Waste Management in Bermuda
Teacher's Guide 2014

Our Waste Our World Our Choice

GOVERNMENT OF BERMUDA

Ministry of Public Works

Acknowledgements

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1.0 Introduction

Bermuda is a special island that enjoys beautiful landscapes, a sound economy and a modern way of living. The high standard of living fuels consumerism which ultimately drives the production of waste in our community. When all waste generated on this island is considered on an annual basis this amounts to nearly 1 tonne per person per year for every resident. This is also true for other major metropolitan areas like the UK and the USA.

Bermuda is also special in that it is a very small and isolated island. These features require that we manage our waste in a responsible manner to protect and ensure the beauty of our island home and marine environment. The Ministry of Public Works has a Comprehensive Waste Management Programme that provides "a place for everything and for everything a place" ensuring all types of waste produced in Bermuda are handled and disposed of in a safe and environmentally sound manner. In order to function maximally this programmes requires the support and participation of Bermuda's public. The Ministry needs the support of the Bermuda's residents to manage their own waste the right way as it is-Our Waste, Our World, and Our Choice.

2.0 About Waste Management

The Waste Management Section is responsible for collecting garbage and recyclables from residents (excluding the cities of Hamilton and St. George's which are collected by the Corporation of Hamilton and Corporation of St. George's respectively). Garbage is taken to the Tynes Bay Waste To Energy Facility to be incinerated and the recyclables are taken to the Recycling Centre (aka the MRF) for processing and are either shipped abroad or used on-island.

The Waste Management Section of the Ministry of Public Works is responsible for the operation of:-

1) The Airport Waste Management facility where bulky metal waste is used for land fill.

2) Special Waste Facility - the processing of special waste, both household amounts and commercially generated waste takes place at the Sally Port Special Waste Facility. Special waste is shipped off the island for recycling, reprocessing and/or disposal.

3) Composting the island's horticulture waste, some food waste and animal carcasses is done at the Marsh Folly composting facility.

4) The Material Recovery Facility (MRF, aka the recycling centre) - all recyclables are sent here for processing and are either shipped to the US recycling markets or used on-island

5) Public awareness of waste management issues and enforcement of the Waste and Litter Control Act, 1987.

3.0 Waste Audits

A waste audit is a structured process carried out to gather data on waste such as trash, recycling and composting. Waste audits are important because it is a part of waste reduction, giving businesses a starting point in how they can reduce waste and environmentally friendly as well as showing the progress of how far they have come since their previous waste audit. It is a benchmark as well as a measurement of progress. The high-level steps involved in a waste audit are as follows:

- Inform staff and students of the proceedings.
- Determine:
  - The amount of time needed to conduct the audit in days, weeks or months.
  - Decide what areas will be targeted, bathrooms, work stations, eating areas, etc.
  - Gather volunteers.
- Have scales, gloves, table clothes, scissors, recording sheets, pens, digital camera and extra trash bags.
- When the waste has been collected, weigh and then sort the waste into categories such as paper, tin, aluminum, glass, food and plastic. Then properly dispose of the waste.
- Record everything on sheets provided and photograph your findings.
- Present the results to other staff and students.
- Come up with ideas to reduce energy consumption as well as waste and increase recycling.

Schools in Bermuda that have participated in a waste audit are Saltus Grammar School Upper Primary, Berkley Institute and Sandys Middle School. Saltus Grammar School performed two waste audits over the span of two years. They reduced their numbers from 16 bags of trash (per week) to 9.25 bags of trash (per week) in the span of a year by promoting trash free lunches to reduce plastics and giving smaller portions at lunch to students who purchase a hot lunch. Berkley's waste audit project was conducted amongst 191 students within the school for a day. Waste bins were placed in a central disposal area in the school and students separated their trash according to waste type and deposited items into the relevant bins. Subsequently, when the contents of each bin were counted and revealed an average of 1.94 pieces of plastic, 0.51 pieces of papers, 0.38 pieces of food and 0.35 recyclables per student.

Waste Management can help your school with a waste audit.

Commercial waste audits are certified by LEED (Leadership in Energy & Environmental Design) at Bronze, Silver, Gold and Platinum levels. LEED certification is recognized across the globe as the premier mark of achievement in green building. Locally, ACE Insurance received LEED Gold, Audit firm, KPMG will shortly be finishing their first recertification and HSBC's Harbourview Center became LEED Gold certified in 2013. The assessment considers commitments to working towards increased recycling, water conservation, energy consumption and waste reduction by, for instance, removing trash cans from work stations and putting them into central areas and thereby reducing the number of trash bags needed on a daily basis.

Further information on LEED is available on their website at the following link:

http://www.usgbc.org/leed

4.0 Waste Production

On an annual basis the Tynes Bay Waste to Energy Incinerator processes approximately 70,000 tonnes of waste, the Airport Waste Facility receives an estimated volume of 10,000 tonnes of metal (including cars) and other inert waste, and the Marsh Folly Composting Facility receives an estimated 20,000 tons of organic (mostly horticultural) waste. All told this amounts to nearly 1.6 tonnes per person per year for every resident (this includes all the trash produced from residential, industrial, commercial and institutional sectors).

In 2010 a residential waste audit was carried out to determine the composition of Bermuda's residential waste. This information is essential for developing waste programmes and educational campaigns to ensure that the public is disposing of their waste correctly. The residential sector produces approximately 23,000 tonnes of waste per year which is approximately 800 pounds per person per year. The composition of the residential waste is shown in the diagram below.

The composition data suggests that approximately 15% of this waste consists of cans and glass that could be recycled. If all residents complied with the recycling programme this would result in an additional 50 tonnes a week of waste diverted from Tynes Bay. This is approximately the weight of 50 small cars!

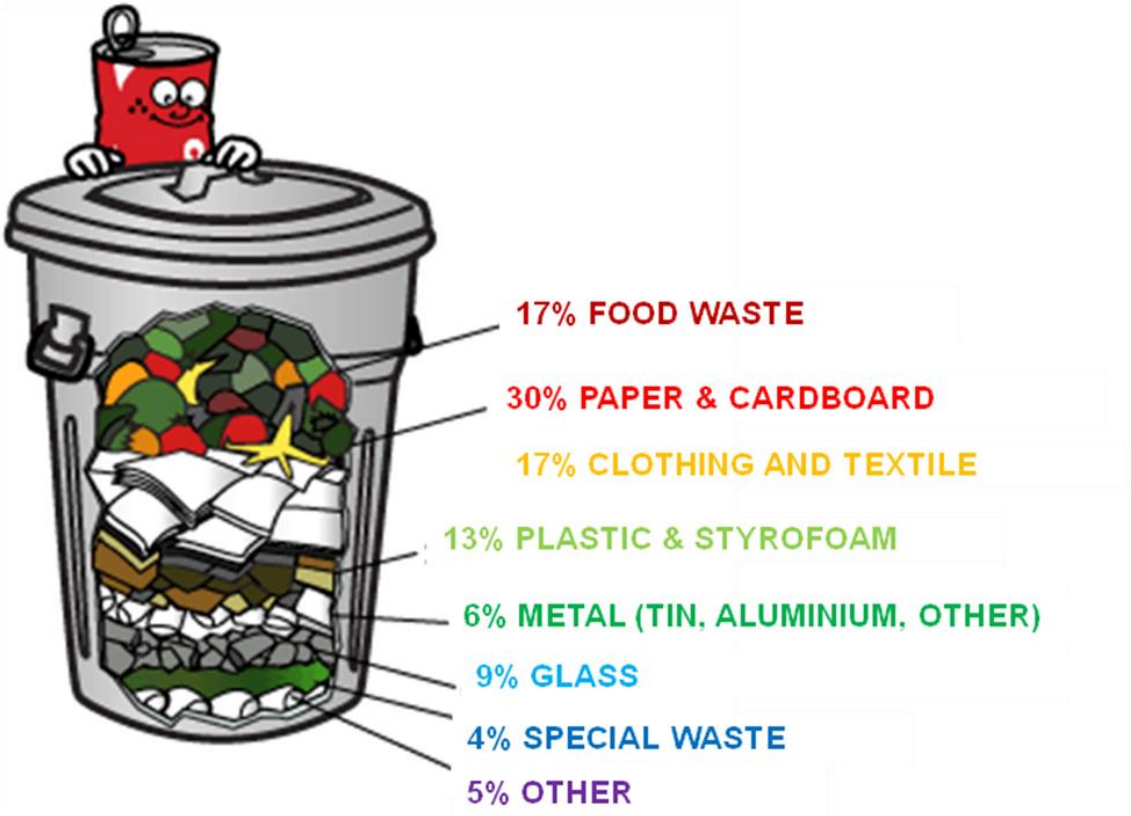
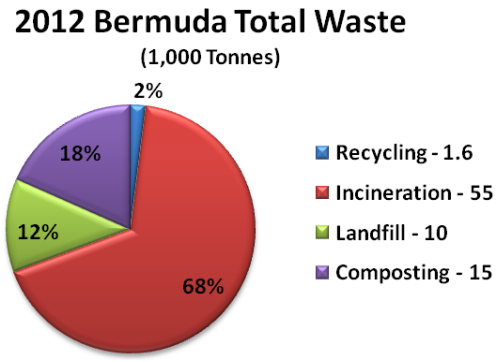
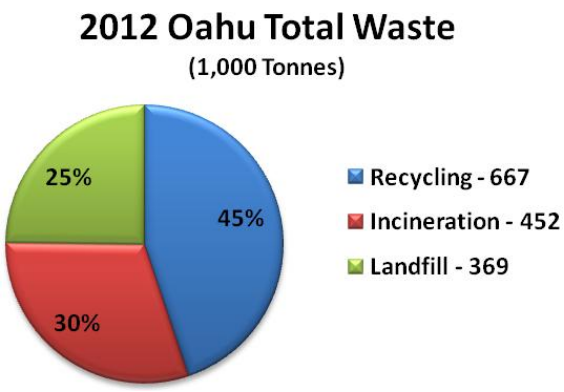


Fig 1: Composition of Residential Waste based on Waste Audit carried out in May 2010

The following graphs provide comparisons of waste management statistics between Bermuda, the UK and Oahu, a small Hawaiian island that is similar to Bermuda in that it is an island far away from a prominent land mass. In places like the UK, where incineration is not widely used, a larger proportion of their waste, around 66%, goes into landfill, compared to Bermuda which landfills just 12% of its waste. On the other hand, the largest sector for waste management in Bermuda is incineration 68%, compared with the UK which is 11%. However, Bermuda is similar to the UK in terms of recycling and composting numbers. Oahu, in contrast, clearly does not rely on incineration to the same extent as Bermuda, however, they do keep landfill numbers down by focusing on recycling.





5.0 What Goes Where

In Bermuda we have an integrated waste management plan to properly dispose of all the types of waste produced on the island so that it does not have a negative impact on the environment. We have five waste facilities to deal with combustible wastes, non-combustible wastes, recyclables, potentially hazardous waste and horticultural waste. These programmes were set up in conjunction with the implementation of the Tyne's Bay Waste to Energy Incinerator which was opened in 1994. Not all of our waste can be burned and in fact can reduce the efficiency of the incinerator. The next sections will cover the five waste facilities in Bermuda.

The Airport Facility

Sally Port: Special Waste Facility

The Material Recovery Facility (aka the Recycling Centre)

Marsh Folly Composting Facility

The Tyne's Bay Waste to Energy Facility

Figure 2. Waste Management Facilities

6.0 Tyne's Bay Waste Treatment Facility

One effective way of managing solid waste and reducing the amount going into landfill sites is to burn it and create steam which is then used to drive a turbine to generate electricity. This process is called waste-to-energy (WTE) and is used at the Tyne's Bay incinerator.

The incinerator is a mass burn system, which burns the solid waste as it arrives at the plant, without processing or separation. The plant can process up to 12 tonnes of refuse per hour- the equivalent of three garbage trucks. The refuse collection vehicles enter the reception area and deposit refuse into the storage pit. A large crane picks up the refuse and places it into a hopper. From there it is fed into the furnace. A moving grate at the bottom of the furnace ensures an even flow of material into the furnace. Air is forced into the burning material to help it burn completely. The hot gasses (flue gasses) caused by the burning of refuse are then used to heat water in a boiler system. This water becomes superheated steam which is used to spin a turbine which turns the alternator to produce electricity. Operating at capacity, the incinerator can produce on average 2.74 megawatts.

After furnishing the plant itself with electricity, excess power flows through high voltage cables where a transformer increases the voltage from 4,160 volts to 22,000 volts for transmission to Belco's substation in Parson's Lane. Once electricity is transmitted to the substation, it is distributed to homes and businesses in the surrounding area.

The flue gases are filtered and cleaned by a pollution control device called an electrostatic precipitator. They are then exhausted into the air through a chimney, or stack (this is why it is important that hazardous material, that could cause air pollution, is kept out of the rubbish being burned). The dust particles are collected and disposed of with the ash. WTE does not eliminate all the solid waste it receives. About 10 per cent of the original volume is left over as ash that must itself be either recycled or deposited in a landfill site. At present the ash is mixed with cement and formed into concrete blocks which are used for foreshore protection and land reclamation.

7.0 Marsh Folly Composting Facility

Records in the Bermuda Archives reveal that it was not until the 1800s that Bermuda even began to address its waste problems and it was in fact a public health issue rather than a garbage issue which prompted the earliest legislation. Although it is not well documented it is believed that it was after the passage of the Public Health Act of 1949 that government began obtaining land around the Pembroke marsh with an aim to establishing one central dumping site. Previous attempts to turn the site into a race track in the 1920's had failed, because every time peat and rubble were added to the site it would sink down into the marsh. It was in fact a result of the numerous efforts to unsuccessfully land fill the area that the site became known as the Marsh Folly!

Today the site is used as a composting facility where horticultural waste and source separated food waste from restaurants and cruise ships are composted. Organic waste is formed into rows of long piles called "windrows" and aerated by turning the pile periodically by either manual or mechanical means. The ideal pile height, which is between 4 and 8 feet, allows for a pile large enough to generate sufficient heat and maintain temperatures, yet small enough to allow oxygen to flow to the windrow's core. The ideal pile width is between 14 and 16 feet. The end product is a soil amendment that has been used to restore the Marsh Folly site and that is also available to the public for horticultural practices. Marsh Folly Composting Facility currently receives approximately 60 to 80 tonnes of organic waste per day.

Backyard Composting

Backyard composting is a process that allows you to decompose some of your table scraps and yard waste. This is done by a layering process so everything decays into fertile humus a wonderful enhancement to soil.

Composting at home reduces your personal volume of trash by an average of 17%, conserves water, increases plant growth and replaces the need for harsh chemical fertilizers and pesticides.

It is a fun and simple activity that allows you to do something for the part of the Earth you live in everyday: your own backyard! You may purchase an Earth Machine compost bin from Waste Management by emailing recycle@gov.bm.

Figure 3. The Earth Machine home compost bin

Crash Course in Composting

All composting "ingredients" generally fall under one of two categories: "browns" or "greens". Browns are dry materials such as wood chips, dried leaves, grass and other plants. Greens are fresh, moist materials such as grass cuttings and food scraps (avoid meats, fats and grease).

Follow these three easy steps to produce a good quality soil amendment for your garden.

1. Collect as many browns and greens as you can to start your compost pile. Larger piles tend to hold moisture better and decompose faster.
2. Place approximately equal amounts of browns and greens in a heap or bin. Always cover food scraps with other composting materials.
3. Soak well with water to create uniform dampness (damp as a wrung-out sponge). Cover pile with tarp or lid to keep moisture in and prevent over soaking from rain.

For quicker composting (1-3 months):

- Chop materials into smaller pieces and moisten.
- Alternate 3" to 6" layers of greens and browns.
- Mix the pile by turning and stirring.
- Soak the pile once a week.

For slower composting (3-6 months plus):

- Just keep adding materials to the pile or bin and sprinkling it with water. It's that simple!

Troubleshooting:

- Odors? Turn and add brown materials.
- Dry pile? Add water, greens and mix.
- Fruit flies? Stir and add leaves or grass.

8.0 The Material Recovery Facility (MRF) a.k.a. Recycling Centre

Recycling is an integral part of Bermuda's waste management system and it is important that the island's residents and businesses jump on board to help our facilities work efficiently and to reduce our impact on the environment. Our recycling programme reduces waste, saves natural resources, conserves energy and improves the efficiency of our waste-to-energy incinerator. For example, recycling one aluminium can saves enough energy to light a 100-watt light bulb for 3.5 hours (210 minutes).

In Bermuda we recycle tin (or steel) and aluminium cans and glass. Material to be recycled is collected in blue bags and processed at the new recycling centre located at the Government Quarry in Hamilton parish. This new facility uses the best available technology to sort and bale recyclables automatically. Since aluminium cans, tin (steel) cans and glass bottles do not burn these materials reduce the efficiency of the incinerator. Diverting these waste types into the recycling programme helps to increase its operational lifespan. Materials that may be recycled in other countries, such as plastic containers and paper, are reused (burned) to produce electrical power at the Tynes Bay Waste to Energy Facility.

The aluminium and tin are baled and shipped to recycling facilities in the U.S. for processing into new consumer goods. The crushed glass product is reused on island and can be mixed into aggregate for asphalt or used as free-draining fill in various construction applications where it's use can significantly reduce costs.

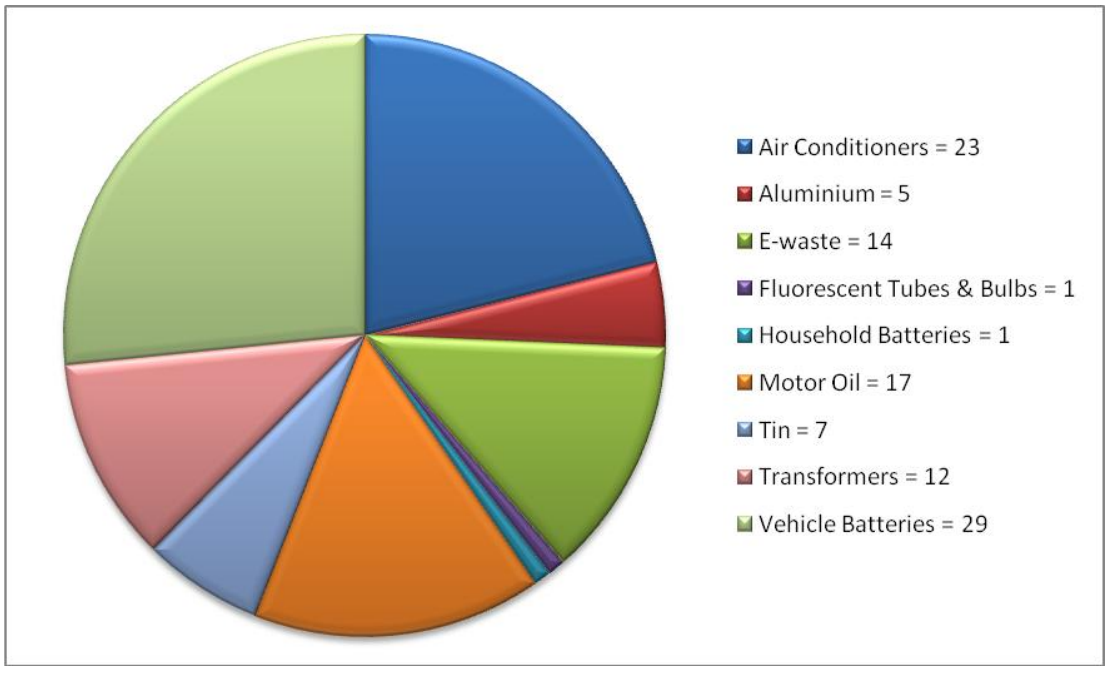


Figure 4. 20' Shipping Container Loads Recycled By Bermuda 2010.
Total of 109 Containers.

9.0 Special Waste Facility

In 1992 as part of the new comprehensive waste management strategy Works and Engineering developed specific waste streams and facilities to handle those wastes. One of these waste streams was hazardous waste which we now refer to as special waste to fall in line with international definitions. In order for the five waste programmes to work in harmony a special waste programme had to be developed as none of the other facilities could handle this type of waste. Our practices had to tie in with existing acts or new ones had to be created.

The types of waste that are handled at this facility include paints, waste oils, fluorescent tubes, batteries, acids and bases, pesticides, old medicines, refrigerants, flammable liquids, items containing mercury and anything with a hazardous or warning label on it. These wastes are processed on island and then sent abroad for either recycling or proper disposal. Some of the special waste that we collect is recycled and these items include materials like paint, motor oil, batteries, refrigerants, acids, fluorescent tubes and waste containing mercury.

This facility offers an on call and scheduled collection service for this type of waste. There are also drop-off locations at participating businesses around the island for disposal of batteries, paint and oil. Special waste can also be dropped off at the public drop-off facility at Tyne's Bay Waste Treatment facility daily between 7 a.m. and 7 p.m. They accept paint, oil, batteries, compact fluorescent lights and fluorescent tubes here. Finally, this section will also provide battery buckets to organizations that want to participate in our household battery recycling programme. It is up to the organization to inform the Waste Management section when the bucket is full and needs to be collected. Bermuda recycles approximately 80,000 gallons of waste oil which can be reused as furnace oil as well as lubricating oil

10.0 Airport Waste Facility

The Ministry of Public Works became the authorized licensee of the Airport Facility in 2004. The license authorizes the ministry to operate a metal processing plant and a foreshore reclamation facility located east of the Bermuda International Airport in St. George's.

This facility accepts inert waste material such as cars, bikes, scrap metal, white goods, rubble or stone, PVC plastic, clean soil, e-waste (i.e.TVs computers etc), and tires. Before vehicles are used as fill material they are drained of all waste oils and refrigerants. In addition, refrigerators and any appliance containing refrigerants or chlorofluorocarbons (CFCs) are also drained before being deposited at this site. This site does not accept hazardous wastes, wood, residential garbage, plastics other than PVC, asbestos, paint, oil, furniture or horticultural waste.

The ash product from the incineration process at Tyne's Bay Waste Treatment facility is processed at this facility into ash blocks. The ash is mixed with cement and then placed in molds which are then allowed to set. Once they are set they are placed along the edge of the waste facility for foreshore protection against wave action. On average 300 to 500 blocks are produced in a week and approximately 15,600 and 26,000 in a year.

In order to maximize the space at this facility the waste is compacted with a landfill compactor. Cells are created using a boom, which are then filled with garbage. Once a cell is completed compacted and full it is then covered with topsoil. Due to the nature of the facility and the location there are certain factors that can cause environmental concern. Some of these include contamination of the waters in Castle Harbour by leachate from the fill site, wind blown litter, floating debris or silt from run off. This site has remediation measures in place to prevent these potential impacts from occurring. For example, a floating boom is installed to prevent debris from floating away. They have a litter prevention programme and all waste is monitored that enters the site.

11.0 The 3Rs- Reduce Reuse Recycle

It is very important that the residents of Bermuda incorporate the 3Rs – Reduce, Reuse and Recycle into their day to day lives in order to decrease the amount of trash we produce as a society and decrease the demand on our waste facilities. By following the "3Rs" Bermuda can reduce its waste and reduce the need to expand our waste facilities such as the incinerator and the airport land reclamation site.

The diagram below illustrates the hierarchy of waste disposal and where the 3Rs fit into waste disposal. The first step is waste reduction; trying not to produce waste at all or minimizing the amount that you create. Examples of this are taking trash free lunches and buying products with less packaging. Also, if at a store don't take a bag or a straw unless you really need it. Finally, in this age of technology we can reduce the amount of paper used by reducing the amount of printing that occurs. Most information can be shared by e-mail or online.

Reuse is the next step of the waste disposal pyramid. This is using items over and over or finding another use for them. For example wrapping paper can be used again. Old toys and clothes can be taken to a re-use centre where others might get use out of them. Rechargeable batteries are a great way to re-use items that would normally be thrown away at the end of their life. Re-usable bags are another great way to minimize waste and save natural resources. Generally,

brown paper bags are made from virgin trees so that they are durable. It takes one 15-20 year old tree to make only 700 brown grocery bags. They also cause problems when people use them for trash bags as they get wet and break and help to cause litter problems around the island.

If reduction or reuse is not possible the next step in the waste pyramid is to recycle or compost. Recycling is making something new out of something old. Tin, aluminium and glass are all recyclable and actually have a value associated with them. They are not trash! Composting is nature's way of recycling and can reduce your trash by nearly a third!

Recycling is important as it reduces waste, diverts material from the incinerator and the airport reclamation facility, improves the operation of the incinerator by keeping non-combustibles out of it, saves natural resources and energy and reduces the amount of green house gases produced.

Figure 5: Waste Disposal Hierarchy

12.0 The Life Cycle of the Aluminium Can

The Earth's crust contains metals and metal compounds, like gold, iron oxide and aluminium oxide, but these are mixed with other substances. To be useful to us, the metals have to be extracted or mined. A metal ore is a rock containing metal or a metal compound in a high enough concentration to make it economically viable to extract the metal. The way in which metals are extracted depends on the way they react chemically with other elements.

Aluminium ore, also known as bauxite, is plentiful, but despite this, aluminium is expensive, mainly because the process used to extract the aluminium from the ore uses up a lot of electricity. Once the bauxite is mined from the ground, it is purified to yield a white powder, aluminium oxide trihydrate (alumina), from which aluminium can be extracted. Extracting the aluminium is done through a process called electrolysis, which uses up a great deal of electricity.

The aluminium is cast into ingots - large blocks of metal - and then fabricated into long bars and thin sheets of metal which are used to manufacture different items, including aircraft bodies, cooking equipment, building materials, beverage cans and foil. Aluminium is useful because it does not corrode quickly when exposed to air and water, that is, it takes a long time to be

destroyed by a chemical reaction. It is also light, a good conductor of both electricity and heat and becomes very strong when alloyed (mixed) with other metals. Being softer than steel it is more easily shaped.

Because aluminium does not corrode easily, aluminium cans and other products do not break down or decompose, and remain in landfills taking up room unless they are recycled. When recycled, aluminium is melted down and reshaped into new cans and other items. Making new aluminium cans from old ones requires only five percent as much electricity as it does to make new cans from bauxite. Therefore recycling saves two resources: aluminium and fossil fuels used to generate electricity needed for the extraction process. It also reduces the need to mine new areas for bauxite and reduces the space in landfills, helping the environment in both cases. Finally, removing aluminium from the trash helps the incinerator burn more efficiently.

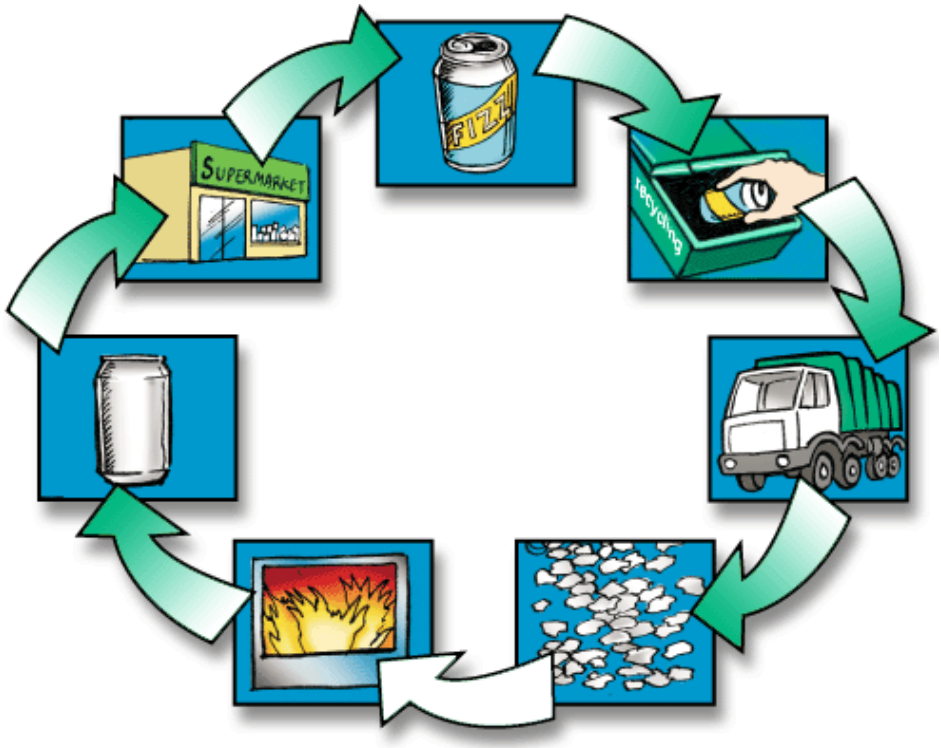


Figure 6. The Life Cycle of an Aluminium Can.
Only 60 Days Can-To-Can.

Useful youtube links to aluminium recycling videos:-

Sesame Street – Recycle can video: http://www.youtube.com/watch?v=BKpoCzt03B8

Can recycle video: http://www.youtube.com/watch?v=F4tiYwWKkBI&feature=related

How Stuff Works – Discovery Chanel – Aluminium Recycling:
http://www.youtube.com/watch?v=AOpGhAdQFEY&feature=related

13.0 Implementing a Waste Reduction Programme

Introduction

On April 2nd 2007 the Government of Bermuda opened a new state of the art recycling facility. In conjunction with this they also made recycling mandatory within all government workplaces. This section will help outline what schools need to do in order to set up a waste reduction programme.

Getting to Know Your Trash

In order to get started, you first need to understand the amount and types of raw materials you have for your recycling enterprise. In other words, how much solid waste does your school produce, including tin, aluminium, glass, special waste, electronics, food and yard wastes? Next, you will need to assess where the particular types of wastes are generated within the school.

A good exercise would be to get students to do a waste audit of their trash to find out what it is composed of. Also, they can take a walk around the school to determine what types of trash are produced in different parts of the school, and how the waste is collected and managed. A trip to the incinerator, recycling centre or other final disposal point may also be of interest. Worksheet 1 will help students keep track of how their waste is handled.

Determining What to Collect in your Recycling Programme

The blue bag recycling items include tin and aluminium cans and glass bottles. These are to be placed all into one blue bag and placed out for collection. However, in addition to the blue bag programme there are other items that can be recycled in Bermuda. Household batteries are collected by our special waste team and sent abroad for recycling. Also, some other organizations have specialized recycling programmes for things like cell phones and Christmas cards. Composting is another form of recycling that will help to reduce waste as well as helping to nurture and beautify your school gardens. Compost material would include yard scraps as well as food scraps that do not contain animal fat as this attracts rodents (i.e. meat and dairy products).

Setting Up Your Programme

Keep it simple

It is important to keep your programme simple at first as an overly ambitious programme may be hard to sustain. It's better to start with the blue bag programme and build from there as you discover other items that can be recycled.

Involve the custodial staff early and often

It is very important to involve the people who might actually do much of the work during the set up period. They have to be educated on what should be recycled, what containers to use, what bags go in which bins and what days they should be placed out.

Placement of Bins

It is important to have recycling bins and trash bins side by side in convenient locations where trash and recyclables are likely to be generated. By having them side by side it reminds students that they need to make a choice.

Collection of Recyclables

You must contact the Waste Management Section to ensure that your school has been added to the recycling collection list. It is required by our recycling contractor to collect from all schools but they must be notified when schools get on board with their programmes. With respect to battery buckets you must also contact the Waste Management Section to arrange getting a battery bucket and again getting on the collection schedule. E-waste recycling for computers, cell phones and other electronic devices is currently being developed by Waste Management. Check with our department before disposing of these items. Recycling of Christmas cards has been organized by Dolphin Quest in the past and if you would like to get involved with this then they should be contacted directly.

Educational Activities

It is important that your recycling message about the programme is clear and positive and easy to implement. Students need to be informed what is going to be recycled in the school and what bins they need to be put in. Bins should be labeled as well to remind students what they are for.

The Waste Management Section can help with promoting recycling within the schools. They can supply you with recycling activity books, posters, stickers or arrange tours of the various waste facilities. They can also visit your schools or classrooms to give further information on recycling or waste management in general.

14.0 Definitions

Aggregate: Construction aggregate, or simply, aggregate, is a broad category of coarse particulate material used in construction, including sand, gravel, crushed stone, slag and recycled concrete. Aggregates are a component of composite materials such as concrete and asphalt concrete, the aggregate serves as reinforcement to add strength of the overall composite material. Aggregates are also used as base material under foundations and roads.

Baler: A machine that compacts waste materials to reduce volume, usually into rectangular bales.

Chlorofluorocarbons: Chlorofluorocarbons (CFC) are haloalkanes with both chlorine and fluorine. They were formerly used widely in industry, for example as refrigerants, propellants, and cleaning solvents.

Combustible Waste: Waste material that can burn, especially paper and plastic.

Composting: The controlled biological decomposition of organic solid waste under aerobic (in the presence of oxygen) conditions; organic waste materials are transformed into soil amendments such as humus or mulch.

Electrostatic Precipitator: An electrostatic precipitator (ESP), or electrostatic air cleaner is a particulate collection device that removes particles from a flowing gas (such as air) using the force of an induced electrostatic charge.

Ferrous metal: Of or containing iron (this makes it magnetic).

Flue gases: A gas that exits to the atmosphere via a flue, which is a pipe or channel for conveying exhaust gases from a fireplace, oven, furnace, boiler or steam generator.

Hopper: Storage container or silo at the recycling centre where tin and aluminium cans are stored after separation before being baled and sent off island for recycling.

Horticultural Waste: Grass clippings, leaves, and tree trimmings from yards and landscaped areas.

Incinerator: A combustion plant designed to reduce waste volume by burning (see Waste to Energy).

Inert Waste: It does not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm to human health.

Integrated Solid Waste Management: A practice of disposing of solid waste that utilizes several complementary components, such as source reduction, recycling, composting, waste-to-energy and landfill.

Landfill: A designated area in which refuse is disposed in such a way that it does not create hazards to public health or safety.

Leachate: Leachate is the liquid produced when water percolates through any permeable material. It can contain either dissolved or suspended material, or usually both. This liquid is most commonly found in association with landfills, where rain percolates through the waste and reacts with the products of decomposition, chemicals and other materials in the waste to produce the leachate.

Magnetic Separator: A large magnet that separates ferrous material from the recyclable stream.

Natural Resources: They are naturally occurring substances that are considered valuable in their relatively unmodified (natural) form. A natural resource's value rests in the amount of the material available and the demand for the certain material.

Non-combustible waste: Waste material which is not capable of being burned, especially metals and glass.

Organic material: Derived from living organisms; organic waste include food, leaves, grass clippings etc…

Potentially hazardous waste: Waste that contains hazardous ingredients that if not handled or disposed of correctly can pose health risks or environmental concerns. E.g. pesticides and fungicides, some household cleaning products, paints, oils and batteries.

Residential Waste: trash produced from households.

Recycling: A resource recovery method that collects and treats a waste product for use as a raw material in the manufacture of the same or other useful products.

Recyclables: Waste materials that can be recycled.

Reuse: The use of a product more than once in its same form for the same purpose; e.g., refilling a reusable water bottle.

Solid Waste: All useless, unwanted or discarded materials: refuse, trash, garbage, debris.

Steel: A hard, durable, and malleable alloy material made from iron and carbon. In food-service use, steel is found as beverage and food cans and lids, and can be distinguished from aluminium by its magnetic properties.

"Tin" Can: steel can with a thin tin coating.

Trommel: A screened cylinder used to separate materials by size - for example, separating different sizes of crushed glass.

Turbine: A turbine is a rotary engine that extracts energy from a fluid flow.

Waste to Energy Plant: A facility that converts waste materials into some form of fuel or energy; often an incinerator that produces electricity.

Windrow Composting: The production of compost by piling organic matter or biodegradable waste, like animal manure and crop residues, in long rows (*windrows*). This method is suited to

producing large volumes of compost. These piles are generally turned to improve porosity and oxygen content, mix in or remove moisture, and redistribute cooler and hotter portions of the pile.

15.0 References

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16.0 Worksheets

Work Sheet 1: How is your solid waste handled now?

Name of garbage hauler:_____

Where in the school does your hauler collect the trash? _____

How does the trash get to this point of pickup? _____

How many bags do they currently pick up? _____

How frequently is trash collected? _____

What is your trash mostly composed of (e.g. paper, food waste, tin, aluminium or glass, special waste etc…) _____

Where does the trash end up? _____

Is there any recycling at this time? Yes_____ No _____

If yes, which items are recycled? _____ and

Approximately how many bags per week? _____

Worksheet 2: Tynes Bay Waste to Energy Facility

1. What's in our garbage? List 5 different items you can see in the garbage in the refuse bunker.

   Domestic waste, wood, paper, plastic, furniture, cooking oil, carpet, empty plastic paint cans, cardboard

2. What happens to our garbage? What are the major steps in the process at Tynes Bay?

   Trucks get weighed and inspected at the weighbridge → Trash is dumped into the refuse bunker → Wood and domestic garbage needs to be mixed to keep a good steady burn → Mixed waste gets put into the boiler to get burned → Waste is completely burned → Ash residue drops into a bath of water that cools it → Metal is removed from the ash → Ash is mixed with concrete and transported to the airport facility to make cement blocks → Heat from the incineration process moves up the boiler and gives up its heat to the cooling water → This water turns into steam → The steam pushes a steam driven turbine which drives an electric generator and produces power → The power is sold to Belco.

3. What are the products that are formed from burning? What happens to them?
   Ash *→ Mixed with cement, turned into cement blocks, used for land reclamation and foreshore protection at the airport waste facility*
   Power *→ Exported to Belco to enable energy to be exported to the public supply system*
   Combustion Gases *→ Cooled by passing them over banks of boiler tubes containing water and cleaned by passing through electrostatic precipitators which remove in excess of 99% of particulate matter.*
   Waste water *→ Collected in a large storage tank and pumped into the quench tank to be absorbed by the hot ash.*

4. What should you not include in the trash for Tynes Bay?

   Hazardous waste, Fluorescent lamps, vehicle batteries, household batteries, PVC, tires, waste oil containing heavy metals, glass, aluminium cans, steel food cans, white goods, swill, construction and demolition debris, horticultural waste.

5. What can you do to reduce the amount of trash from your household?

Reduce, Reuse, And Recycle. Try to buy things with less packaging. Give old clothes and household goods to re-use centres. Participate in the recycling programme. Try backyard composting for your kitchen scraps and garden waste.

6. How much energy is produced per year from burning our garbage?

   2.47 megawatts of electricity per year on average

7. Did you know…
   Make a list of some of the interesting facts that you have heard today
   e.g.
   Trash is burned at ____800 -1000_____ °C.

   Tynes Bay processed ____68,000_____ tonnes of trash last year.

   This volume increases by approx ____3___% each year

Worksheet 3: Airport Waste Facility

1. What type of waste is brought to this facility? Name 8 different items that will be accepted here.

   Cars, bikes, scrap metal, white goods, rubble or stone, PVC plastic, clean soil, tires.

2. What type of waste is not accepted at this site, name 8?

   Hazardous wastes, wood, residential garbage, plastics other than PVC, asbestos, paint, oil, furniture, horticultural waste

3. What types of waste received at the airport can possibly be recycled, name 3.

   Scrap metal, e-waste, white goods, tires,

4. Describe what happens to the bottom and fly ash that is generated at Tynes Bay.

   ash → mixed with cement → placed in molds at airport allowed to set →and used as foreshore protection.

5. How many blocks are made in an average week? In a year?

   300 to 500 blocks are produced in a week, 15,600 to 26,000 in a year.

   Name three potential problems with the operation of the site.

   Contamination of the waters in Castle Harbour by leachate from the fill site, Wind blown Litter, Floating debris, silt from run off,

6. How do we contain floating debris

   Installed a floating boom.

7. How do we make sure we get the most out of the available space in the site?

   The waste is compacted with a landfill compactor.

8. Two types of processing occur at the site before certain materials can be disposed. Describe them.

   Fluids are drained from vehicles and CFCs are removed from air conditioners and refrigerators before disposal.

9. The future…
   What can the site be used for when it is rehabilitated?

   Probably green space, perhaps parking and green space for the airport.

Worksheet 4: Making Good Out Of Green

Marsh Folly Composting Facility

1. What is the purpose of this site?

   The purpose of this site is to dispose of organic waste in a way that it will be useful to Bermuda again and produce soil that can be used to grow crops and plants. Also, in Bermuda we produce a lot of organic waste that the Tyne's Bay incinerator can not burn efficiently because the material is too wet to burn.

2. What is the name of the type of composting process that takes place at this site?

   Static Windrow Composting

3. What is included in horticultural waste and where does it come from?

   Trees, roots, stumps, garden waste. It comes from commercial landscapers as well as residents who have carried out work in their gardens.

4. What is another type of organic waste that gets composted at this facility and where does it come from?

   Food waste from restaurants and cruise ships.

5. What happens to the organic waste on this site?

   Placed in windrows → Temperature Monitored Daily to ensure bacteria have optimum environment to carryout their work → Turned Daily to keep aerated and moist → Organic waste is decomposed by bacteria → Piles are left to mature → Compost is sifted → Stockpiled ready for distribution →Used for landscaping, turning in gardens, planting

6. What are the products formed?

   Mulch and compost

   What is the difference between mulch and compost?

   Mulch is just chipped wood that can be used to improve the appearance of your garden and keep dirt from splashing up on your flowers and plants when it rains. Organic mulch used to be living and is generally from trees. It provides nutrient to the soil when it decomposes and also encourages earthworm activity.

   Compost is the product made from mixing garden waste with food waste. It is a mix of carbon and nitrogen in a 3:1 ratio that will get broken down by bacteria to make a soil amendment that can be used to grow something again.

7. What temperatures can the piles get up to?

They can get up to 70^{o}C

8. What factors must always be taken into consideration?

When composting it is important to keep the 3:1 ratio between carbon and nitrogen. Carbon is the brown waste like dry leaves and woody material. Nitrogen is the green waste like grass clippings and food scraps. It is also important to make sure that the compost pile gets enough air and moisture so that the bacteria can work at their optimum to decompose the organic waste. If they do not get enough oxygen they will die and the compost pile will produce foul odors and the composting process will stop.

9. Did you know…
Make a list of some of the interesting facts you have heard today
e.g.
Approximately _200 trucks of horticultural waste per day and approximately 20 tonnes of food waste per week.

Marsh Folly is named this because they were trying to construct a horse and pony track. Because it was a marsh the rubble kept sinking. They abandoned the project and called it a folly. Hence the name Marsh Folly.

The speed of the hammer rotor in the tree milling machine moves at _____21,000_____rpm.

Composting takes place predominantly between the months of __April and October _.

Compost can be formed in _17_ weeks during these months.

10. Where else can you make compost?

At home in your own backyard.

Worksheet 5: Treasure out of Trash

The Material Recovery Centre (aka The Recycling Centre)

1. What is the purpose of this site?

The purpose of this site is to collect recyclables from the blue bag curbside collection programme, sort it into the three recyclable streams and prepare it for either shipping abroad for recycling or for use here in Bermuda.

2. What materials are collected here?

Tin, Aluminium and Glass are accepted here

3. How are the tin cans separated from the rest of the recyclables?

A magnetic separator is used to separate the tin cans from the other recyclables. They are made up of ferrous metals.

4. What happens to the tin and aluminium cans?

The tin and aluminium cans are baled and then shipped abroad for recycling.

5. What is the glass used for?

The crushed glass product can be mixed into aggregate for asphalt or used as free-draining fill in various construction applications.

6. Why is it important to empty and clean your recyclables before placing them out for collection?

It is important that liquids or food products are cleaned from the recyclables as they can cause damage to the automated equipment and also provide health concerns for the staff on the sorting line.

7. How long does it take to for an aluminium can to go through its lifecycle?

Approximately 60 days.

8. Why should we recycle? Name five reasons.

Waste reduction, Save natural resources, Save energy, Improve efficiency of incinerator, Reduce reliance on incinerator and landfill sites.

Worksheet 6: The 3Rs and litter reduction: A guide for schools

1) Trash free lunches – **Reduce** waste
    a. Keep all the waste from lunches for one week (if possible).
    b. Show the children how much waste is made in a week.
    c. Discuss how this uses the earth's resources and impacts human health by affecting the environment.
    d. Get parents on board by creating a trash free lunch policy for the school.

2) Collect cardboard, plastic and other materials from the community and parents for art and craft project - **Reuse** waste
    a. Have an art show of the children's work.
    b. Emphasize to parents and other visitors the Reuse aspect.

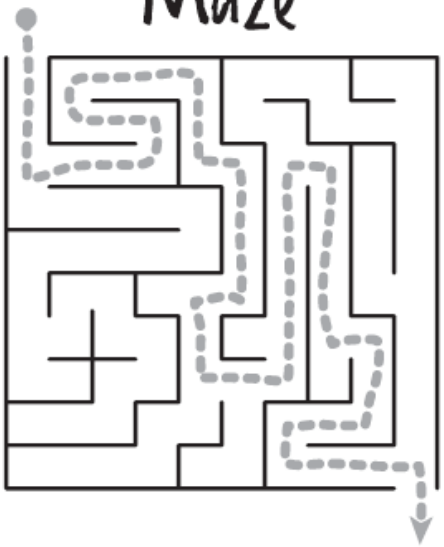
3) Ensure there is a separate box or bin in each classroom for TAG recyclables (tin, aluminium and glass) – **Recycle** waste
    a. Allow the children to decorate the box with paints and found objects.
    b. Help the children to recognize TAG materials.
    c. Place materials out for collection in blue bags – Thursday in the west end, Friday in the east end.
    d. If you truly have trash free lunches this may not be necessary.

4) Help the children understand the **impacts of Litter** on our island home.
    a. Unfortunately, you will probably see some litter during a quick walk around school perimeter.
    b. Show this to the children and help them to understand the negative impacts of litter:
        i. Litter is ugly!
        ii. Breeding ground for mosquitoes
        iii. Kills birds, marine life and other organisms
        iv. Reduced numbers of tourists and hurts our economy
        v. The cost of cleaning it up diverts resources that could be used for other project
    c. Organize a parent student KBB clean-up event near the school during a KBB Clean-up – contact KBB at 295-5142 for assistance.

17.0 The Recyclables Activity Book Answer Sheet
(email recycle@gov.bm for copies of "The Recyclables" Activity book)

Answer Sheet

Maze



Word Search

B	G	T	I	N	O	P	R	Y	G
L	R	S	H	P	K	D	E	A	L
U	N	T	P	N	O	P	C	X	A
E	R	K	W	T	D	K	Y	P	S
A	E	J	Z	N	B	T	C	O	S
F	D	T	L	U	O	P	L	B	M
C	U	O	S	Q	C	L	E	A	N
D	C	F	I	K	G	P	R	K	S
R	E	U	S	E	L	Y	I	G	J
A	L	U	M	I	N	I	U	M	G

Trivia

1. B
2. C
3. A
4. B
5. False

Connect the dots

Answer: Tony Tin!

Unscramble

1. TIN
2. GLASS
3. BAG
4. BLUE
5. CLEAN
6. TRUCK
7. REUSE
8. CAN

RECYCLE BERMUDA

18.0 What Goes Where

The following four pages can be found in the BTC Blue Pages 2011/12.