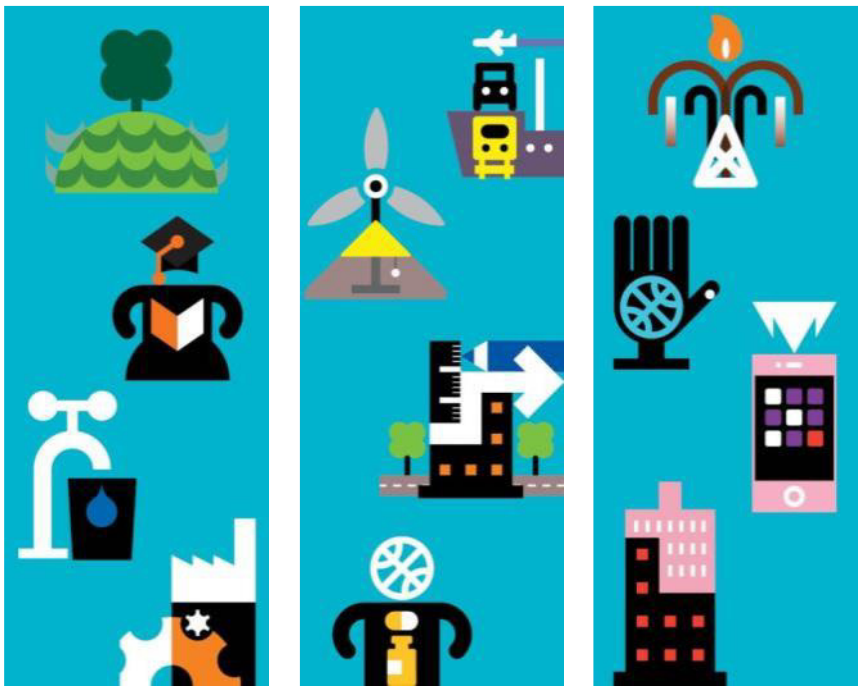

Curitiba Solid Waste Management Project Phase 1A: Assessment Report

September 2015

International Finance Corporation

Mott MacDonald

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Information Class: Standard

Contents

Figures

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List of Acronyms

ABNT -	Brazilian Technical Norms Association
BAT -	Best Available Technology
BNDES -	Brazilian Development Bank
Conresol –	Inter-Municipal Consortium for the Management of Municipal Solid Waste
CMSP –	Curitiba Municipal Sanitation Plan 2013
COMEC -	Curitiba Metropolitan Area Coordination
CONAMA -	National Environment Council
CPI -	Consumer Price Index
CSWMS –	Curitiba Solid Waste Management Strategy 2010
C&D –	Construction and Demolition
C&I –	Commercial and Industrial
HGV -	Heavy Goods Vehicle
IAP –	Environmental Institute of Paraná
IBAMA –	Brazilian Institute of Environment and Renewable Natural Resources
IBGE –	Brazilian Institute of Geography and Statistics
IDB -	Inter-American Development Bank
IFC –	International Finance Corporation
IPPC –	Curitiba Pro-Citizenship Institute
IPPUC -	Curitiba Research and Urban Planning Institute
MAPA -	Ministry of Agriculture, Livestock and Supply
MSW –	Municipal Solid Waste
PET –	Polyethylene Terephthalate
PGRS -	Waste Management Plan

PNMA -	National Environmental Policy
PPE -	Personal Protective Equipment
PPP -	Public Private Partnership
PSP -	Private Sector Participation
RCV –	Refuse Collection Vehicle
RFI –	Request for Information
SMMA –	Municipal Secretary of Environment
SWOT -	Strengths, Weaknesses, Opportunities and Threats analysis
UVR –	Residue Valorisation Unit
WBO –	World Bank Organization
WEEE –	Waste Electric and Electronic Equipment
WFM –	Waste Flow Model
WNW –	Waste that is not Waste

Executive Summary

Mott MacDonald's Appointment

Mott MacDonald (MM) was appointed in June 2015 to provide technical advisory support (the 'MM Commission') to the International Finance Corporation (IFC) for the development of a Public Private Partnership (PPP) transaction (the 'Project') that is aimed to improve the waste management systems in the Municipality of Curitiba (the 'Municipality').

The appointment is financed by the country's Private Sector Participation (PSP) programme, a partnership between the IFC, the Brazilian Development Bank (BNDES) and the Inter-American Development Bank (IDB).

Technical Due diligence Scope

This report presents the findings of the first phase of the MM Commission. The objective of this first phase was to perform technical due diligence on the existing waste management arrangements in the Municipality.

The scope of the technical due diligence comprised the review and assessment of the following aspects:

- Waste Generation
  - Waste volume statistics; and
  - Waste compositions and calorific value.
- Waste Collection and Transport Arrangements
  - Organisation;
  - Existing contracts;
  - Infrastructure and equipment;
  - Routes; and
  - Waste volumes and statistics.
- Recycling Activities
  - Key stakeholders;
  - Infrastructures;
  - Regulation; and
  - Off-take markets and pricing.
- Waste Treatment Arrangements
  - Current contracts;
  - Waste volumes and statistics; and
  - Pricing.
- Key Regulations Applicable to Waste Separation and Treatment
  - National level; and
  - Local level.

Project Background

The Municipality of Curitiba is widely recognised in Brazil as an innovator in sustainable urban planning and development. In terms of waste management, the City has also developed a number of innovative initiatives aimed at reducing the environmental impact of waste, improving recycling and promoting social inclusion. Notwithstanding, Curitiba faces on-going challenges with regard to waste generation and management which require the development of more sustainable, long-term solutions.

A key challenge that the Municipality currently faces relates to its reliance on a single landfill site for the disposal of its waste. The landfill capacity is only available in the short to medium term, within the context of sustained population growth coupled with a generally high prosperity level compared to the average for Brazil. This leads to increasing tonnages of waste being produced, requiring collection, transport and treatment.

The Municipality acknowledges that there is a need to make a step-change in the way it manages the city's waste, recognising that there are currently untapped opportunities to extract additional value from materials, whilst also facilitating wider social and environmental benefits.

With its waste collection and disposal contracts due to expire shortly, the Municipality's aim is to develop a new, integrated waste management approach that is able to exploit such opportunities in full.

Strategic Context

Administrative Arrangements

The City of Curitiba lies within the Curitiba Metropolitan area, which sits within the State of Paraná in the South of Brazil. Paraná is divided into 20 regions, one of which is the Curitiba Metropolitan area. The Metropolitan area comprises 29 municipalities including the Municipality of Curitiba, the most densely populated municipality, sitting at the centre.

The consortium Conresol is responsible for much of the waste management structure in the region. Conresol has arrangements with multiple Municipalities near Curitiba and run the main Curitiba Municipality landfilling contract.

Relevant Waste Strategies

Municipal Waste Strategy

The Municipality's objectives and targets in relation to waste management are set in the 'Municipal Waste Strategy' 2010, which was revised in 2013 via the 'Municipal Sanitation Plan'. Changes incorporated through the 2013 revision reflect the aspirations of the current government, but do not substitute the 2010 plan as not yet formally approved. The key targets and objectives in the Municipal Waste Strategy are shown in Table 1.1, whilst the revised quantitative targets in the Municipal Sanitation Plan are shown Table 1.2.

Table 1.1: Municipal Waste Strategy Key Targets and Objectives

Key Targets and Objectives
Municipality Collection Objectives and Strategies;
– Maintain 100% household coverage of the residual collection scheme;
– Maintain 100% household coverage of the "Waste that is not Waste" collection scheme;
– Support and develop 25 new areas for waste picker turn-ins and support;
Municipality Disposal and Processing Objectives and Strategies;
– Process 100% of waste, diverting at least 85% and at most landfilling 15%;
– Evaluate the use of new technologies and equipment;
– Support composting and biogas utilisation;
– Increase recycling bailing and processing capacity;
– Install a reverse manufacturing plant in the city for electronic waste processing;
– Look into construction and demolition (C&D) waste processing technologies;
Other Municipality Objectives and Strategies;
– Intensify fiscal monitoring of the recycling industry;
– Maintain cleaning services;
– Monitor 100% the waste plans of "large generators";
– Promote the reduction of waste generation and sustainable practices; and
– Reduce greenhouse gas emissions.

Table 1.2: Municipal Sanitation Plan Targets and Objectives

Key Targets and Objectives
– Progressive reduction of landfilled waste: reduction of 43% in short term, 50% in midterm and 53% in long term;
– Implementation of five Eco-Citizen Sites in short term, and implement the number of Eco-Citizen Sites needed to reach the number of registered waste collectors in midterm;
– Increase number of registered waste pickers by 40% in short term, 30% in midterm and another 30% in long term;
– Reduction of landfilled food waste: reduction of 30% in short term, 40% in midterm and 50% in long term

Conresol Strategies

In addition to the Municipality's strategy and plan, there are strategies laid out by the regional waste management consortium Conresol. One of the presented objectives includes the decentralisation of the waste management infrastructure and treatment processes in the region, as currently the region is dependent on one landfill operator, with recycling as the only significant landfill diversion option. The strategy aims to reduce haulage costs across the Conresol Municipalities by implementing different treatment or disposal units across the region.

Regional Waste Strategy

A Regional Solid Waste Management Plan was also developed at the Paraná State level in 2013, to address waste management issues and formulate strategies for the combined area. The plan covers a range of concerns and provides some detail on where additional development is desired. This process aims to increase the number of sites able to receive waste in order to lower haulage costs, for example through a network of transfer stations. These stations, which would be located closer to the point of origin of the waste, would then be used to bulk and haul the material to the treatment and disposal sites.

Existing Waste Management Contractual Arrangements

The Curitiba Municipality has a number of contracts in place for the provision of waste and street cleansing collection and transport services. Waste disposal is instead contracted directly between the Conresol Consortium and the Estre Landfill.

The main contracts that were presented to Mott MacDonald are summarised in Table 1.3.

Table 1.3: Summary of Existing Waste Management Contracts

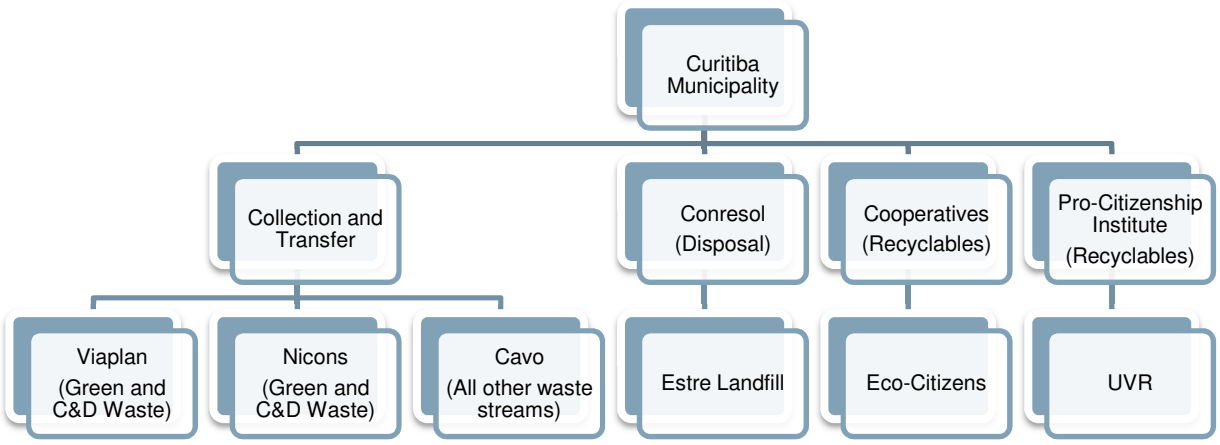
Contract Company	Duration and End Date	Material Stream	Comments
Viaplan with Municipality	5 years, Sept 2017	Green and C&D collection and transfer	Zones 1, 3, and 4 (4 zones in total).
Nicons with Municipality	5 years, Sept 2017	Green and C&D collection and transfer	Zone 2. (4 zones in total)
Cavo with Municipality	5 years, Apr 2016	All other streams collection and transfer	
Conresol (Consortium) with Municipality	1 year, Dec 2014	Waste Disposal	Landfilling Fee

Contract Company	Duration and End Date	Material Stream	Comments
Conresol with Estre	2 years, October 2012	Waste Disposal	Landfilling Fee
Conresol Tender with Waste Management Companies	Up to 5 years, October 2017, with the option to stop the contract earlier	Waste Disposal	Landfilling / Processing.

Source: RFI response document "Item 10 and 11" (Ref.12), RFI response document "Material Consortium" (Ref.21)

The contractual structure for the Curitiba Municipality as understood by Mott MacDonald is as shown in Figure 1.1:

Figure 1.1: Curitiba Municipality Contractual Structure



Cavo is the single contractor for the majority of waste collection for which the Municipality is responsible. This is listed in the contract as the following services:

- Collection and transport of household residual solid waste and street cleansing waste;
- Collection and transport of solid recyclable waste (Waste that is not Waste and Green Exchange);
- Indirect collection of household residual solid waste;
- Manual sweeping;
- Mechanical sweeping;
- Market sweeping and washing;
- Poster removal and sidewalk washing;
- Special cleaning;

- River cleaning;
- Collection, transport, and destination for treatment of household hazardous waste; and
- Maintenance and monitoring of the Curitiba Landfill (Caximba).

Conresol Contract Tender

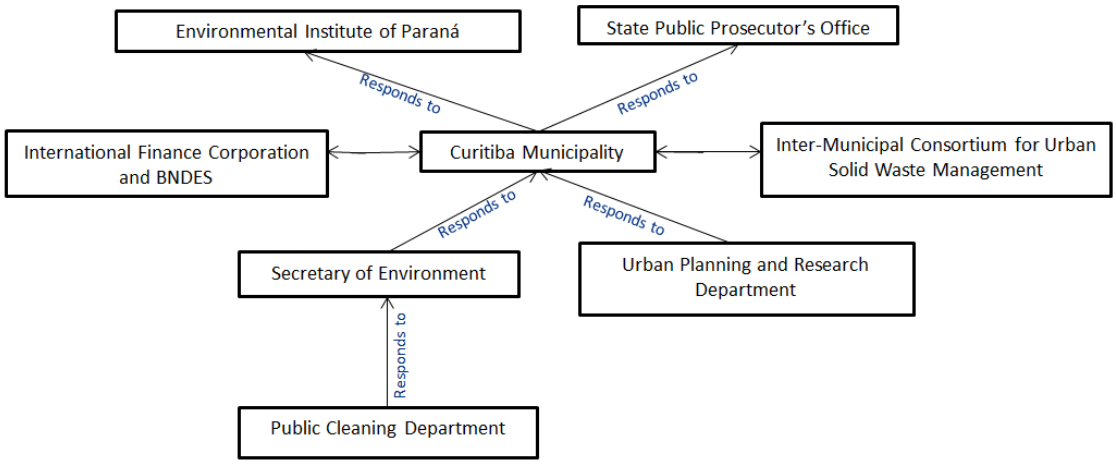
Conresol has a contract with Estre for the purposes of landfilling the waste arising from the Curitiba Municipality as well as the 22 other Municipalities covered by the consortium. It is understood that the Conresol – Estre contract provided to Mott MacDonald was renewed multiple times with price and tonnage adjustments and is currently due to expire in October 2015.

Conresol has now begun a new tendering process for the disposal of its waste. The aim of the tendering process is to develop new contractual arrangements to begin in October 2015 and last for a period of up to five (5) years. The contract is understood to include break clauses allowing the Municipality to terminate the contract before the end of its term. It is understood that discussions are being held with regards to the possibility of varying the terms of the contract.

Key Project Stakeholders

Within the strategic context previously outlined, Mott MacDonald has identified from a project deliverability point of view the primary institutional stakeholders that have influences or decision making capabilities within the Municipality's waste management structure. This is shown in Figure 1.2.

Figure 1.2: Primary Institutional Stakeholders and Relationships



Status of Curitiba's Current Waste Management Services

Waste Streams

A diverse range of waste streams from domestic, commercial and industrial sources, are generated within the Municipality of Curitiba. Table 1.4 summarises the main categories, as well as their identified streams, that were used for the purposes of this study.

Table 1.4: Waste Categories and Streams

Waste Categories and Identified Streams
Domestic Waste generated by individual households, condominiums, and apartment complexes: – Household Residual Waste; – Household Dry Recyclable Waste; – Waste Electric and Electronic Equipment (WEEE); – Household Green Waste; – Household Construction and Demolition (C&D) Waste; – Household Bulky Waste; and – Household Hazardous Waste
Public area waste from cleaning and washing parks, streets, rivers, and other public grounds: – Street Sweeping Waste; – Gardening Waste; and – River Cleaning Waste
Commercial wastes generated by small businesses in the City:

Waste Categories and Identified Streams
– Commercial Residual Waste; – Commercial Recyclable Waste; and – Commercial Construction and Demolition (C&D) Waste
Animal carcasses from households and street cleaning operations Medical waste generated by healthcare facilities

Waste Collection and Transfer

A large number of waste collection schemes and programmes currently operate in Curitiba, as shown in Table 1.5; this includes multiple services operated by the municipality, services that are provided by the private sector and informal arrangements, the latter involving some vulnerable local population groups (i.e. informal waste pickers or 'catadores').

Table 1.5: Curitiba Waste Collection Services

Waste Collection Services in Curitiba
Municipality operated collection services: – Residual waste collection service for households; – Recyclables collection service for households, known as 'Waste that is not Waste'; – Voluntary Collection Recycling Programme; – Green Exchange Programme for recyclable materials; – Social Action Foundation scheme for collecting (reusable) bulky household wastes; – C&D and green waste collection (small quantities) from households; – Commercial and Industrial (C&I) waste from small businesses (small quantities only); – Hazardous waste collection for households; – Special collection of animal carcasses; and – Collection of wastes from public areas.
Informal collection of recyclables by waste pickers; Private waste collection for generators of large quantities of C&I and C&D; and Healthcare waste collection operated by the private sector.

Commercial and industrial sites with a waste generation capacity of less than 600 litres (0.6m^3) a week are classified as "small generators" and it is the responsibility of the Municipality to collect their waste. The Municipality does not collect from any site that produces more than 0.6m^3 of waste per week.

Waste Pickers (Catadores)

There are formal (Eco-Citizen) and autonomous waste pickers in Curitiba. The waste pickers collect recyclable materials on the street, from household bin bags and from commercial sites. Often they collect the materials before the official municipal collection

service comes through, in order to separate the waste that is more valuable to them, such as aluminium and iron, some plastics and cardboard.

Eco-Citizen waste pickers deliver their waste to the Eco-Citizen sites, which also get deliveries from other collections. These waste pickers are part of Associations or Cooperatives and have been formalised by the Municipality. There is data regarding the Eco-Citizens waste picker numbers and activities. Autonomous waste pickers are not registered by the Municipality, although they may work in formally agreed groups. As they are not registered there is little information about their practices and numbers. Autonomous waste pickers collect and separate waste from households and commercial organisations in order to obtain the most valuable material possible.

Waste That Is Not Waste Programme (WNW)

The Waste that is not Waste Programme is the collection of mixed recyclables from households and small commercial sites. Collection is performed from one to three times per week, depending on the demand and output of the location, and covers 100% of the Municipality area. The programme aims to recycle a variety of materials, including paper, plastics, glass, metals, and scraps from bulky waste such as ovens, washing machines and other WEEE sources.

Individual households are expected to separate their waste for recycling. Waste collected by the programme is presented in black bags, usually left outside houses and apartments in locked metal containers or on the sidewalk. As all wastes are collected in black bags, there is not an easy way to determine if the material is recyclable or is contaminated. In addition, as the most valuable recyclable materials put out by households and small commercial businesses are typically picked by formal and informal waste pickers prior to the formal collection round, this mainly leaves lower quality/contaminated material for collection by the Waste that is Not Waste Programme.

Another operational aspect identified as an area for improvement relates to the fact that vehicles may fill up to only around 80% of their maximum capacity.

Residual Waste Collection

The Municipality offers a residual waste collection for materials that do not fit the criteria of the “Waste that is not Waste” programme. These materials are collected directly from households and small commercial establishments, or, in the case of gated condominiums and apartments, an internal collection service is usually performed by the

site management. The collected material is then stored in a specific accessible location or taken to the street for collection by the municipality's refuse collection vehicles.

The collection service covers almost 100% of the city, providing collections either three times per week or daily. There are a few remaining inaccessible areas that do not have direct collection. This is understood to be due to a number of access issues. No maps were provided therefore it was not possible to identify where these areas are. These areas have their residual waste removed via an indirect collection programme where waste is taken by the householders to a specific location which is accessible for collection vehicles.

Mott MacDonald has identified potential to improve the efficiency of the collection system through optimisation of collection routes and increasing capacity limits such that fewer vehicles are required to transfer waste to the current landfill, approximately 40km from the city centre.

Efficiency could be improved through the use of organised collection routes and transfer stations. This would allow for bulk carriers to be used to transport the waste from the transfer stations to the landfill site, maximising the time spent by the smaller collection vehicles in collecting waste. Recycling Voluntary Collection Programme

The voluntary collection programme began in November 2014 as an attempt to reduce collection fees by encouraging the population to take their own recyclable material to bring sites and separate them themselves. The project currently has four sites where the collection is performed; these have been used as a trial to study the programme efficiency and set-up.

Each site accepts recyclable materials including plastics, ferrous and non-ferrous metals, glass, paper and card and Tetrapak cartons. Although the programme is new and its effectiveness not yet proven, it has in principle the potential to divert additional waste from landfill and, depending on its success, reduce future collection requirements. The Municipality intends to continue the current pilot phase and has plans to progressively expand the scheme across the city.

Green Exchange Programme

The Green Exchange Programme is dedicated to exchanging mixed recyclable waste for food in poorer areas of the Municipality. The programme began in 1991 with 53 exchange points and currently has around 100 points. Each point receives a collection

every two weeks. It is understood that this programme is very important to the local residents where it is based and therefore existing locations will be continued, although no new locations will be introduced.

Household Green and C&D Collection

The Municipality provides a service to householders for the collection of green waste and small volumes of C&D material. Households are able to dispose of any tree/grass cuttings or similar (up to $1m^3$ per month) as well as $0.5m^3$ of C&D material every two months. Quantities above these limits must be privately collected.

As these materials are collected together, in the same vehicle, without any separation, this is likely to limit the extent to which they can be recycled or recovered.

Public Sweeping and Cleaning

There are a variety of sweeping and cleaning services that are provided by the Municipality. These services are conducted by Cavo. For the most part, these materials are of residual nature. Some of the cleaning is performed by teams dedicated towards addressing specific green waste sources, such as some parks, large trees, etc. This service is understood to operate well, although the majority of the waste collected would be unsuitable for further treatment as it is likely to contain high levels of grit from sweeping.

Hazardous Waste Collection

There are 24 points in the city where a vehicle visits once a month and remains available for the day. The vehicle accepts hazardous material delivered by city residents. As this service is not for private industrial and commercial businesses, there are limits on the quantity of material that can be accepted from each person

Privately Operated Waste Collection Services

There are about 15-20 companies that offer collection services to businesses that generate large quantities of C&I and C&D waste. It is understood that although the Municipality could technically provide this service to large generators of waste, the service is not performed.

Healthcare Waste Collection

Medical waste is collected by Cavo. The company also owns a microwave treatment facility and utilises that process to ensure the waste is dealt with appropriately.

Processing and Disposal

Curitiba has a number of waste processing and disposal sites; these have been divided into formal sites versus informal and illegal locations. These sites are presented in Table 1.6:

Table 1.6: Curitiba Waste Sites

Curitiba Waste Processing and Disposal Sites
Formal Sites: – Materials Recycling Facility (UVR) at Campo Magro; – Eco-Citizen sites; – Estre Landfill; – Essencis Landfill and Compound; and – PET Shredding and Flaking Plant (currently closed).
Informal and Illegal Sites – Informal waste picker sites; – Illegal C&D waste disposal sites used by private contractors and informal waste pickers; and
Caximba Landfill (no longer accepting waste).

Materials Recycling Facility (UVR) – Campo Magro

Curitiba has one large materials recycling facility, the UVR, located in the region of Campo Magro, roughly 30km from Curitiba's city centre. The site is owned and operated by the IPCC (Curitiba Pro-Citizenship Institute) in partnership with the Municipality. The facility was initially designed to process 800 tonnes of material per month but has increased its capacity and now processes 1,000-1,200 tonnes per month.

The facility has been operating for around 25 years, with very little investment on the site and equipment. This changed in March 2015, when it was decided that 30% of sales revenue is to be re-invested into site infrastructure, as opposed to the previous arrangements whereby all the revenue from the sale of the separated material was utilised for social programmes and standard operation site expenses.

Around 40% of the material taken to the UVR ends up as reject and is sent to landfill. The high level of rejected material is due to:

- Reported poor source segregation by householders;
- Lack of contamination controls, exacerbated by the use of black bags for both recyclables and residual waste, allowing non-recyclable material to reach the site; and
- Pre-removal of higher quality materials by waste pickers prior to collection, leaving lower value recyclable materials being received at the site, some of which are not financially viable to justify separation.

The site receives around 12,000–20,000 visitors per year from schools, charities, and open days and has social programmes to educate the visitors on the importance of separation and waste management.

Eco-Citizen Sites

The Eco-Citizen programme was developed in 2008 as an attempt to formalise the private waste picker market and legalise activities. Eighteen sites were formalised by June 2015 and operate under the Cataparaná network, whilst another three sites are formalised but do not operate under the same cooperative. The Associar Network is responsible for 22 sites, one of which is formalised and receives waste from the Municipality. In total, there were 22 Eco-Citizen sites formalised and receiving waste at the time this report was produced. These sites account for around 550 waste pickers, who are contracted by the cooperatives, and take in an average of 1,100–1,350 tonnes of material from the Waste that is Not Waste collection every month, in addition to any material site workers pick from nearby waste sources.

It is understood that pickers who work at Eco-citizen sites collect recyclables just before the collection vehicle in an attempt to gather the most valuable material from the waste. This happens because there is no certainty that the local Municipality collection material would be brought to a particular site, meaning that a ‘waste picker collection round’ is needed to guarantee the incoming of valuable recyclables.

People employed at the Eco-Citizen sites separate waste into constituent material streams and are able to sell the material to reprocessors, with the contracts and arrangements for this managed on a site by site basis, outside of the control of the Municipality.

Autonomous Waste Separation Sites

Autonomous waste separation sites, comprising both private, legally run sites, as well as illegal sites, also operate in the Curitiba municipality. These sites have not gone through the formalisation procedure to be a part of the Eco-Citizen Programme and, therefore, do not formally receive waste from the Municipality. The owners /site managers of these sites indicated various reasons for not participating in the Eco-Citizen Programme, ranging from not wanting to be a part of a cooperative in order to hire workers as regular employees, not wanting to comply with regulations, to not having the adequate knowledge of how to formalise their sites.

These sites receive their waste from waste pickers, who may or may not have an official link to the site. Many informal waste pickers depend on the structure of the site to shower, eat and sleep, especially in the cold months.

From a regulatory and safety point of view, many sites do not have environmental permits or authorisation from the fire service to operate, with some located in environmental protection areas (and most in high crime areas). Working conditions may also be precarious, specifically in terms of use of Personal Protective Equipment.

Landfill

The main landfill utilised by the Curitiba Municipality and some of the surrounding municipalities from 1989 until 2010 was the Caximba Landfill. This site is owned by the Curitiba Municipality and is located south of the city, about 23km from the city centre. It is now closed.

As of November 2010, waste from the City of Curitiba and most of the other municipalities in the Curitiba Metropolitan area was diverted from Caximba to the Estre Landfill. The site is located south of the Curitiba Municipality, in the “Fazenda Rio Grande” Municipality, about 40km from the city centre and is owned and operated by Estre Environmental S.A. The site is estimated to have a total of 10 years of remaining life expectancy.

Hazardous waste collected by Curitiba Municipality is currently taken to the Essences Landfill site. However, It is understood that Essencis is currently facing permitting challenges which could influence the ability of the site to operate.

Illegal C&D Dump Sites

There are 42 known sites that attract large volumes of illegal C&D dumping or “fly tipping”. This practice is illegal. A programme existed to clean the sites, however this is not currently in operation.

Development of the Waste Flow Model

There are two key aspects of waste data, tonnage and composition. Tonnage is the amount of waste produced and composition is what it is comprised of.

Waste Quantities (Tonnage)

Tonnage data was provided from a number of sources showing the total waste arising figures. This has been used by Mott MacDonald to produce a waste flow model outlining the current waste generated and estimating future waste figures based on potential population growth and changes in practices.

The collection of data in Curitiba is not fully complete; whilst waste which is not recycled or otherwise treated is sent to landfill and recorded through a system of weighing each vehicle as it enters the landfill site, data for recycling tonnages and other waste streams is less clear. Where data was not made available by the Municipality, assumptions have been made in order to estimate the tonnages produced each year.

Waste Composition

The composition is important to be able to understand the options for waste management and treatment, and potential recycling opportunities. Waste compositions have been compiled for each stream from a series of provided documents and best estimates from Mott MacDonald. The most recent study, performed in August 2015, was utilised for the composition of the collected household waste. Where information was not available estimates have been conducted based on waste management experience.

Waste Flow Model

In order to summarise the total waste arisings in the Municipality and analyse their potential growth, composition and impact of changes on one stream to the other wastes, a Waste Flow Model has been prepared by Mott MacDonald. This has currently been produced showing the base case of current practices in the Municipality and will be further developed during the course of project to model scenarios for future, alternative

waste management options. Table 1.7 shows the modelled tonnages by collection type for 2015 and projected forward over the likely project period.

Table 1.7: Stream Tonnages Summary

Category	Unit	2015
Population	person	1,886,128
HH and Commercial Residual	tpa	528,010
Indirect Residual	tpa	7,426
Public Cleaning	tpa	81,222
River Cleaning	tpa	1,296
Illegal C&D Dumping	tpa	15,000
Total Residual	tpa	632,955
Residual per Capita	kg/person/day	0.92
Waste that is Not Waste	tpa	31,208
Voluntary	tpa	28
Green Exchange	tpa	3,158
Waste Picker Collection (estimated)	tpa	171,346
Total Mixed Recyclable	tpa	205,741
Small C&D	tpa	49,296
HH Green	tpa	24,037
HH Hazardous	tpa	47
Animal Carcasses	tpa	189
Total Waste	tpa	912,264
Recycling Rate	%	22.6%
Total Waste per Capita	kg/person/day	1.33

Key Technical Due Diligence Findings

Mott MacDonald has utilised two types of analysis in its review and assessment of all primary and secondary information collated for this initial phase of the project:

- A strength, weaknesses, opportunity and threats (SWOT) analysis; and
- A gap analysis against international benchmarking.

The two analyses complement each other in that: the SWOT analysis provides a straight to the point snapshot of the current state of things with regard to the existing waste management arrangements; the gap analysis looks to identify where Curitiba stands compared to international best practice and identifies a series of recommended actions to bridge any gaps.

SWOT Analysis

Strengths	Weaknesses
▪ Diversity of collection schemes and wide range of services provide resilience to the waste management system. ▪ Coverage of almost 100% of households served by waste collection services. ▪ Current arrangements for sorting of recyclables provide source of income for vulnerable elements of the community and provides an important service to the waste management system. ▪ The Municipality has positively engaged the private and community sectors in providing recycling and waste disposal services. ▪ Well-established recyclables market with various companies working within it. ▪ As a major generator of waste, the Municipality is in a strong position to negotiate a contract with the private sector which addresses the Municipality's priorities (e.g. cost, landfill diversion, quality, etc.).	▪ Inefficiencies due to non-optimum routes, high collection frequencies, non-optimum crew utilisation, transport distance / lack of transfer stations, non-optimum vehicle capacity utilisation. ▪ All waste is collected in black bags and therefore it is difficult to identify contaminated recyclable waste. ▪ Limited capacity of monitoring and fining. ▪ Lack of waste composition data for all of the waste streams. ▪ Informal recyclate collections bypass the regulated system and are unrecorded in the recyclate they collect and sell on. Lack of quantitative data on informal waste collectors ▪ No material or energy value is recovered from residual waste. All residual waste currently disposed to landfill. ▪ Illegal dumping of C&D waste causing environmental impact in some parts of the city. ▪ Dependency of Eco-Citizen sites on sums paid by the Municipality upon receiving the waste, rather than them being self-sufficient purely from the income from the sale of recyclates. ▪ Lack of follow through from the Municipality to know what happens with the waste that is responsible for managing. ▪ In the absence of clear incentives for diverting waste from landfill, it will be difficult for options based on non-landfill technologies to compete on a commercial basis.

Opportunities	Threats
▪ Scope for significant improvement of cost efficiencies for waste collection and transfer. ▪ Improved community engagement/ communication and education could improve significantly separation of waste and recycling rate. ▪ Incorporation of informal waste collection and transfer streams into a more structured and regulated environment could enable increased reliance / utilisation of waste-pickers and limit overlap of formal waste collection and transfer provision. ▪ Development of transfer infrastructure to allow bulk transport of residual wastes could reduce costs and impacts of transfer of wastes to landfill. ▪ Potential to recover value from residual waste in the form of increased materials recovery, refused derived fuel production or energy from waste. ▪ Engage the community in development of new waste treatment infrastructure to minimise the potential for opposition and rejection. ▪ The Eco-Citizen sites work in cooperatives and networks; strengthening these connections can improve capacity for bulking and storing so as to improve commercial possibilities ▪ The established activities of the informal waste collection sector in the city currently provide cost benefits by providing recycling services at little or no direct cost to the Municipality. By procuring a new contract that incorporates or integrates with the informal sector, this benefit could be maintained.	▪ Opposition by elements of the pickers' community to make informal collection sector more structured. ▪ Conflicts between social benefits and private interest that might make new management schemes difficult. ▪ Scoping the Eco-Citizen project as a service to a vulnerable sector of the society may lead to poor efficiency and management ▪ Autonomous recycling sites are unregulated and unsupervised, meaning that the Municipality does not have control over their practices or materials targeted. ▪ Regional opposition to energy from waste facilities appears high based upon reported experience elsewhere in Parana State. ▪ Loss of shelter for waste pickers that depend on the autonomous sites for their well-being if formalised ▪ The informal waste collection sector plays a key role in the current delivery of waste management services. If the role of the informal sector is not handled sensitively and positively in the procurement of a new contract, there is a risk of conflict between the informal and private sectors over waste management.

Gap Analysis

The aim of the gap analysis was to assess primary elements of the Municipality's waste management system against international norms and to identify areas that would require a specific focus going forward.

The framework used is based upon the Wasteaware benchmark indicators for sustainable waste management in Cities. The Wasteaware benchmark framework has been used to benchmark over forty cities worldwide.

The framework is divided into five main areas that reflect the key aspects of a City's waste management systems:

1. Waste data: This part of the framework considers the extent to which the City collects and maintains the necessary data to support planning and strategic decision-making to operate and progressively improve waste management systems and services. Key data includes information on waste generation, composition and factors that will influence these issues over time (e.g. population growth and demographic change).

2. Waste collection: This aspect considers the status of the city's waste collection services including the coverage of the collection services, their efficiency and effectiveness and operation.

3. Waste treatment and disposal: This part of the framework assesses the city's waste treatment and disposal operations, including assessing the degree of controlled management and disposal of waste materials (i.e. level of uncontrolled dumping of wastes) and the level of environmental protection provided by existing management routes.

4. Resource value: This aspect considers the extent to which the city's waste management systems meet international norms in the principles of the '3Rs' (i.e. reduce, reuse, recycle). It considers the level of resource value obtained from the city's waste materials, including considering the level and quality of recycling, waste prevention activities and the degree of integration of the community and informal sectors (recognising that they form a key part of many municipal waste management systems).

5. Governance factors: This part of the framework considers the institutional, policy and financial aspects of the city's waste management system. It includes consideration of the service's financial sustainability (e.g. is there a consistent budget allocation for waste management), the level of policy development and associated planning, and the approach taken to positively engage the private sector.

A summary of the main gap analysis findings is provided below.

Waste Data

No.	Component	Assessment	Areas for Improvement
1A	Waste generation	Data on waste generation allows an initial assessment of rate of generation. However, current data may be an underestimate, as current data does not include materials removed by waste pickers directly from households.	▪ Consider options to try and capture more accurate data on recyclable waste collected by the informal pickers sector. ▪ Undertake reviews of the informal waste management sector to gain an understanding of total waste tonnages managed in this manner. ▪ Introduce waste prevention policies to reduce waste arisings per capita.
1B	Waste composition	Data only available for some parts of the waste flow (e.g. UVR and Estre Landfill) but not from point of generation. Further composition analysis is recommended in order to provide bidders with as much information as possible during the PPP procurement.	▪ Undertake ongoing waste audits of each waste stream to build up as much data as possible across the waste management streams.

Note: See Table 9.1 for detailed for referencing numbering.

Waste Collection

No.	Component	Assessment	Areas for Improvement
2A	Waste collection coverage	Waste collection service coverage is close to 100%, the level of international best practice. Informal waste pickers (catadores) undertake collection of higher value recyclables prior to the arrival of official Waste that Is Not Waste (WNW) municipal scheme vehicles. This is a duplication of collection effort.	▪ In recognising the importance of the informal waste pickers sector, evaluate recycling collection options to reduce duplication of effort between WNW crews and waste pickers. ▪ Consider reducing collection frequency to reduce costs, whilst maintaining an appropriate level of service provision.
2B	Percentage of waste captured	Majority of waste materials are captured by formal or informal waste collection systems. However, some construction and demolition materials are illegally dumped in some areas of Curitiba. Organic and C&D waste collected together preventing these two material streams being recovered.	▪ Implement education and enforcement measures to tackle illegal dumping of C&D wastes. This may be best undertaken by a large taskforce, clearing all of the sites at one time in order to avoid people moving on to the next closest site and defining future uses that would occupy the space and make illegal dumping difficult. It would also mean that the Municipality could be responsible for additional waste, at a tonnage which is not currently known. ▪ Ensure segregation of organic and C&D wastes so as to allow their recovery.
2C	Transfer efficiency and quality	No defined routes for collection vehicles leading to inefficient use of vehicles and crews. No waste transfer arrangements are in place. This is an inefficient use of vehicles and collection staff time. Collection of hazardous waste from households is also inefficient.	▪ A detailed service efficiency review for waste collection services is recommended. ▪ Optimisation of collection routes for vehicles through arrangement of defined routes. ▪ Minimise the number of staff in vehicles during trips to the landfill to increase collection productivity. ▪ Maximise vehicle capacity prior to transfer to disposal sites. ▪ Maintain consistent drop off points for recyclable wastes so that Eco-Citizen sites can plan for the waste which they will receive.

No.	Component	Assessment	Areas for Improvement
			▪ Encourage waste analysis at the Eco-Citizen site so that waste is checked before it is accepted and therefore poor quality waste is noted. ▪ Introduce system to transfer crews from a vehicle when full to another vehicle to continue collections. ▪ Consider use of transfer stations to allow bulking of residual wastes prior to transportation to landfill. ▪ Consider providing permanent, centralised hazardous waste collection points to reduce the need for expensive mobile hazardous waste collection vehicles.
2D	Appropriate service planning and monitoring	High level of complaints from residents suggests that the system is not operating effectively.	▪ Improve current waste collection system operation by improving monitoring and enforcement. ▪ Ensure that new contract includes a performance related payment mechanism.

Note: See Table 9.1 for detailed for referencing numbering.

Waste Treatment and Disposal

No.	Component	Assessment	Areas for Improvement
3A	Percentage managed via controlled treatment and disposal	Residual waste generated by the Municipality is managed at controlled treatment and disposal sites. However, there is some illegal dumping of C&D wastes in some areas of the city. Although the Eco-Citizen sites are generally controlled there is a lack of regulation and regulation enforcement and the Municipality is not aware of/does not receive reports of where the recyclables are sold. The reason for the requirement for vehicles with four axles to deliver to the landfill is not clear. The Municipality is responsible for the recyclable materials separated by households and small businesses but effectively hands over this task to Eco-Citizen and autonomous waste separation sites.	▪ Implement education and enforcement measures to tackle illegal dumping of C&D wastes (also see 2B above). ▪ Investigate the possibility (in the context of the regulatory requirements) of using three axle vehicles in the new contract to deliver waste to the landfill. ▪ Provide increased support to and regulation of (by the Municipality or associated bodies) the Eco-Citizen sites and, where possible, the autonomous sites, to encourage good practices.
3B	Degree of environmental protection in waste treatment and disposal	Initial assessment indicates that the UVR and landfill sites are operated to a good standard with regard to environmental controls. However, the Eco-Citizen and autonomous separation sites are variable and some have poor health and safety and environmental controls.	▪ The development of any new waste treatment sites should follow the principle of best available technology (BAT) to facilitate maximum environmental protection and recovery of value/energy from the waste streams. ▪ The Eco-Citizen and autonomous sites could be better regulated and oversight provided to encourage good practice.

Note: See Table 9.1 for detailed for referencing numbering.

Resource Value

No.	Component	Assessment	Areas for Improvement
4A	Recycling rate	Recycling rate is estimated 23%. This is low/medium in comparison to international norms. However, this does not take into account recycling undertaken by informal waste pickers.	▪ See point 1A above.
4B	Quality of source separation	The level of material rejected by the UVR is high (estimated at 40%), and it is understood that some of the Eco-Citizen sites also have high rejection rates. This may be caused by poor segregation of recyclables by householders and/or by the activities of waste pickers removing valuable materials before the bags are collected by the municipality. The situation is not helped by the use of the same type of black bag for both recyclable and residual materials and lack of contamination monitoring by the collection crews.	▪ Consider options to improve the quality of material generated by the Waste that is not Waste scheme and/or the interaction with waste picker activities. ▪ Consider the use of different types of collection containers for residual and recyclable materials and link to the education and communication activities, as well as monitoring by crews. ▪ Carry out periodic education and communication programmes so that households and companies are made aware of which materials they should separate for recycling.
4C	Quality of recycled materials	The activity of waste pickers is typically driven by a well-functioning market in recyclables so the quality of this aspect of the system is considered to be good. However, the remaining material for separation at the UVR and that delivered from the WNW collection to the Eco-Citizen sites of a less good quality. There are complex interactions between these different elements of the recycling value chain that need careful assessment.	▪ See point 2A and 2D above. ▪ Provide increased support and regulation enforcement to the Eco-Citizen sites and, where possible, the autonomous sites, to encourage good practices.
4D	Waste prevention	No waste prevention policies or programmes in place.	▪ Develop waste prevention education campaigns.
4E	Integration of community and/or informal sector in resource recovery	The informal sector forms a key part of the Municipality's waste management system. Efforts have been made to register informal waste pickers and to improve their conditions, but the results have been mixed. The issue is a complex one which will require careful consideration as part of measures to improve the Municipality's waste collection services.	▪ Proactively engage with representatives of the informal sector so that any changes to the city's waste collection services can be done in consultation, maximising the benefits for all stakeholders. ▪ Optimise the role that l waste pickers (registered and unregistered) will have as part of a new waste management system.

Note: See Table 9.1 for detailed for referencing numbering.

Governance Factors

No.	Component	Assessment	Areas for Improvement
5A	User inclusivity	The extent of public consultation undertaken in relation to the existing waste management system is not fully clear	▪ Consider the enhancement of the role of citizens and business in the development of the new waste collection system.
5B	Provider inclusivity	The Municipality currently engages with the private and informal sectors. This on-gong engagement will be important to maximise the benefits that the informal sector can deliver and to derive value for money through any contracts that may be procured.	▪ Further develop engagement with private sector. This could include market sounding events to gauge and build private sector interest, and identify risks and opportunities (e.g. site availability, new technologies, level of competition).

			▪ Proactively engage with the informal sector and its representatives.
			▪
5D	Sound institutions and policies	Clear institutions and responsibilities are in place. A waste strategy has been developed which includes clear and, in some cases, very ambitious targets. However, the strategy does not appear to include an action plan which identifies how and over what timescale these targets will be achieved.	▪ Define a clear action plan for achieving the targets identified in the strategy.

Note: See Table 9.1 for detailed for referencing numbering.

The gap analysis identified a number of areas for improvement. These fall into three main types:

1. **Key issues.** Immediate priorities to support the options appraisal process and any subsequent procurement process.

2. **Quick wins.** Measures that the Municipality can implement to improve the waste management system in the short term.

3. **Longer-term issues.** Issues for consideration as part of the Municipality's long-term planning for waste management.

These areas for improvement are summarised in the tables below.

Key Issues

No.	Component	Areas for Improvement
1A	Waste generation	▪ Consider options to for capturing further data on recyclable waste collected by the informal pickers sector.
1B	Waste composition	▪ Arrange waste composition analysis to provide as much information as possible to bidders during the procurement of waste treatment capacity.
2C	Transfer efficiency and quality	▪ Consider use of transfer stations to allow bulking of residual wastes prior to transportation to landfill.
2D	Appropriate service planning and monitoring	▪ Ensure that new contract includes a performance related payment mechanism.
3A	Percentage managed via controlled treatment and disposal	▪ Investigate the possibility (in the context of the regulatory requirements) of using three axle vehicles in the new contract to deliver waste to the landfill.
3B	Degree of environmental protection in waste treatment and disposal	▪ The development of any new waste treatment sites should follow the principle of best available technology (BAT) as well as attend to applicable IFC Performance Standards to facilitate maximum environmental protection and recovery of value/energy from the waste streams.
4B	Quality of source separation	▪ Consider options to improve the quality of material generated by the Waste that is not Waste scheme and/or the interaction with waste picker activities.
4E	Integration of community and/or informal sector in	▪ Proactively engage with representatives of the informal sector (e.g. Cooperativa Cataparaná) so that any changes to the city's waste collection

No.	Component	Areas for Improvement
	resource recovery	services can be done in consultation, maximising the benefits for all stakeholders.
4E	Integration of community and/or informal sector in resource recovery	▪ Optimise the role that informal waste pickers (registered and unregistered) will have as part of a new waste management system.
5A	User inclusivity	▪ Consider the enhancement of the role of citizens and businesses in the development of the new waste collection system.
5B	Provider inclusivity	▪ Further develop engagement with private sector. This could include market sounding events to gauge and build private sector interest, and identify risks and opportunities (e.g. site availability, new technologies, level of competition).
5C	Financial sustainability	▪ Adopt lifecycle costing approach that encompasses consideration of all waste management system operations whilst taking into account the Municipality's affordability envelope.
5C	Financial sustainability	▪ Use improved payment structure for the new contract so as to incentivise the optimisation of the collection system.
5D	Sound institutions and policies	▪ Define a clear action plan for achieving the targets identified in the strategy.

Note: See Table 9.1 for detailed for referencing numbering.

Quick Wins

No.	Component	Areas for Improvement
2A	Waste collection coverage	▪ Evaluate recycling collection options to reduce duplication of effort between WNW crews and waste pickers.
2A	Waste collection coverage	▪ Consider reducing collection frequency to reduce costs, whilst maintaining an appropriate level of service provision.
2B	Percentage of waste captured	▪ Implement education and enforcement measures to tackle illegal dumping of C&D wastes.
2B	Percentage of waste captured	▪ Ensure segregation of green and C&D wastes so as to allow their recovery.
2C	Transfer efficiency and quality	▪ A detailed service efficiency review for waste collection services is recommended.
2C	Transfer efficiency and quality	▪ Optimisation of collection routes for vehicles through arrangement of defined routes.
2C	Transfer efficiency and quality	▪ Maximise vehicle capacity prior to transfer to disposal sites.
2C	Transfer efficiency and quality	▪ Maintain consistent drop off points for recyclable wastes so that Eco-Citizen sites can plan for the waste which they will receive.
2C	Transfer efficiency and quality	▪ Introduce system to transfer crews from a vehicle when full to another vehicle to continue collections
2C	Transfer efficiency and quality	▪ Consider providing permanent, centralised hazardous waste collection points to reduce the need for expensive mobile hazardous waste collection vehicles.
2D	Appropriate service planning and monitoring	▪ Improve current waste collection system operation by improving monitoring and enforcement.
3A	Percentage managed via controlled treatment and disposal	▪ Implement education and enforcement measures to tackle illegal dumping of C&D wastes (also see 2B above)

Note: See Table 9.1 for detailed for referencing numbering.

Long Term Issues

No.	Component	Areas for Improvement
1A	Waste generation	▪ Implement waste prevention policies.
4B	Quality of source separation	▪ Consider the use of different types of collection container for residual and recyclable materials and link to the education and communication recommended above.
4B	Quality of source separation	▪ Carry out periodic education and communication programmes so that households and companies are made aware of which materials they should separate for recycling.
4D	Waste prevention	▪ As per point 1A (develop waste prevention education campaigns).
5A	Provider inclusivity	▪ Proactively engage with the informal sector and its representatives.

Source: Mott MacDonald
Note: See Table 9.1 for detailed for referencing numbering.

Note on Methodology

The information used to prepare this assessment report has included documentation provided by Curitiba Municipality up to 13 August 2015 and through three (3) fact finding missions conducted by Mott MacDonald on 1st – 3rd June, 8th – 10th July, and 4th – 6th August 2015.

The visits comprised site visits to waste management sites and discussions with Municipality officers, IFC staff, National Economy and Social Development Bank (BNDES) members and other key stakeholders. Mott MacDonald also undertook an initial assessment of the social issues related to the waste management system in Curitiba, with a special focus on the recycling chain. This included surveys of information concerning waste pickers (catadores), both those who are members of cooperatives and those who work informally; their role in the waste management system and their relationship with direct stakeholders; the third parties involved in the recycling chain and the final destinations; and the identification of any other stakeholders and understanding of their existing roles and perception.

1 Introduction

1.1 Appointment of Mott MacDonald

Mott MacDonald was appointed in June 2015 to provide technical advisory support to the IFC in the development of a PPP transaction to improve the Municipality of Curitiba's (the Municipality) waste management systems.

Mott MacDonald's assignment is financed by Brazil's Private Sector Participation (PSP) Program. PSP is a partnership between IFC, the Brazilian Development Bank (BNDES) and the Inter-American Development Bank (IDB).

1.2 Scope of Assessment Report

This report has been prepared in accordance with the Scope of Work agreed between Mott MacDonald and IFC under the project Terms of Reference. Under the Scope of Work, IFC has appointed Mott MacDonald to address the project's objective of introducing private sector participation in the Client's solid waste management sector through PPP. The aim is to improve infrastructure and services in the sector by introducing industry best practice and by ensuring sustainability and compliance with international standards in waste management.

For this initial phase of the project (Phase 1A), the Scope of Work consists of performing technical due diligence for the purpose of providing relevant information to bidders regarding the existing situation with respect to:

- Waste collection organisation, existing contracts, infrastructures, volumes and statistics;
- Transportation organisation (equipment, routes);
- Organisation of waste treatment (current contracts, pricing, statistics);
- Current City and National regulations regarding recycling and separation;
- Recycling activities (stakeholders, infrastructures, regulation, off-take markets and pricings); and
- Waste streams (volume statistics, compositions, calorific values - based on available existing data from the City).

1.3 Project Overview

Through the implementation of the project, the Municipality aims to develop an integrated, efficient and sustainable waste management system for the benefit of the local environment and population. Specific objectives include:

- Contribution to the overall sustainability of the Municipality area and the quality of life of its residents;
- The implementation of technologically sound solutions of a suitable scale, able to address the Municipality's current and future waste management needs;
- The use of an integrated approach throughout the waste management cycle, applying sustainability principles from collection to treatment;
- Help deliver the Municipality's plans for increased recycling levels and reduction of waste sent to landfill;

- Adaptation and creation of waste management employment and improvement of the working conditions of current workers;
- Contributing to improving the local environment and economy through enhancing recycling sectors;
- Addressing inefficiencies in the current waste management system, to ensure value for money in the way services are provided;
- To enhance the knowledge and good practices of the stakeholders involved and development of local knowledge and capacity in the procurement of PPP and subsequent management of PPP contracts; and
- Demonstration of how PPP can be applied as a model for the mutual public and private benefit whilst delivering optimum results for the community.

This initial assessment report forms part of a package of deliverables aimed at building a sound basis on which to develop a waste management solution that best addresses the Municipality's needs.

1.4 Approach and Report Structure

This report is a review and analysis of the current waste management context in Curitiba, combining information provided by the Municipality and direct information obtained on the ground by Mott MacDonald. It presents:

- A review of the Municipality's waste quantities and composition;
- Current waste management arrangements and key stakeholders;
- Regulatory issues and contractual arrangements associated with waste management, and;
- Initial SWOT (strengths, weaknesses, opportunities and threats) analyses of the current practices for each service area.

The report summarises the key findings using a gap analysis, identifying key issues and opportunities associated with the Municipality's waste management systems, and identifies a number of areas for improvement.

This report is structured as follows:

- Section 2 provides an overview of the key stakeholders identified to date for the project, divided in two categories: primary stakeholders; and secondary stakeholders;
- Section 3 provides an overview of the context of the City of Curitiba and its role as part of the wider Conresol partnership of metropolitan municipalities. The section also provides an overview of the Municipality's waste strategy and relevant elements of the regional and national waste strategies;
- Section 4 provides a review of available data on the quantities and composition of waste generated by the Municipality and waste generation growth;
- Section 5 describes the Municipality's existing waste collection and transfer arrangements; provides a high level overview of a number of private sector waste collection services; and describes the role of the 'informal sector' in the city's waste management system;

- Section 6 presents information on the Municipality's arrangements for waste recovery and disposal, including a description of the Municipality's existing waste recovery and disposal sites;
- Section 7 provides an overview of key regulatory issues; a summary of the Municipality's current contracts for waste management services; and identifies key stakeholders associated with the current Municipality's waste management arrangements;
- Section 8 presents a summary of Mott MacDonald's current progress in developing a waste model for the project and of the information required from the Municipality.;
- Section 9 presents a gap analysis of the Municipality's waste management system, identifying key additional information which will be required to procure a new waste management contract. This section also sets out a number of recommended actions, including measures (or 'quick wins') that Mott MacDonald considers may help address inefficiencies or key problems with the Municipality's current arrangements; and
- Appendices provide background data and supporting information.

1.5 Information Review and Site Visits

The information presented in this report is based on analysis of documents and information provided by Curitiba Municipality up to 10th August 2015 through a Request for Information (RFI) process and during three fact finding missions were conducted by Mott MacDonald between the 1st and 3rd of June, the 8th and 10th of July 2015, and between 4th and 6th August.

The 'June 2015' fact finding mission comprised site visits to waste management sites and discussions with Municipality officers, IFC staff, National Economy and Social Development Bank (BNDES) members and other key stakeholders. A stand-alone summary of this fact-finding mission was provided in Mott MacDonald's 'Curitiba Waste Management Background Report', dated 22 June 2015 (Ref.26).

The 'July 2015' fact finding mission was focussed on an initial assessment of the social issues related to the waste management system in Curitiba, with a special focus on the recycling chain. This included surveys of information concerning waste pickers (catadores), both those who are members of cooperatives and those who work informally; their role in the waste management system and their relationship with direct stakeholders; the third parties involved in the recycling chain; and the identification of any other stakeholders and understanding of their existing roles and perception. Visits were carried out at ten locations, including local government secretaries, waste separation sites, recyclable receiving sites, associations and cooperatives. During these visits, semi-structured interviews were held and observations were made. In addition, interviews were held with autonomous waste pickers outside of formal venues.

The 'August 2015' fact finding mission was carried out in order to obtain further information regarding informal waste pickers and the markets that they sell recyclable materials to. During the visits interviews were held and information was requested. Interviews were carried out with a number of end-users who buy materials from the UVR, Eco-Citizen sites and informal waste picker sites.

2 Key Project Stakeholders

2.1 Stakeholders and Institutions

The review has identified a number of key stakeholders, listed in Table 2.1. These stakeholders have been categorised as:

- **Primary Stakeholders:** organisations with a key direct influence and decision-making capacity in the Municipality's waste management.
- **Secondary Stakeholders:** organisations with an interest in waste management but not amongst key decision-makers or influencers.

Table 2.1: Summary of Key Stakeholders

Primary Stakeholders	Secondary Stakeholders
International Finance Corporation	Greater Curitiba Metropolitan Municipalities (29)
BNDES	Contractors and Current Waste Service Providers[1]
Curitiba Municipality	Waste Pickers and representatives[2]
Municipal Secretary of Environment	Local Businesses and Industry
Curitiba Public Cleaning Department	Local Residents
Curitiba Urban Planning and Research Department	
Inter-Municipal Consortium for Urban Solid Waste Management (Conresol)	
Environmental Institute of Paraná	
State Public Prosecutor's Office	

Source: Mott MacDonald
Note 1: Includes UVR workers
Note 2: Includes Eco-Citizen workers and autonomous waste pickers (see below).

Further discussion in relation to Individual stakeholders is included in the following sections. It is envisaged that additional stakeholders may be identified and added to this list as the project progresses.

2.1.1 Primary Institutional Stakeholders

2.1.1.1 International Finance Corporation

The IFC, as an international financial institution member of the World Bank, provides advisory, investment, and assessment services in developing countries, usually by encouraging the development of the private sector. Within this context, the Municipality of Curitiba has commissioned IFC to provide assistance in structuring a PPP transaction to improve the waste management system of the city, ultimately aimed at the tendering of a new waste management contract(s).

2.1.1.2 BNDES - *Banco Nacional de Desenvolvimento Econômico e Social* (The Brazilian Development Bank)

The Brazilian Development Bank (BNDES) is one of the main federally-owned financial institutions that provide investments in all segments of the economy, focusing on social, regional and environmental issues. The BNDES is a partner with the IFC in structuring concessions and PPP transactions across Brazil, including the project commissioned by the municipality of Curitiba. Besides this, the BNDES works with investments aimed at formalising the employment of waste pickers in metropolitan cities, and is the main financer of the Eco-Citizen formalisation project in the municipality of Curitiba.

2.1.1.3 Curitiba Municipality

Curitiba is the beneficiary of the IFC's assistance and, as such, is the primary local stakeholder. The Municipality has responsibility for the collection and management of municipal waste. This includes waste generated by residents, small businesses and the municipality's public grounds. The municipality lets the collection and disposal of waste materials to private sector operators.

2.1.1.4 Municipal Secretary of Environment (SMMA)

The municipal environmental secretary is the local branch of Brazil's national system of the environment, in charge of implementing municipal environmental policy. The SMMA is responsible for many of the legislative and administrative roles with environment related concerns in Curitiba including licensing of activities and programmes.

2.1.1.5 Curitiba Public Cleaning Department

The Department of Public Cleaning operates within the Municipal Environment Department of Curitiba and coordinates public and municipal waste collection. This task involves managing the day to day activities of a variety of public services, including cleaning and collections, as well as planning for optimisation and cost reductions. Detail on the streams covered and material handled are discussed under Section 5. Municipal collection has been contracted since 1984 through public competition to private companies. Curitiba Urban Planning and Research Department

2.1.1.6 Urban Planning and Research Department

The Urban Planning and Research Department or Curitiba Research and Urban Planning Institute (IPPUC) was created in 1965 to pursue implementation of the Curitiba Master Plan. The IPPUC is responsible for optimising the effectiveness of Curitiba community's land use and infrastructure and formulate plans for the development and management of urban and suburban areas. This is typically done by analysing land use compatibility as well as economic, environmental and social trends. The Department is also responsible for research and analysis, strategic planning, architecture, urban design, public consultation, policy recommendations, implementation, and management of urban planning.

The Urban Planning Department considers a wide array of issues such as sustainability, air pollution, traffic congestion, crime, and land values.

2.1.1.7 Inter-Municipal Consortium for Urban Solid Waste Management (Conresol)

Conresol is the inter-municipal waste management consortium, currently formed of 23 of the 29 Curitiba Region Municipalities. The body is responsible for the waste management and disposal arrangements for many of them, including the Curitiba Municipality landfilling contracts. The consortium has the power to present proposals, integrate policy and cover new institutional arrangements to support waste management in the region. The relationship between the Municipality and the Consortium will be critical for understanding option limitations.

2.1.1.8 Environmental Institute of Paraná (IAP)

Created by the state government, under the State Bureau of Environment, the IAP is one of the main regulatory agencies which sets environmental regulations in a wider area. The IAP has a significant focus on hydrological resources as well as environmental planning and resource management at a state level. It is responsible for the licensing process of projects at the State Level.

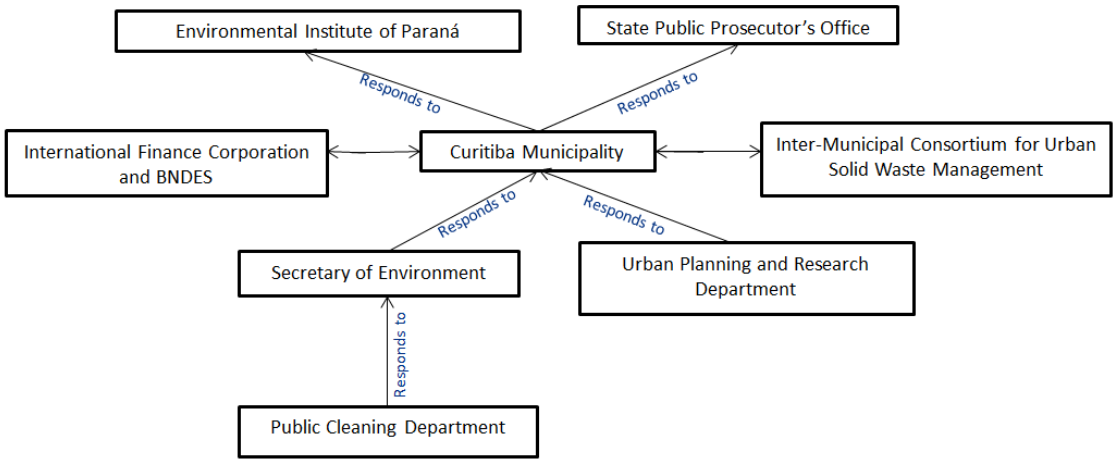
2.1.1.9 State Public Prosecutor's Office

The State Public Prosecutor is responsible for guaranteeing that the local government follows regulations. Specifically with respect to waste management, the State Public Prosecutor‘s Office has been active in the state of Paraná in reviewing and commenting on technology solutions and environmental permitting processes.

The State Public Prosecutor's Office of Employment as well as the Office of Accountability are actively involved in verifying the attendance of the National and State Waste Policies by local governments, including the inclusion of waste pickers and other stakeholders in the waste management plans.

Figure 2.1 shows the relationship between these identified primary stakeholders.

Figure 2.1: Relationship Between Identified Primary Institutional Stakeholders



Source: Mott MacDonald

2.1.2 Secondary Stakeholders

2.1.2.1 Greater Curitiba Municipalities (29)

The Greater Curitiba Metropolitan Region, one of the 20 regions of the state of Paraná, has 29 distinct Municipalities; these are listed in Table 2.2.

Table 2.2: Greater Curitiba Municipalities

Municipality		
Adrianópolis	Cerro Azul	Pinhais
Agudos do Sul	Colombo	Piraquara
Almirante Tamandaré	Contenda	Quatro Barras
Araucária	Curitiba	Quitandinha
Balsa Nova	Doutor Ulysses	Rio Branco do Sul
Bocaiúva do Sul	Fazenda Rio Grande	Rio Negro
Campina Grande do Sul	Itaperuçu	São José dos Pinhais
Campo do Tenente	Lapa	Tijucas do Sul
Campo Largo	Mandirituba	Tunas do Paraná
Campo Magro	Piên	

Source: RFI response document "Item 7 consortium" (Ref.19)

In 1974 Curitiba Metropolitan Area Coordination (COMEC) was created to integrate and organise the planning and execution of public functions of interest of the population and municipalities that make up Greater Curitiba. The integrated planning of economic and social development within and between cities is coordinated by the secretariat.

2.1.2.2 Contractors and Current Waste Service Providers

The Municipality performs multiple services in public areas to deal with the generation of a number of waste streams. Among these services are: manual sweeping, mechanical sweeping, street cleansing and highway litter picking, park and garden pruning, street market cleaning, and river cleaning. These services are conducted with a variety of third party contractors.

Many of the public services are provided through private companies and thus there are a number of private operators involved in the Curitiba waste management. The two main companies are Cavo Services and Sanitation S.A. (Cavo), which operates almost all collection services, and Estre Environmental S.A. (Estre), which owns Cavo, and operates the main landfill utilised.

Some services are provided by multiple companies, including Cavo and Estre, as well as dozens others. Services that are known to be provided by other contractors include:

- Inert waste collection and hauling for construction and demolition programmes;
- Recyclable and residual waste from large commercial sites (collection and separation/processing);
- Residual and industrial waste form large industrial sites (collection and separation/processing); and
- Household green and C&D collection for the Municipality, a service provided by companies Viaplan and Nicons; discussed in detail under Section 5.2.7.

There is a network of autonomous waste separation sites as well as middlemen, bulkers, small recycling centres and recycling industry companies that are an important part of the current recycling system. These companies work with both municipal and commercial waste, as well as waste from other municipalities in the metropolitan region.

2.1.2.3 Waste Pickers and Representatives

Waste pickers provide a crucial service in the waste management system of Curitiba, through formal relations with the Eco-Citizen project or autonomously. The autonomous waste pickers collect and separate waste through kerbside collection and on site separation, rather than being involved in waste picking at the landfill site. There are many cooperatives and associations that work with the waste pickers, including the Cataparaná network and Associar. The Instituto Cidadania e Lixo is a local representation of the Movimento Nacional de Catadores de Materiais Reciclaveis, an important national movement that organizes and represents waste pickers and their rights in terms of working conditions and territory. Changes to the waste management procedures of the city would inevitably affect their operations, income, jobs, and their responsibilities. Waste pickers, regardless of whether they are part of formalised arrangements or autonomous, have been considered a secondary stakeholder as they are not directly responsible for changing local waste management regulations and legislation but would be significantly affected by them and should therefore be considered in the development of these changes.

2.1.2.4 Local Businesses and Industry

Local Businesses and Industry rely on waste management infrastructure in the region and would be impacted by any changes to waste collection. Small businesses typically have their waste collected by the Municipality so are users of the waste management services. Larger businesses and industry use commercial collections so are not directly users of the municipality services but could be impacted by operations. The Metropolitan Area of Curitiba has attracted large companies such as Audi, VW, Nissan, Renault, New Holland, Volvo, Fiat, ExxonMobil, Sadia, Kraft Foods, Esso, HSBC and Siemens.

Medium and large sized commercial and industrial sites use private contractors for the removal of their waste streams. In order to reduce cost material is usually also made available for waste pickers to collect prior to formal collection. Organisations require a waste management plan (PGRS) and annual permits from the Municipality for their collection contracts. Even though these sites do not have their waste collections directly removed by the Municipality, the policy and legislative influence of the waste management arrangements and requirements affect how these services are conducted by the private sector.

Although the medium and large sized sites' waste is outside of the scope of this project some of their wastes could potentially be incorporated in the future, if this is contractually viable and the waste streams are beneficial to the treatment processes selected.

2.1.2.5 Local Residents

With a population of around 1.8M people, Curitiba residents are an important consideration for the waste management policies and services provided in the Municipality. Schemes such as the green exchange programme have a significant impact on the lives of many residents of the poorer communities in Curitiba and alterations to such schemes could have consequences for many people.

Collection services are also crucial for the residents from a health, safety, and convenience standpoint; any changes would affect how the residents manage and view their waste. The choice of location and technology for any waste treatment facility must take into consideration neighbourhood conditions and public opinion.

3 Context: The City of Curitiba

3.1 Introduction

The Municipality of Curitiba is widely recognised in Brazil as an innovator in sustainable urban planning and development. In terms of waste management, the City has developed a number of innovative initiatives, including the "Waste that is not Waste" (WNW) scheme, the "Green Exchange" programme and, more recently, the "Voluntary Collection" system for recyclables (these schemes are outlined in more detail in Section 5).

Notwithstanding the above, Curitiba faces on-going challenges with regard to waste generation and management which require the development of more sustainable solutions. One example includes the Municipality's dependency on a single landfill for the disposal of its waste; the landfill site is located about 40 kilometres from the city centre and has a forecasted life span of less than ten years. The Municipality also recognises that there are opportunities to gain more value from the waste being generated and to move its management up the waste hierarchy, thereby reducing the amount of waste going to landfill and increasing recycling of materials.

With its waste management services contract due to expire in 2016, the Municipality has identified an opportunity to re-evaluate Curitiba's waste management systems and to make a step-change in the management of the city's waste materials. The Municipality aims to generate additional value from waste and to also create wider benefits such as local environmental improvement, resource conservation, job creation and social inclusion.

3.2 Location, Size and Administrative Arrangements

The Curitiba Municipality lies within the Curitiba Metropolitan area, which sits within the State of Paraná in the South of Brazil. Paraná is divided into 20 regions, one of which is the Curitiba Metropolitan area. The Metropolitan area comprises 29 municipalities including the Municipality of Curitiba, the most densely populated municipality, sitting at the centre.

Curitiba is the capital and largest municipality of Paraná state, with a land area of 430.9 km^2 and a population estimate of 1.75[1] million in 2010. It is considered the 4th most prosperous capital in Brazil and the 8th most populous[2].

Curitiba City is divided into nine regional governments covering 75 neighbourhoods - 10% of the population live in favelas. All regions are governed from a central body.

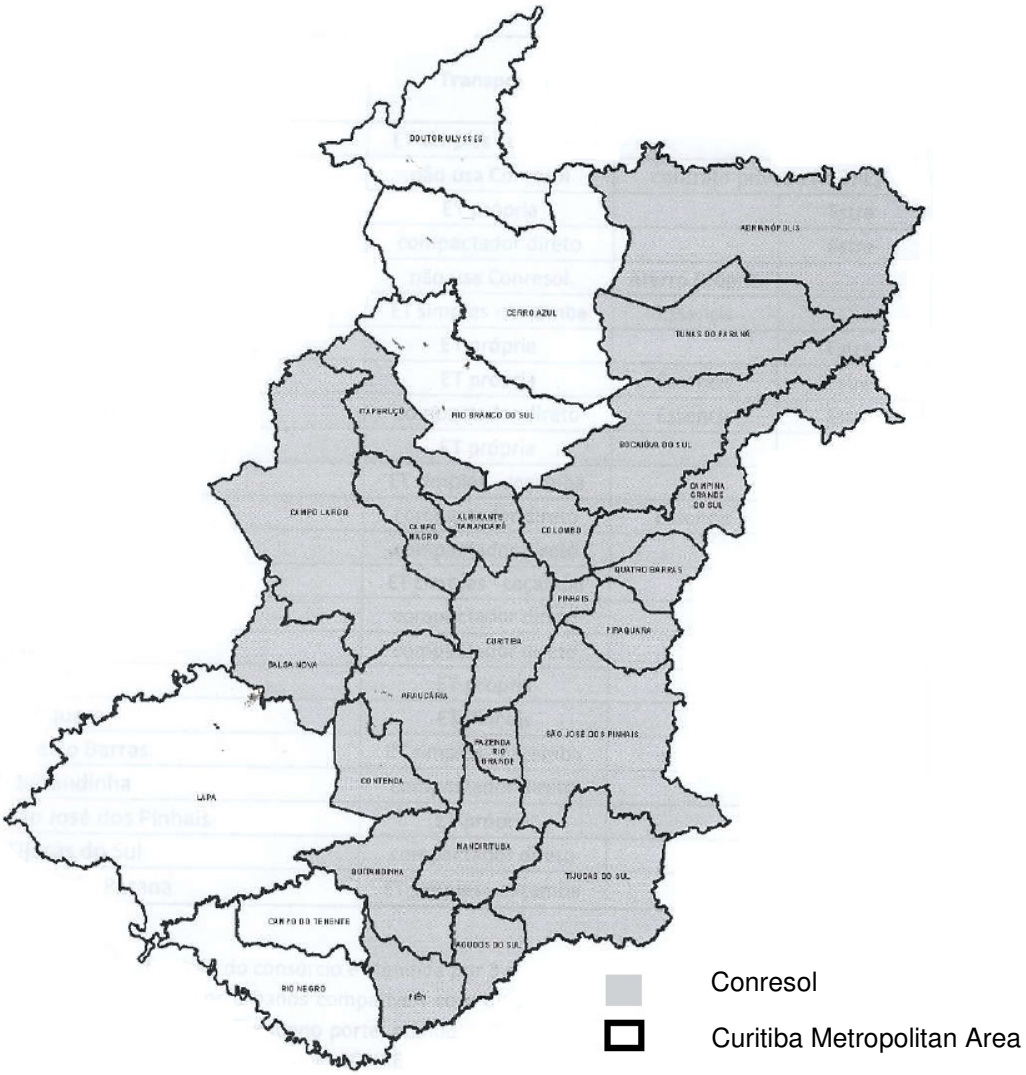
[1] http://www.sidra.ibge.gov.br/bda/tabela/listabl.asp?z=t&o=25&i=P&c=202

[2] https://en.wikipedia.org/wiki/Curitiba

Curitiba's economy is split between services (66%) and industry (34%). It is home to many multinationals across a range of sectors such as the car industry, oil & gas, paint and food manufacturing. It is home to the second largest car manufacturing plant in Brazil.

Waste management in the Curitiba Metropolitan region is largely managed by Conresol, a consortium formed of 23 of the 29 municipalities, including Curitiba itself. Figure 3.1 shows how the region is split and where the consortium operates.

Figure 3.1: Curitiba Metropolitan Area and Conresol Operation



Source: RFI response document – "Item 7 consortium" (Ref.19)

Figure 3.2 shows the rough urban and rural layout of the Municipality and thus provides an indication of the more populated areas.

Figure 3.2: Curitiba Municipality Layout

Source: RFI response document – “Item 7” (Ref.11)

3.3 Population and Growth

According to the Brazilian Institute of Geography and Statistics (IBGE), the most commonly utilised census and data source for Brazilian population statistics, the Curitiba Municipality population[3] was 1,752,000 in 2010 and 1,587,000 in 2000. This change corresponds to a 10.4% growth over the decade. The population information listed in the Curitiba Solid Waste Management Strategy 2010 (Ref.1) is slightly different to that of the IBGE census. The document lists the 2010 population of Curitiba to be higher than the IBGE figures by 120,000 people.

The IBGE also provides statistics for the Curitiba Metropolitan area. The data indicates a regional population of 2,727,000 in 2000 and 3,174,000 in 2010. This corresponds to a 16.4% growth over the decade, which is larger than the growth for the Municipality of Curitiba, indicating that a significant element of the region's population growth has been in the surrounding municipalities (Table 3.1).

Table 3.1: Curitiba Population Statistics

Area	2000	2010	Growth
Municipality of Curitiba	1,590,000	1,750,000	10.4%
Curitiba Metropolitan Area	2,730,000	3,170,000	16.4%

Source: IBGE (Ref.27)

3.4 Current Waste Strategy

3.4.1 Municipal Waste Strategy

The Curitiba Solid Waste Management Strategy was published in 2010 (Ref.1). The Strategy sets out a number of ambitious objectives and targets, including treating 100% of waste and diverting 85% from landfill – these are outlined in Table 3.2. It is understood that these targets are not legally binding requirements but are aspirations for the municipality.

Table 3.2: Curitiba Solid Waste Management Strategy 2010 Key Targets and Objectives

Key Targets and Objectives
Municipality Collection Objectives and Strategies;
– Maintain 100% household coverage of the residual collection scheme;
– Maintain 100% household coverage of the "Waste that is not Waste" collection scheme;
– Support and develop 25 new areas for waste picker turn-ins and support;
Municipality Disposal and Processing Objectives and Strategies;
– Process 100% of waste, diverting at least 85% and at most landfilling 15%;
– Evaluate the use of new technologies and equipment;
– Support composting and biogas utilisation;

[3] http://www.sidra.ibge.gov.br/bda/tabela/listabl.asp?z=t&o=25&i=P&c=202 (Ref.27)

Key Targets and Objectives
– Increase recycling bailing and processing capacity; – Install a reverse manufacturing plant in the city for electronic waste processing; – Look into C&D waste processing technologies;
Other Municipality Objectives and Strategies;
– Intensify fiscal monitoring of the recycling industry; – Maintain cleaning services; – Monitor 100% the waste plans of “large generators”; – Promote the reduction of waste generation and sustainable practices; and – Reduce greenhouse gas emissions.

Source: Curitiba Solid Waste Management Strategy 2010 (Ref.1)

In 2013, the Municipal Sanitation Plan was revised, presenting key targets and objectives for the waste management of the municipality. This plan does not substitute the 2010 plan, but it does reflect the aspirations of the current government. The revised key targets and objectives that present quantitative goals are outlined on Table 3.3.

Table 3.3: Curitiba Municipal Sanitation Plan 2013 – Section V – Key Targets and Objectives

Key Targets and Objectives
– Progressive reduction of landfilled waste: reduction of 43% in short term, 50% in midterm and 53% in long term; – Implementation of five Eco-Citizen Sites in short term, and implement the number of Eco-Citizen Sites needed to reach the number of registered waste collectors in midterm; – Increase number of registered waste pickers by 40% in short term, 30% in midterm and another 30% in long term; – Reduction of landfilled food waste: reduction of 30% in short term, 40% in midterm and 50% in long term

Source: Curitiba Municipal Sanitation Plan 2013 (Ref.2)

The ability to meet the targets in the waste strategy would be dependent on the development of waste treatment infrastructure. In particular, the diversion of 85% of waste (assumed to be by mass) would typically require both recycling and thermal treatment. The aims in the strategy are in line with other waste management strategies of which Mott MacDonald is aware internationally. It is important to note, however, that the majority of changes in waste management cannot be implemented in a single stage; setting staged targets, therefore, would be considered typical and beneficial.

Strategy details are also established in the Municipal Sanitation Plan 2013 (Ref.2), together with the list of mechanisms for achieving these objectives. The strategy discusses the importance of appropriate site licensing and monitoring in order to ensure that processes, be them treatment or disposal, operate properly and effectively. These are presented as an overarching strategy; details on specific actions and targets are not presented. Attention is also brought to the waste hierarchy and the Municipality’s desire to provide solutions which incorporate more sustainability principles and reduce landfilling. Lastly, the plan lists a series of actions, such as “study new financial models for cleaning services based around tonnages”, which are designed to help achieve the desired objectives.

3.4.2 Regional Waste Strategy

Information has also been provided by the Municipality regarding the strategies laid out by the regional waste management consortium Conresol (Ref.17 and 20). These documents provide insight on some of the waste service challenges encountered throughout the region of Curitiba, and the resulting actions to address them.

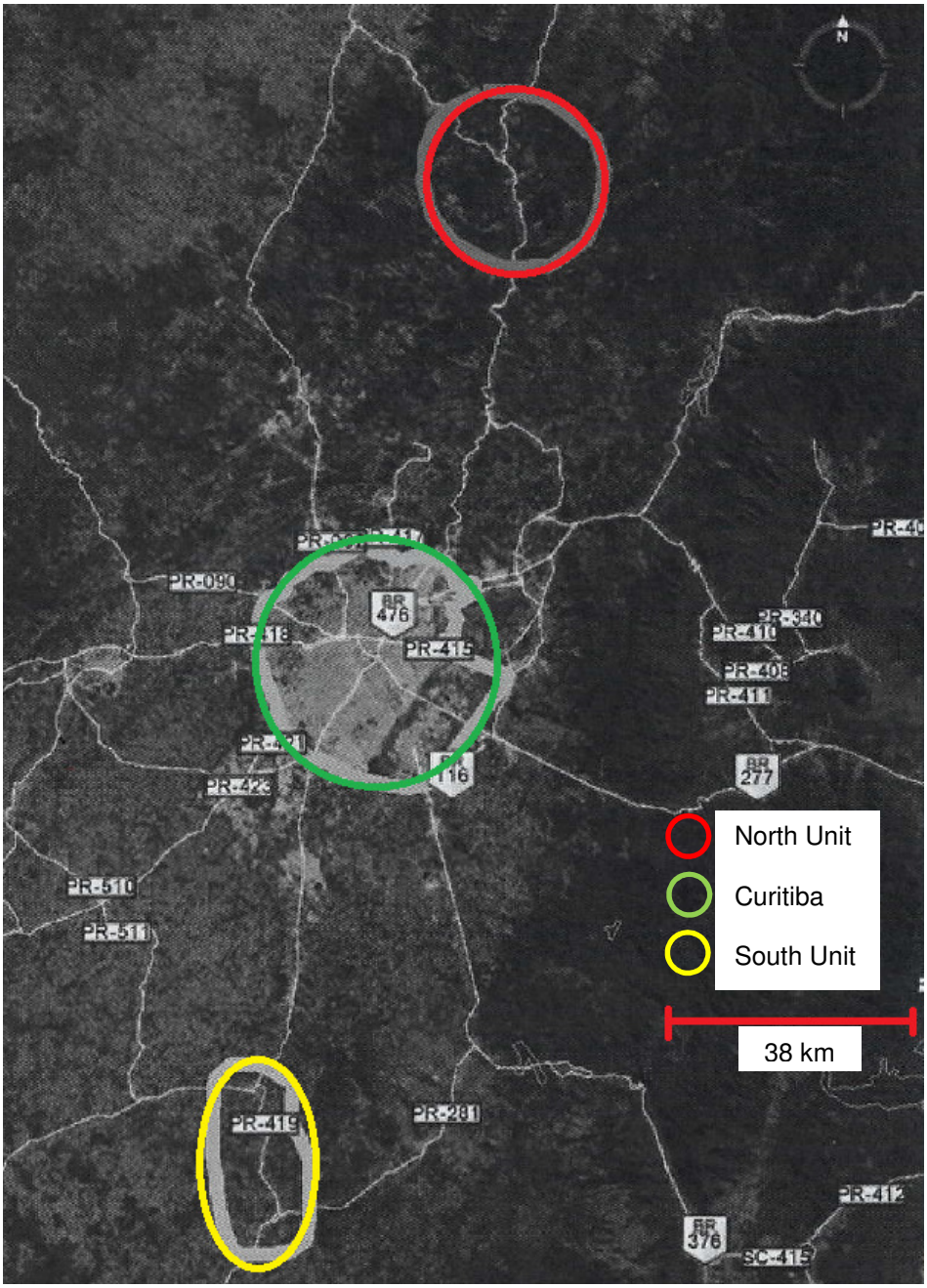
One of the presented objectives includes the decentralisation of the waste management structure and treatment processes in the region, as currently the region is dependent on one landfill operator, with few landfill diversion options. The strategy aims to reduce haulage costs across the Conresol Municipalities by implementing different treatment or disposal units across the region. The first stage for this plan includes the licensing and implementation of two units: the first, referred to as the Extreme North Advanced Unit, would be located roughly 50km north of the Curitiba Municipality; the second, referred to as the Extreme South Advanced Unit, would be located around 40km south. It is unknown if the units would be responsible for waste treatment or solely disposal. The regions of interest for the facilities are indicated in Figure 3.3. It is understood that specific sites have not been identified.

The consortium also states that it supports other strategies for the region, including alternative processing technologies to increase landfill diversion and a complete integration of waste management within the Municipalities.

A Regional Solid Waste Management Plan was also developed at the Paraná State level in 2013 (Ref.3) to address similar issues and formulate strategies for the combined area. The plan covers a range of concerns and provides some detail on where additional development is desired. Maps are presented detailing which Municipalities in Paraná require waste treatment and disposal infrastructure and how haulage can be optimised within the region through strategic transfer facilities.

The document does not appear to cover issues addressing land ownership and suitable specific sites but shows target areas and regions of strategic value for the decentralisation of the Conresol area. This process aims to increase the number of sites able to receive waste in order to lower haulage costs, for example through a network of transfer stations. These stations, which would be located closer to the point of origin of the waste, would then be used to bulk and haul the material to the treatment and disposal sites.

Figure 3.3: Conresol Regional Waste Facility Plan



Source: RFI Response Document “Item 24” (Ref.20)

3.5 Regulations

3.5.1 Overarching Regulatory Context

In this section of the report we have presented a general overview of the regulatory context of waste management in Brazil. It is worth noting that an in-depth legal due diligence is being carried out by the legal advisors to this information is to provide context rather than an exhaustive review.

In Brazil, the overarching legal regulation relating to waste management is contained in the National Solid Waste Policy. It highlights the goals of integrated waste management on a national level and sets out guidelines to be followed at state, regional or municipal level.

Legal regulations regarding waste collection, transport and disposal exist on the national, state and municipal level, ranging from laws to decrees, resolutions and guidelines. These regulations have been considered further in this report.

3.5.2 National Solid Waste Policy

The National Solid Waste Policy (PNRS) covers the guidelines for solid waste management in Brazil and was published in 2010 and revised 2012 (Ref.4).

The national policy identifies a priority list of actions for waste management, the preferred option being non generation, followed by reduction, reuse, recycling, treatment and environmentally adequate final disposal.

The policy is based on the premise of co-responsibility for post-consumer waste management, between government bodies and companies involved in the manufacturing, transportation and distribution of products. It recommends the inclusion of waste pickers in the waste management system that is put in place, including the prioritisation of contracts with associations and cooperatives over private companies.

The policy covers targets on the national level, including the elaboration and implementation of local plans (municipal, regional and/or state). The municipal and regional waste strategies discussed in Section 3.4 were elaborated in accordance with the national policy, presenting the waste management targets on a local level aligned with those indicated on a national level.

One of the most ambitious targets of the PNRS was the eradication of non-regulated waste dumps in the country by 2014; these have not been fully met yet.

3.5.3 National Environmental Policy

The National Environmental Policy (PNMA) is considered an important regulatory benchmark due to the formalisation of environmental concerns and definitions in an overarching national law. It puts forth the requirement for environmental licensing and institutes the polluter pays principle.

3.5.4 Environmental Permitting

Brazilian law requires environmental permitting of potentially polluting projects, which may be carried out on a federal, state or municipal level, depending on the specificities of the project, its location and the coverage of its environmental impacts, as put forth in CONAMA Resolution 237 of 1997. In the municipality of Curitiba, waste transportation and treatment projects are included on the list of projects that may be permitted by the municipality, if located within the limits of the municipality. Should the site chosen for the treatment plant be located in another municipality, or should there be concerns in relation to the extent of potential environmental impacts of the chosen technology, the permitting process would have to be carried out by the state environmental authority, IAP, the Environmental Institute of Paraná.

The permitting process consists of three main phases:

1. The pre-installation permit;
2. The installation permit; and
3. The operation permit.

Each of these permits are obtained through a series of processes carried out in conjunction with the Municipal Environmental Secretary in accordance with the specific terms of reference produced by the Secretary. These processes may include, but are not limited to, elaboration of environmental studies (including environmental diagnosis, environmental impact evaluations and propositions of environmental measures, projects and programs), elaboration of environmental plans where the measures, projects and programs are presented in detail and implementation of the environmental plans.

3.5.5 Specific Legislation in Relation to Waste Pickers

Waste pickers (sometimes referred to as scavengers) are an important part of the waste management operations in Curitiba. However, not all of the waste pickers operate within the formal legal framework. Therefore, Mott MacDonald has undertaken a high level review of the legislation and guidance relating to waste pickers in order to understand the current legal context with respect to this aspect of waste management.

3.5.5.1 Municipal Law

On a municipal level, waste pickers are regulated through Municipal Law n. 7410/90, although it is understood that this law is not implemented. According to the law waste pickers are allowed to operate with a permit issued by the municipal government and the Urban Development Secretary has the role of giving technical and legal support to waste pickers who want to create associations or cooperatives. Waste pickers are allowed to use pushcarts on public roads.

Law num. 7162/1988 prohibits scavengers from working within landfill areas. This is understood to be complied with, and during the site visit no waste pickers were observed on the landfill and no reports were recorded of this occurring.

According to the Municipal Waste Management Plan (Ref.1), waste pickers are supported through a series of programmes and foundations, including the "Total Inclusion Recycle Plan (Programa Reciclagem Inclusão Total – "Ecocidadão"), the municipal program that works to formalise their activities. This plan lists one of its objectives as to "promote the inclusion of scavengers in the recycling network".

3.5.5.2 Federal Law

On a federal level, the Federal Waste Management Law has a specific section dedicated to the participation of waste pickers in the collection of recyclable waste, where the involvement of cooperatives and associations should be prioritised.

3.5.5.3 State Law

The State Waste Management Strategy (Ref.3) calls for the inclusion of waste pickers in waste collection.

3.5.6 Waste to Energy Legislation

The use of waste to energy technologies in Brazil is relatively new and largely unregulated. CONAMA resolution 316/2002 deals specifically with thermal technologies. It puts forth procedures and criteria for the functioning of thermal waste treatment, including specificities for urban waste. It states the need to first implement a segregation programme so as to prioritise recycling and reuse before thermal treatment. Monitoring of emissions and burn tests are also called for. CONAMA resolution 264/1999 stipulates the permitting obligations of co-processing waste to be used in cement industries.

No laws could be identified that deal with waste to energy at Federal, State or Municipal levels. At Federal level, an inter-ministerial act has been proposed to be developed in order to regulate incineration technologies, but it is believed that this has not progressed yet. There are various draft laws at each level of government, the majority of which are to varying degrees against the use of incineration, with the exception of two at the federal level.

There have been various public protestations against the use of incineration across Brazil, as well as specifically in the State of Paraná. This included official statements of the Public Defender's Office against the use of incineration technologies.

Outside the State of Paraná, the State Environment Secretary of São Paulo published Resolution number 79 of November 4th, 2009 that put forth guidelines and conditions for permitting of solid waste thermal treatment facilities in the state of São Paulo. This publication is worth noting, as other states often follow São Paulo's lead in environmental regulations.

3.5.7 Recycling Legislation

CONAMA resolution 275/2001 specifies a collection colour-code system for all government locations and suggests that this colour code system be used in all recyclable waste collection. The colour code breaks

up the collection in various types of waste: paper; plastic; metal; glass as well as hazardous, food waste, non-recyclable, etc. At municipal level, Curitiba shopping centres are required to separate their waste in accordance with these regulations, dividing at least: paper, plastic, metal, glass and non-recyclable waste. These regulations are understood to be enforced primarily for large companies but possibly less so for smaller organisations.

Municipal Decree 983/2004 presents the necessity of separation of household recyclable from non-recyclable waste, but does not detail the type of separation that should be undertaken. There is also the scope for households to be fined if recyclable material is contaminated with non-recyclable material, or if excess amounts of waste are put out for collection; the mechanism for this, however, is not completely clear.

3.5.8 Composting Legislation

CEMA resolution 090/2013 regulates the conditions and criteria for composting plants and for the use of produced compost, including the needs for source segregation, the environmental controls that must be in place and orientations for the permitting process. The permitting process is carried out at the state level with the IAP.

The following guidelines are specified by IAP[5]:

- Any liquid effluent generated in the composting process should be collected and returned to the composting system;
- No civil construction waste, tires or mining waste may be sent to composting;
- If the final product of the composting plant is to be used in agriculture, it must attend to the quality standards put forth by the Ministry of Agriculture, Livestock and Supply (Mapa - Ministério da Agricultura, Pecuária e Abastecimento) and the Secretary of Agriculture and Supply of Paraná. Mott MacDonald was not able to find these specifications, and would request for a formal legal search to be undertaken should composting be an option to be reviewed.
- An Environmental Authorisation is needed if the final product is to be used for agricultural purposes in accordance with IAP Ordinance num. 224/2007.

3.5.9 Residual Collection

Law 8985/1996 stipulates obligations for commercial and residential buildings as well as closed condominiums to construct a covered area which should be reserved for the storing of waste. The covered area is required to have space to separately store at least organic and recyclable waste.

3.5.10 Waste Transport

At state level, Law 12.493/1999 stipulates the principles, procedures, norms, and criteria for generation, storage, collection, transportation, treatment and final destination of solid waste in the state of Paraná.

[5] http://www.cema.pr.gov.br/arquivos/File/Doc/IAP_GT_Compostagem_parte1.pdf

Specifically for transportation, the law cites the Brazilian Technical Norms Association regulation presented below.

There are regulations regarding registration, permitting and documentation of companies that transport waste. These regulations are defined in Municipal Law 7972/1992.

In this law, the following requirements are put forth:

- Necessary registration with the Municipality;
- Indication and approval of the location that the waste will be taken to;
- Brooks trucks should be utilised with retractable loader;
- Only inorganic waste may be transported by the trucks specified here;
- Maximum capacity shouldn't exceed 5m³; and
- Vehicles may only circulate between 8pm and 7am in preferential pedestrian areas.

A norm published by the Brazilian Technical Norms Association (ABNT) sets general guidelines for urban waste[6]:

- Use of adequate equipment;
- Leaking and spilling of the waste is not accepted;
- The waste must be covered;
- The waste may not be transported with food, medicine or products for consumption;
- Accompaniment by waste control documents (Waste Transport Manifest); and
- Decontamination is the responsibility of the generator and must be done in authorised locations.

Aside from these, there are also laws in regard to transport of construction and demolition, hazardous and health services waste which are outside the scope of this project.

3.5.11 IFC Performance Standards, EHS Guidelines for Waste Management Facilities, and Other Applicable Policies and Guidelines

As part of its Sustainability Framework, the IFC puts forth eight performance standards that provide guidance for identifying risks and impacts of projects, as well as assisting in avoiding, mitigating and managing risks and impacts in the search for sustainable implementation of projects.

The Performance Standards, together with the social-environmental themes to which the standards are related to, are listed below:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts;
- Performance Standard 2: Labour and Working Conditions;
- Performance Standard 3: Resource Efficiency and Pollution Prevention;
- Performance Standard 4: Community Health, Safety, and Security;
- Performance Standard 5: Land Acquisition and Involuntary Resettlement;

[6] http://wp.ufpel.edu.br/residuos/files/2014/04/Abnt-Nbr-13221-Transporte-Terrestre-De-Residuos.pdf

- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- Performance Standard 7: Indigenous Peoples; and
- Performance Standard 8: Cultural Heritage

The 'Environmental, Health and Safety Guidelines for Waste Management Facilities' provide specific guidelines for reaching Good International Industry Practice (GIIP) for the installation of waste management facilities.

The proposed waste management project for Curitiba will follow the guidelines put forth by the Performance Standards and the Environmental, Health and Safety Guidelines for Waste Management Facilities as well as any other guidelines published by IFC that may be applicable to the project.

4 Waste Quantities and Composition

4.1 Waste Types

The Municipality of Curitiba generates a diverse range of waste streams from domestic, commercial and industrial sources. The list below summarises the main categories, as well as their identified streams, that were used for the purposes of this study.

- **Domestic Waste** generated by individual households, condominiums, and apartment complexes:
  - Household Residual Waste;
  - Household Dry Recyclable Waste;
  - Waste Electric and Electronic Equipment (WEEE);
  - Household Green Waste;
  - Household Construction and Demolition Waste;
  - Household Bulky Waste; and
  - Household Hazardous Waste.
- **Public area waste** from cleaning and washing parks, streets, rivers, and other public grounds:
  - Street Sweeping Waste;
  - Gardening Waste; and
  - River Cleaning Waste
- **Commercial and industrial wastes** generated by small businesses in the City:
  - C&I Residual Waste;
  - C&I Recyclable Waste;
  - C&I Construction and Demolition Waste; and
  - Industrial Waste.
- **Animal carcasses** from households and street cleaning operations.
- **Medical waste** generate by healthcare facilities.

It should be noted that this technical assignment is concerned with municipal solid waste (i.e. wastes managed by the municipality). Clearly, there are a number of other waste streams generated within the Municipality (e.g. hazardous industrial wastes); these were not considered to have a direct implication for the management of the Municipality's solid waste and thus have not been included as a part of the waste flow model.

4.2 Waste Quantities

The CSWMS 2010 (Ref.1) report presents conflicting waste quantity information regarding the per capita generation of waste.

The document states that for the year of 2009, utilising a population count of 1,851,215 and an average of 2,560 tonnes of collected waste per day, the per capita waste generation is of 1.38kg/day (page 18). For this calculation to be correct, 365 collection days per year must be utilised. Utilising the same value for collection days would yield a total waste production of around 934,400 tonnes per year, which is

significantly above the presented data in other pages of the document (such as the 400,000 tonnes collected for residual waste in page 25). Based on other documents provided by the municipality (Ref.24), it is believed that about 300 collection days per year should be considered; this indicates that the per capita waste generation has been miscalculated in the report, and is closer to a value of 1.14kg/day (2009). Information from the CMSP 2013 (Ref.2) supports this estimation, as it is just above that, at a value of 1.20kg per capita (2013).

The majority of this material comprises residual waste from households, equivalent to about 1,500 tonnes of waste per day on average (about 58% of the total generated). Tonnages vary on a day-to-day basis, peaking on Tuesdays, when around 3,800 tonnes of waste are collected.

The Municipality's waste generation also varies with seasonal changes and alterations in the population's income and spending patterns. A 13th month salary is paid in November and the additional income increases the waste produced. Variations are also linked to the general state of the economy within country and city. The current slow economic environment is believed to have resulted in a reduction of waste generation in Curitiba.

Table 4.1 summarises information on tonnage of waste generated in Curitiba as extracted from the CSWMS. It is noted that this does not include data for a number of waste streams generated by the Municipality (e.g. hazardous domestic waste, and animal carcasses). Therefore, the total waste quantities shown in the table do not equate to 2,600 tonnes per day as discussed above. Details on how these figures have been calculated are not fully explained in the document. It is also understood that the Informal Recyclable Collection quantities have been estimated by the Municipality. The data also indicates a recycling rate of approximately 23% is achieved. Not all data presented below has been utilised for the generation of the Waste Flow Model (WFM), as other sources have also been considered. The WFM is discussed in detail in Section 8 of this report.

Table 4.1: Main Waste Generation Figures for 2009 in Curitiba

Waste Service	Tonnes per Day	Tonnes per Month	Tonnes per Year
Residual Collection	1,473	36,818	441,810
Recyclable Collection	86	2,154	25,848
Informal Recyclable Collection	(445)	(11,125)	(133,500)
(quoted version)	[486]	[12,163]	[145,959]
[estimated version based on understanding that 133,500tpa was the 1999 figure and example projection]			
Green Waste	71	1,771	21,249
Public Cleaning Waste	266	6,659	79,911

Source: Curitiba Solid Waste Management Strategy 2010 (Ref.1)

Table 4.2 presents information in relation to the quantities of waste landfilled from Curitiba as well as other Municipalities in the Conresol consortium. This data has been provided by Conresol, based on the figures provided through the contract with Estre.

Table 4.2: Landfilled Material by Conresol (Tonnes)

Region	2011	2012	2013	2014
Curitiba	574,000	575,000	573,000	577,000
Other Municipalities	241,000	254,000	269,000	281,000
Total	815,000	829,000	842,000	858,000

Source: RFI response document – "Item 2 and 3 Consortium" (Ref.18)

The largest waste stream collected by the Municipality, with around 440,000 tonnes per year based on 2009 estimate, is the door to door residual waste collection, which is itemised in Table 4.1 . It is worth noting that this stream alone appears to correspond to around 75% of the landfilled material by the Municipality, based on the 2011 figures presented in Table 4.2.

Table 4.3 provides the monthly collected waste quantities for 2013 as provided by the Consortium. These are important as they provide an indication of seasonal fluctuations.

Table 4.3: Monthly Waste Variation 2013

Month	Tonnes	Proportion of total annual tonnage	Variance from average monthly tonnage
January	72,709	8.7%	+3.6%
February	65,149	7.7%	-7.2%
March	69,322	8.2%	-1.2%
April	69,962	8.3%	-0.2%
May	67,755	8.0%	-3.4%
June	67,792	8.0%	-3.4%
July	72,804	8.6%	+3.8%
August	70,058	8.3%	-0.1%
September	69,443	8.2%	-3.9%
October	73,839	8.8%	+5.2%
November	70,165	8.3%	+0.1%
December	74,876	8.9%	+6.8%
Total	843,874	100.0%	-

Source: RFI response document – "Material Consortium" (Ref.21)

4.3 Waste Composition

Mott MacDonald understands that no 'source waste composition' studies (i.e. studies of waste as it is put out for collection) have been performed by either the Municipality or Conresol for any of the wastes that are managed by the Curitiba Municipality.

There are three main studies conducted for the composition of the material generated within the Municipality; two of these are historical and one has been completed in August 2015. The historical studies

are based on data acquired by the site operators at the Caximba and Estre Landfills. Data was provided in RFI response document “Item 2” (Ref.9), which includes hazardous waste tonnages and landfill waste composition, as well as RFI document “Item 2 and 3 Consortium” (Ref.18) which includes information regarding the composition of material arising at the Estre Landfill in 2011. The 2011 information was also included in the Curitiba Municipal Sanitation Plan 2013 (CMSP) (Ref.2). The data is presented in Table 4.4 and shows the average composition (by weight) from data provided from 2005 to 2010 in the Caximba landfill and in the Estre landfill in 2011.

Table 4.4: Waste Composition at Curitiba Landfills (w/w)

Material Type	Caximba (%)	Estre (%)	Material Type	Caximba (%)	Estre (%)
Organic Material	37.7	40.5	Long Life Containers	1.1	1.1
Paper	15.9	17.9	Metals (magnetic)	1.9	0.9
Plastic Film	10.0	10.0	Metals (non-magnetic)	0.8	0.8
Plastic (hard)	7.8	6.9	Wood	0.8	0.7
Cardboard	6.0	6.8	Rubber	2.0	0.2
Diapers	5.5	7.6	Leather	0.7	-
Cloth	4.5	3.1	Other Material	0.6	1.0
Glass	4.6	2.5	Total	100	100

Source: RFI response document “Item 2” (Ref.9) and “Item 2 and 3 Consortium” (Ref.18)

Information was also provided in RFI response document “Items 27, 28, and 29” (Ref.17), which includes the Municipality’s waste strategy and data on the recently developed voluntary collection scheme. Collection tonnages for each material were available for two of the four sites that have been implemented to date. As the programme only started in 2014, tonnages are still very low. Therefore, there is a likelihood that as the programme develops, compositions may alter significantly. The data available has been utilised to calculate the composition percentages of materials that are collected at each of these sites. More detail on the Voluntary Collection programme is included in Table 4.5.

Table 4.5: Voluntary Collection Programme Composition (w/w)

Material	Boa Vista	Candida	Average
Glass (white)	27.2%	20.2%	23.7%
Glass (coloured)	26.7%	20.4%	23.6%
Cardboard	13.7%	18.0%	15.9%
Paper (coloured)	10.8%	16.3%	13.6%
Paper (white)	10.8%	14.1%	12.5%
Metal (magnetic)	2.2%	4.7%	3.5%
Plastics	2.6%	1.7%	2.2%
PET Bottles	2.4%	1.7%	2.1%
Market Bag	1.5%	1.5%	1.5%
Long Life Containers	1.5%	1.2%	1.4%
Metal (non-magnetic)	0.6%	0.2%	0.4%

Source: RFI response document “Item 27, 28, and 29” (Ref.17)

5 Waste Collection and Transfer

5.1 Introduction

A large number of waste collection schemes and programmes currently operate in Curitiba; this includes multiple services operated by the Municipality, informal arrangements, and services that are provided by the private sector. Table 5.1 summarises the main waste collection schemes.

Table 5.1: Summary of Waste Collection Services in Curitiba

Waste Collection Services in Curitiba
1. Municipality operated collection services: ▪ Residual waste collection service for households; ▪ Recyclables collection service for households, known as 'Waste that is not Waste'; ▪ Voluntary Collection Recycling Programme; ▪ Green Exchange Programme for recyclable materials; ▪ Social Action Foundation scheme for collecting (reusable) bulky household wastes; ▪ C&D and green waste collection (small quantities) from households; ▪ C&I waste from small businesses (small quantities only); ▪ Hazardous waste collection for households; ▪ Special collection of animal carcasses; and ▪ Collection of wastes from public areas.
2. Collection of recyclables by waste pickers
3. Private waste collection for generators of large quantities of C&I and C&D
4. Healthcare waste collection operated by the private sector

Source: Mott MacDonald

Table 5.2 and Table 5.3 summarise the information available in relation to the Municipality's waste services. The subsequent sub-sections of this report provide an overview of each scheme separately.

Table 5.2: Summary of Waste Collection Services

Waste Stream	Household % Coverage	Collections per Week	Estimated Tonnes per Year (2015)	Collected From	Destination
Recyclable Waste					
Waste that is not Waste	100	1-3	31,000	Black bags on street	UVR and Eco-citizen (50:50)
Voluntary Collection				Bring sites	UVR
Green Exchange	0.3[1]	Each site every two weeks.	3,000	Mixed bags, boxes, carts	UVR and Eco-citizen
Waste Pickers	100	7	170,000 (rough estimate only)	Pull carts, trucks	Eco-citizen or autonomous sites
Residual Waste					
Door to door	100	3 to 7	528,000	Black bags on	Estre landfill

Waste Stream	Household % Coverage	Collections per Week	Estimated Tonnes per Year (2015)	Collected From	Destination
				the street	
Indirect Collection		2	7,500	7m^3 containers	Estre landfill
		Other Wastes			
Green and C&D	100	Max 2 week wait	73,000	Black bags on the street	Estre landfill
Public Cleaning		7	80,000	Lutocar bins	Estre landfill
River Cleaning			1,000		Estre landfill
Domestic Hazardous		1 day in each point per month	50	24 collection points	Essencis Landfill
Animal Carcasses			190		Petworld Incinerator

Source: Mott MacDonald, RFI response documents "1-11" (Ref.7)
Notes: 1. Percentage of population using the service.

A number of different vehicles are utilised by the Municipality for collection of wastes around Curitiba. The fleets are almost entirely owned by operators. Vehicles that are partly owned by the Municipality are labelled accordingly. The table below summarises the vehicles identified for collection of each waste stream, vehicle capacity, and number of employees that operate these vehicles during collection. The data has been compiled from RFI response documents 1 through 13 (Ref.7), which include vehicle details for individual collection and cleaning programmes, as well as other information sources such as the Curitiba Solid Waste Management Strategy 2010 and the Curitiba Municipal Sanitation Plan 2013.

Table 5.3: Waste Collection Vehicles

Waste Stream	Main Vehicle type	Vehicle capacity	Total Vehicles and Vehicles per Shift	Total Number of Operators
Recyclable Waste				
– Waste that is not waste	Ford Cargo 1317 (understood to have all been purchased in 2011)	40m^3	34 total. 27 day shift and 32 night shift	212
– Voluntary collection				
– Green exchange	Ford Cargo 1317	40m^3	10 total. 4 hours a day	
– Waste Pickers	Pull carts and pick-ups	2-4m^3		Estimated by the Municipality to be 3,000 – 5,000
Residual Waste				
– Door to door	Ford Cargo 1722 with compaction (understood to have all been purchased in 2010/11)	19m^3	75 total. 66 day and night shift	566
– Indirect collection	Ford Cargo 1517	10 tonnes	4. Single day shift	24
	Ford Cargo 1317	15m^3	5. Single day shift	

Waste Stream	Main Vehicle type	Vehicle capacity	Total Vehicles and Vehicles per Shift	Total Number of Operators
Other Wastes				
– Green and C&D		15m^3	62 total	295
– Public Sweeping	FC 1517	12m^3	2	Over 1000
– River Cleaning	FC 1517	12m^3	1	44
– Domestic Hazardous	Ford Cargo 1317	25m^3	1. Single Day shift.	2
– Animal Carcasses			3 total.	
– Bulky Wastes	Ford Cargo		3 total.	

Source: RFI response documents "1-11" (Ref.7), CSWMS (Ref.1), CMSP (Ref.2)

Commercial and industrial sites with waste generation capacity under 600 litres (0.6m^3) a week (often home businesses) are classified as "small generators". It is the responsibility of the Municipality to collect waste from small generators. The Municipality does not collect from any site that produces more than 0.6m^3 of waste per week[7]. These premises are served by private contractors. This collection arrangement applies to all waste collection services in the Municipality.

5.2 Municipality Collections and Services

The following sections discuss collections and services performed by the Curitiba Municipality.

5.2.1 Residual Waste Collection

The Municipality offers a residual waste collection for materials that do not fit the criteria of the "Waste that is not Waste" programme. These materials are collected directly from households and small commercial establishments, or, in the case of gated condominiums and apartments, an internal collection service is usually performed by the site management. The collected material is then stored in specific accessible locations or taken to the street for collection by the Municipality's Refuse Collection Vehicles (RCV).

The collection service covers almost 100% of the city, providing collections either three times per week or daily (see Figure B.1 in Appendix A). In 2000, a study showed that 99.7% of the city's population used public collection services. There are a few remaining small inaccessible areas that do not have direct collection; these areas have their residual waste removed via the indirect collection programme (please refer to Section 5.2.2 for further information).

There are 66 compaction vehicles with a 19m^3 capacity[8] which operate both day and night shifts. These were purchased in 2010/2011 and are owned by Cavo (please refer to Figure 5.1 and Figure 5.2). A fourth axle was added to these vehicles in 2014 due to the weight limits exceeding those allowed for 3-axle vehicles by the federal weighbridge near the landfill site. Nine vehicles with 19m^3 capacity are kept in

[7] RFI response document "Item 1" (Ref.8)

[8] RFI response document "1 – Household Collection" (Ref.7)

reserve and there are two vehicles with 15m^3 capacity in use, with an additional reserve vehicle of this type.

Residual waste collection is performed three times a week across the vast majority of the Municipality, and daily in the city centre. The Municipality has stated that they are required to collect residual waste at least three times a weekCollection crews are composed of a driver and three collectors. The collection service has a total of 566 employees.

Given the potential waste growth that can be attributed to population increase, these costs are likely to continue to rise. This gives rise to a need to review collection operations, collection frequencies and service efficiency.

Given the relatively cool climate in Curitiba, collection three times a week may not be necessary from a technical and environmental perspective, particularly if appropriate containers for wastes and separate organic collection are provided. The reducing of collection frequency would be expected to reduce the associated cost and impacts of vehicle movements.

Through interviews at the initial site visits the Municipality stated that transport inefficiencies such as poor routing and low capacity limits, as well as the recent landfill change have led vehicles to hauling waste for long distances whilst carrying waste quantities that are below their maximum capacity. This appears to be a weakness of the current collection system that may be possible to be addressed without significant expenditure.

Figure 5.1: Residual Vehicle Type and Size

Source: Mott MacDonald

Figure 5.2: Residual Collection Operator and Vehicle

Source: Mott MacDonald

5.2.2 Indirect Collection

Areas that are inaccessible due to poor surface conditions or location, as well as some public areas such as cemeteries and transport police stations, receive an indirect collection. These areas are provided with large containers which are collected twice a week.

RFI response document "3 – Indirect Collection" (Ref.7) indicates that the service is performed by 4 roll-on roll-off trucks with a 10 tonne capacity, 5 trucks with a 15m^3 capacity, and 80 containers with a 7m^3 capacity[9]. The Curitiba Solid Waste Management Strategy 2010 indicates that around 500 tonnes per month of material are collected in this manner. This is unusual as typically indirect collection would be cheaper due to lower frequency of collections and lower staff requirements.

5.2.3 Waste that is not Waste Programme

The Waste that is not Waste Programme involves the collection of mixed recyclables from households and small commercial sites. Maps and interviewed sources suggest that the programme covers 100% of the houses in the Municipality. Collection is performed from one to three times per week, depending on the demand and output of the location.

The programme aims to recycle a variety of materials, including paper, plastics, glass, metals, and scraps from bulky waste such as ovens, washing machines and other WEEE sources[10]. The only available data for the rough composition of these wastes has been sourced from RFI response document Item 12, which covers the UVR composition and tonnage. This is further discussed in Section 6.2.1. Table 5.4 shows that all the separated material is sold (typically for reprocessing) and that around 40% of the material collected from the WNW programme is not of suitable quality or there is inadequate commercial demand to justify the cost of such materials being separated by the UVR.

Table 5.4: UVR Material Feed and Processing (Tonnes)

Year	Input (WNW)	Input (Other)	Separated	Sold	Reject	Reject Rate (%)
2013	9,402	408	5,765	5,750	3,888	41%
2014	9,223	299	5,507	5,500	3,852	42%

Source: RFI response document – "Item 12" (Ref.13)

Table 5.5 shows the composition of the materials that are separated in the plant. These are mainly paper, cardboard, and plastics, with significant portions of metals and glass. Although the category "metals" has not been further separated, it is understood that the vast majority of the metals separated at the plant are ferrous.

Table 5.5: UVR Separated Material Composition

Year	Paper & Card	Plastics	Metals	Glass	Other
2013	52%	21%	10%	15%	2%
2014	47%	19%	12%	19%	3%
Average	50%	20%	11%	17%	2%

Source: RFI response document – Item 12 (Ref.13)

[9] RFI response document "3 – Indirect Collection" (Ref.7)

[10] http://geocoletalixo.curitiba.pr.gov.br/reciclavel.aspx - accessed 30/06/2015

Data in Item 12 (Ref.13) indicates that the programme has collected 29,000-33,000 tonnes of waste per year, equivalent to around 100 to 110 tonnes of material per collection day (6 days a week)[11]. Monthly tonnages vary from about 2,300 tonnes (May/June) to 3,300 tonnes (December/January). The material collected is delivered to the UVR and the Eco-citizen project, each site receiving approximately half of the waste (see Sections 6.2 and 6.2.2).

The recyclables collection service is conducted by 34 loose-loaded collection vehicles, each with a 40m^3 capacity; 32 of them operate the night collection round, whilst 27 of them also operate during the day[12]. These vehicles are understood to have been purchased by Cavo in 2011. Vehicles are kept in two separate depots: João Negrão and João Betega; both depots are operated and maintained by Cavo.

Figure 5.3 and Figure 5.4 show the WNW fleet at the depot visited.

Figure 5.3: Recyclable Collection Vehicle Fleet Depot

Source: Mott MacDonald

Figure 5.4: Recyclable Vehicle Type and Size

Source: Mott MacDonald

Individual households are expected, but not required, to separate their waste. Waste collected by the programme is presented in black bags, usually left outside houses and apartments in locked metal containers or on the sidewalk. The bags are left directly on the curb or in small elevated baskets utilised to keep material out of the reach of dogs and other animals.

As all wastes are collected in black bags it is not possible to discriminate between recyclable and residual material, or to see if the recyclable material is contaminated. The material is not checked by the operators unless there is significant reason to suspect that it is heavily contaminated with non-recyclable waste. Bags that show significant evidence of contamination are left uncollected and put out for residual collection. Much of the recyclable waste is sorted by waste pickers prior to collection; the higher value recyclables are likely to have been removed from the bags before Municipal vehicle collection.

[11] RFI response document “Item 6” (Ref.10)

[12] RFI response document “2 – Recyclable Waste Collection” (Ref.7)

Curitiba City has many private condominiums and apartment complexes. In these locations, separation and recycling education is often part of the internal waste management provision. There are attempts to maintain a high quality of material from such sites; these are usually in the form of education programmes as well as monitoring by the Municipality. As it is hard to inspect individual generators, the Municipality stated that poor separation and high cross contamination is not uncommon. When external bins are utilised for waste storage, they are often kept in locked metal containers and are unlocked before the expected collection time, as shown in Figure 5.5 and Figure 5.6.

Figure 5.5: External Metal Waste Containers

Source: Mott MacDonald

Figure 5.6: Locked Street Containers

Source: Mott MacDonald

The Municipality has stated that education programmes and awareness campaigns have resulted in increases in recyclable material quality and decreases in cross contamination for a period of around six months to a year, with quality decreasing after that period. This has been reviewed by the Municipality through WNW tonnage data.

It is not uncommon for material to be poorly sorted and inappropriate for their specified collection and there is no direct financial benefit for households to separate their waste. As there is very little monitoring and checking, there are limited incentives to increase source separation quality. Some fines have been issued, usually based on contaminated recyclable waste collections, but these are usually only applied to major sites.

Collection crews have established regions, routes, and frequencies for their service. The routes closest to the UVR tend to dispose of the waste at the facility; otherwise, vehicles must be weighed at the depots before being sent to an Eco-citizen site ready to receive the material. Vehicles may fill up to around 80% of their maximum capacity; this is due the method used for filling the vehicle, which involves throwing rubbish bags in from the back, and the waste containment method, which utilises a net that does not reach the top of the container. Due to variables in waste production quantities, assistance is sometimes requested for additional vehicles to aid in an area when high volumes of waste are encountered. Alternatively, during lower production periods vehicles may end up not being full. Vehicles tend to travel a larger distance once they are loaded with waste to get to a processing site than during their collection course.

Cavo, the contractor that performs the service, is paid per collection team sent out, rather than per tonne collected. Both the Municipality and Mott MacDonald have concerns that this may promote system inefficiencies. Crews are formed of a driver and two collectors. The program has a total of 212 employees.

5.2.4 Recycling Voluntary Collection Programme

The voluntary collection programme began in November 2014 as an attempt to reduce collection fees by encouraging the population to take their own recyclable material to 'bring' sites and separate tem themselves (such as the one shown in Figure 5.7 and Figure 5.8). The programme currently has four sites where the collection is performed; these have been used as a trial to study the programme's efficiency and set-up.

Each site accepts 11 types of materials, including mixed plastic, PET bottles, plastic bottle caps, bottle labels, aluminium cans, other metals, coloured glass, transparent glass, white paper, coloured paper, cardboard, and Tetrapak cartons. The sites have can and PET bottle crushers and a storage capacity of $6m^3$.

An electronic identification transport card can be touched-in at these stations. The Environment Agency secretary stated that, based on the amount of times a citizen utilises the compound, he/she will be given some prizes such as theatre tickets, etc.

Available data indicates that material received per station varies from 250kg to 6,500kg. This is due to the different installation dates related to each station, and as the programme is very recent it is anticipated that will develop considerably. Information provided by the Municipality covering some of the Municipal strategies and objectives[13] indicates that the Municipality is aiming to expand this programme to at least one station in each of the 75 neighbourhoods of Curitiba. The proposal is for the waste to be collected by a contractor appointed by the Municipality and taken to nearby Eco-Citizen stations. The document outlines proposed developments to the programme including accepting C&D waste and green waste, and integrating these stations with current Eco-Citizen locations.

[13] RFI response document "Item 27, 28 and 29" (Ref.17)

Figure 5.7: Voluntary Collection Station External

Source: Mott MacDonald

Figure 5.8: Voluntary Collection Station Internal

Source: Mott MacDonald

5.2.5 Green Exchange Programme

The Green Exchange Programme is dedicated to exchanging mixed recyclable waste for food in poorer areas of the Municipality. The programme began in 1991 with 53 exchange points and currently has around 100 points (an example of such sites is shown in Figure 5.9 and Figure 5.10). Each point receives a collection every two weeks.

Around 10 to 15 tonnes of material are collected per day[14]. Verbal sources indicated that the largest sites collect around 3.5 tonnes per month, whilst the smallest ones around 0.7 tonnes per month. The programme benefits a total of 6,000 people (0.3% of the population), with around 80 tonnes of food being handed out. Food is purchased from the local market, based on the cheapest price obtainable from the farmers union..

The programme is delivered with 10 vehicles, 4 owned by the Municipality and 6 owned by Cavo. Collections are from Tuesday to Friday from 9-11am and 2-4pm; during each two hour period, vehicles visit either one or two points, depending on size of the site.

Each collection crew has 3 vehicle operators and another 4-6 people to aid in weighing, food delivery, etc. The Municipality has stated its intention to keep the programme ‘as is’ in terms of locations and size. Moving the established locations has proven to be very challenging in the past due to local pressure and opposition.

[14] RFI response document “Item 6” (Ref.10)

Figure 5.9: Green Exchange Collection System

Source: Mott MacDonald

Figure 5.10: Green Exchange Produce

Source: Mott MacDonald

In 2010, vegetable and animal oil began being collected through the programme. Around 5,500 – 6,000 litres are collected each month; this is taken to the UVR for storage/accumulation and sold to "Ambiental Santos" for re-use. Two litres of oil are exchanged for 1kg of food.

Only basic visual inspection is undertaken on the materials and bags brought to these collection points. Material is often brought in black bags and not inspected for contents. There is a potential for significant amount of cross-contamination with non-recyclable material, especially considering that the material is not required to be sorted by type (paper, plastic, glass, etc.).

5.2.6 Social Action Foundation Programme

A charitable organisation called the Social Action Foundation provides a service that collects waste electronic and electrical equipment (WEEE), clothing, shoes, toys, bicycles, and furniture such as sofas, beds, etc. to donate them to charities and people in need. This service requires a household to contact the Foundation to arrange a collection. Around 1,000 requests are submitted per month. Items are collected with two vehicles and a pick-up truck[15]. The aim of the programme is to provide material of usable condition to families and people of vulnerable social status. It is understood that some of the material collected by the programme includes items that may be of non-reusable quality. These are often salvaged or landfilled as required. Information provided in RFI response document "Relatório Resíduos Disque" (Ref.25) shows that in 2014 a total of 14,100 households used this service. The most common items collected are presented in Table 5.6:

Table 5.6: Social Action Foundation - Common Items Collected

Item	Quantity	Item	Quantity	Item	Quantity
Sofa	1,185	Screen	543	Computer	385
Gas Oven	693	Refrigerator	504	Closet	375
Double Mattress	689	Common Chair	458	Wardrobe	368

[15] Curitiba Solid Waste Management Strategy 2010

Item	Quantity	Item	Quantity	Item	Quantity
Television	687	Keyboard	454	Office Chair	329
Single Mattress	659	Washing Machine	430	Single Bed	178

Source: RFI Response Document "Relatório Resíduos Disque" (Ref.25)

5.2.7 Household Green and C&D Collection Service

The Municipality provides a service to householders for the collection of green waste and small volumes of construction and demolition (C&D) material. Households are able to dispose of any tree/grass cuttings or similar (up to 1m^3 per month) as well as 0.5m^3 of C&D material every two months[16]. Quantities above these limits must be privately collected. It is also understood that unusable household bulky material is often collected with this service.

These materials are collected together, in the same vehicle, and without any separation. Collection of these materials together is likely to limit the extent to which they can be recycled or recovered. The collection functions through individuals contacting the Municipality and requesting the service. The Municipality aims to complete collections within a maximum of two weeks and has recently developed vehicle routes and collection plans for these operations.

The Curitiba Municipal Sanitation Plan 2013 states that this service is performed by 75 teams with 48 vehicles with a 15m^3 capacity each. The project manager for this service however, has stated that there are 62 RCV's currently operating. There are two shifts per day and the programme employs 75 drivers and 220 collectors. The plan provides a collection map (Figure B.2) for the collection dates in each region of the city; 100% of the Municipality area is covered. Approximately 5,400 tonnes of material are collected per month[17].

A company called 'Viaplan Engineering' is responsible for three of the four city regions, with the remaining region being collected by a company called 'Nicons Plants Commercial'[18]. The collection contracts state that the companies are paid per collection team.

5.2.8 Public Sweeping and Cleaning Services

There is a variety of sweeping and cleaning services that are provided by the Municipality. These services are conducted by Cavo. Cavo's contract details and list of services are provided in Section 7. Information has been provided for the tonnages generated from these services; details are provided in Table 5.7. For the most part, these materials are of residual nature. Some of the cleaning is performed by teams dedicated towards addressing specific green waste sources, such as some parks, large trees, etc.

[16] Curitiba Municipal Sanitation Plan 2013 (Ref.2)

[17] Curitiba Municipal Sanitation Plan 2013 (Ref.2)

[18] RFI response document "Item 10 and 11" (Ref.12)

Cavo is paid for the provision of these services based on the number of kilometres of roads where sweeping and cleaning is performed. Manual sweeping services are conducted with small "Lutocar" bins and a few electric pull carts. Cleaning services are performed with specialised equipment as well as a few smaller hauling vehicles, usually of around 12m^3. The Curitiba Municipal Sanitation Plan 2013 estimates that around 80,000 tonnes of waste are collected from public cleaning services each year; this figure is higher than those presented in Table 5.7 as they include other services that have been given separate tonnages and thus have not been presented in the table.

Table 5.7: Cleaning and Sweeping Service Tonnages

Service	2013 Tonnage	2014 Tonnage
Special Cleaning	10,400	10,600
Mechanical Cleaning	14,700	12,800
Mechanical Sweeping	3,800	3,600
Manual Sweeping	400	500

Source: RFI response documents "SMMA Report 2013 and 2014" (Ref.24). Providing data on tonnages collected for each waste stream in those years.

5.2.9 Hazardous Waste Collection Service

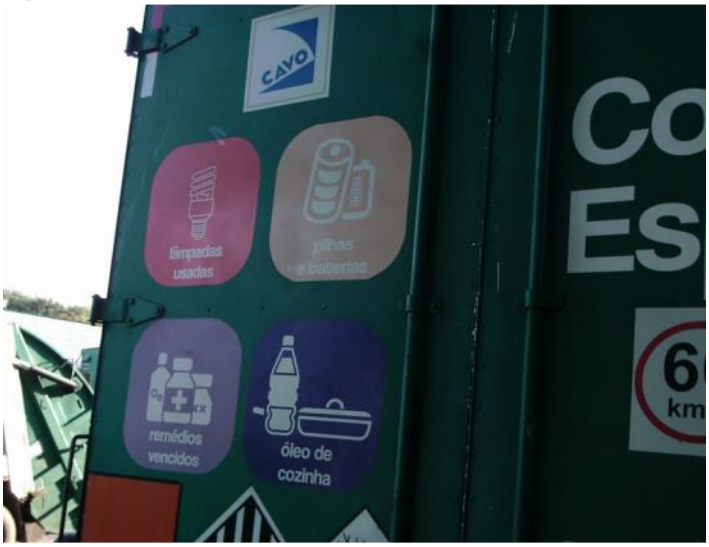
There are 24 collection points in the city, often adjacent to bus stations, where a vehicle visits once a month and remains available for the day. The vehicle accepts hazardous material delivered by city residents. As this service is not for private industrial and commercial businesses, there are limits on the quantity of material that can be accepted from each person. The amount of waste delivered by each resident is visually checked on visually (e.g. around 10 florescent light bulbs maximum). Material that is accepted is separated and stored appropriately.

This service is performed by a single 25m^3 vehicle (shown in Figure 5.11)[19]. Around 35 to 40 tonnes of material is collected every year[20]. This rose sharply to around 65 tonnes when used kitchen oil started being collected in 2012, but has fallen back to around 40 tonnes in the recent years.

[19] RFI response document "11" (Ref.7)

[20] RFI response document "Item 2" (Ref.9)

Figure 5.11: Hazardous Waste Collection Vehicle



Source: Mott MacDonald

5.2.10 Animal Carcases Collection Service

A special collection service is provided by the municipality for dead animals. According to the 2010 Municipal Waste Strategy, this service is performed by a third party company hired by the Municipal Heath Department. The service is conducted by a 12m^3 vehicle and two pick-up trucks and around 180 tonnes of carcasses were collected in 2009, which is the latest data currently made available for this service.

5.3 Other Waste Collections and Services

5.3.1 Waste Pickers (Catadores)

5.3.1.1 Summary

Waste pickers collect waste on the street, from household bin bags and from commercial sites. In some cases, they have pre-arranged agreements with commercial sites. Often they collect the waste before the arrival of the official municipal collection service in order to collect waste that is more valuable such as aluminium and iron, different kinds of plastics and cardboard.

Waste pickers establish informal agreements amongst themselves regarding territories that each has the right to cover and the prices that should be charged. The areas most covered by the waste pickers are the Curitiba city centre, especially after commercial hours and southern neighbourhoods that are considered to be ‘wealthier neighbourhoods’, throughout the day and, the bus and train station. During high tourist season, waste pickers intensify their activities in tourist areas.

Waste pickers use pushcarts that can collect up to 400kg of material (Figure 5.12) or trucks. Pushcarts may be rented or loaned by the deposit sites that they will then take their waste to. Some will walk up to 5km to return from their collection point to the deposit site. The dependency of the waste pickers on the site (when they do not own a cart) is considered by the Municipality to be a point of vulnerability as it may offer an unfair advantage to employers that may be exploited as there are no guaranteed legal rights for waste pickers.

On average, a waste picker receives R$40.00 for a full cart of unseparated waste (excluding the cost of renting a cart).

Some waste pickers travel to and from other municipalities in order to do collections, usually using horse-drawn carts which are illegal in Curitiba. The municipality has tried to stop this activity by confiscating the carts, however, since many waste pickers come from other municipalities, this initiative had limited success. Waste pickers are often accompanied by children.

Waste collected by waste pickers is either separated at deposit sites (section 6.2.2) or at the home of the waste picker. Some waste pickers depend on deposit sites for shelter, this number was put at 21% in a study done by the Municipality in 1999. The fact that waste pickers may use their homes as separation sites is identified as a public health risk by the Municipality.

In the municipality of Curitiba, some waste pickers have organised themselves into Associations and Cooperatives in order to work directly with the municipality through the Eco-Citizen Project, discussed in section 6.2.2. The Eco-Citizens project goal is to formalise the work of the waste pickers through registration and direct contracts, following the orientations of the National Waste Policy. It is understood that there are few Associations and Cooperatives that work independently, none of which were available for contact, during the fact finding visits.

A weakness in the organisation of the Associations and Cooperatives has been identified, possibly due to the lack of historic existence in Curitiba. Are they are new to Curitiba the lack of experience in management and finances may cause challenges.

5.3.1.2 Quantitative Estimates

The Municipality provided monthly quantitative data for the Eco-Citizen sites, this data is supplied by each Eco-Citizen site and is collected internally. Data included in this section includes the values made available (from January to June 2014) and are summarised in Table 5.8. Further data is available but the most recent data has been used, as this is considered more likely to be representative of the current status.

Table 5.8: 2014 Eco-Citizen Sites Data

	Jan	Feb	Mar	Apr	May	Jun	Average
Active Cart Users	50	53	60	59	62	67	59
Active Waste Separators	351	346	380	399	396	409	380

	Jan	Feb	Mar	Apr	May	Jun	Average
Number of People Indirectly Benefited from Programme	1260	1203	1345	1211	1358	1418	1299
Collected Material Weight (tonnes)	195	136	152	143	123	129	146
Collected Paper %	73%	63%	58%	60%	64%	66%	64%
Collected Plastic %	14%	23%	23%	23%	22%	23%	21%
Collected Metal %	7%	8%	13%	13%	10%	8%	10%
Collected Glass %	4%	1%	3%	2%	1%	1%	2%
Collected Reject %	2%	5%	3%	2%	3%	2%	3%

Source: RFI Eco-Citizen Data (Ref.22)

Eco-citizen waste collectors collected an average of 146 tonnes of waste per month using electric and hand push-carts. Collected waste is divided into paper, plastic, metal, glass, and rejects. The largest fraction of street collected material is the paper/cardboard fraction which averages 64% of the total collected waste weight. Due to the high selectivity whilst collecting, material reject rates are significantly lower than at the UVR.

A significant portion (87%) of waste pickers working at the Eco Citizen sites do not participate in collection operations and instead work solely as waste separators. As they are members of waste picker associations and cooperatives, they continue to identify themselves as a part of this group.

According to data collected at each site an average of 1,299 people indirectly benefit from the Eco-Citizen project per month; these include dependants of the active Eco-Citizen workers, and averaging around 3 benefiters per worker.

It is important to note that the Eco-Citizen project has grown over the past year, with a total of 22 sites currently working as part of the Eco-Citizen project, representing an increase of 4 sites.

Aside from those who are registered and working in the Eco-Citizen project, there are also autonomous waste pickers who work individually or in networks. The number of individuals who work this way varies as they often work with this trade seasonally or in response to market fluctuations.

The last study carried out by the Municipality to estimate the total tonnage of material collected by waste pickers was in 1999 (quoted in Ref.1). The 1999 study found that the majority of waste pickers worked in the Portão district. This appears to still be the case, as in the fact finding missions undertaken various interviewees stated that there were a large number of waste pickers in the area. The revised Municipal Waste Strategy from 2013 identifies an increase in waste pickers from 1999 throughout the city and other informal verbal sources state that there are between 3,000 and 5,000 waste pickers working in Curitiba currently. This is substantially different to the estimate of 5,000 – 15,000 which was verbally given by the Municipality.

More representative quantitative data on these workers was not found, neither through the municipality, nor in secondary research or through site visits. The difficulty in establishing a robust estimate of the number of waste pickers is a result of the high turnover rate and transient aspects of this sector. The registration process carried out by the Eco-Citizen project is not currently able to fill this gap due to the small proportion of waste pickers registered at Eco-Citizen sites.

There are many waste pickers who choose informality for a variety of reasons; these reasons given during interviews at the fact finding missions included: lack of interest in following the rules of the cooperative, interest in receiving payment at the time of collection, attraction of working for oneself, involvement in other illicit trades, such as the drug trade, lack of trust in the cooperative system; among others. The demographics of the waste pickers vary, including children and the elderly. The majority are men, though women are also involved, particularly in separation lines. According to a study done by IPEA (2010)[21], only 10% of waste pickers across Brazil are part of a cooperative or association.

It was estimated by the Municipality that each waste picker collected 135kg per day in 1999. At the time, this estimate represented 133,500 tonnes of material per year[22]. Assuming that there are between 3,000 and 5,000 waste pickers currently, and each waste picker collects for an average of 300 days a year, it can be inferred that between 122,000 and 203,000 tonnes of waste per year are collected by informal waste pickers. This is in line with the modelled estimated.

Mott MacDonald has not been able to find any further data on tonnage of waste collected by autonomous waste pickers. Therefore, the 1999 figure has been used, along with the Eco-Citizen data as a best estimate but cannot be corroborated and leads to the risk that the actual figure may be significantly higher or lower.

Figure 5.12: Small Waste Picker Pulled Cart

Source: Mott MacDonald

[21] IPEA: http://www.ipea.gov.br/agencia/images/stories/PDFs/situacao_social/131219_relatorio_situacaosocial_mat_reciclavel_brasil.pdf

[22] Curitiba Sanitation Plan 2013 (Ref.2)

5.3.2 Privately Operated Waste Collection Services

There are about 15-20 companies that offer collection services to businesses that generate large quantities of C&I and C&D waste. This service is often performed by leaving containers capable of compaction on-site; these are then removed as required/contracted with each generator. It is understood that although the Municipality could technically provide this service to large generators of waste, the service is not performed as sites prefer the private collection and therefore these wastes would be outside the scope of this project.

5.3.3 Healthcare Waste Collection

Medical waste is collected by Cavo. The company also owns a microwave treatment facility and utilises that process to ensure the waste is dealt with appropriately. Medical and clinical waste is a private service and is also outside the scope of the project.

5.4 Socio-Environmental Analysis

This section includes the findings of the initial assessment of the social and environmental issues associated with the current waste collection system in Curitiba. It is based on information collected during the fact finding missions in June, July, and August 2015, including interviews with waste pickers. Key issues identified by the review are summarised below in accordance with the aspects identified as positive and negative from a social-environmental perspective.

5.4.1 Positive Aspects

The range of collection options set up for recyclable wastes are identified as positive aspects, including the Recycling Voluntary Collection Programme, the Green Exchange Program and the special waste collections. The Recycling Voluntary Collection Programme presents a positive solution that contributes towards the increase in recyclable collection through individual initiatives as well as diminishing the need for collection in the areas surrounding the sites. One important aspect from a social perspective is that the waste collected through the Voluntary Collection Programme is also sent to Eco-Citizen sites, which provide employment for those that work at these sites.

The Green Exchange Programme provides important incentives for lower-income residents to recycle. As discussed above, some residents have come to depend on the food they receive in exchange for the recyclables they bring in. The exchange of vegetable oil is particularly important as it reduces the quantity of oil that is disposed of in the sewage system, increasing sewage efficiency and decreasing water contamination.

The collection of bulky waste, green waste, C&D and hazardous waste contributes towards the reduction of waste that is sent to the landfill, thus increasing the life span of the landfill and therefore decreasing environmental impact. Specifically in relation to hazardous waste collection, the environmental benefits are significant, as the collection of this kind of waste diminishes possible contamination that would occur if such waste was disposed of incorrectly.

The working conditions of the formal workers involved in the collection services are considered to be good, in that they meet legislative requirements of paying minimum wage and receiving benefits.

5.4.2 Negative Aspects

The negative aspects were more widely identified in relation to transportation inefficiencies, issues in the recyclables collection and the situation of the waste pickers.

5.4.2.1 Environmental impacts of waste collection

As identified earlier in Section 5, there are no clearly defined routes for residual or WNW collection, vehicles are not always completely filled and residual collection vehicles are used to take waste to the Estre landfill located a considerable distance from the Municipality. The result is that the use of these vehicles is not optimised. Inefficiencies in the transportation of waste and recyclables would be expected to result in low efficiency in terms of fuel usage, unnecessary emissions and greater amenity impacts associated with vehicle movements.

5.4.2.2 Recyclables collection

Mott MacDonald understands from observations during fact finding missions that there are significant levels of contamination in the recyclables received from households under the WNW programme. The contamination of recyclable waste decreases the value of recyclable materials and increases the quantity of waste sent to the landfill. Lack of continued education and communication campaigns are likely contributing factors that lead to incorrect segregation.

High levels of contamination were also observed in the Green Exchange Programme. This is believed to be primarily due to insufficient monitoring of materials accepted. It is believed that there are cases where rocks are placed in bags of waste or bottles are filled with water in order to increase the overall weight of material being delivered and therefore the associated reward.

Lower sale prices of some potentially recyclable materials directly affects the collection of recyclables. Due to lack of interest in the separation of these less valuable wastes, a big part of this material enters the residual waste stream and is disposed of to landfill, even if it can be categorised as a recyclable material.

5.4.2.3 Waste pickers

Waste pickers, particularly in the informal and autonomous sector, play an essential role in Municipal waste collection services. The lack of data in relation to waste picker numbers and volumes of waste collected is representative of the informality of the sector and high rates of waste picker turnover. Waste-pickers' livelihood depends directly on the collection of waste on the streets. Their working conditions are very precarious since they work on the streets, usually at night, often in dangerous areas. From discussion during the fact finding missions there is indication that many use drugs and alcohol or are involved in the drug trade. The fact that children often help their parents or other adults is also an important issue.

It appears that no single Association and Cooperative that works with the Eco-Citizen project represents a uniform identity of the waste pickers, nor do they operate in the democratic way that their conception demands. This weakness in the organisation of the Associations and Cooperatives may be due to the lack of culture of cooperation or lack of experience in management and finances.

Assistance and support from the Municipality could be beneficial for the improvement and ongoing preservation of the Associations and Cooperatives, leading to the long-term stability of the Eco-Citizen project.

In general, waste pickers are a particularly vulnerable social group, many are dependent on third parties for the carts they utilise or for shelter, which aggravates the lack of their autonomy. Those who are not members of a cooperative or association often prefer this form of work, either because they do not think they could work the eight hours a day that would be required of them or because they do not have the financial capacity to receive a pay check only once a month, or because they prefer to work hours of their own choice. Often they work in articulated networks, involving the separation sites (as discussed in section 6 below) and middlemen or bulkers. Some separate waste at their homes, which presents a series of problems in terms of environmental contamination and public health issues.

Waste pickers are often invisible in the waste management system, as they themselves report, though they perform an essential role in maintaining the system and providing adequate destinations for recyclable waste. There seems to be a lack of clarity on the part of the Municipality and the public of how the Eco-Citizen programme should operate; whether it is a social program for a vulnerable sector of the society or a waste management program providing a necessary service to the Municipality. This is a source of ambiguity in how the programme will look in the future and what its objectives are.

The waste pickers interviewed for this study reported that no social program or assistance is offered by the Municipality to them.

5.5 SWOT analysis

The table below summarises a 'SWOT' analysis of Curitiba's waste collection arrangements.

Table 5.9: Collection and Transfer SWOT Analysis

Strengths	Weaknesses
▪ Diversity of different collection schemes and wide range of services provide resilience to the waste management system. ▪ Current arrangements facilitate employment / provide source of income for vulnerable members of the community. ▪ Good examples of partnership, private sector incentivisation and cooperation with charitable organisations. ▪ Coverage of almost 100% of households served by waste collection services. ▪ Public receptive and responsive to education programmes. ▪ Innovative collection programs that combine social programs with waste management.	▪ Duplication of recycling and collection services due to various concurrent schemes (e.g. formal and informal, green exchange and WNW). ▪ Inefficiencies due to non-optimum routes, high collection frequencies, non-optimum crew utilisation, transport distance / lack of transfer stations, non-optimum vehicle capacity utilisation. ▪ Poor waste source separation performance. ▪ Limited communication/ engagement with community / service users in relation to recycling. ▪ All waste is collected in back bags and therefore it is difficult to identify contaminated recyclable waste.

▪ Innovative & early adoption of concepts such as voluntary recycling, for example, bring centres	▪ Limitations in ability to monitor separation of waste by individual generators. ▪ Limited capacity of monitoring and fining. ▪ Social vulnerability of waste pickers. ▪ Lack of waste composition data. ▪ Lack of current waste collection quantitative data ▪ Informal recyclate collections bypass the regulated system and are unrecorded in the recyclate they collect and sell on. ▪ Lack of clarity on the part of the municipality and the public of how the Eco-Citizen project should be carried out, whether it is a social program for a vulnerable sector of the society or a waste management program providing a necessary service to the Municipality, which causes confusion in how the project should look in the future. ▪ Organisation of the Associations and Cooperatives
Opportunities	**Threats**
▪ Scope for significant improvement of cost efficiencies for waste collection and transfer. ▪ Improved community engagement/ communication and education could improve significantly separation of waste and recycling rate. ▪ Introduction of different colour bags scheme could improve separation of waste and recycling rate and allow better monitoring of contamination. ▪ Incorporation of informal waste collection and transfer streams into a more structured and regulated environment could enable increased reliance / utilisation of waste-pickers and limit overlap of formal waste collection and transfer provision. ▪ Development of transfer infrastructure to allow bulk transport of residual wastes could reduce costs and impacts of transfer of wastes to landfill. ▪ A service efficiency review could make a significant impact in the reduction in operating costs	▪ Informal waste collection and transfer schemes are unregulated and unsupervised. ▪ Local opposition to relocation or establishment of Voluntary Recycling Collection Points. ▪ Opposition by elements of the picker community to make informal collection sector more structured. ▪ Potential population growth could make the costs of collection unsustainable. ▪ Potential instability of the waste pickers' collection. ▪ Conflicts between social benefits and private interest that might make new management schemes difficult. ▪ Lack of consistency of the autonomous sector, which makes understanding it in quantitative terms difficult. ▪ Scoping the Eco-Citizen project as a service to a vulnerable sector of the society may lead to poor efficiency and management ▪ No support to the Associations and Cooperatives could lead to a failure in the system ▪

6 Waste Processing and Disposal

6.1 Introduction

Curitiba has a number waste processing and disposal sites. These are categorised as formal sites, informal and/or autonomous locations.

- Formal Sites:
  - Materials Recycling Facility (UVR) at Campo Magro;
  - Eco-Citizen sites;
  - Estre Landfill;
  - Essencis Landfill and Compound; and
  - PET Shredding and Flaking Plant (currently closed).
- Autonomous, and Illegal Sites:
  - Autonomous waste picker sites;
  - Illegal C&D waste disposal sites used by private contractors and informal waste pickers; and
- Other Sites:
  - Caximba Landfill (no longer accepting waste).

Conresol, the entity responsible for all landfilling arrangements from the Municipality, has provided some basic information on the Curitiba Disposal arrangements as shown in Table 6.1.

Table 6.1: Current Curitiba Collection Arrangements

Municipality	City Centre to Landfill Distance	Tonnage Landfilled 2014	Monthly Landfill Trips	Monthly Kilometres Run
Curitiba	31 km	577,000	7,226	448,000

Source: RFI response document "Material Consortium" (Ref.21). Monthly information provided for December 2014.

6.2 Formal Sites

6.2.1 Materials Recycling Facility (UVR) – Campo Magro

Curitiba has one large materials recycling facility, the UVR, located in the region of Campo Magro roughly 30km from Curitiba's city centre. The site is owned and operated by the IPCC (Curitiba Pro-Citizenship Institute) in partnership with the Municipality. The facility was initially designed to process 800 tonnes of material per month but has increased its capacity and now processes 1,000-1,200 tonnes per month. An average of 40-45 vehicles, comprising light and heavy vehicles, go to the site each day; these include material brought to site and offtake material sold by the UVR.

The facility has been operating for around 25 years, but had very little investment until March 2015. Until recently, all revenue generated from the sale of the separated material was utilised for social programmes and site expenses. Since March 2015 30% of sales revenue is re-invested into site infrastructure.

The facility contains four conveyor belts, operating with an average of 10-15 operators per line. The first two operators in each of the conveyor belts act as bag-rippers and are in charge of ensuring the contents of all bags are adequately exposed. An average operator is expected to sort around 150kg of material in an 8 hour shift, whilst a good operator may achieve 200-220kg in the same period (see Figure 6.1 and Figure 6.2). In practice, the amount of material which can be separated depends on the material being selected and the levels of contamination of the feedstock, along with the density of material on the conveyor belts.

Figure 6.1: UVR Conveyor Belt Operation

Source: Mott MacDonald

Figure 6.2: UVR Material Classification Divisions

Source: Mott MacDonald

Around 40% of the material taken to the UVR ends up as reject and is sent to the Estre Landfill[23]. The rejected material is due to a number of factors:

- poor source sorting;
- pre-removal of higher quality materials by hand pickers prior to collection;
- allowing non-recyclable material to reach the site due to lack of contamination controls; and
- some recyclable materials received at the site having a low value, which means that it is not financially viable to separate them.

It is likely that the fraction of rejects from the plant has a high calorific value due to the dense plastics, plastic film, and Styrofoam fraction in the stream, although data on the composition of this fraction is not available[24]. The reject stream also contains organic matter. Studies on reject composition and properties have not been performed.

The site manager stated that the plant operates with two eight-hour shifts from Monday to Friday and two four-hour shifts on Saturday. Each operator works a total of 44 hours per week. The first shift operates with 110 staff and processes around 260 tonnes per week, whilst the second shift operates with 80 staff and processes around 190 tonnes per week. Workers in the facility have work documents, official leave, food

[23] RFI response document "Item 12" (Ref.13)

[24] RFI response document "Item 2 and 3 Consortium" (Ref.18)

support, pension schemes, etc. and are paid minimum wage. The workers are also supplied with work uniforms, masks and appropriate PPE.

Figure 6.3 and Figure 6.4 show material storage at the UVR.

Figure 6.3: UVR Bundled Material Storage

Source: Mott MacDonald

Figure 6.4: UVR WEEE Waste Storage

Source: Mott MacDonald

In July 2013 (when the current site manager assumed his role) the site was separating 51 types of materials into different streams; the site currently separates 72 different streams. The streams separated at the site are based on current market value and best judgement from the site manager.

The site also receives WEEE material collected from the door to door recyclables collection and donated material. Some material is separated (such as keyboards and computers) into different components, whilst others are kept whole (such as TVs and fridges). Most of this material is sold to a company called “Hamaya do Brasil”.

The site manager has stated that a 3-5m^3 container is usually filled with metal each day. These are typically in the form of rods, chair pieces, scraps, etc. Very few metal cans or smaller pieces are found due to them being valuable material picked from the waste before it reaches the site.

Large glass containers (5lt wine jugs) that are brought to the site are sold for re-use. All other materials are separated and sold or given for recycling. Glass is separated by colour (green, brown/amber and clear) and crushed.

A “jacaré” press machine is utilised for baling cans that are taken to site. At the time of Mott MacDonald’s site visit the press was not operating as it had malfunctioned. On-site maintenance is exclusively reactive and repair based as there is no preventative schedules or budget.

Figure 6.5 and Figure 6.6 show the operations at the UVR, including the scale utilised for weight measurements, the bailer, and site vehicles.

Figure 6.5: UVR Scale and Bundling Press

Source: Mott MacDonald

Figure 6.6: UVR Site Machinery

Source: Mott MacDonald

All material separated in the conveyor belt is weighed on-site. The UVR also buys some materials from the Eco-Citizen sites (around 10-15% of the UVR total tonnage). The purchased material is mixed with the higher quality separated material from the UVR and sold as a mixture in order to increase the sale price.

The site receives around 12,000–20,000 visitors per year from schools, charities, and open days; and has social programmes to educate the visitors on the importance of separation and waste management. The site also has a "waste museum" that collects items of interest found in the rubbish delivered to the site. The museum is currently being redeveloped and expanded.

6.2.2 Eco-Citizen Sites

The Eco-Citizen programme was developed in 2008 as an attempt to formalise the waste picker market and legalise activities. There are a total of 22 sites currently registered; there are indications that this number will continue to grow. Eighteen sites were formalised by June 2015 and operate under the Cataparaná network, whilst three additional sites are formalised but do not operate under the same cooperative.

Associar is an association that accounts for 22 sites, one of which is registered and began receiving waste from the municipality in July, 2015. It was identified that although only one site is registered to receive waste from the municipality, this site distributes this waste to the other 21 sites, suggesting that they also indirectly work with waste from the municipality.

The Credenciar cooperative has a total of five sites and is currently going through the registration process to become part of the Eco-Citizen project. All of the sites currently operate as small companies, but are organising into cooperatives in order to receive the waste from the municipality.

Interviews conducted during the initial site visits have mentioned that Eco-Citizen sites are required to receive a minimum of 10 tonnes of material per week for sorting and processing from the Municipality. The two largest sites receive around 150 tonnes per month. Fourteen of the sites have some form of conveyor belt system and all of them also have tables to separate the waste on.

Waste collected from the door to door recyclable collection and green exchange is taken to these locations.

This system is identified as inefficient by various interviewees, including municipality representatives and site workers. It is reported that the rejection rate is often high and many bulkers or middlemen do not purchase waste from the sites due to their low quality and poor separation. Lack of oversight from the Municipality was also indicated as a point of difficulty in ensuring the ongoing operation of the sites. Conflicts between the Eco-Citizen sites and autonomous sites were identified, as prior to the Eco-Citizen programme, the autonomous sites also received waste from the municipality.

Operatives in the programme are contracted by the cooperatives and often have different contractual arrangements based on their association. The Municipality has stated that it does not interfere with the arrangements within the cooperatives, which can possibly lead to problems, as there were comments during site visits about lack of financial and operational management. The management structures at some sites were also criticised. The lack of involvement between the Municipality and the Cooperatives is one of the reasons for lack of data and knowledge on the part of the municipality about the waste processed by the sites. Figure 6.7 and Figure 6.8 show the separated materials at the Osternack Eco-Citizen site, including the bailed material storage and the material brought to the site.

Figure 6.7: Bailed Material Storage at Osternack

Source: Mott MacDonald

Figure 6.8: Osternack Eco-Citizen Site

Source: Mott MacDonald

Many of the sites are rented by the Municipality on a 6 + 6 year contract (based on performance rates being maintained). Sites that are not rented by the Municipality (the ones owned/rented by the cooperatives and associations) get paid a higher rate, for each tonne for the first 40 tonnes each month and the standard rate for anything above the 40 tonne limit. As the programme has been slowly increasing

in size with waves of site additions, it is understood that different Eco-Citizen project locations are in different stages of their leases. There have been problems reported of sites not being able to make timely payments due to delay of payment by the Municipality.

Separators are typically paid based on the quantity and quality of material brought in and separated. It was stated in the 1999 estimate that a waste separator typically separates 135kg of material per day. Minimum monthly wage in Curitiba was at R$950 in 2014.

Not all of the Eco-Citizen sites have the necessary documentation and permits needed to operate legally, although these documents are required to be a part of the project. Many are located in high-crime or environmentally vulnerable areas. Safety and money security is a key concern as the site managers often have to draw large quantities of cash to pay the employees at given dates. Although formalised, workers often work without the appropriate Personal Protective Equipment (PPE) and the environmental conditions can be precarious (such as lack of appropriate protection from weather elements).

There are also formalised pickers working at the Eco-Citizen sites, as described in the collection section. They collect recyclables just before the collection vehicle in an attempt to gather the valuable material from waste. This is because there is no certainty that the local Municipality collection material would be brought to a particular site, so a 'waste picker collection round' is needed to guarantee the incoming of valuable recyclables. This means that a lot of waste is double handled, with pickers sorting it initially, followed by Municipality collection staff.

By way of example, the Osternack Eco-Citizen site separates roughly 120 tonnes of material a month with a 48 person day shift and 7 person night shift. The site has 55 operatives and uses separation tables (the conveyor being in disrepair). It has three vertical presses, and a total area of 2,200m^2 of which with 800m^2 covered (standard site size). Workers are paid by the weight of material they bring-in and separate, although almost all other sites pay based on output.

Figure 6.9: Smaller Eco-Citizen Site Visited

Source: Mott MacDonald

Figure 6.10: Osternack Vertical Press Utilised

Source: Mott MacDonald

6.3 Autonomous Waste Separation Sites

6.3.1 Site Description

Autonomous waste separation sites represent those that have not been formalised and joined the Eco-Citizen project. Some are legal and operate as small private companies (but not as part of the Eco-Citizen project) and some are illegal, operating without any permits. As these sites are not part of the Eco-Citizen project, they do not receive waste directly from the Municipality. Some sites indirectly receive waste through the Associar association.

According to the study carried out in 1999 by the Municipality, there were 229 autonomous waste separation sites in the city of Curitiba working with residential and commercial waste. As was the case with the waste pickers, the autonomous sites identified were concentrated in the region of Portão. This is still the case today, as corroborated through site visits, where at least 35 sites were identified in this area.

A series of investigative interviews were conducted with the owners and/or site managers of these sites. They have provided various reasons for not participating in the Eco-Citizen project. These included:

- avoiding to be a part of a cooperative in order to hire workers as regular employees;
- avoiding compliance with regulations;
- not having the adequate knowledge of how to go about formalising their sites (in this last case, a lack of support from the municipal government was cited by the site owner); and
- cost, time and lack of understanding of the formalisation process.

6.3.2 Working, Operation, and Social Conditions

According to interviews carried out during site visits, it is understood that the majority of these sites work in a well-established commercial network, having the necessary documentation to work with waste and operating permits, as well as contracting their workers formally and providing necessary benefits. The owners of the legalised autonomous sites often cited higher productivity as a reason for not participating in cooperatives or associations. Illegal sites, which work without permits, and often do not follow labour and employment regulations, are the main exception to this operating standard.

There are, however, some sites that work illegally, existing without registration and taking advantage of waste pickers. The Municipality stated that there have been reported cases of suspected slave and child labour at the illegal sites.

There are issues with the location of the sites, as they are often in high crime areas. Some do not have environmental permits or authorisation from the fire service to operate or are located in environmental protection areas. Working conditions may also be precarious, specifically in terms of use of PPE. The environmental conditions are also an issue, for lack of appropriate coverage and storage space, for example. Many informal waste pickers depend on the structure of the site to shower, eat and sleep, especially in the cold months, which increases relationships of dependency.

These sites receive their waste from waste pickers, who may or may not have an official link to the site. As stated in the section about waste collection, many sites will rent or lend pushcarts to waste pickers in exchange for waste being brought to their site and separated there. The sites may also receive waste from commercial generators. The efficiency levels identified at these sites are considered to be relatively high, with some reporting reject levels as below 5%.

The workers' situation varies between sites. In some cases the workers are formally hired and therefore are paid at least minimum wage and receive benefits. In others, they are all autonomous, receiving payment for the waste they separate.

6.3.3 Site Operating Structure

The following roles were identified at the sites: (i) collector; (ii) unloader; (iii) separator; (iv) compactor; (v) weigher. The same person can perform all of these roles or there may be people hired for each role, depending on the site. Aside from these roles, there is often a cook, a commercial and a management section.

Along with the waste separation sites, there also exist private bulking and middlemen sites and recycling companies of various sizes that make up the recycling industry in Curitiba.

The private bulking and middlemen sites often purchase waste directly from autonomous waste pickers, who might have separated waste in another location, such as their home, from waste separation sites and from commercial generators. Some purchase only specific waste, such as scrap metal or plastic, others work with all kinds of waste. Most will carry out more detailed separation and bulking to then sell their waste to recycling companies. The waste bought and sold is done so at prices that vary by market and quantities, all of the sites interviewed stated that there is a large variation in prices and that they do not have precise data to make available.

The recycling companies identified vary in terms of size and kinds of waste they process. Most large companies collect the waste directly from the sites due to the large quantities that are bought. Two companies are located outside of the stat of Paraná in Santa Catarina.

Table 6.2 presents the data that was raised about the recycling companies that purchase waste from the separation sites, the UVR and/or middlemen and bulkers. It is important to note that this list is not exhaustive, representing those that were identified during the site visits. The purchase rates were also not identified by these companies.

Table 6.2: Recycling companies identified in the Curitiba area.

Name	Type of Waste Received	Waste Bought At
GERDAU	Scrap Metal	UVR and Bulkers
ARCELOR	Scrap Metal	Bulkers
TETRAPAK	TetraPak (longlife)	Bulkers
REVITA	TetraPak (longlife)	UVR

Name	Type of Waste Received	Waste Bought At
HAMAI	Electronic	UVR
RECITOTAL	Glass	UVR
VOLOPLASTIC	Plastic	Bulkers
CREAPET	Plastic	Bulkers
NIZER	Plastic	Bulkers
PLASKAPER	Plastic	UVR
QUALIPAST	Plastic	UVR
KLABIN	Paper / Card	UVR, Bulkers and Separation sites
PLUSH	Paper / Card	Bulkers
TROMBINI	Paper / Card	UVR
INDÚSTRIA DE PAPELÃO HORLLE	Paper / Card	Bulkers
TROMBINI	Paper / Card	Bulkers
BRAGAGNOLO	Paper / Card	Bulkers

Source: Mott MacDonald Site Visits

6.4 PET Shredding and Flaking Plant

A small processing plant was built to shred and flake Polyethylene terephthalate (PET) recovered by the pickers and UVR. The plant operated for several years, but did not have its contract renewed with the operator and is currently mothballed. The Municipality is looking into reopening the plant. Details on operating years for this facility are not known.

6.5 Caximba Landfill

Information for the Caximba Landfill description section has been acquired through discussion at the initial project site visits conducted in June 2015. The main landfill utilised by the Curitiba Municipality and some of the surrounding municipalities from 1989 until 2010 was the Caximba Landfill (Figure 6.11). This site is owned by the Curitiba Municipality and is located south of the city; about 23km from the city centre. The site used to operate with 91 RCVs (15-19m$^{3)}$ for waste collection.

Figure 6.11: Caximba Landfill View from the Top

Source: Mott MacDonald

The site began with a total area of 400,000m^2, of which 250,000m^2 was filled with waste. Over the three decades of operation, the site area was expanded twice and now covers an area of 1,000,000m^2, of which 450,000m^2 is filled with waste. The area that does not have waste directly on it is either part of an extensive water treatment and management area (Figure 6.12) which includes aerobic air lagoons, wetlands, equalising tanks, and chemical dosing or listed as environmental protection forest area.

Figure 6.12: Caximba Leachate Treatment System

Source: Mott MacDonald

Figure 6.13: Caximba Landraise

Source: Mott MacDonald

According to the Municipality one of the main drivers for closing the Caximba Landfill was pressure from local residents due to complaints about local environmental conditions and changes to the development plan. The landfill still had capacity to accept more material when it was shut.

6.6 Estre Landfill

As of November 2010, waste from the City of Curitiba and most of the other municipalities in the Curitiba Metropolitan area was diverted from Caximba to the Estre Landfill (Figure 6.14, Figure 6.15 and Figure 6.16). The site is estimated to have a total of 15 years of life expectancy, including the five years it has already been operating for. The site is located south of the Curitiba Municipality, in the “Fazenda Rio Grande” Municipality, about 40km from the city centre and is owned and operated by Estre Environmental S.A.

Figure 6.14: Estre Landfill

Source: Mott MacDonald

The site receives around 2,500 tonnes a day of non-hazardous waste from 21 different municipalities and operates 24 hours per day, six days a week; 60% of the material taken to the site comes from Curitiba, whilst the other municipalities make up the remaining 40%. The contract with Estre is done via Conresol, who utilise 100% of the landfill capacity the site is licensed for. The landfill is currently at around 30% of its capacity and operates with 80 workers, 10 of which are in an administrative role. There are 11 machines in total, all owned by Estre, including four bulldozers, and five excavators. Around 400 HGV's enter and leave the site each day.

Figure 6.15: Estre Landfill Surface Drainage and Side

Source: Mott MacDonald

Figure 6.16: Estre Landfill Waste Front

Source: Mott MacDonald

Landfill gas extraction takes place at the site, although the site currently does not have a centralised gas extraction system and gas wells are flared individually. There are plans to centralise the system once additional areas are completed, as currently only around 10% of the landfill surface has reached final profile. The initial installation is expected to include a 3MW generator.

On-site leachate treatment is due to begin in July 2015. Leachate is currently stored and driven to a sewage treatment plant. There is an on-site hydrocarbon soil clean-up compound that receives material with light contamination from a nearby field. Around 6,000 tonnes of contaminated soil are received each month; the soil is recovered with bioremediation processes and is then utilised as daily cover for the landfill waste front. The soil clean-up facility is being enlarged and will have a capacity of 26,000 tonnes per month[25].

6.7 Essencis Landfill and Compound

Information for the Essencis Landfill and Compound description section was acquired through discussions during the initial project site visits conducted in June 2015. Essencis operates an industrial complex near Curitiba. The complex covers an area of 500,000m^2 and has a hazardous waste cell, a non-hazardous landfilling area (Figure 6.17), leachate treatment, contaminated soil treatment, organic waste blending (Figure 6.18), WEEE shredding and separation, and hazardous waste co-blending. Hazardous waste

[25] Estre website

collected by Curitiba Municipality is taken to the site. This site is the only hazardous waste disposal site in Paraná State[26].

The site receives around 3 tonnes of hazardous material from the Municipality per month. The entire complex, including all of its processes, takes in around 8,000 tonnes a month.

Figure 6.17: Essencis Non Hazardous Waste Front

Source: Mott MacDonald

Figure 6.18: Essencis Organic Blending Unit

Source: Mott MacDonald

Organic waste that is mixed and blended on-site is sold to the company “K2 Agro” in the region of Ponta Grossa, where it is composted. A site at Solvi Farm, in the region of Araçatuba, also accepts organic waste materials. The organic blending facility processes around 200 tonnes per month.. The process involves mixing food, expired products, and green waste to produce a homogenous compostable mass, although the period the material is composted over and the quality of the compost is not known. The processing involves removing contaminants such as plastic and controlling parameters such as humidity. Composting is not undertaken on the site due to lack of space.

Both hazardous and non-hazardous landfills are at around 90% capacity and have an estimated 2 years of life remaining. The hazardous waste landfill accepts around 4,000m^3 of material per month. The non-hazardous takes in around 14,000m^3 per month. An expansion project is underway to provide an additional area that would extend capacity by a further 10 years for both landfills.

Hazardous waste co-blending, which involves mixing hazardous wastes together with some inert material to create homogenous mixtures, is done at a rate of around 300 tonnes per month and the mixture is sold to Votorantim, where it is combusted in cement kilns. Essencis currently pays for the cement industry to accept this waste material from this process.

The WEEE processing plant inlet is composed almost entirely of refrigerators. There are two shredders that process the material and a magnet/eddy current to remove metals. A plastic separator removes hard

[26] Mott MacDonald, Curitiba Waste Management background Report, June 2015 (Ref.26).

plastics from the foam. The plant processes around 70 to 80 tonnes of material per month and has five operators.

6.8 Household Green and C&D Waste

The Municipality has stated that material from the household green and C&D waste collection programme is too contaminated for re-use or recycling purposes and is sent to the Estre Landfill. The landfill operator uses this mixed material to increase surface traction on on-site roads when conditions are not suitable for RCVs. The material is usually required after heavy rainfall as the site has been stated to become too muddy for the vehicles. The Municipality considers that the household green waste is often contaminated with other materials before it is collected and thus could not be utilised for another purpose.

6.9 Other Green Wastes

The Municipality collects other green waste streams which are sold to the company Ajardine and to the company Byocom. This material is used by the two companies to create a bio-mass product which is then sold for use as a fuel to companies such as Votorantim and Ambev.

Essencis has also confirmed that it receives small quantities, around 3 tonnes a month, of green waste material from the Municipality. This material is processed by shredding it and mixing with other organic materials before being sold to a composting company called K2 Agro.

6.10 Illegal C&D Waste Dumps

The Municipality has stated that it is aware of 42 sites that attract large volumes of illegal C&D dumping or “fly tipping” (for example see Figure 6.19 and Figure 6.20). This practice is illegal. A programme existed where a single vehicle and an excavator were used to clean these sites but it is currently suspended for unknown reasons. The Municipality is developing collection programmes to help reduce the amount of waste on these sites, but methods of preventing more illegal dumping are not currently being integrated to the solution. If the Municipality restarts cleaning services at these sites the waste collected will have to be addressed and incorporated into the Curitiba Waste Strategy.

Typically, in order to clear waste a much larger group of vehicles would be needed to clear all known sites at once, so that people cannot dump waste at the nearest un-cleared site. There would also be a requirement for regular policing of the sites to prevent them from further dumping as well as a change in law to increase the fines applicable to fly tipping. The definition of possible other future land uses could help to combat this issue whereby the public spaces would be occupied by other uses and therefore not able to be used for illegal dumping.

Interviews conducted during the initial June site visits have stated that an average collection cost of a C&D container is around R$150 to R$200, whilst a waste collector operating illegally might charge around R$30 for the collection and dump the material at twilight/night.

Figure 6.19: Fly-tip "It is Illegal to Through Waste" Sign

Source: Mott MacDonald

Figure 6.20: Santa Clemencia Fly-tip View of the Site

Source: Mott MacDonald

6.11 Other Disposal Sites

A plant for recycling Tetrapak/longlife containers is located in Ponta Grossa, a Municipality about 110km away by road. It is not known if the Municipality uses this facility for any processing.

Many of the municipalities surrounding Curitiba City have sensitive surface and ground water resources and are key sources of water supply to the City. Landfills have not been constructed in the municipalities due to the risk of contaminating these water sources[27].

6.12 Socio-Environmental Analysis

An initial assessment of key social-environmental issues identified in relation to the waste treatment and disposal is presented below in accordance with the aspects identified as positive and negative from a social-environmental perspective. Some of these issues are directly related to those presented in the collection section, such as issues related to separation, while others are specific to the treatment and disposal processes and sites.

6.12.1 Positive Aspects

We understand from stakeholders interviewed during the fact finding missions that the money provided from the income of the UVR for the IPCC's social programmes is important for the continuation of the programmes operated by the institute. The education campaigns and visits to the UVR are considered to be positive for the improvement of separation and dissemination of information. It is possible that this kind of action could be replicated for other kinds of sites. There is doubt, however, about the role of the UVR in

[27] Mott MacDonald, Curitiba Waste Management Background Report, June 2015 (Ref.26).

the waste management system, as it receives waste from the municipality even though it is not an association or cooperative.

The treatment of gas and leachate, as well as the usage of bioremediated soil are considered as effective environmental measures used by the Estre landfill, though there is room for improvement in terms of efficiency. Note that a change in destination of Curitiba's waste could impact the landfill, decreasing income, but increasing lifespan.

The working conditions at most of the formal treatment and disposal sites, such as the Estre Landfill and the UVR, are good; including in terms of wages and benefits, as well as health and safety. In most cases, Personal Protective Equipment (PPE) is regularly used by the workers.

6.12.2 Negative Aspects

As is the case with collection, the negative aspects identified cover a wider range of issues, including material rejected by separation sites, existence of illegal dumping sites, limited landfill diversion options, the working and environmental conditions of the separation sites and the management aspects of the Eco-Citizen sites.

6.12.2.1 Material Rejected by Separation Sites

The high reject rate found at the UVR and the Eco-Citizen sites is a concern, both in terms of use of fuel and emissions for transportation as well as double handling of waste and low operational productivity and financial stability. The fact that Eco-Citizen sites will soon begin paying for reject waste may lead to an improvement in separation levels. However, this does not deal with the source separation problems (i.e. householder understanding/behaviour in separating recyclable materials) and separation of higher value materials by the informal sector prior to the material reaching the separation sites. It also might cause sites to accept less waste or to dispose of reject waste in other ways, not necessarily improving efficiency. The lack of commercial value for some recyclable waste directly affects the types of waste that is separated, causing potentially recyclable waste to end up as reject waste.

6.12.2.2 Illegal Dumping Sites

The illegal dumping sites pose environmental, health and safety risks to the natural environment as well as to the neighbouring communities.

6.12.2.3 Limited Landfill Diversion Options

The availability of alternative options for hazardous, food, green, C&D, electronic and other special waste is an environmental issue in the sense that sending these wastes to the landfill diminishes viable space and may contaminate the environment. Solutions available at the Essencis landfill are positive, but the short time remaining before reaching capacity is a problem. Aside from this, Essencis is in the midst of a permitting conflict that might cause it to close earlier than expected. It is important to note that the sensitive

surface and ground water resources identified in the municipalities surrounding Curitiba continue to present a significant constraint on the development of alternative landfill facilities in the region.

6.12.2.4 Working and Environmental Conditions at Waste Separation Sites

The working conditions at the Eco-Citizen and autonomous waste separation sites are considered to be precarious, including lack of Personal Protective Equipment (PPEs). The Public Prosecutors Office has identified problems with slave and child labour at the clandestine autonomous sites. The autonomous waste separation sites often play a role in the livelihood of the waste pickers, not only in terms of wages, but also as a place to shower, eat and sleep.

There are also concerns in terms of the environmental conditions, where many do not have the appropriate infrastructure to store the waste, nor to treat any liquid runoffs there might be. The lack of regulations, environmental permits, health and safety permits, etc. is critical. The location of some of these sites in Environmental Protection Areas aggravates this situation.

6.12.2.5 Eco-Citizen Sites

The efficiency of the Eco-Citizen sites is questioned in comparison to the efficiency of autonomous separation sites that have previously worked with municipal waste. There are various reasons related to this low efficiency: lack of management and financial experience; lack of market knowledge; lack of financial incentive (they receive income from the municipality if they separate and sell or not); lack of maintenance of equipment; lack of storage space for bulking of material; low quality of waste/high source contamination; among others.

Some potential solutions to these issues include training and capacity building, strengthening of identification with cooperatives and associations, changes in payment structure, strengthening of networks, reworking of maintenance responsibility, and improvement at source separation through educational campaigns (as mentioned above).

The analysis presented about the role of the Associations and Cooperatives in the collection section is valid here as well, as they represent both collectors and separators. Improvement in management and identity will likely improve the system. Omission will likely cause operational problems.

The fact that some Eco-Citizen sites do not have the correct documentation and permits, even though required by the municipality to be registered is a concern.

The lack of involvement between the Municipality and the Cooperatives is one of the reasons for lack of data and knowledge on the part of the municipality about the waste processed by the sites. According to Brazilian law, the Municipality is responsible for all waste generated residentially until its final destination.

In general, there seems to be recognition of the importance of the recycling sector, including the UVR, Eco-Citizen sites, autonomous separation sites, middlemen and bulkers and recycling companies in the management of the recyclable waste of Curitiba by the Municipality. However, the aspirations towards

supporting this group of people and organisations are not yet all being met. This is reflected in the lack of clarity of the role of the Eco-Citizen project as presented in the analysis about collection. SWOT Analysis

The table below presents a SWOT analysis of the Municipality's current waste treatment and disposal arrangements.

Table 6.3: Treatment and Disposal SWOT Analysis

Strengths	Weaknesses
▪ High level of controlled disposal for municipal wastes. ▪ Current arrangements for sorting of recyclables provide source of income for vulnerable elements of the community and provides an important service to the waste management system. ▪ The Municipality has positively engaged the private and community sectors in providing recycling and waste disposal services. ▪ There is a market for recyclable materials (based on evidence of WNW scheme). ▪ A number of recycling systems appear to be operating effectively with relatively high levels of recycling (although more data is needed to assess this in detail). ▪ Well-established recyclables market with various companies working within it	▪ Very limited recovery of organic wastes. ▪ Levels of rejects produced by recycling sites are high (although more data is needed to assess this in detail). ▪ No material or energy value is recovered from residual waste. All residual waste currently disposed to landfill. ▪ Illegal dumping of C&D waste causing environmental impact in some parts of the city. ▪ Dependency of separation sites on middlemen and bulkers which generates lower commercial return and less financial stability ▪ Dependency of Eco-Citizen sites on sums paid by the Municipality upon receiving the waste ▪ Lack of understanding and recognition of the service provided by the Eco-Citizen, autonomous separation sites as well as the rest of the recycling chain ▪ Lack of follow through from the Municipality to know what happens with the waste that is its responsibility
Opportunities	**Threats**
▪ Potential to recover value from residual waste in the form of increased materials recovery, refused derived fuel production or energy from waste. ▪ Recycling of organic wastes via composting or anaerobic digestion. ▪ Increase the number and quality of material streams recycled could divert materials from landfill, provide environmental benefits and potentially increase revenues from recyclables. ▪ Established C&I waste management private sector capacity and capability could offer additional short term outlet for residual waste. ▪ Engage the community in development of new waste treatment infrastructure to minimise the potential for opposition and rejection. ▪ Efficiency levels at autonomous sites are high, possible motivations to increase efficiency at UVR and Eco-Citizen sites: monitoring of waste received and less income at the input of the waste, more at output ▪ The Eco-Citizen sites work in cooperatives and networks, strengthening these connections can improve capacity for bulking and storing so as to improve commercial possibilities	▪ Landfill disposal capacity is provided by a single, privately operated landfill which has a limited capacity. ▪ Autonomous recycling sites are unregulated and unsupervised. ▪ Local opposition to relocation or establishment of new waste management sites. ▪ Regional opposition to energy from waste facilities appears high based upon reported experience elsewhere in Parana State. ▪ Vulnerability of surface and groundwater resources in surrounding municipalities severely limits options for locating waste disposal facilities. ▪ Loss of shelter for waste pickers that depend on the autonomous sites for their well-being if formalised ▪ Lack of necessary documentation and permits of Eco-Citizen and autonomous waste separation sites. ▪ Lack of appropriate Personal Protective Equipment (PPE) for workers at Eco-Citizen and autonomous waste separation sites.

7 Contractual Arrangements

7.1 Introduction

Curitiba Municipality has a number of contracts in place for the provision of waste and street cleansing services. The contracts are split into: main contracts, which cover the operation scope, price, and service list, and; amendments, which often deal with small additions or variations to the main contracts, such as new collection teams or vehicle replacements.

The main contracts that were presented to Mott MacDonald are summarised in Table 7.1 and discussed in greater details below.

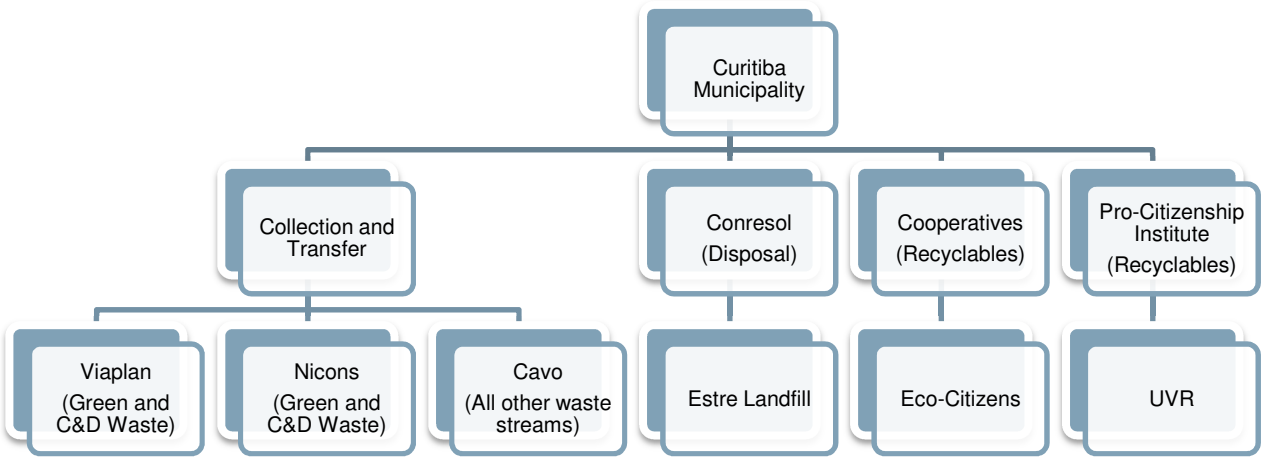
Table 7.1: Curitiba Municipality Presented Main Contract Summary

Contract Company	Duration and End Date	Material Stream	Comments
Viaplan	5 years, Sept 2017	Green and C&D collection and transfer	Zones 1, 3, and 4 (4 zones in total).
Nicons	5 years, Sept 2017	Green and C&D collection and transfer	Zone 2. (4 zones in total)
Cavo	5 years, Apr 2016	All other streams collection and transfer	
Conresol (Consortium)	1 year, Dec 2014	Waste Disposal	Landfilling Fee
Conresol with Estre	2 years, October 2012	Waste Disposal	Landfilling Fee
Conresol Tender	Up to 5 years, October 2017, with the option to stop the contract earlier	Waste Disposal	Landfilling / Processing.

Source: RFI response document “Item 10 and 11” (Ref.12), RFI response document “Material Consortium” (Ref.21)

From information provided, it is understood that the contractual structure for the Curitiba Municipality is as presented in Figure 7.1:

Figure 7.1: Curitiba Municipality Contractual Arrangements



Source: Mott MacDonald, RFI response documents "Item 10 and 11" (Ref.12) and "Material Consortium" (Ref.21)

Curitiba Municipality manages all waste contracts and operation through the Public Cleaning Department, which is part of the Secretary of the Environment.

7.2 Municipality Contractual Arrangements

Curitiba is divided in four zones for contracting the household green and construction and demolition wastes; Viaplan was appointed for collection in three zones whilst Nicons was granted one zone. The Viaplan Engineering Limited and Nicons Plants Commerce Limited contracts differ only in the region where the collection will operate. Both contracts cover the collection and transport of green waste as well as C&D waste. Each of the contracts lists a set of neighbourhoods that must have collections carried out during the day and another for the night in each zone. Responsibility is placed on the contractor to provide the full collection and transfer services for the relevant zone.

Cavo was granted the contract for the management (excluding disposal) for all the other waste streams which the municipality is responsible for. This is listed in the contract as the following services:

- Collection and transport of household residual solid waste and street cleansing waste;
- Collection and transport of solid recyclable waste (Waste that is not Waste and Green Exchange);
- Indirect collection of household residual solid waste;
- Manual sweeping;
- Mechanical sweeping;
- Market sweeping and washing;
- Poster removal and sidewalk washing;
- Special cleaning;
- River cleaning;
- Collection, transport, and destination for treatment of household hazardous waste; and

- Maintenance and monitoring of the Curitiba Landfill (Caximba).

The Cavo contract covers some of the commercial information for the services, such as how frequently payments will be made, what the estimated total values will be and when the financial model may be revised. The contract does not detail how each of the services must be conducted. There are requirements in relation to performance monitoring, penalty frameworks for performance failures and breaches of the contract terms as well as procedures for equipment procurement and personnel recruitment.

Information is also provided on some of the fines that may be charged for clause and term breaches. The fines are calculated based on equivalent cost of a number of collected tonnes; this can vary from 10 to 100 tonnes in fine. 100 tonne fines are roughly equivalent to around R$14,000 and include acts such as not permitting a Municipality officer to access a site, attempting to bribe an officer and not providing the agreed number of employees or vehicles for a service.

Minor contracts have not been covered in detail as they cover less critical aspects such as where the bins are located in specific parks.

Contracts were not provided for the Municipality and Eco-Citizen Cooperatives or for the UVR contractual arrangements. Both of these are not directly operated by the Municipality, as discussed in their respective sections, but are related to their waste requirements and structure.

7.3 Conresol Contractual Arrangements and Tender

The waste disposal contract with the Estre Landfill is done via the Conresol Consortium. Mott MacDonald was provided with the 2014 edition of the Municipality-Consortium contract, which covers the cost and tonnages of landfilling; these are detailed under Section 6.6.

Conresol has a contract with Estre for the purposes of landfilling the waste arising from the Curitiba Municipality as well as the 22 other Municipalities covered by the consortium. The version of the contract provided was signed in October 2010, covers the landfill arrangements from 2010 to 2012.and stipulates that 100% of the landfill licensed waste acceptance rate will be utilised by the Consortium (2,500 tonnes per day).

It is understood that the Conresol – Estre contract provided to Mott MacDonald was renewed multiple times with price and tonnage adjustments and is currently due to expire in October 2015.

Conresol has begun a new tendering process for the disposal of its waste. The tender stipulates that applicable sites must be at most 22 kilometres away from the Curitiba ring road and aims to grant portions of the material to different sites in an effort to reduce transport costs. The tender document provides information on average monthly landfill rates for multiple Municipalities as well as flowrates by month, week day, and hour.

In Mott MacDonald's opinion, provided that there is sufficient competition between bidders, allowing bidders to propose their own rates and solutions provides the best value for money for the Municipality.

The aim of the tendering process is to develop new contractual arrangements to begin in October 2015 and last for a period of up to five (5) years. The contract to be awarded based on the tender process has also been made available and is based on the previous running contracts. The contract will have break clauses so that the Municipality could leave the contract before the end of its term. We understand that discussions are being held with regards to varying the terms of the contract.

7.4 Contract Costs - Collection and Transport

A table is provided within the Cavo contract, covering the base unit for each service and how much it costs. The information mentioned has been combined with the information gathered for how many kilometres, tonnages, or teams there are for each service to provide an initial financial data baseline. The household green and C&D waste data has been added to the results. The compiled information is presented in Table 7.2.

Table 7.2: Municipal Collection and Transport Contracts Cost Summary

Service / Contract	Unit	Quantity
Collection and transport of household residual solid waste and cleaning waste	tonne	39,832
Recyclable collection and transport	team	59
Indirect household residual collection	team	5
2 way manual cleaning	km	3,209
1 way manual cleaning	km	15,768
Mechanised cleaning	km	4,047
Market cleaning and washing	team	1
Poster removal and sidewalk washing	team	2
Special cleaning	team	7
River cleaning – “olho d'agua” program	team	2
Household hazardous waste collection, transport, and destination for treatment	team	1
Maintenance and monitoring of the Curitiba Landfill (Caximba)	team	1
Household Green and C&D collection	team	70
Total	-	-

Source: RFI Item 10 and 11 (Ref.12), RFI Item 16 (Ref.14), CSWMS (Ref.1)

Table 7.2 presents the cost of each service based on how the contractor is paid. Cleaning and sweeping services are usually based per team or kilometre. When paid per team, there is a risk that the contract encourages low value in the “quantity” column and consequently a high “unit cost” value; the reverse is true for contracts paid by kilometres. The single exception to this is the residual waste contract with Cavo, where the contractor is paid based on the amount of material collected.

Services that are paid per team specify number of teams as well as cost per team stated in the contractual arrangement. Mott MacDonald and the Municipality have concerns that this model does not promote the

most efficient service. Contracts that are based in tonnage and kilometres have fixed price per tonne/kilometre in the contract, and establish areas that must be serviced, but total price will vary on how much waste is collected and what areas are swept.

8 Waste Flow Model

8.1 Introduction

The Waste Flow Model (WFM) presented in this section has been based on data provided by the Curitiba Municipality in response to a number of RFIs, combined with best judgement assumptions from Mott MacDonald based on regional indicators and similar project experience. Where direct data from the Municipality was not available or needed to be extrapolated or adjusted, this has been made clear. In particular, assumptions were made for some of the waste streams for composition, base tonnages, growth rates, and growth rate decay.

The summary of quantitative data sources is presented in Appendix A.

The information covered in this chapter details the data used and the assumptions made based on the continuation of the status quo scenario in relation to the existing waste management system in Curitiba.

For the purposes of data presentation for this chapter, any table cells shaded grey are indicative of source information acquired from the RFI response items or other factual sources utilised. Non-shaded cells are estimated figures based on modelled rates and values.

8.2 Municipality Population

A key aspect for modelling waste arisings is the population growth expected in the project area. Mott MacDonald was provided with historic population figures from the IBGE for the years 2000 and 2010. These values have been utilised for the waste estimates presented in this section[28].

In order to look at estimated historical trends, the data for the years available was extrapolated linearly backwards to cover the missing population data from 2001 to 2009. The method for calculating this is described in Appendix A.

8.3 Residual Municipality Waste Streams Tonnages (Business as Usual)

The data provided is based on current practices in Curitiba.

8.3.1 Household and Commercial Residual Waste Door to Door Collection

Household and commercial residual waste arisings have been based on the figures provided in the CSWMS 2010 (Ref.1) as well as the CMSP 2013 (Ref.2) and RFI Item 16 (Ref.14), which summarises some collection tonnages and costs. Data was provided for the tonnages from 2003 to 2014 from a range

[28] More detailed considerations on population data sources were provided in Section 3.3

of sources. An initial growth rate for the waste stream has been calculated based on the average yearly growth rates from 2010 to 2014, the details of which are provided in Appendix A.

Table 8.1: Residual Collection Historical and Projected Growth Rates and Tonnages

Year	Tonnage
2005	369,452
2010	475,865

Source: Mott MacDonald

8.3.2 Indirect Residual, Public Cleaning and River Cleaning

8.3.2

Each of the three streams modelled (indirect residual, public cleaning, and river cleaning) had different years of data presented as these were extracted from the CSWMS (Ref.1), which provides data for 2009, and the CMSP (Ref.2), which provides data for 2012 and 2013.

8.3.2

8.3.3 C&D Dumped Waste

8.3.2

There is no known information on the quantity of waste that is collected from illegal C&D dump sites. A fixed value of 15,000 tonnes has been utilised, assuming a programme to clean and restore these sites is established, and that there are 42 sites (as stated by the Municipality) each producing up to 1 tonne of waste per day. The figure of 1 tonne per day was estimated based of the view of the sites which were visited at the first site visit in June 2015 The degree of accuracy of this figure cannot be corroborated; notwithstanding, it is likely that the C&D waste would be sent to landfill, as valuable materials would have already been removed, meaning that the precise tonnage is unlikely to impact treatment technologies or recycling figures.

8.3.2

8.3.2

8.3.4 Tonnage Summary

The summary of the residual waste tonnages from the streams outlined in the previous subsections is presented in Appendix A.

Table 8.2: Residual Waste Arisings Summary

Year	Population	HH and Commercial Residual	Indirect Residual	Public Cleaning	River Cleaning	Illegal C&D Dumping	Total Residual	Residual per Capita
2015	1,886,000	528,010	7,426	81,222	1,296	15,000	632,955	0.92

Source: Mott MacDonald

8.4 Recyclable Municipality Waste Streams Tonnages (Business as Usual)

8.4.1 Waste that is not Waste

The Waste that is not Waste stream calculations were carried out in the same way as those for the Household and Commercial Residual Waste stream, also utilising the years of 2009 through 2014 for a total of 5 growth rates. The base information was supplied by the CSWMS 2010 as well as the RFI response document “Item 6”. The data has an extremely high degree of variability, showing yearly growth rates as high as 50.6% (2009) and as low as -34.5% (2003). The reasoning for this is not fully clear, but it appears that it may be partly due to data collection differences, as the corresponding population figures do not change in the same manner. Without further data, the figures available have been used, but it is recommended that further studies of the WNW stream are undertaken by the Municipality, in order to obtain more accurate data.

A summary of estimated historical tonnages and growth rates are presented in Table 8.3.

Table 8.3: Waste that is not Waste Collection Historical Growth Rates and Tonnages

Year	Tonnage	Annual Growth Rate
2000	13,619	-
2001	14,872	9.20%
2002	14,308	-3.79%
2003	9,376	-34.47%
2004	8,555	-8.76%
2005	7,662	-10.44%
2006	10,653	39.04%
2007	12,652	18.76%
2008	14,890	17.69%
2009	22,420	50.57%
2010	24,487	9.22%
2011	26,561	8.47%
2012	32,109	20.89%
2013	33,017	2.83%
2014	29,415	-10.91%
2015	31,208	6.10%

Source: “Item 6”, Mott MacDonald

8.4.2 Waste Picker Collection

A single point of data has been provided for the **total** waste picker collection, a stream that includes materials collected by waste pickers registered under the Eco-Citizen programme, as well as materials

collected by autonomous waste pickers ("catadores"). It is important to note that this stream does not include the material taken to the Eco-Citizen sites by the WNW collection.

The data point provided is a value of 133,500 tonnes per year of collected material, which was calculated assuming a mass collection figure per waste picker and an estimate of the number of pickers. It is understood that this figure is based on a study undertaken in 1999, meaning that the data assumptions behind this figure are not up to date. No further data is available, however, regarding the **total** amount of informal waste picker collection and recycling.

Data covering the period up to July 2014 has instead been provided (Ref.22) for the Eco-Citizen waste pickers collection tonnages. The average collection rate for each waste picker varies significantly, but is approximately 1.9 – 3.9 tonnes per month (88 – 178kg/day). The Eco-citizen waste pickers represent a minor percentage of all of the waste pickers in Curitiba and the collection data may not be accurately representative of autonomous waste pickers' collection rates, as the Eco-Citizen pickers often only focus on collection (with sorting being undertaken by other workers at the Eco-Citizen site), whilst informal pickers might also spend time sorting the individual recyclable streams. Notwithstanding, the calculated daily average collection rate per Eco-Citizen pickers (133kg/day) is very close to the one used in the 1999 study (135 kg/day).

Tonnage figures in the waste flow model have been based on population growth rates and residual door to door collection growth. From 2010 onwards the growth rate for the tonnage has been assumed to be an average of the population growth rate and the Household and Commercial Residual Waste collection growth rate. The calculated figures are presented in Table 8.4.

Table 8.4: Total Waste Picker Collection Estimate

Year	Estimated Tonnage	Corresponding Waste Pickers Numbers
2000	133,500	3,300
2005	140,421	3,470
2010	148,654	3,670
2015	171,346	4,230

Source: Mott MacDonald

Overall, despite some converging data waste picker collection tonnage assumptions are still considered by Mott MacDonald a significant source of uncertainty in the model. There are multiple factors that may affect waste picker collection on a yearly basis and the total number of autonomous and informal waste pickers cannot be accurately estimated.

8.4.3 Voluntary Collection

Voluntary collection is a very recent programme with limited historical data. There are plans to grow this scheme with a number of new collection points being introduced across the Municipality.

8.4.4 Green Exchange

Green Exchange waste has a significant amount of provided historical data and shows high annual growth rate variations, ranging from -20% (2004 and 2010) to 32% (2006). Initial growth rate calculations utilised the same methodology as the Household and Commercial Residual Waste collection for the data provided from 2011 to 2014. The resulting average yearly growth rate was 0.16%.

It is known that the Green Exchange programme is not planned to be developed further in terms of number of sites or locations of service, and that it would not be feasible to remove a collection point due to the public outcry this would lead to.

8.4.5 Tonnages

The summary of the recyclable waste tonnages used in the waste flow model is presented in Table 8.5.

Table 8.5: Estimated Recyclable Waste Arisings Summary

Year	Population	Waste that is Not Waste	Voluntary	Green Exchange	Waste Picker Collection (rough estimates)	Total Mixed Recyclable	Recyclable per Capita
2015	1,886,000	31,208	28	3,158	171,346	205,741	0.30

Source: Mott MacDonald

Note that the figures presented are not representations of the amount of material that is actually recycled, but rather a calculation of the amount of material obtained through each method of recyclate collection (some of which will be recycled, others sent to landfill as rejected material).

8.5 Other Wastes Streams

Four (4) other waste streams, which have specific management requirements outside those of typical residual or recyclable wastes, have been modelled in the WFM; these include: small construction and demolition waste, household green wastes, household hazardous wastes, and animal carcasses collection.

8.5.1 Small C&D, Unusable Bulky, and Household Green Waste

Small C&D Waste (including unusable Household Bulky Waste) are collected together with Household Green Waste. There were a number of data sources provided in response to the RFI, some of which included data for the whole collection and some for green waste only. This is discussed in detail in Appendix A. The total tonnage arising between 2012 and 2014 is shown in Table 8.6.

Table 8.6: Small C&D and Green Waste Arisings

Year	Total Tonnage	Source
2012	65,000	CMSP 2013
2013	79,000	SMMA Report
2014	72,000	SMMA Report

Source: SMMA Reports (Ref.24), CSWMS (Ref.1), CMSP (Ref.2)

Assuming that the proportions per individual stream have not significantly changed from 2012, it can be estimated that 40% of the material steam is “Green and Unusable Bulky Waste”, with the remainder being small C&D. Estimating the proportion of green waste is important as this could potentially be treated and recycled separately to the other wastes. Therefore, it is assumed, based on Mott MacDonald’s previous experience rather than data, that 75 – 90% of the combined waste is green waste, being modelled as 82.5%. It is recommended that further analysis of the waste steams is undertaken if possible, as the more data available during the PPP procurement, the better.

8.5.2 Animal Carcases

The animal carcasses waste stream only has a single provided value of 183 tonnes per year for 2009.

8.5.3 Household Hazardous Waste

A significant amount of data was provided by the Municipality for the Household Hazardous Waste stream, including collected tonnages from 2000 to 2014.

8.5.1 Tonnages

The summary of the ‘other waste streams’ tonnages is presented in Table 8.7.

Table 8.7: Estimated ‘Other Waste’ Arisings Summary

Year	Population	Small C&D	HH Green	HH Hazardous	Animal Carcasses	Total Waste	Total Waste per Capita
2015	1,886,000	49,296	24,037	47	189	912,264	1.33

Source: Mott MacDonald

8.6 Waste Composition

Composition data has either been provided by the Municipality through a variety of studies or estimated by Mott MacDonald based on information discussed in Section 4.3. Further analysis and assumptions have been conducted on this data to develop the waste composition for the WFM. Composition information is critical for the development of facility and processing outputs as well as potential collection changes and optimisation as technology design and performance will be directly impacted by the composition of waste.

8.6.1 Residual Waste Composition

8.6.1.1 Household and Commercial Residual Waste

The data provided for residual collections has been extracted from studies conducted at the landfill sites utilised by the Municipality. The historic studies were reflective of all the material that was sent to the landfills, with the most recent study being specific to Municipality collected waste.

The historic data is discussed in Appendix A, along with a review of a recent composition analysis provided by the Municipality. The historic data has not been used in the WFM as the more recent data from August 2015 is considered most relevant to the material being disposed of by the Municipality.

The results of the August 2015 analysis are presented in Table 8.8.

Table 8.8: Curitiba Residual Waste Collection Material Composition

Neighbourhood Material	Centre w/w %	High Standard w/w %	Low Standard w/w %	Medium Standard w/w%	Average w/w %
Paper	17.2	6.9	5.6	5.3	8.8
Cardboard	3.3	2.6	4.9	6.6	4.4
Plastic Film	5.0	8.2	7.0	4.4	6.2
Plastic (Hard)	9.3	7.3	11.3	11.9	10.0
Metal – Ferrous	1.3	0.9	1.4	1.3	1.2
Metal – Non Ferrous	2.6	4.3	2.5	9.7	4.8
Glass	1.7	4.3	2.8	8.0	4.2
Rubber	0.3	0.2	4.2	1.3	1.5
Wood	0.3	0.1	1.1	1.3	0.7
Cloth	0.3	1.7	7.0	2.2	2.8
Leather	0.0	0.0	0.0	0.0	0.0
Diapers	1.3	9.5	7.0	1.8	4.9
Tetrapak (Long Life)	0.7	4.1	2.8	1.8	2.3
Other Materials	9.3	13.7	11.3	9.7	11.0
Organic Materials	47.5	36.1	31.0	34.5	37.3
Total	100.0	100.0	100.0	100.0	100.0

Source: Relatório Caracterização Domiciliar (Ref.30)

An average of the data sampled has been used in the WFM. This shows significant levels of recyclables remaining in the residual waste, meaning that further recyclable separation should be able to remove valuable material prior to final treatment and disposal.

8.6.1.2 River Cleaning and Illegal C&D Dumping

Both River Cleaning and Illegal C&D Dumping wastes streams have been assumed to be composed of 100% “other” material. In reality, these materials are composed of a variety of different fractions; however, they are highly contaminated to the point that it is assumed that there are no practical solutions for the waste streams other than landfilling.

8.6.1.3 Street Sweeping

It is understood that some specific parks and garden maintenance teams provide a separate green waste collection service, but the majority of public green waste is collected with the residual street waste. Street sweeping waste has therefore been estimated to contain 85% “other” and 15% “green waste”. The 85% “other” is typically highly contaminated due to the amount of grit and dust swept up with other materials and, therefore, may not be suitable for treatment. The green waste fraction of this stream is not currently recovered, but may be processed if it can be separated from other wastes.

8.6.2 Recyclable Waste Composition

8.6.2.1 Waste that is Not Waste and Green Exchange

The main data provided for the composition of recyclable wastes is based on the study conducted at the UVR for the processed material at the facility. Based on the data provided for the classification of the separated materials, as well as the 41% reject rate of mixed contaminated materials presented by the site, the composition has been evaluated and has been utilised for both the Waste that is Not Waste stream and the Green Exchange stream. This composition has already been presented in Table 5.4 and Table 5.5 in Section 5.2.3 and is collated in Table 8.9 for ease of reference.

Table 8.9: UVR Estimated Input Material Composition

Year	Paper & Card	Plastics	Metals	Glass	Other	Rejects
2013	31%	12%	6%	9%	1%	41%
2014	27%	11%	7%	11%	2%	42%
Average	29%	12%	6%	10%	1%	42%

Source: RFI response document – Item 12 (Ref.13)

The average data for 2013 and 2014 has been used for modelling purposes. The composition appears reasonable in comparison to other recycling facilities of which Mott MacDonald is aware. Paper and card are the highest proportion of materials, which is typical, and there are high percentages by weight of glass, which is in line with expectations as glass is a dense material and is easy to recycle.

8.6.2.2 Voluntary Collection Sites

Data has been provided by the Municipality regarding the composition of the recyclable waste from Voluntary Collection Sites. Mott MacDonald notes that, as the programme is very recent, composition data

may not be representative of future composition due to the low collection tonnages and initial programme difficulties. Until further information is available as further sites become operational, however, data for collected material to date has been used in the model – this data has been presented under Table 4.5 in Section 4.3 and is summarised in Table 8.10.

Table 8.10: Voluntary Collection Programme Waste Composition

Material	Average (by weight)
Glass (white)	23.7%
Glass (coloured)	23.6%
Cardboard	15.9%
Paper (coloured)	13.6%
Paper (white)	12.5%
Metal (magnetic)	3.5%
Plastics	2.2%
PET Bottles	2.1%
Market Bag	1.5%
Long Life Containers	1.4%
Metal (non-magnetic)	0.4%

Source: RFI response document "Item 27, 28, and 29" (Ref.17)

The types of materials being collected in the voluntary collection programme are in line with those collected in other bring sites. Glass is the highest percentage by weight, which is expected due to its density and ease of separation for recycling. The other materials being collected are typical at a site for people to bring recyclates to, with plastics appearing lower than is typically seen elsewhere. However, as the data is based on only two collection points, composition may change as more points become operational and members of the public become used to using the facilities.

Mott MacDonald also notes that the data available does not include the level of contamination in each material stream.

8.6.2.3 Eco-Citizen Waste Pickers

Composition data has been calculated by Mott MacDonald for the material collected in the streets by Eco-Citizen waste pickers. This data has been compiled from the information provided (Ref.22) for the months of January 2014 to June 2014. The results have been presented in Table 5.8 under Section 5.3.1.2. Averaging the figures for the indicated period of time provides an estimate that waste collected by Eco-Citizen waste pickers from houses, commercial, and small industrial establishments near their surrounding areas is made of: 64% paper, 21% plastic, 10% metal, 2% glass, and 3% rejects.

8.6.2.4 Autonomous Waste Picker Collections

The composition of the material collected by informal waste pickers, which represent the majority of the waste picker collections, is not known. As the autonomous sites operate without formal monitoring and there are no studies conducted for the analysis of their material, or the quality of salvage that is being collected.

At this stage, the composition data provided for the Eco-Citizen sites has been used for the autonomous sites.

8.6.3 Other Waste Stream Compositions

8.6.3.1 Small C&D, Unusable Bulky, and Household Green Waste

The Small C&D and the Household Green waste streams are currently co-collected. For the purposes of investigating options in the future where these collections may not be combined, the streams have been modelled separately.

Household Green Waste has been modelled as being composed of 95% suitable green material on the basis that there will always be residues in this waste, as no collection is completely pure. However, the contamination level may be low, as the waste is typically sourced from activities that are completely separate to other household waste streams, such as gardening and lawn mowing, and thus, with appropriate education and support material segregation can be high.

Information has not been provided regarding the compositions of C&D and unusable household bulky material. It is understood that this material is highly contaminated with a variety of unrecyclable household objects as well as other contaminated material. For this reason, it is not believed that there is potential for further waste processing. Due to the lack of data, this stream has been subdivided into 50% unusable household bulky material and 50% unsuitable inert waste, all of which would require landfilling.

8.6.3.2 Animal Carcasses

No composition data for the animal carcasses stream has been provided; it has therefore been assumed that the stream is composed of 100% animal carcasses. As this is a hazardous stream requiring specialised disposal and treatment it requires continued specialist treatment and disposal.

8.6.3.3 Household Hazardous Waste

Composition studies have been performed for the household hazardous waste collected by the Municipality and have been provided in the RFI response document “Item 2” (Ref.9). This information has been presented in Table 8.11. For this analysis, average data from 2012, 2013, and 2014 has been utilised as they are the only complete years of data.

Table 8.11: Household Hazardous Waste Composition

Material Type	2012	2013	2014	Average
Batteries (Small)	7.8%	8.9%	9.3%	8.7%
Batteries (Large)	0.4%	0.4%	0.2%	0.3%
Kitchen Oil	25.7%	23.5%	23.9%	24.3%
Paint	27.9%	27.9%	30.3%	28.7%
Medicine	12.3%	15.3%	13.8%	13.8%
Light Bulbs	25.5%	23.7%	21.8%	23.7%
Poison	0.5%	0.4%	0.7%	0.5%

Source: RFI Response Document "Item 2" (Ref.9)

8.7 Waste Data Comparisons

Waste generation in the EU, according to the Digest of Waste and Resource Statistics (2015 Edition)[29] is 1.17kg per person per day for household waste and 2.77kg/person/day for commercial and industrial waste. Initial estimates as provided by the WFM presented suggest that the household waste generation in Curitiba is below that value, at0.92 kg/person/day for 2015. However, as household and commercial waste is collected partially together, both by waste pickers and door to door collection, and the total tonnage of waste picker collected waste cannot be accurately determined, a direct comparison cannot be formulated.

The USA Environment Protection Agency figures for 2013 MSW[30] show a per capita figure of 2.21kg/person/day. This includes all MSW, rather than household waste only, but excludes commercial waste; it is therefore more likely to be comparable to the waste which Curitiba Municipality is responsible for. The USA has one of the highest per capital waste generation figures in the world, and it would not be expected, or advisable, for Curitiba to have the same waste generation rate as the USA.

[29] Defra https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/422618/Digest_of_waste_England_-_finalv2.pdf

[30] http://www.epa.gov/osw/nonhaz/municipal/pubs/2013_advncng_smm_fs.pdf

9 Gap Analysis and Key Issues

This section sets out the findings of a gap analysis which assesses each key element of the Municipality's waste management system against international norms. The framework used for the gap analysis is summarised in Table 9.1. The majority of factors are assessed using a qualitative approach. However, quantitative data is used where available and deemed appropriate (e.g. waste generated per capita).

The gap analysis framework is based upon the Wasteaware benchmark indicators for sustainable waste management in Cities[31]. The Wasteaware benchmark framework has been used to benchmark over forty cities worldwide. As well as providing a consistent, tested approach for assessing Curitiba's waste management system, its use also provides the potential for benchmarking the Municipality against other similar cities.

By its nature, the framework is generic (allowing it to be used in a wide range of contexts internationally) so clearly some areas will appear less relevant or of concern for Curitiba than others. The framework is divided into five main areas that reflect the key aspects of a City's waste management system:

1. **Waste data.** This part of the framework considers the extent to which the City collects and maintains the necessary data to support planning and strategic decision-making to operate and progressively improve waste management systems and services. Key data includes information on waste generation, composition and factors that will influence these issues over time (e.g. population growth and demographic change).

2. **Waste collection.** This aspect considers the status of the city's waste collection services including the coverage of the collection services, their efficiency and effectiveness and operation.

3. **Waste treatment and disposal.** This part of the framework assesses the city's waste treatment and disposal operations, including assessing the degree of controlled management and disposal of waste materials (i.e. level of uncontrolled dumping of wastes) and the level of environmental protection provided by existing management routes.

4. **Resource value.** This aspect considers the extent to which the city's waste management systems meet international norms in the principles of the '3Rs' (i.e. reduce, reuse, recycle). It considers the level of resource value obtained from the city's waste materials, including considering the level and quality of recycling, waste prevention activities and the degree of integration of the community and informal sectors (recognising that they form a key part of many municipal waste management systems).

5. **Governance factors.** This part of the framework considers the institutional, policy and financial aspects of the city's waste management system. It includes consideration of the service's financial

[31] Wilson et al (2015) *'Wasteaware' benchmark indicators for integrated sustainable waste management in cities.* Waste Management 35, p.329-342.

sustainability (e.g. is there a consistent budget allocation for waste management), the level of policy development and associated planning, and the approach taken to positively engage the private sector.

Table 9.1: Analysis Framework

No.	Component	Description
1	Waste data	
A	- Waste generation	Review of available data on the quantity of waste produced by the Municipality, including assessment of data on population growth and per capita waste production.
B	- Waste composition	An assessment of available data on composition, taking into consideration the difference in composition that is likely to arise at different points in the waste management system.
2	Waste collection	
A	- Waste collection coverage	The proportion of households which have waste collection services.
B	- Percentage of waste captured	The proportion of waste generated by the Municipality that is captured by the waste collection system (i.e. what proportion of waste is disposed of by illegal dumping or burning?)
C	- Transfer efficiency and quality	An assessment of the efficiency and effectiveness of arrangements for transporting collected waste to treatment and disposal locations (e.g. is waste bulked prior to transfer, are covered vehicles used, etc.)
D	- Appropriate service planning and monitoring	An assessment of the extent to which waste management services are defined, managed and monitored (e.g. are clearly specified contracts in place, is a formal monitoring scheme used to improve the service, etc.)
3	Waste treatment and disposal	
A	- Percentage managed via controlled treatment and disposal	An assessment of the proportion of wastes that are managed via controlled treatment or disposal sites.
B	- Degree of environmental protection in waste treatment and disposal	An initial assessment of the quality of waste treatment and disposal operations (e.g. effective waste reception arrangements, degree of engineered control at landfill sites, operations, degree of monitoring, etc.).
4	Resource value	
A	- Recycling rate	Percentage of total generated wastes which are recycled.
B	- Quality of source separation	Percentage of total quantity of materials collected for recycling that are collected as clean, source separated materials.
C	- Quality of recycled materials	An assessment of the likely quality of recycled materials and recovered organic materials, including consideration of measures used to minimise contamination from other materials.
D	- Waste prevention	An assessment of the level of focus on waste prevention and reduction issues (e.g. behaviour change programmes).
E	- Integration of community and/or informal sector in resource recovery	An assessment of the extent to which community/informal sector has been positively integrated with formal waste management service provision.
5	Governance factors	
A	- User inclusivity	The extent to which users of services, irrespective of income level, receive good waste management services, including consideration

No.	Component		Description
			of: public participation in decision-making, public feedback mechanisms, public education and awareness activities, and effectiveness in achieving behaviour change.
B	-	Provider inclusivity	An assessment of the degree to which public and private sector participants are involved in providing waste management services, including consideration of: clear bid processes for private sector involvement, recognition of the role of the organised informal and community sectors in delivering waste services, and a balance of public and private sector interests in providing waste services.
C	-	Financial sustainability	An assessment of the degree of financial sustainability in providing waste management services, including consideration of cost accounting, coverage of available budget, the extent of local cost recovery, appropriate pricing of disposal, access to capital for investment.
D	-	Sound institutions and policies	An assessment of the policy and regulatory framework for waste the Municipality's waste management services, including the existence of a robust regulatory framework, clear responsibilities for different aspects of waste management, a defined strategy for waste management, and the existence of guidance and implementation procedures.

Source: Wilson et al (2015) 'Wasteaware'

9.1 Gap Analysis Findings

9.1.1 Waste Related Data

Data on the Municipality's rate of waste generation is based on records of the quantity of waste collected daily for the residual, recyclable, informal recyclable, green waste and public cleaning streams. This is a relatively comprehensive data source and provides a good basis for understanding the variation in waste generation between streams and over different times of year. At an estimated 1.14kg per capita per day (According to the Municipal Waste Strategy for 2009 – see section 4.2), the level of waste generation is within the expected range for a Latin American country[32]. This value attempts to take into account the quantity of recycled materials collected by informal waste pickers directly from households; a practice that, Mott MacDonald understands, is widespread. There is a risk, however, that waste generation quantities are underestimated, as there is very limited information on the informal market, indicating that per capita waste generation rates may be higher than 1.14.kg per capita per day. This suggests that waste prevention measures should form a key part of the Municipality's policy approach on waste. The lack of information about the amount of informally collected waste is a risk with respect to procuring a waste treatment technology, as it makes it difficult to estimate potential future trends or to understand potential impacts of changes to the informal market. It is also understood, as presented in Section 8, that these figures are now closer to 1.3kg/capita/day; indicative that Curitiba is generating waste at a rate just above that of upper-middle income countries, likely reflecting the city's affluent status.

[32] Per capita waste generation rates average 1.2 kg/day for upper-middle income countries and 1.1 kg/day for Latin American countries (Hoornweg and Bhada-Tata, 2012, *What a Waste*, World Bank, Washington).

The Municipality has some data on waste composition but analysis has only been conducted on wastes as received at the disposal site and for the fractions of the material received at the Eco-Citizen sites and the UVR. As such, the composition analysis does not provide a detailed insight into the composition of waste generated by households and small businesses at source. This data will be needed to allow a thorough assessment of waste management options. For instance, the effect of any changes to informal waste picking activities on the composition of waste received at the Eco-Citizen, UVR and landfill site can only be understood by first understanding the nature of waste generated at the source prior to the removal of any valuable materials by informal waste pickers (catadores). This issue will be particularly important for assessing the likely organic, moisture and calorific content of the waste materials. These issues will be critical in determining the feasibility of waste treatment technologies in the long term. Ideally, an on-going programme of periodic waste composition analysis of the waste at its source, rather than after it is picked, should be implemented by the Municipality. For the purposes of the procurement of a new contract, we would recommend that some additional waste composition analysis be conducted to support the procurement process and provide appropriate data for inclusion in tender documents.

Table 9.2: Gap Analysis of Waste Related Data Issues – Summary

No.	Component	Assessment	Areas for Improvement
1A	Waste generation	Data on waste generation allows an initial assessment of rate of generation. However, current data may be an underestimate, as current data does not include materials removed by waste pickers directly from households.	▪ Consider options to try and capture more accurate data on recyclable waste collected by the informal pickers sector. ▪ Undertake reviews of the informal waste management sector to gain an understanding of total waste tonnages managed in this manner. ▪ Introduce waste prevention policies to reduce waste arisings per capita.
1B	Waste composition	Data only available for some parts of the waste flow (e.g. UVR and Estre Landfill) but not from point of generation. Further composition analysis is recommended in order to provide bidders with as much information as possible during the PPP procurement.	▪ Undertake ongoing waste audits of each waste stream to build up as much data as possible across the waste management streams.

Source: Mott MacDonald

9.1.2 Waste Collection

Discussions with the Municipality indicate that the waste collection service coverage for the city is close to 100%. A small number of households that do not receive direct collection due to their inaccessibility receive collection via an indirect method (i.e. provision of centralised containers within walking distance of households). The highest level of international best practice standards is typically regarded as being in the 99-100% bracket.

The majority of MSW is captured by either formal or informal waste collection systems. As discussed in Section 5, the Municipality operates a number of waste collection services for key waste streams. The informal sector also conducts waste collection operations and collects valuable materials directly from the

kerbside. This is likely to be providing a cost saving to the Municipality by providing recyclable collection services that it does not pay for directly.

We understand that C&D waste is collected together with green waste. This is likely to prevent the recovery of these two materials streams. It is also evident that uncontrolled dumping of C&D waste is currently occurring in some areas of Curitiba, indicating that these waste materials are not captured effectively by waste collection systems. This situation is a departure from international norms.

The Municipality does not currently operate any waste transfer arrangements. This means that collection vehicles are used to transport wastes from the collection rounds to the treatment and disposal locations, including the Estre Landfill which is some distance from the centre of Curitiba. We also understand that, in some cases, the vehicles may not be full. Furthermore, the collection crew is understood to accompany the vehicle to the disposal location.. If vehicle and staff movements were optimised, it would result in cost saving.

As a minimum, without the need for additional infrastructure, there could be a system whereby the collection crew transfer from one vehicle, when full, to another, so that only the driver does the round trip to the landfill site. This would mean that the three collection staff in each vehicle could be productive for a much larger proportion of their day. Alternatively, the introduction of transfer stations would enable waste to be bulked onto bulk carriers, which have a much higher payload than RCVs. This would mean that there would be fewer vehicles on the roads between the City and the landfill, potentially lower emissions from those vehicles, the vehicles could be loaded to capacity, rather than on 70-80% currently possible, and that the collection crews would then be free to collect waste rather than driving to the landfill.

It is understood that waste collection crews do not follow set routes with set end points, and that there is significant uncertainty at Eco-Citizen sites over whether local waste will get delivered to the local site. This has led to Eco-Citizen sites sending out waste pickers prior to the Municipality's (through Cavo) collection crews, effectively collecting the same waste twice. Whilst there are clearly a number of reasons for this, including past practices and competition with the autonomous waste pickers, if the waste from each area was specifically going to be delivered to a set drop off point it could reduce costs and minimise double collections.

Hazardous waste collection is currently undertaken by temporarily siting collection vehicles at various locations around the city for householders to bring their hazardous waste materials. Initial review suggests that this is not a cost-effective method for collecting hazardous wastes from households due to the low level of waste collected by each vehicle per day.

The details of contract monitoring and enforcement arrangements for the Municipality's existing contracts have not been reviewed as part of this study but we understand that the Municipality receives around 1,000 calls for collection requests and complaints each day. It is important to keep this figure in context. For a Municipality with a population of approximately 1.7 million, this rate is not necessarily excessively high. However, it needs to be considered together with data on household sizes, the number of repeated missed collections and other complaints. This indicates that, whilst comprehensive waste collection systems are in place, the collection system may not be operating effectively.

It is understood that waste collection is paid for on a per crew basis. This is not in line with international practices and encourages inefficiencies, as the contractor is paid more for more crews, rather than for optimising waste collection. A more typical method of payment is to have a fixed fee based on the amount of waste to be collected, with regular reviews and price adjustments should the waste tonnages change.

Table 9.3: Gap Analysis of Waste Collection Issues - Summary

No.	Component	Assessment	Areas for Improvement
2A	Waste collection coverage	Waste collection service coverage is close to 100%, the level of international best practice. Informal waste pickers (catadores) undertake collection of higher value recyclables prior to the arrival of official Waste that Is Not Waste (WNW) municipal scheme vehicles. This is a duplication of collection effort.	▪ In recognising the importance of the informal waste pickers sector, evaluate recycling collection options to reduce duplication of effort between WNW crews and waste pickers. ▪ Consider reducing collection frequency to reduce costs, whilst maintaining an appropriate level of service provision.
2B	Percentage of waste captured	Majority of waste materials are captured by formal or informal waste collection systems. However, some construction and demolition materials are illegally dumped in some areas of Curitiba. Organic and C&D waste collected together preventing these two material streams being recovered.	▪ Implement education and enforcement measures to tackle illegal dumping of C&D wastes. This may be best undertaken by a large taskforce, clearing all of the sites at one time in order to avoid people moving on to the next closest site and defining future uses that would occupy the space and make illegal dumping difficult. It would also mean that the Municipality could be responsible for additional waste, at a tonnage which is not currently known. ▪ Ensure segregation of organic and C&D wastes so as to allow their recovery.
2C	Transfer efficiency and quality	No defined routes for collection vehicles leading to inefficient use of vehicles and crews. No waste transfer arrangements are in place. Collection of hazardous waste from households is inefficient.	▪ A detailed service efficiency review for waste collection services is recommended. ▪ Optimisation of collection routes for vehicles through arrangement of defined routes. ▪ Minimise the number of staff in vehicles during trips to the landfill to increase collection productivity. ▪ Maximise vehicle capacity prior to transfer to disposal sites. ▪ Maintain consistent drop off points for recyclable wastes so that Eco-Citizen sites can plan for the waste which they will receive. ▪ Encourage waste analysis at the Eco-Citizen site so that waste is checked before it is accepted and therefore poor quality waste is noted. ▪ Introduce system to transfer crews from a vehicle when full to another vehicle to continue collections. ▪ Consider use of transfer stations to allow bulking of residual wastes prior to transportation to landfill. ▪ Consider providing permanent, centralised hazardous waste collection points to reduce the need for expensive mobile hazardous waste collection vehicles.

No.	Component	Assessment	Areas for Improvement
2D	Appropriate service planning and monitoring	High level of complaints from residents suggests that the system is not operating effectively.	▪ Improve current waste collection system operation by improving monitoring and enforcement. ▪ Ensure that new contract includes a performance related payment mechanism.

Source: Mott MacDonald

9.1.3 Waste Treatment and Disposal

Much of the waste material collected by formal and informal waste collection systems in Curitiba are managed at controlled waste treatment and disposal facilities, including Eco-Citizen sites, the UVR and the Estre Landfill Site and associated treatment locations. It is noted that some uncontrolled dumping of C&D wastes does occur in Curitiba. Whilst a detailed review of environmental controls operating at the Municipality's treatment and disposal sites does not form part of this study (a detailed audit of operations would be required to assess compliance and environmental performance of the Municipality's sites), visual observations made during the site visits in June 2015 indicate that the landfill is operated to a good standard. The site is engineered to contain/manage leachate and landfill gas, waste is received in a controlled manner, daily cover is applied to freshly tipped wastes, and informal waste pickers are prevented from accessing the site. Landfill gas is collected and flared at the Estre Site; it is understood that there are plans to install a plant to generate power from the landfill gas. The other sites visited during the site visits also appear to be operated to a good standard with regards to environmental controls. However, there were occasions during site visits where lack of permits and adequate structure and control were identified. The processing of this waste is also done outside of the Municipality's system, meaning that it is also not paid for directly.

The main concern regarding the Estre landfill is the requirement for Curitiba vehicles to have a fourth axle and to have limited amounts of waste in each vehicle, according to the requirements for the Federal weighbridge. The reason for this is not clear. The fourth axle has been added to vehicles and was designed to be lifted up, rather than be used at all times. Therefore, clearly the vehicles can be used on the roads with three axels and there will be additional fuel use from carrying extra weight.

Table 9.4: Gap Analysis of Waste Treatment and Disposal Analysis - Summary

No.	Component	Assessment	Areas for Improvement
3A	Percentage managed via controlled treatment and disposal	Residual waste generated by the Municipality is managed at controlled treatment and disposal sites. However, there is some illegal dumping of C&D wastes in some areas of the city. Although the Eco-Citizen sites are generally controlled there is a lack of regulation and regulation enforcement and the Municipality is not aware of/does not receive reports of where the recyclables are sold. The reason for the requirement for vehicles with four axles to deliver to the landfill is not clear. The Municipality is responsible for the recyclable	▪ Implement education and enforcement measures to tackle illegal dumping of C&D wastes (also see 2B above). ▪ Investigate the possibility (in the context of the regulatory requirements) of using three axle vehicles in the new contract to deliver waste to the landfill. ▪ Provide increased support to and regulation of (by the Municipality or associated bodies) the Eco-Citizen sites and, where possible, the autonomous sites, to ensure compliance with labour, health and safety, and environmental legal requirements and

No.	Component	Assessment	Areas for Improvement
		materials separated by households and small businesses but effectively hands over this task to Eco-Citizen and autonomous waste separation sites.	encourage good practices.
3B	Degree of environmental protection in waste treatment and disposal	Initial assessment indicates that the UVR and landfill sites are operated to a good standard with regard to environmental controls. However, the Eco-Citizen and autonomous separation sites are variable and some have poor health and safety and environmental controls.	▪ The development of any new waste treatment sites should follow the principle of best available technology (BAT) to facilitate maximum environmental protection and recovery of value/energy from the waste streams. ▪ The Eco-Citizen and autonomous sites could be better regulated and oversight provided to encourage good practice.

Source: Mott MacDonald

9.1.4 Resource Value

The collection and transfer of recyclable materials in Curitiba is complex. There is a very active informal sector operating both under registered and unregistered systems, collecting waste directly from households and companies and via Eco-Citizen sites and unregistered recycling sites. Furthermore, levels of participation by households appears to be high, with householders providing recyclables via the Waste that is not Waste scheme, the new Voluntary Collection Recycling Programme and the Green Exchange Programme. What is less clear is how well households understand what materials they should be putting out for recyclable collection, as there are relatively high levels of non-recyclable materials in the recyclables streams, as can be seen by the high levels of rejects from the UVR and Eco-Citizen sites. There may also be some confusion caused by the use of the same type of black bag for recyclables and residual waste, compounded by the lack of monitoring/enforcing. We understand from interviews conducted during fact finding missions that, when undertaken, communication campaigns on waste and recycling have been successful. However, consideration should be given to periodic and sustained communication and education activities to reinforce messaging around waste prevention and recycling so as to encourage householder engagement on these issues.

There is clearly a relatively well-functioning market in the key recyclable materials that is driving the activity of informal waste pickers, autonomous waste separation sites, middlemen and bulkers and recycling companies. However, there is duplication of effort by the informal and municipal operated sectors, leading to poor quality of recyclable materials at the UVR, with the result being that the UVR generates a number of material streams that do not have a good market value. We understand that reject rates at the UVR are of the order to 40%, very high for this type of facility. This is likely to be caused, at least in part, by the Eco-Citizen and autonomous waste pickers removing the most valuable materials directly from the bags of waste set out by householders and businesses. It is important to note, however, that the reject rate would reduce significantly (closer to 8%-10% from a high level assessment) if the quantity of recyclables collected by waste pickers was included.

The informal sector is recognised by the Municipality as a key part of the city's waste management system. As discussed in Section 4.2, extrapolated data from a 1999 estimate suggests that waste pickers collected

over 170,000 tonnes of waste per year (in 2015), substantially more than the quantity collected by the Municipality under the Waste that is not Waste scheme (approximately 30,000 tonnes per year). These actions, whilst on the one hand removing valuable materials for offtake, may be saving the Municipality substantial collection and treatment costs. Efforts have been undertaken since 2008 to register cooperatives and associations of waste pickers at waste separation sites through the Eco-Citizen project.

Precise data on the level of recycling is not available. An initial review of data suggests that Curitiba is achieving a recycling rate of approximately 23% (see Section 4.2), which would be low/medium with respect to international norms.

There is a complex interaction between informal sector activities and other parts of the recyclable collection and separation process. The combination of the Municipality's Waste that is not Waste scheme and the activities of informal waste pickers, combined with Eco-Citizen and autonomous sites, may serve to maximise the level of separation of recyclables from residual waste. However, the viability of the UVR in this context needs careful assessment. For example, if in the future the UVR receives progressively poorer and poorer quality recyclables (due to the valuable materials being captured by waste pickers prior to collection by the Municipality) then it will become increasingly expensive to operate the UVR as revenues from recyclables drop. Conversely, if the market value of key recyclables drops suddenly then we would expect the activity of the informal sector to drop as well, meaning that the municipality could be left to manage greater quantities of material with a lower value, potentially at relatively short notice.

With respect to waste reduction issues, as far as we are aware, there are no waste prevention policies or related education campaigns underway in Curitiba. This represents a good opportunity to improve the quality of recyclables and reduce the overall quantities of waste generated by the Municipality.

Table 9.5: Gap Analysis of Resource Values Issues - Summary

No.	Component	Assessment	Areas for Improvement
4A	Recycling rate	Recycling rate is estimated 23%. This is low/medium in comparison to international norms. However, this does not take into account recycling undertaken by informal waste pickers.	▪ See point 1A above.
4B	Quality of source separation	The level of material rejected by the UVR is high (estimated at 40%), and it is understood that some of the Eco-Citizen sites also have high rejection rates. This may be caused by poor segregation of recyclables by householders and/or by the activities of waste pickers removing valuable materials before the bags are collected by the municipality. The situation is not helped by the use of the same type of black bag for both recyclable and residual materials and lack of contamination monitoring by the collection crews.	▪ Consider options to improve the quality of material generated by the Waste that is not Waste scheme and/or the interaction with waste picker activities. ▪ Consider the use of different types of collection containers for residual and recyclable materials and link to the education and communication activities, as well as monitoring by crews. ▪ Carry out periodic education and communication programmes so that households and companies are made aware of which materials they should separate for recycling.
4C	Quality of recycled materials	The activity of waste pickers is typically driven by a well-functioning market in recyclables so the quality of this aspect of the system is considered	▪ See point 2A and 2D above. ▪ Provide increased support and regulation enforcement to the Eco-Citizen sites and,

No.	Component	Assessment	Areas for Improvement
		to be good. However, the remaining material for separation at the UVR and that delivered from the WNW collection to the Eco-Citizen sites of a less good quality. There are complex interactions between these different elements of the recycling value chain that need careful assessment.	where possible, the autonomous sites, to encourage good practices.
4D	Waste prevention	No waste prevention policies or programmes in place.	▪ Develop waste prevention education campaigns.
4E	Integration of community and/or informal sector in resource recovery	The informal sector forms a key part of the Municipality's waste management system. Efforts have been made to register informal waste pickers and to improve their conditions, but the results have been mixed. The issue is a complex one which will require careful consideration as part of measures to improve the Municipality's waste collection services.	▪ Proactively engage with representatives of the informal sector so that any changes to the city's waste collection services can be done in consultation, maximising the benefits for all stakeholders. ▪ Optimise the role that all waste pickers (registered and unregistered) will have as part of a new waste management system.

Source: Mott MacDonald

9.1.5 Governance Factors

International best practice suggests that citizens should be proactively engaged in the improvement and development of new waste management systems. New waste management systems that have been developed in close consultation with users of the service (i.e. citizens, householders and businesses) are more likely to be adopted successfully. This is because citizens are likely to be more positively engaged in a waste management system that they have been involved in developing, rather than perceiving it to be a system imposed upon them by the Municipality. Furthermore, citizens are likely to be more conscious of the need to reduce waste and more aware of their own role in the waste management system with respect to separating recyclable materials correctly.

As with the users of the service, it is important that the private and informal sectors are both engaged in the development of the new service so as to ensure that it is developed sensitively with regard to the range of priorities and requirements that different stakeholders have.

With respect to the informal sector, the Municipality recognises the role that waste pickers play in delivering the service. As highlighted above, it will be important that the Municipality proactively engages with the informal sector so as to maximise the benefits that the sector brings and to sensitively manage issues around any changes to the waste management system.

In terms of financial sustainability, we understand from the Municipality that the waste management budget is derived from a property tax. The tax strictly allocated to waste management services only accounts for a proportion of the cost of the service. The remaining budget for waste management services is sourced from other areas of taxation.

It is suggested that the process for the forthcoming PPP tender evaluates more criteria than just financial considerations to allow for multiple processes to enter the solution bid.

Curitiba has clear institutional structures with respect to waste management responsibilities. The Municipality has responsibility for collecting and disposing of waste. It discharges the waste collection responsibilities via a series of private sector contracts and the disposal responsibility via a partnership arrangement with the Conresol Consortium which holds a contract with the landfill operator, Estre. The municipality also has a defined waste strategy, which sets clear targets and objectives. Some of these objectives and targets are specific and quantitative in nature including, for example: some easily achievable targets such as maintaining 100% waste collection coverage, and; more ambitious targets such as processing 100% of waste, diverting at least 85% and at most landfilling 15%. Others are more aspirational and qualitative such as investigate C&D waste processing technologies. As far as Mott MacDonald is aware, the strategy does not include an action plan or programme which sets out a timescale and programme for achieving these targets. This will be critical if the Municipality is to achieve treatment of all waste and diversion of over 85% of waste from landfill.

Table 9.6: Gap Analysis of Governance Issues - Summary

No.	Component	Assessment	Areas for Improvement
5A	User inclusivity	The extent of public consultation undertaken in relation to the existing waste management system is not fully clear	▪ Consider the enhancement of the role of citizens and business in the development of the new waste collection system.
5B	Provider inclusivity	The Municipality currently engages with the private and informal sectors. This on-going engagement will be important to maximise the benefits that the informal sector can deliver and to derive value for money through any contracts that may be procured.	▪ Further develop engagement with private sector. This could include market sounding events to gauge and build private sector interest, and identify risks and opportunities (e.g. site availability, new technologies, level of competition). ▪ Proactively engage with the informal sector and its representatives.
5C	Financial sustainability	Current costs for waste management services are very high.	▪ Adopt lifecycle costing approach that encompasses consideration of all waste management system operations whilst taking into account the Municipality's affordability envelope. ▪ The payment structure for the new contract should incentivise the optimisation of the collection system (e.g. with performance related measures).
5D	Sound institutions and policies	Clear institutions and responsibilities are in place. A waste strategy has been developed which includes clear and, in some cases, very ambitious targets. However, the strategy does not appear to include an action plan which identifies how and over what timescale these targets will be achieved.	▪ Define a clear action plan for achieving the targets identified in the strategy.

Source: Mott MacDonald

9.2 Conclusions

The gap analysis has identified a number of areas for improvement. These fall into three main types:

4. **Key issues.** Immediate priorities to support the options appraisal process and any subsequent procurement process.

5. **Quick wins.** Measures that the Municipality can implement to improve the waste management system in the short term.

6. **Longer-term issues.** Issues for consideration as part of the Municipality's long-term planning for waste management.

These areas for improvement are summarised in the tables below.

Table 9.7: Key Issues

No.	Component	Areas for Improvement
1A	Waste generation	▪ Consider options to for capturing further data on recyclable waste collected by the informal pickers sector.
1B	Waste composition	▪ Arrange waste composition analysis to provide as much information as possible to bidders during the procurement of waste treatment capacity.
2C	Transfer efficiency and quality	▪ Consider use of transfer stations to allow bulking of residual wastes prior to transportation to landfill.
2D	Appropriate service planning and monitoring	▪ Ensure that new contract includes a performance related payment mechanism.
3A	Percentage managed via controlled treatment and disposal	▪ Investigate the possibility (in the context of the regulatory requirements) of using three axle vehicles in the new contract to deliver waste to the landfill.
3B	Degree of environmental protection in waste treatment and disposal	▪ The development of any new waste treatment sites should follow the principle of best available technology (BAT) to facilitate maximum environmental protection and recovery of value/energy from the waste streams.
4B	Quality of source separation	▪ Consider options to improve the quality of material generated by the Waste that is not Waste scheme and/or the interaction with waste picker activities.
4E	Integration of community and/or informal sector in resource recovery	▪ Proactively engage with representatives of the informal sector (e.g. Cooperativa Cataparaná) so that any changes to the city's waste collection services can be done in consultation, maximising the benefits for all stakeholders.
4E	Integration of community and/or informal sector in resource recovery	▪ Optimise the role that informal waste pickers (registered and unregistered) will have as part of a new waste management system.
5A	User inclusivity	▪ Consider the enhancement of the role of citizens and businesses in the development of the new waste collection system.
5B	Provider inclusivity	▪ Further develop engagement with private sector. This could include market sounding events to gauge and build private sector interest, and identify risks and opportunities (e.g. site availability, new technologies, level of competition).
5C	Financial sustainability	▪ Adopt lifecycle costing approach that encompasses consideration of all waste management system operations whilst taking into account the Municipality's affordability envelope.

No.	Component	Areas for Improvement
5C	Financial sustainability	▪ Use improved payment structure for the new contract so as to incentivise the optimisation of the collection system.
5D	Sound institutions and policies	▪ Define a clear action plan for achieving the targets identified in the strategy.

Source: Mott MacDonald
Note: See Table 9.1 for detailed for referencing numbering.

Table 9.8: Quick Wins

No.	Component	Areas for Improvement
2A	Waste collection coverage	▪ Evaluate recycling collection options to reduce duplication of effort between WNW crews and waste pickers.
2A	Waste collection coverage	▪ Consider reducing collection frequency to reduce costs, whilst maintaining an appropriate level of service provision.
2B	Percentage of waste captured	▪ Implement education and enforcement measures to tackle illegal dumping of C&D wastes.
2B	Percentage of waste captured	▪ Ensure segregation of green and C&D wastes so as to allow their recovery.
2C	Transfer efficiency and quality	▪ A detailed service efficiency review for waste collection services is recommended.
2C	Transfer efficiency and quality	▪ Optimisation of collection routes for vehicles through arrangement of defined routes.
2C	Transfer efficiency and quality	▪ Maximise vehicle capacity prior to transfer to disposal sites.
2C	Transfer efficiency and quality	▪ Maintain consistent drop off points for recyclable wastes so that Eco-Citizen sites can plan for the waste which they will receive.
2C	Transfer efficiency and quality	▪ Introduce system to transfer crews from a vehicle when full to another vehicle to continue collections
2C	Transfer efficiency and quality	▪ Consider providing permanent, centralised hazardous waste collection points to reduce the need for expensive mobile hazardous waste collection vehicles.
2D	Appropriate service planning and monitoring	▪ Improve current waste collection system operation by improving monitoring and enforcement.
3A	Percentage managed via controlled treatment and disposal	▪ Implement education and enforcement measures to tackle illegal dumping of C&D wastes (also see 2B above)

Source: Mott MacDonald
Note: See Table 9.1 for detailed for referencing numbering.

Table 9.9: Long Term Issues

No.	Component	Areas for Improvement
1A	Waste generation	▪ Implement waste prevention policies.
4B	Quality of source separation	▪ Consider the use of different types of collection container for residual and recyclable materials and link to the education and communication recommended above.
4B	Quality of source separation	▪ Carry out periodic education and communication programmes so that households and companies are made aware of which materials they should separate for recycling.
4D	Waste prevention	▪ As per point 1A (develop waste prevention education campaigns).

No.	Component	Areas for Improvement
5A	Provider inclusivity	▪ Proactively engage with the informal sector and its representatives.

Source: Mott MacDonald
Note: See Table 9.1 for detailed for referencing numbering.

Appendices

Appendix A. Waste Flow Model Assumptions

A.1 Data sources

The summary of quantitative data sources is presented in Table A.1.

Table A.1: WFM Quantitative Data Sources

RFI Document Title	Utilised Information Description
Curitiba Solid Waste Strategy 2010 (Ref.1)	2009 waste tonnages for multiple streams. 2000-2009 residual and recyclable door to door collection and green exchange tonnages. Average tonnages for multiple streams. Hazardous waste collection composition.
Item 2 (Ref.9)	Hazardous waste collection yearly tonnages for different material types 1998-2015. Caximba landfill material composition 2005-2010.
Item 6 (Ref.10)	Waste that is not Waste and green exchange monthly collection figures 1989-2015.
Item 9 (Ref.29)	Table provided with no label, but understood to be monthly collection figures for residual door to door collection from 1989-2015.
Item 12 (Ref.13)	Yearly tonnages received, processed and sold at the UVR for 2013 and 2014. Composition of separated material (i.e. outputs) at the UVR 2013 and 2014. Waste that is not Waste and green exchange monthly material destination 2011 to 2015.
Item 16 (Ref.14)	Waste that is not Waste 2014 tonnage. Residual collection 2014 tonnage.
Item 27, 28, and 29 (Ref.17)	Tonnage per material stream collected in the voluntary collection sites.
Item 2 and 3 Consortium (Ref.18)	Yearly landfill tonnages 2010-2015 for each Municipality. Weighbridge data for RCVs. Composition data for landfilled material.
Material Consortium (Ref.21)	Data on monthly, daily, and hourly waste variations.
Eco-Citizen Data (Month, Year) (Ref.22)	Monthly information for material sources and processing weights for all eco-citizen sites in the programme.
SMMA Report (2013-2015) (Ref.24)	Monthly tonnages for a variety of streams, including sweeping and cleaning, from 2013 to 2015.
Municipal Sanitation Report 2013 (Ref.2)	Collection tonnages for a variety of streams in 2012. Average figures for multiple streams.
Curitiba in Data (Ref.28)	Data provided by the IFC from the online source Curitiba em Dados.

Source: RFI response documents

A.2 Curitiba Population Assumptions

A.2.1 Missing Data for 2001 to 2009

As indicated in Section 8.2, population data for the years available (year 2000 and 2010) was extrapolated backwards to cover the missing population data from 2001 to 2009. This was done by modelling a steady increase from those years with the formula:

$$Decade\ Population\ Difference * \frac{Year - 2000}{2010 - 2000} + Population\ in\ 2000$$

Source: Mott MacDonald

A.3 Residual Municipality Waste Streams Tonnage Assumptions (Business as Usual)

The data provided and the growth rate assumptions in the following sections are based on current practices in Curitiba.

A.3.1 Household and Commercial Residual Waste Door to Door Collection

Household and commercial residual waste has been based on the figures provided in the CSWMS 2010 (Ref.1) as well as the CMSP 2013 (Ref.2) and RFI Item 16 (Ref.14), which summarises some collection tonnages and costs. Data was provided for the tonnages from 2003 to 2014 from a range of sources. An initial growth rate for the Household and Commercial Residual Waste Door to Door Collection waste stream has been calculated based on the average yearly growth rates from 2010 to 2014. This process utilised the tonnage figures from 2009 to 2014, calculated the yearly growth rates from 2010 to 2014, and averaged those for an estimation of the final growth trend. Data was extracted from agreeing sources provided in different documents (Ref.1 and 14).

This method was chosen over utilising the growth between two figures (such as decade growth from 2004 to 2014) as this minimises the risk of skewing the results based on a single abnormality in data. This is particularly relevant for waste streams that provide significant yearly variations or low tonnages.

Table A.2: 2015 Growth Rate Calculation Data

Year	Collected Tonnage	Growth Rate
2009	437,904	-
2010	475,865	8.67%
2011	466,205	-2.03%
2012	490,693	5.23%
2013	498,383	1.57%
2014	511,540	2.64%
2015	528,010	3.22%
Average Annual Growth Rate (2010-2014)		3.22%

Source: CMSP 2013, RFI Item 16, Mott MacDonald

A.3.2 Indirect residual, river and public cleaning wastes

The last known combined tonnage figure for public cleaning is for 2012; therefore, the first year where the value was predicted for was that of 2013. As 2013 experienced an abnormal population growth rate (4.06%) basing future growth on the ratio between the population growth in 2013 and other years would have significantly reduced the growth rate for this stream.

A.3.3 Summary of residual waste collection figures

Table A.3: Population Residual Waste Arisings Sources and Assumptions

	Population	HH and Commercial Residual	Indirect Residual	Public Cleaning	River Cleaning	Illegal C&D Dumping
Data Source 1	IBGE	CSWMS 2010 page 25	Relatório SMMA 2013	CSWMS 2010 page 18	CSWMS 2010 page 46	n/a
Data Source 2	"Curitiba em Dados" Website	CMSP 2013 page 35	Relatório SMMA 2014	CMSP 2013 page 35	CMSP 2013 page 51	n/a
Data Source 3		RFI Item 16	CSWMS 2010 page 27			n/a

Source: Mott MacDonald

A.3.4 Summary of residual waste collection figures

Table A.4: Recyclable Waste Arisings Sources and Assumptions

	Waste that is Not Waste	Voluntary	Green Exchange
Data Source 1	CSWMS 2010 page 30	Items 27, 28, and 29	CSWMS 2010 page 37
Data Source 2	Item 6		Item 6
Data Years Utilised for Initial Growth Calculation	2009 to 2014		2011 to 2014

Source: Mott MacDonald

A.4 Recyclable Municipality Waste Streams Tonnage Assumptions (Business as Usual)

A.4.1 Small C&D, Unusable Bulky, and Household Green Waste

Data presented by the CSWMS 2010 indicates that 21,000 tonnes of household green wastes were collected in 2009.The CMSP 2013 indicates that 26,000 tonnes of household green wastes and unusable bulky material were collected in 2012. Information provided by the SMMA report 2013 indicates that 79,000

of combined wastes were collected; similarly, the SMMA report 2014 quotes the value as 72,000. Lastly the CMSP 2013 states that 65,000 tonnes of combined material were collected in 2012.

Table A.5: Small C&D and Green Waste Arisings

	Green and Unusable Bulky Waste		Household Green Waste Only		All Small C&D, Unusable Bulky, and Household Green Waste	
Year	Tonnage	Data Source	Tonnage	Data Source	Tonnage	Data Source
2009			21,000	CSWMS 2010		
2012	26,000	CMSP 2013			65,000	CMSP 2013
2013					79,000	SMMA Report
2014					72,000	SMMA Report

Source: SMMA Reports (Ref.24), CSWMS (Ref.1), CMSP (Ref.2)

Provided these values have not significantly changed from 2009 through 2012 and 2013, it can be understood that 26,000 tonnes of a total of 65,000 are composed of green wastes; this would indicate that the stream is about 33% Green Waste and 67% Small C&D and Unusable bulky wastes. This calculation was chosen over using the 2012 green and unusable value of 26,000 tonnes as it allows the unusable bulky material to be calculated as part of the Small C&D fraction of the collection as opposed to being combined with the green waste. In order to appropriately calculate the value of Green and Small C&D Wastes separately, it has been assumed that this composition split is constant. This has not been corroborated, but it is considered reasonable by Mott MacDonald in the absence of further data sources to use.

A.5 Composition Data

A.5.1 Residual Waste Composition

Historic Landfill Analysis

The composition data for residual waste includes both the household and commercial residual collected waste as well as the indirectly collected residual. This information is provided in Table 4.4 in Section 4.3 and is also included as Table A.6 for ease of reference.

Table A.6: Waste Composition at Curitiba Landfills (w/w)

Material Type	Caximba (%)	Estre (%)	Average used for modelling (%)	Material Type	Caximba (%)	Estre (%)	Average used for modelling (%)
Organic Material	37.7	40.5	39.1	Long Life Containers	1.1	1.1	1.1
Paper	16.0	17.9	17.0	Metals (ferrous)	1.9	0.9	1.4
Plastic Film	10.0	10.0	10.0	Metals (non-ferrous)	0.8	0.8	0.8
Plastic (hard)	7.8	6.9	7.4	Wood	0.8	0.7	0.8

Material Type	Caximba (%)	Estre (%)	Average used for modelling (%)	Material Type	Caximba (%)	Estre (%)	Average used for modelling (%)
Cardboard	6.0	6.8	6.4	Rubber	2.0	0.2	1.1
Diapers	5.5	7.6	6.6	Leather	0.7	-	0.4
Cloth	4.5	3.1	3.8	Other Material	0.6	1.0	0.8
Glass	4.6	2.5	3.6	Total	100	100	100

Source: RFI response document "Item 2" (Ref.9) and "Item 2 and 3 Consortium" (Ref.18)

The Caximba data relates to samples carried out up to 2010 and the Estre data is from 2011. The variations in composition are typical, and the relatively low levels of metals, particularly non-ferrous, is also typical for waste which has high value material removed by waste pickers.

Composition Analysis

A composition analysis study was conducted by the Municipality between 5th to the 7th of August 2015. Samples were collected from RCVs arriving in the landfill; the material was then placed in drums and transported to the Caximba landfill, where a scale was utilised to measure the samples before waste separation was initiated. A total of 475 kilograms of material were sampled in total. The procedure utilised for this study is illustrated in Figure A.1 and Figure A.2.

Figure A.1: Material Containment and Weighing

Source: Relatório Caracterização Domiciliar (Ref.30)

Figure A.2: Separation Table and Process

Source: Relatório Caracterização Domiciliar (Ref.30)

Material was collected from four (4) vehicles in total, each selectively targeted from a different region of Curitiba. Table A.7 presents the origin of the material sampled and separated based on the region of Municipality it was taken from.

Table A.7: Composition Study Collection Round Sources

Collection Date	Shift	Neighbourhood	Neighbourhood Standard	Average Material Density $kg^{1}m^{-3}$
5/8/15	Day	Industrial City	Low	178
5/8/15	Day	Portão	Medium	270
5/8/15	Night	Central	Commercial	233
6/8/15	Night	Água Verde	High	273

Source: Relatório Caracterização Domiciliar (Ref.30)

Twenty (20) drums of material were collected in total, four (4) for each of the low, medium, and high standard neighbourhoods, and eight (8) for the city centre collection. Density varied from sample to sample; the averages are presented in Table A.7.

Material classification was based on visually separating the material into 15 different categories. This process was done manually; each of the different categories were then weighed separately for each of the collection region. The results are presented in Table A.8.

Table A.8: Curitiba Residual Collection Material Composition

Neighbourhood Material	Centre w/w %	High Standard w/w %	Low Standard w/w %	Medium Standard w/w%	Average w/w %	Variance Index
Paper	17.2	6.9	5.6	5.3	8.8	0.65
Cardboard	3.3	2.6	4.9	6.6	4.4	0.41
Plastic Film	5.0	8.2	7.0	4.4	6.2	0.29
Plastic (Hard)	9.3	7.3	11.3	11.9	10.0	0.21
Metal – Ferrous	1.3	0.9	1.4	1.3	1.2	0.20
Metal – Non Ferrous	2.6	4.3	2.5	9.7	4.8	0.70
Glass	1.7	4.3	2.8	8.0	4.2	0.66
Rubber	0.3	0.2	4.2	1.3	1.5	1.24
Wood	0.3	0.1	1.1	1.3	0.7	0.84
Cloth	0.3	1.7	7.0	2.2	2.8	1.03
Leather	0.0	0.0	0.0	0.0	0.0	0.00
Diapers	1.3	9.5	7.0	1.8	4.9	0.82
Tetrapak (Long Life)	0.7	4.1	2.8	1.8	2.3	0.63
Other Materials	9.3	13.7	11.3	9.7	11.0	0.18
Organic Materials	47.5	36.1	31.0	34.5	37.3	0.19
Total	100.0	100.0	100.0	100.0	100.0	-

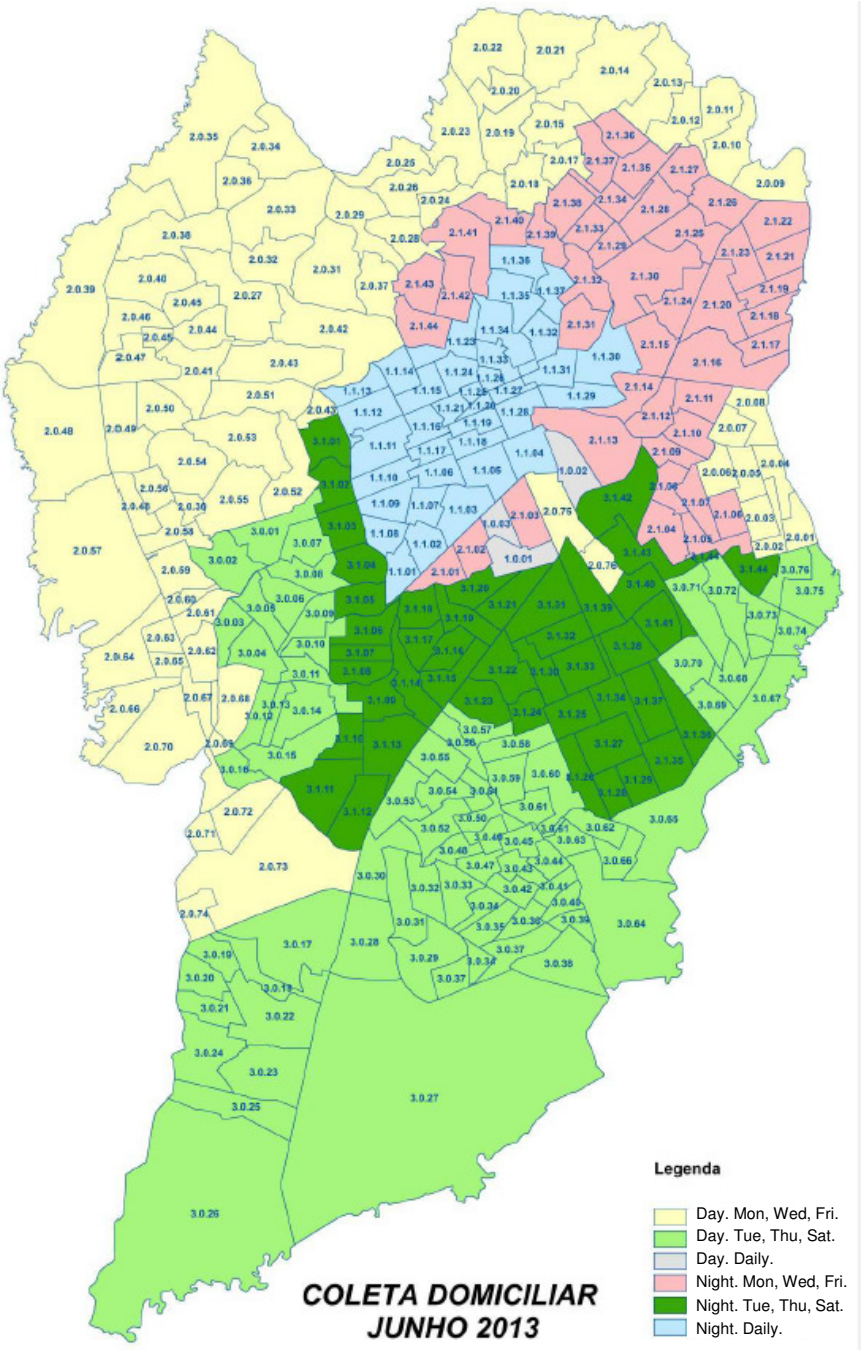
Source: Relatório Caracterização Domiciliar (Ref.30)
Key: Green: variance index smaller than 0.1 Yellow: variance index between 0.1 and 0.6 Red: variance index larger than 0.6

There are significant degrees of variation regarding the composition of the residual waste collected based on the area of origin for the collection. Although the formula for the calculation was not disclaimed in the report, it is understood that the variance index provides a measure of the degree of variability of the different percentages provided for each waste category classified.

Indexes labelled in red correspond to materials that show a high degree of variability in their composition fraction due to their fluctuations from their corresponding weight percentages on each of the different material collection areas and standard. This is in line with expectations.

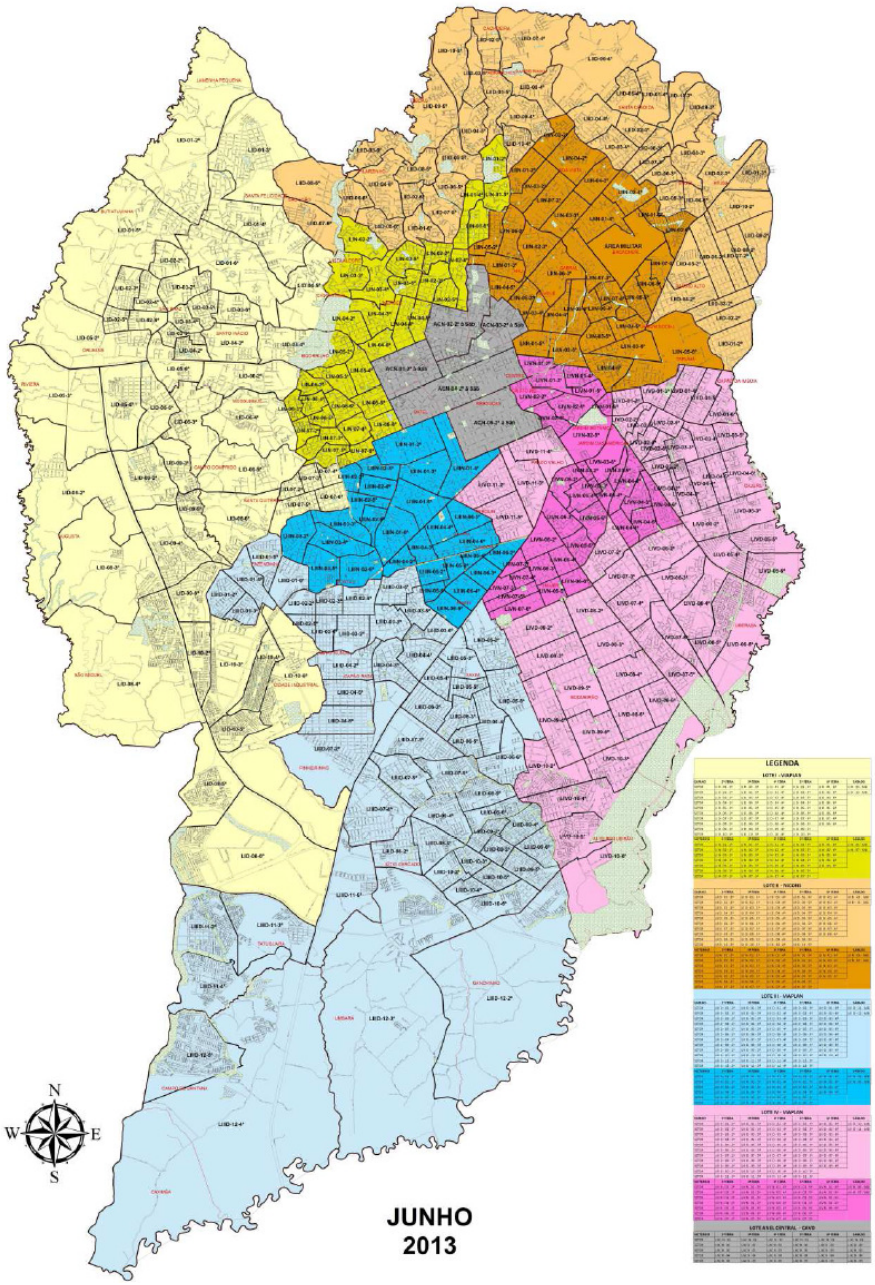
Appendix B. Curitiba Collection Days Maps

Figure B.1: Curitiba Residual Collection Days



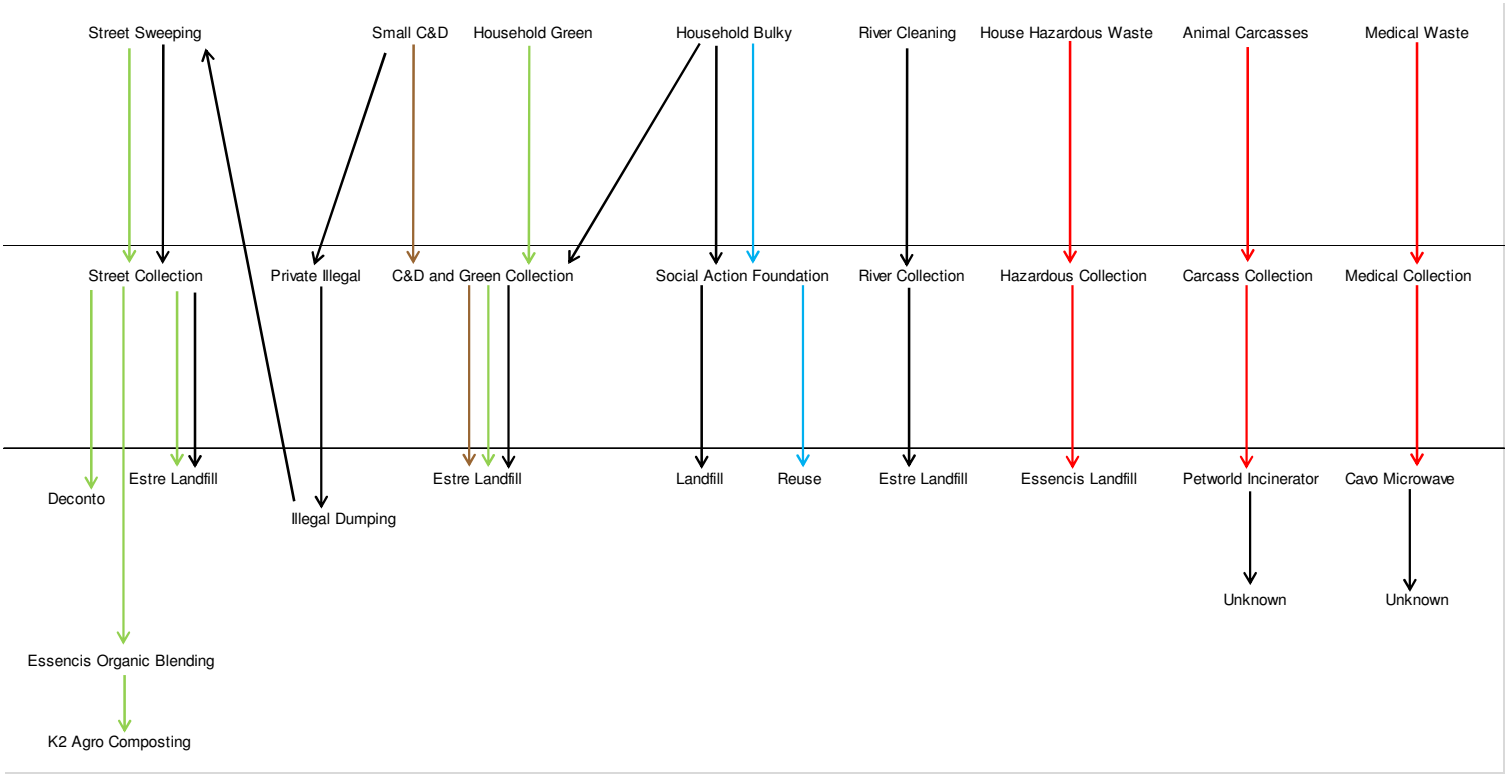
Source: Curitiba Municipal Sanitation Plan 2013

Figure B.2: Household Green and C&D Collection Days

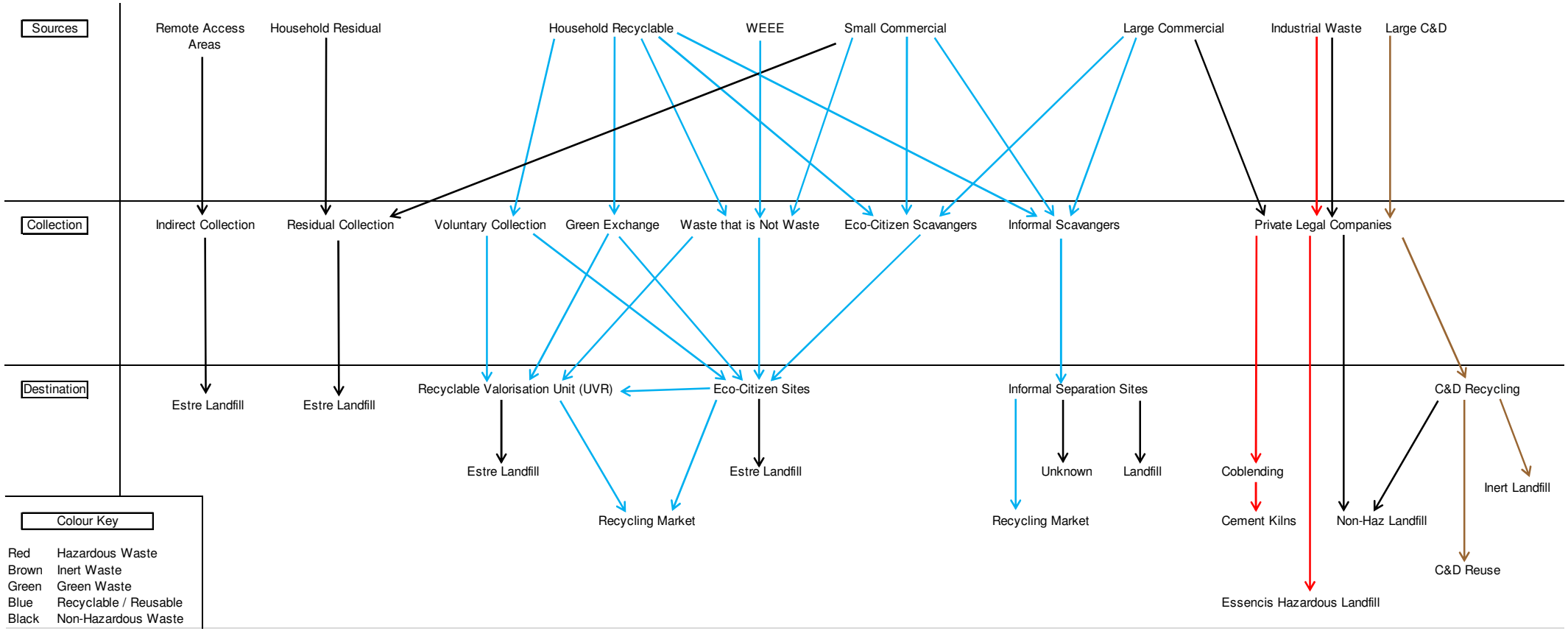


Source: Curitiba Municipal Sanitation Plan 2013

Appendix C. Schematic of Current Waste Flow Arrangements



Source: Mott MacDonald



Source: Mott MacDonald

Appendix E. Risk Analysis

Risk	Explanation	Potential Mitigation Strategies
Municipality runs out of landfill capacity for non-hazardous and/or hazardous waste.	Should the capacity of the existing landfills used for non-hazardous and hazardous waste be filled, the Municipality will need to use alternative disposal capacity which is likely to be some distance from Curitiba. This is likely to add significantly to costs and, in a worst case scenario, lead to no disposal capacity and the need to stockpile wastes.	Develop contingency options for non-hazardous and hazardous waste disposal. In the longer term, develop waste treatment infrastructure to divert waste from landfill.
Quantities of waste generated by the Municipality continue to rise, increasing costs of waste management and placing increasingly significant strain on existing waste infrastructure.	Rates of waste generation in the Municipality have risen significantly over the past decade. Should this trend continue as expected the costs of waste management will also rise significantly. Existing waste collection and treatment infrastructure is unlikely to be able to cope with this rise.	Implement waste prevention campaign. Enhance waste collection and treatment infrastructure.
Lack of comprehensive data on waste arisings and composition prevents appropriate planning of waste management operations and infrastructure development, leading to unnecessary costs and/or service failure.	Without good data on waste arisings and composition, it is not possible to accurately assess current service performance and identify the needs for future collection and treatment capacity. The data is particularly scarce with respect to the informal and autonomous recyclate collections. This could lead to unnecessary costs and, in the worst case, service failure, as the system is unable to cope with the quantity and type of waste generated by the Municipality.	Implement comprehensive waste tracking system and collect composition data.
Unregulated waste collection activities suppress value of recycled materials and undermine feasibility of Eco-citizen and other Municipality-led schemes.	Unregulated waste management operations have the potential to disrupt regulated operations by capturing materials that would otherwise be managed by Eco-citizen schemes or other programmes operated by the Municipality. The costs incurred by unregulated waste management providers are also likely to be lower (e.g. by avoiding registration/administrative, health & safety costs, and disposal costs), allowing these organisations to provide a service at a lower cost to waste producers and/or gaining extra profit from sale of recyclables.	Encourage waste pickers and separators to become registered and the Municipality to provide support and enforce regulation.
Inefficient collection separation of WNW materials leads to potentially recyclable material being rejected.	The Eco-Citizen sites have had concerns raised about the quality of recyclables and the level of rejects. If this continues it could lead to reprocessor being unwilling to take separated waste from Eco-Citizen sites, or that some materials are not separated, changing the tonnage and composition of the waste requiring management through the treatment contract.	Encourage waste pickers and separators to become registered and the Municipality to provide support and enforce regulation.

Lack of enforcement of environmental standards and regulations leads to increasing environmental impacts.	Not all of the Eco-Citizen or autonomous sites have environmental permits. If environmental standards and regulations are not enforced, there are limited incentives for waste management operators to comply. This will lead to increasing environmental impacts associated with waste collection (e.g. emission from vehicles, spills of waste being transported), waste treatment (e.g. increased atmospheric emissions, odour issues, noise, etc.) and disposal (e.g. illegal dumping, gas and leachate emissions and long-term land blight).	Enforce regulatory requirements.
Unregulated and some regulated waste management activities cause health, safety and environmental concerns.	Unregulated and some regulated operators are unlikely to be complying with all health, safety and environmental requirements causing, for example, health and safety risks for workers, environmental impacts caused by waste storage.	Encourage waste pickers and separators to become registered and provide support and regulation. Take regulatory actions against illegal dumping and other illegal activity, and enforce duty of care.
Greenhouse gases generated by landfilled organic waste continue to rise.	The majority of the Municipality's organic waste is landfilled. This is likely to be a significant (and potentially growing) source of GHG.	Divert organic waste from landfill through waste prevention, home composting, with possible future consideration for organic waste separation and treatment.

Appendix F. Document Reference List

Table F.1: Document Reference List

Reference Number	Document Title	Translation / Description of Information	Provided By	Date Provided
1	Plano de Gestão Integrada de Resíduos Sólidos de Curitiba (2010)	Curitiba Solid Waste Management Strategy 2010	Curitiba Municipality	22nd May 2015
2	Plano Municipal de Saneamento de Curitiba – Volume V – Gestão Integrada de Resíduos Sólidos Urbanos (2013)	Curitiba Municipal Sanitation Plan 2013	Curitiba Municipality	22nd May 2015
3	Plano de Gestão Integrada e Associada de Resíduos Sólidos Urbanos do Estado de Paraná 2013	Paraná Regional Waste Management Strategy 2013	Curitiba Municipality	2nd July 2015
4	Plano Nacional de Resíduos Sólidos 2012	Brazilian National Solid Waste Strategy 2012	Curitiba Municipality	22nd May 2015
5	Legislação Federal, Estadual, e Municipal (Vários)	National, Regional, and Municipal Legal Documents (Various)	Curitiba Municipality	22nd May 2015
6	Cadastros, Licenças, e Solicitações (Vários)	Registers, Licences, and Requests (Various)	Curitiba Municipality	22nd May 2015
7	X – Nome do Serviço[1]	X – Service Name[1]	Curitiba Municipality	10th June 2015
8	Item 1	Large Generators Collection Information	Curitiba Municipality	10th June 2015
9	Item 2	Hazardous and Landfill Compositions	Curitiba Municipality	10th June 2015
10	Item 6	Collection Flow and Recyclable Tonnages	Curitiba Municipality	10th June 2015
11	Item 7	Collection Schedule and Eco-Citizen Map	Curitiba Municipality	10th June 2015
12	Item 10 e 11	Municipal Contracts	Curitiba Municipality	10th June 2015
13	Item 12	UVR Data and Eco-Citizen and UVR Material Split	Curitiba Municipality	10th June 2015
14	Item 16	Financial Summary	Curitiba Municipality	10th June 2015
15	Item 18	Tax Summary and IPTU Data	Curitiba Municipality	10th June 2015
16	Item 21	Summary of Relevant Laws	Curitiba Municipality	10th June 2015
17	Item 27, 28, e 29	Strategy and Objectives	Curitiba Municipality	10th June 2015
18	Item 2 e 3 Consórcio	Landfill Composition and Density Data	Conresol	26th June 2015
19	Item 7 Consórcio	Consortium Operations	Conresol	26th June 2015
20	Item 24	Consortium Strategy	Conresol	26th June 2015
21	Material Consórcio	Consortium Strategy and Tender	Conresol	26th June 2015

Reference Number	Document Title	Translation / Description of Information	Provided By	Date Provided
22	Mês.Ano[2]	Month.Year[2] – Eco-Citizen Data	Curitiba Municipality	2nd July 2015
23	Concorrência Publica 2011 Coleta do Lixo	Public Competition 2011 Waste Collection	Curitiba Municipality	2nd July 2015
24	Relatório SMMA 2013, 2014, e 2015	SMMA Report 2013, 2014, 2015	Curitiba Municipality	2nd July 2015
25	Relatório Resíduos Disque	Phoned Collection Waste Report	Curitiba Municipality	10th July 2015
26	Curitiba Waste Management Background Report	Initial Site Visit Report	Mott MacDonald	22nd June 2015
27	IBGE – Banco de Dados Agregados	IBGE Data Bank	IBGE	22nd May 2015
28	Curitiba em Dados	Curitiba in Data – Population Statistics	Curitiba Municipality	27th July 2015
29	Item 9	Table Provided with no Label	Curitiba Municipality	10th June 2015
30	Relatório Caracterização Domiciliar	Household Characterization Report	Curitiba Municipality	12th August 2015

Source: Mott MacDonald, RFI Documents
Note[1]: Series of finance and transport documents provided for different contract services in the format: e.g. “3 – Indirect Collection”
Note[2]: Series of document with Eco-citizen site and programme data received in the format: e.g. “April.2012”
Note : Other documents have been received through the RFI process but may have not been utilised or may have covered overlapping information and thus have not been quoted in the table.