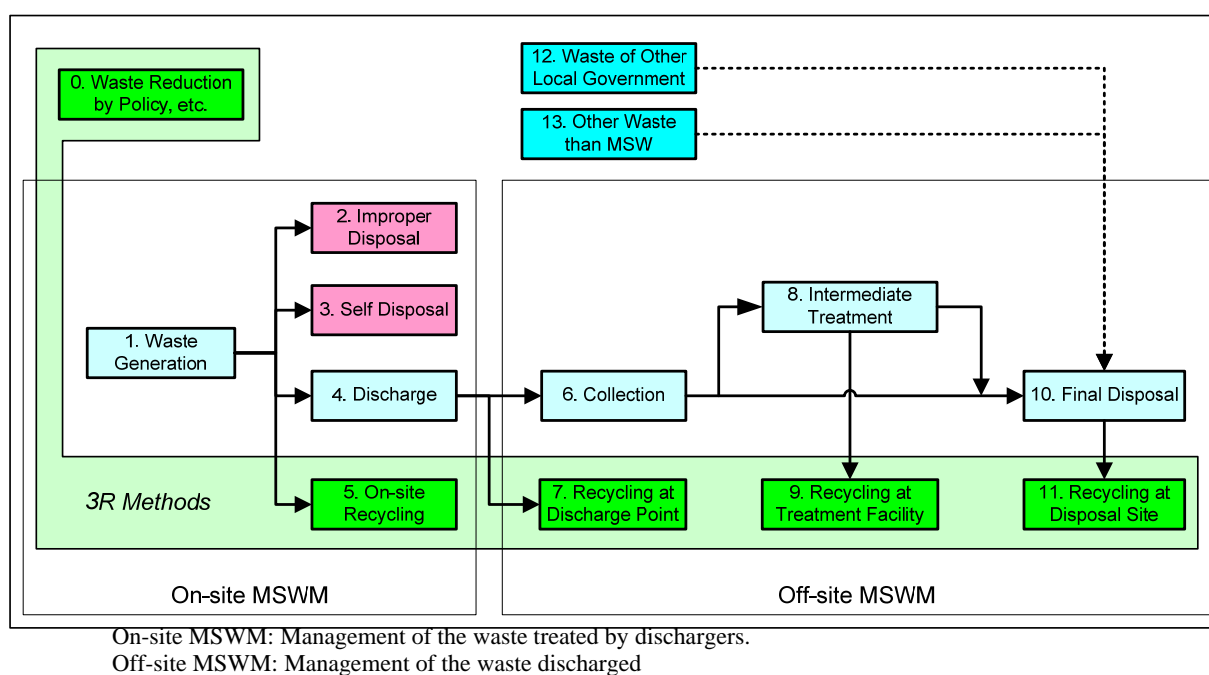
composting municipal waste is that the waste is sorted into a “green” fraction (i.e. organic waste), and a fraction that is not appropriate for composting (plastics, glass, metals, etc.). Sorting may be conducted at a central compost plant (Off-site composting) or at the source (On-site composting).

Both on-site and off-site composting are applicable intermediate treatment technologies for LAs in Fiji. The details of composting technology are given in the “3R Promotion manual”.

2.2.3 Basic Waste Stream and 3R Promotion Methods

a. Basic Waste Stream

A Waste Stream is an instrument used to depict Municipal Solid Waste Management (MSWM) visually. The method to make a waste stream, using examples from the experiences in LCC and NTC, is explained in the 3R Promotion Manual. The following figure shows the waste stream (from generation to final disposal of the waste) and the relationship to 3R promotion methods.



(Source) JICA Expert Team

Figure 4: Basic Waste Stream and 3R Promotion Methods

An explanation is given here of the 3R Promotion Methods in reference to the waste stream sequence above.

- The Waste Reduction by Policy, etc (item 0, above) signals that MSW Generation (item 1) will be reduced through waste reduction measures. (See previous Table 1: 3R Promotion Methods, 1. “Reduce” for details)
- When waste collection services are not adequately provided, Improper Disposal (item 2) and Self-disposal (3) will take place. It also includes accumulation of refuse in backyard where collection service is provided. Improper Disposal refers to the burning of MSW within a restricted area littering or illegal dumping. Therefore, eliminating

Improper Disposal should be the top priority to improve MSW management.

- Self-disposal (3) refers to permitted burying of kitchen waste or open burning of garden waste, accumulation of refuse etc. in residential backyards in an area where collection service is unavailable.
- The amount of self-disposal and improper disposal activities can be estimated according to population information in areas without collection services, the results of a public opinion survey and the amount of waste detected when illegal dumps are cleaned up.
- When collection services are adequately provided, most of the MSW generated is (4) Discharged (4) and Collected (6).
- On-site Recycling (5) is a measure to reduce waste discharge. Examples of on-site recycling are composting using a composter, and using kitchen waste as food for livestock and pets.
- Recycling at Discharge Point (7) is the collection of recyclables separated at-source before discharge or the collection of these items at discharge points by private recyclers and street waste-pickers.
- Intermediate Treatment (8) is the centralized treatment of collected MSW by the composting facility or incineration plant. In some cases, a facility added to the disposal site.
- Recycling at a Treatment Facility (9) refers to the recycling conducted at the above-mentioned intermediate facility. This includes composting of market waste at a composting facility, heat recovery and power generation at an incineration plant and so forth.
- Final Disposal (10) means the disposal amount at a landfill site which is owned or used by the LA. It is important to note that if the disposal site receives waste from other LAs, or waste other than MSW (such as industrial waste from factories, etc.), in order to know the MSWM of the LA, the amounts for Waste of Other Local Governments (12) and/or Other Waste than MSW (13) must be measured, respectively.
- Recycling at Disposal Site (11) refers to the amount of recyclables collected at the disposal site by waste-pickers.

b. 3R Promotion Methods

b.1 3R Promotion at the On-site MSWM Stage

As shown in Figure 4: Basic Waste Stream and 3R Promotion Methods, MSWM is classified into two categories, which are On-site and Off-site. On-site MSWM is the treatment performed before discharge by the individual at the generation source. The activities for 3R promotion are listed as follows.

Table 2: On-site 3R Promotion Methods

Major key	Minor key*note1	Cost burden by Government	Benefit of Government	Notes
Reduce generation	1.1.1: PPP	<ul style="list-style-type: none"> • Legal expenses • Cost for public awareness raising 	<ul style="list-style-type: none"> • Reduce expense for collection, treatment and disposal of the waste (discharger's expense) 	<ul style="list-style-type: none"> • Paid garbage bag system
	1.1.2: EPR	<ul style="list-style-type: none"> • Legal expenses • Cost for Producer's 	<ul style="list-style-type: none"> • Reduce expense for recycling activities 	<ul style="list-style-type: none"> • Biodegradable shopping bag, etc.

Major key	Minor key*note1	Cost burden by Government	Benefit of Government	Notes
		awareness raising		
	1.1.3: Import tax on troublesome goods for SWM	<ul style="list-style-type: none">• Legal expenses• Cost of custom clearance work	<ul style="list-style-type: none">• Environmental protection by reducing troublesome goods for SWM	
	1.1.4: Promotion of environmentally friendly products	<ul style="list-style-type: none">• Legal expenses• Cost for establishment of Eco-label, label system by the National Government• Cost of transmission and promotion of quality information• Cost for public awareness raising	<ul style="list-style-type: none">• Reduce cost for collection, treatment and disposal of the waste	<ul style="list-style-type: none">• Eco-label
	1.1.5: Promotion of simplified packaging			
	1.1.6: Green waste purchasing system (Eco-label system)			
	1.2.1: Buy less and use less	<ul style="list-style-type: none">• Cost for public awareness raising	<ul style="list-style-type: none">• Reduce cost for collection, treatment and disposal of the waste	
	1.2.2: Buy environmentally friendly products	<ul style="list-style-type: none">• Cost for establishment of Eco-label, label system by the National Government• Cost for public awareness raising		<ul style="list-style-type: none">• Eco-label
	1.2.3: My bag campaign (carrying reusable bags)	<ul style="list-style-type: none">• Cost for public awareness raising		<ul style="list-style-type: none">• “Furoshiki” campaign in Nadi
	2.2.1: Reuse and repair products			
	2.2.2: Buy goods with returnable containers and package			<ul style="list-style-type: none">• Container Deposit Legislation Project
Reduce discharge	1.2.4: On-site recycling	<ul style="list-style-type: none">• Cost for awareness raising, subsidy for purchase of composter, etc.	<ul style="list-style-type: none">• Reduce cost for collection, treatment and disposal of the waste	<ul style="list-style-type: none">• Home composting (LCC, NTC)
Separate discharge	3.1.2: Sorting reuse/ recyclable wastes	<ul style="list-style-type: none">• Cost for public awareness raising• Cost for separate collection of recyclables	<ul style="list-style-type: none">• Reduce cost for collection, treatment and disposal of the waste	<ul style="list-style-type: none">• Separate collection of recyclables (LCC , NTC)

note 1: Refer to the article number of “Table 1: 3R Promotion Methods”

b.2 3R Promotion at the Off-site MSWM Stage

Off-site MSWM is a treatment service provided by the government and/or private company after discharge of the MSW. 3R activities carried out by those in the private sector is considered business-oriented resource recovery, and that by the government is conducted as part of their MSWM activities.

3R promotion activities carried out by the private sector reduce the government cost burden to collect and treat/dispose waste, so it should be encouraged on the condition that the

activities would not burden the government or the environment.

On the other hand, 3R promotion activities generally require additional costs for separate collection, and the construction and operation of intermediate treatment facilities. When the additional costs required are covered by the benefit gained through reduction of waste going to landfill, and less burden on the environment, it can be said to be justified.

However, from experience, 3R promotion activities are generally not profitable. Important part is the social corporate responsibility to environment.

b.3 Recommendation

It is said that promotion of the 3Rs at the On-site MSWM stage, at generation sources, is preferable to the Off-site stage in order to not only improve MSW management, but also to promote the 3Rs in general. The reasons for this are:

- **Low cost:** The additional cost burden to the government to promote On-site is less than that of Off-site.
- **Pure material for recycling:** The most difficult problem is the risk of certain substances contaminating recyclables or becoming mixed in. On-site recycling can minimize this problem. Thus, the saying, “It is *garbage* when mixed, but *resources* when separated.”
- **Raising the awareness of dischargers:** Proper MSWM is not established without the proper understanding and cooperation of waste dischargers. On-site recycling can not be promoted without raising awareness of waste dischargers. In other words, to promote “On-site Recycling” means raising the awareness of those who are discharging the waste.

2.3 3R Promotion by Local Authority (LA)

2.3.1 Characteristics of Fiji for 3R Promotion

A characteristic of island nation on recycling should be considered for promoting 3Rs.

a. Difficulties due to island nation

- To promote “the third R”, *recycling*, it is essential to have industries such as paper mills, electric furnace-powered factories, etc., which are the final users of recyclables. However, a large investment is necessary to establish these recycling industries, which is a real economic challenge for countries with small populations. Therefore, the recyclables collected in Fiji have to be transported thousands of kilometres to Australia, New Zealand or China. Consequently, recyclable materials which maintain profitability after deducting these significant transportation costs are extremely limited.
- Although LA in Fiji are relatively small in scale and not consolidated in any geographic location, the size and investment in an off-site recycling facility that an LA would be able to construct and operate would be limited.
- Most consumables are imported, so goods with applicable Extended Producer

Responsibility (EPR) are limited. Also, the rate of paper packaging and plastic containers are high due to the high number of imported goods.

b. Advantages of island nation

Despite the disadvantages outlined above, an island country carries the following advantages for 3R promotion.

- It is easy to control imported articles, which are only delivered by sea or air transport.
- Accordingly, as a countermeasure to deal with mixed-material containers and plastics which pose difficulty in applying proper treatment methods, it is easy to introduce custom controls or promote proper treatment (e.g. by imposing custom duties to promote proper treatment).
- It is easy to introduce an effective deposit system to promote Reuse/Recycle compared with other countries.

2.3.2 National Policy on 3R Promotion

The National Government, through the Ministry of Local Government, Housing, Squatter Settlement, and Environment will advance the following policies on 3R promotion:

- Prepare the legal system necessary for the national government to strengthen LA's to promote the 3Rs.
- Prepare systems to assist in securing financial sources required to promote the 3Rs and proper treatment.

2.3.3 3R Promotion Policy of Local Authority

Considering the characteristics of Fiji for 3R promotion mentioned above, it is recommended for an LA to promote 3R following the steps outlined below.

To develop an Action Plan for 3R Promotion, the LA is encouraged to utilize the results of surveys and experiences obtained in LCC and NTC, and request LCC/NTC experts to provide them with some support if necessary.

Step 1: **Understanding current problems on MSWM:** The first step for adopting a policy on 3R promotion is to understand its current problems of MSWM as accurately as possible. It is desirable to conduct a baseline survey as in the case of Lautoka and Nadi. However, considerable funds and personnel are necessary for the baseline survey, LA is requested to conduct this by using available personnel and materials as much as possible to develop human resource in charge of waste management. In cases where it is hard for LA to carry out the survey by itself, it is suggested for an LA to utilize the "3R Promotion Manual" and Survey report of MSWM in LCC and NTC and understand their current problems on MSWM with minimum input.

- Step 2 **Development of Action Plan for 3R Promotion:** Considering the current situation and problems on MSWM, the LA should develop an Action Plan (A/P) to solve the current problems and promote 3Rs. The LA will leverage the “3R Promotion Manual” and the master plan on MSWM for LCC and NTC. Therefore, the A/P will be a plan to solve the current problems and promote 3R activities step by step referring to the guidance for waste stream.
- Step 3 **Step-by-step 3R Promotion:** A large amount of input is necessary to conduct 3R promotion. Considering the scale of population of the LA, investment for recycling facility and equipment may be small. The 3R promotion should reflect the regional characteristics and be understandable for the citizens who must be collaborators. Therefore, 3R promotion was proceeded step by step in LCC and NTC considering these points of views. It is suggested that 3R promotion should be initialized as a pilot project and be expanded with amendment of A/P if necessary

2.4 Target of 3Rs

2.4.1 3R Output Indicators

a. Output of 3R

It is exceedingly difficult to obtain a quantitative measure for the output of 3R. The waste generation changes depending on several factors, mainly lifestyle changes, a rise in income, an increase in population, and an increase in business activity. Nevertheless, in general, waste generation shows a tendency to increase. Therefore, It is recommended that the “Final Disposal Amount” and “Recovery Rate”, outlined below, are to be used as the indicators to confirm the output of 3R promotion.

b. Final Disposal Amount

A reduction of *10. Final Disposal Amount* in Figure 4: *Basic Waste Stream and 3R Promotion Methods* is the most easily understandable and obtainable indicator.

However, the following events may arise so the evaluation of this indicator should be taken carefully.

- An LA that does not provide collection service for all of its citizens should make it a priority to expand and strengthen its waste collection service, however, it is also possible to simultaneously promote the 3Rs. Nevertheless, expanding the collection service will likely increase *10. Final Disposal Amount* so, even if 3R is promoted, there may not be a noticeable reduction in the final disposal amount.
- Generally, the amount of MSW generated shows a tendency to increase as the living standard rises. Therefore, it is supposed that the *10. Final Disposal Amount* will not decrease, even if the 3Rs are promoted.

c. Recovery Rate

The following amounts, as shown in Figure 4: *Waste Stream and 3R Promotion Methods*, should be estimated based on the waste stream developed as outlined in the 3R Promotion Manual.

- 5. On-site Recycling
- 7. Recycling at Discharge Point
- 9. Recycling at Treatment Facility
- 11. Recycling at Disposal Site

Estimate the sum of the above recycling amounts, and then calculate this in juxtaposition to item 1. *MSW Generation* to obtain the recovery rate. The increase of this recovery rate is used as an indicator.

2.4.2 Current Situation concerning SWM

There are 13 municipal councils in the Fiji islands and the Department of Health at each council is responsible for waste management. The table below gives a summary of the current situation concerning SWM in these LAs in terms of population, the waste generation amount estimated according to the 3R Promotion Manual, collection system, and final disposal.

Therefore, the waste generation rate of LCC is adopted for estimation of the waste generation. As it is explained in the 3R Promotion Manual, the MSW generation rate of NTC obtained in the Project is 1.894kg/person/day, which is considerably high due to the large portion of the business establishments as a tourist town. This rate is so high compared with that of the other cities in foreign countries that JET determined it is not suitable to use as an average rate for estimation of the MSW generation amount of the other LAs.

Table 3: Current SWM in the Municipal Councils

Councils		Population ^{*1}	Generation ^{*2}	Collection		Final Disposal				Recovery rate
		2010 (Nr)	(ton/year)	System ^{*3}	Rate ^{*4}	Site	(ton/year)	Type ^{*5}	System	
1	Ba	14,868	6,013	CO	100%	Magruru	2,652	SL	DO	
2	Labasa	7,638	3,089	CO	100%	Namara	2,243	OD	DO	
3	Lami	20,045	8,107	DO	100%	Naboro	5,433	SL	CO	
4	Lautoka	43,838	17,729	CO	100%	Vunato	19,037 ^{*6}	CT	DO	8.1%
5	Levuka	1,121	453	DO	100%	Natokalau	1,280	OD	DO	
6	Nadi	11,895	8,432	CO	100%	Vunato	5,166	CT	DO	2.9%
7	Nasinu	86,678	35,054	CO	100%	Naboro	23,494	SL	CO	
8	Nausori	24,169	9,774	DO	100%	Naboro	6,551	SL	CO	
9	Savusavu	5,947	2,405	DO	100%	Savusavu	956	OD	DO	
10	Sigatoka	5,947	2,405	CO	100%	Kulukulu	7,300	OD	DO	
11	Suva	84,939	34,351	DO/CO	100%	Naboro	23,022	SL	CO	
12	Tavua	1,390	562	CO	100%	Magruru	248	SL	DO	
13	Rakiraki	4,909	1,985	DO	100%	Naria	1,442	OD	DO	
Total		313,384	130,359				98,824			3-8%
Disposal rate			100%				76%			

^{*1}: Population in 2010 is estimated based on that in Table 4 shown in the National Solid Waste Management Strategy 2011-2014 except Sigatoka's population confirmed by hearing from the council.

^{*3}: Waste generation amount estimated by population and MSW generation rate (1,108kg/person/day in 2010) which was projected for LCC in the Waste Reduction and Recycling Promotion Project.

^{*3}: CO=Contract out, DO=Direct operation

^{*4}: Rate of waste amount collected on discharged

^{*5}: SL: Sanitary Landfill, CT: Control Tipping, OD: Open Dump

^{*6}: Disposal amount is bigger than the generation amount why the waste from surrounding area other than Nadi is disposed to Vunato DS

The sum total waste generation amount for all LAs is estimated as 296 ton/day. Almost 70% of total generation is concentrated at the Naboro disposal site where waste collected in the eastern metropolitan area of Suva is disposed of. On the other hand, in the western part of Fiji, the total generation amount from Lautoka and Nadi is 61 ton/day, and collected waste is disposed of at Vunato disposal site. The total generation amount of the municipal councils using Naboro or Vunato disposal sites exceeds 90% of the total amount of waste generated in Fiji.

The recovery rate obtained in Lautoka and Nadi in 2008 was 8.1% and 2.9%, respectively. These are the recovery rates prior to 3R promotion. There are no undertakings being carried out by other LAs referred to as 3R activities, however, beer bottles are collected nationally and, thanks to generally spacious properties, traditional backyard composting is popular. Considering the above, confirmed in the baseline survey conducted in LCC and NTC, a Recovery Rate in Fiji may be in the range from 3% to 8% as of 2010.

2.4.3 Numerical Target

Considering the current situation of SWM in Fiji, and the results obtained through the Waste Minimization and Recycling Promotion Project conducted in LCC and NTC, the target year and numerical targets are provided as follows:

- Target year:

The target year for waste minimization is set as 2020.

- Numerical Target for 3Rs:

The numerical target for waste minimization through 3R promotion is given below.

Table 4: Numerical Target for Waste Minimization

	2010 (Present)	2015 (mid term)	2020
MSW generation	130,359 ton/yr	140,671 ton/yr	149,979 ton/yr
Collection rate ^{*2}	100%	100%	100%
Recovery rate ^{*3}	3.0 – 8.0 %	10%	15%
Disposal amount	98,824 ton/yr ^{*1}	100,600 ton/yr	103,500 ton/yr
Disposal rate ^{*3}	76%	72%	69%

^{*1}: Quantities of waste disposed to landfill at dumps in 2010 is shown in Table 13 of the National Solid Waste Management Strategy 2011 – 2014

^{*2}: Collection rate is the ratio of waste amount collected to the waste amount discharged.

^{*3}: Recovery rate and disposal rate are the ratio of the waste recycled and disposed at the landfill site to the waste generation amount respectively.

3 Basic Accord for 3R promotion

3.1 Framework of national policies

To realize the waste minimization target given above, 3R activities must be carried out by individuals, business establishments, local authorities and the central government according to their various roles under laws and regulations such as:

- Environmental Management Act 2005
- National Solid Waste Management Strategy and Action Plan 2008-2010
- Litter Decree Amendment 2010

3.2 Role of individuals, business establishments, local authorities and central government

National government, LAs, people and business establishment need to build proper SWM system with emphasis on 3Rs, whilst playing each role as mentioned below. Furthermore, Fiji may consider supporting 3R initiatives of neighboring Pacific countries.

3.2.1 Individuals

When selecting a purchase, individuals should give priority to less packing, and reusable, durable and/or reprocessed goods. Consumers should strive to use products as long as possible by repairing damaged goods to reduce the amount of waste they themselves discharge. Also, citizens are requested to cooperate by properly separating their waste according to the categories set by the LA for collection in order to encourage appropriate recycling.

3.2.2 Business establishments

Business establishments are responsible for the disposal of waste generated in the process of their activities. Businesses should give consideration to waste discharge reduction and appropriate recycling and reuse when selecting raw materials and/or, if necessary, by reconfiguring their manufacturing process. Then, once efforts have been made for waste reduction, reuse or recycling, businesses should secure appropriate treatment methods for the remaining waste to be disposed.

Also, concerning the manufacture, processing and sale of products, businesses should strive to simplify products and their containers and packaging, produce and sell reusable, durable products, improve product repair services and provide information needed to reduce discharge and readily implement recycling, reuse and treatment.

3.2.3 Local authorities

A LA should promote citizen's voluntary activities within its jurisdiction for discharge-reduction of MSW through proper awareness raising, information services, environmental education, etc. LA must also make efforts to recycle general waste by promoting separate collection and recycling activities.

To implement disposal management of MSW, the LA should consider the necessity to promote proper recycling and disposal, and attempt to establish broad-based management through cooperation with the other local authorities. The LA is requested to conduct cost

analysis on waste management and information services and strive to make waste management effective according to the socio-economic aspects revealed through its analysis. It is recommended for a LA to promote discharge-reduction and recycling, charging a fair rate according to the discharge amount and encourage greater consciousness amount the citizenry by utilizing economic incentives.

When the LA introduces a new, or changes the existing, waste management system through measures such as changing the categories for separate collection and/or disposal methods, it will strive to clearly explain the necessity and environmental and economical merits of the new or revised system to individuals and business establishments.

3.2.4 National Government

National government measures to enhance the base for implementing the method to promote 3R in Table 1.

To promote reduction of waste generation and reuse, it is essential to change people's lifestyle which means that the people are interested in the garbage problem, select the products and services with less environmental impact and cooperates more separate collection for waste minimization and recycling. For this reason, the national government serves for promotion, providing various information and environmental education to change the people's lifestyle with LA.

The National Solid Waste Management Strategy 2011-2014 emphasize financial sustainability for establishment of a proper SWM system. Therefore, DOE will analyse and evaluate the cost for SWM and provide its results, which are the basic information to study the concrete measures adopted for 3R promotion and the optimization of the SWM system including facility development, to be a bases to optimize the system.

The National Government supports each LA to smoothly establish a proper MSW management system and promote 3R activities for the waste minimization.

The National Government shall attempt to build momentum for 3R activities by providing information services regarding progressive examples at home and abroad to promote voluntary activities of individuals and business entities, and to support LAs in proceeding with the 3Rs.

The National Government supports each LA technically and financially to minimize waste and encourages LAs to organize for broad-based, divisional management.

The National Government shall subsidize 3R activities promoted by LAs for waste minimization, as needed, to encourage their smooth implementation.

The National Government considers introduction of an economic incentives in order to inhibit municipal waste generation and promote reuse.

3.3 Establishment of a Sound Solid Waste Management System

Carrying out the following items is essential to establishing a sound SWM system:

- LAs promptly collect, transport and dispose MSW according to the established plan to

avoid any potential damage to the living environment within its jurisdiction.

- LAs consider the policies to achieve waste minimization when preparing a SWM Master Plan. It is necessary to take into account likely changes in the quantity and quality of MSW generated from the mid- and long-term views when preparing the management system.
- A proper collection system that takes disposal and recycling methods into consideration is established. LAs must also establish an effective transportation system considering geographical features and the distribution of their population. A transfer station shall be considered if necessary.
- Broad-based relationships beyond council boundaries are considered, as necessary, to organize collaboration on regional waste management amongst LAs.
- The management system is notified to the public in advance to obtain their support since it is essential that residents and business establishments, which discharge the MSW, are cooperative.
- LAs attempt to harmonize their SWM Master Plan with that of others so that, in cases where it is not possible for an LA to treat waste within the area it was generated, it will be treated in the facility of another LA.
- The Central Government encourages the activities carried out by the existing recyclers and strives to promote the recycling industry.

Appendix

Intermediate Treatment Technologies and Resource Recovery Method

- a. Refuse Derived Fuel (RDF)
- b. Pyrolysis
- c. Biogas Production
- d. Incineration
- e. Ash Solidification

a. RDF

RDF (Refuse Derived Fuel) utilizes plastic and paper, which are components of MSW with high calorific value. The large volume of plastic and paper-waste makes it difficult to use as a fuel, so the volume is typically reduced by processing the waste into pellets. To utilize the RDF as a fuel, however, an incinerator is necessary. However, the incinerator needs air pollution prevention equipment, particularly to prevent the release of dioxin, which is generated when plastics containing chloride are burned. Therefore, a great deal of investment is needed to develop an incinerator for the exclusive use of RDF. It is generally estimated that construction costs are about US\$100,000 per ton. It is also required to introduce continuous incineration at a temperature over 850°C to prevent the release of dioxin. Therefore, due to investment constraints for other components of MSW management, JET does not recommend introducing the technology of RDF to local administrations in Fiji where the amount of waste generated is not that great.

b. Pyrolysis

Pyrolysis is the thermal decomposition of organic material at elevated temperatures in the absence of oxygen. The term is derived from the Greek *pyr*, meaning “fire”, and *lysis*, meaning “to separate”. The process requires heat to produce a mixture of combustible gases (primarily methane, complex hydrocarbons, hydrogen and carbon monoxide), as well as liquid and solid residues. Extreme pyrolysis leaves mostly carbon as the residue, and is therefore called carbonization. Pyrolysis typically occurs under pressure and at operating temperatures above 430 °C.

As stated above, pyrolysis technology requires a facility that can provide high pressure conditions without oxygen and would likely require a large amount of investment. Also, there are not many waste treatment facilities that have adopted this technology. Therefore, due to investment constraints for other components of MSW management and the relatively complicated technology required, it is not recommended to introduce the pyrolysis to the LA in Fiji.

c. Biogas Production

Biogas is a combustible gas developed when organic matter is degraded under anaerobic conditions (i.e. without the presence of oxygen) known as anaerobic degradation. Anaerobic degradation of organic matter, resulting in biogas production, is an efficient means of degrading organic wastes, and making it hygienic. Anaerobic waste treatment is a well known process relating to the treatment of livestock manure, sewage sludge and industrial waste water and other sludge. Biogas can be utilized both for heat and power production. The residue is sludge, but can only be utilized as compost when not contaminated with non-organic matter. Therefore, introduction of this technology is not recommended due to the following reasons:

- b. The required investment for facilities is very high, similar to an incineration plant.
- c. To operate the biogas plant, a collection system preventing the interfusion of non-organic matter would have to be established.

- d. This technology is more appropriate for liquid waste rather than for heterogeneous waste such as MSW due to the high demands to keep organic waste free of non-organic matter.

d. Incineration

Incineration of MSW is one of the most popular methods recently adopted for processing wastes in developed countries. Waste is mainly converted into stable oxidized gases and partly into stable inorganic matters by high temperature combustion. Of the various intermediate treatment technologies, incineration generally reduces waste volume to a large degree. It also stabilizes putrescible organic wastes. Energy from waste incineration can be utilized for the production of electricity and/or district heating, and the income from the sale of energy may contribute to the economics of the plant.

A general observation would indicate that incinerators may be feasible where land for land filling is scarce, expensive or very remote from the center of actual solid waste generation. Modern incineration and flue gas treatment technology makes waste incineration an environmentally acceptable form of waste treatment; it is, therefore, possible to locate such plants even in densely populated areas.

On the other hand, the construction cost of an MSW incineration plant requires more than US\$100,000 per ton and also has very high operation costs. High temperature combustion (above 850°C) should be maintained as a measure against dioxin. Due to investment constraints for other components of MSW management and the relatively small amount of MSW generated, it is not recommended to introduce the incineration system to the LA, except for medical waste and hazardous waste.

e. Ash Solidification

This technology solidifies the ash generated after combustion. Solidified ash becomes slag and may be used as road construction material. Thus, this technology generates no residue that must be disposed of at a landfill site. Many local governments in Japan have adopted this technology because of very expensive disposal costs (more than US\$300/ton). However, it is not recommended to introduce this technology due to high construction and operation costs for solidification.