Example introduction to composting equipment and operations

1.1 Green waste composting process overview

Figure 1 illustrates an example process flow for windrow composting, covering the service from point of collection to finished product. The subsequent Figure 2 illustrates a typical layout of a facility operating this full process. The number sequence in each figure corresponds to the same steps in the process. It is recommended that any body looking to establish a composting operation consider all these steps and plan their establishment and operator model prior to initiating collection of separated green waste.

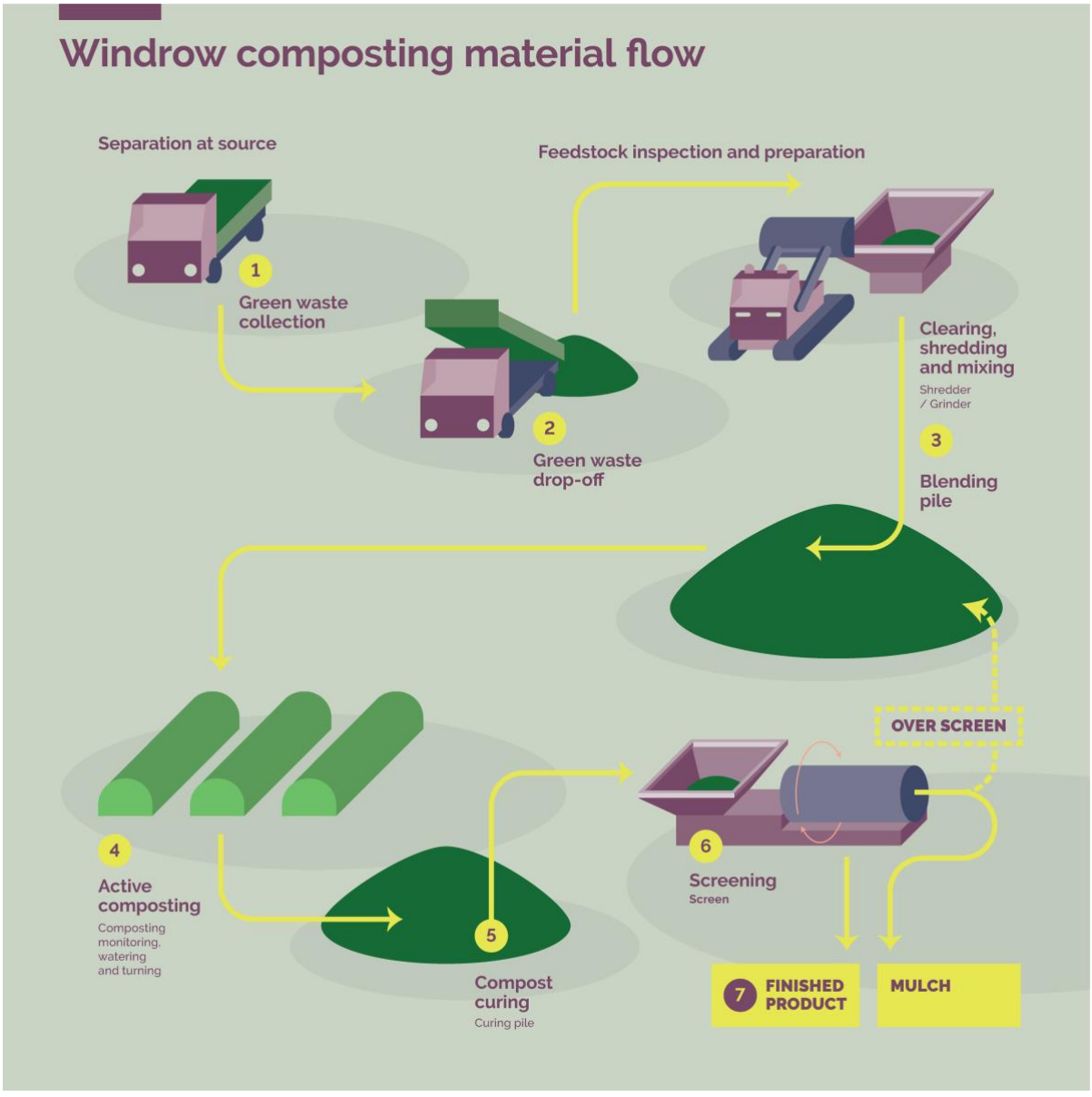

Figure 1: Green waste collection and windrow composting process

Step 1: Separation at source – The separation of green waste from other non-green wastes at point of waste production making subsequent treatment more efficient and effective. This step includes communication and behavioural change campaigns to ensure the right material is collected at the right time and place.

Step 2: Green waste drop-off – Location where source separated homogenous green waste is drop-off by the waste producer / primary collection service provider and made available to the compost facility. Can be located at compost facility or at distributed drop-off points closer to points of green waste production then transferred to composting facility in bulk or following pre-treatment (step 3).

Step 3: Feedstock inspection and preparation – Inspecting dropped-off waste for contaminants, clearing these where possible, shredding / grinding branches and larger items, mixing and blending various materials (nitrogen rich green material with carbon rich brown material) to stimulate good biological activity in composting. A critical component to good composting and achieving good heat and associated pathogen die-off as well as timely decomposition is getting the right Carbon to Nitrogen balance, known as the C:N ratio where 25-30:1 is optimum and 20-40:1 is OK. A list of common materials to compost and their C:N ratio is available from https://www.compostingtechnology.com/compost-calculator/. A useful video and other resources on the topic is available at: https://www.composttechnicalservices.com/resources. Sargassum seaweed would count as a nitrogen rich green waste with a C:N ratio of 19:1. Due to the potential heavy metal content, it is recommended that this material represents a maximum of 15% of the total feedstock or is composted separately and left to mature before being fed into the compost mix of fresh material as part of the blend.

Rejected / contaminant materials are to be collected in appropriate containers and transferred to appropriate waste treatment (i.e. landfill or recycling if appropriate).

Step 4: Active composting – Once an optimum C:N ratio mix (or "recipe") of materials is available, this is moved into windrow piles by bucket loader or manually. For sites where compost will be turned by wheeled loader, these piles can be up to 3m heigh by 5m wide and as long as space enables that size of pile whilst maintaining vehicle manoeuvring and drainage space around the piles. Creating and maintaining the conditions that promote aerobic microorganisms to thrive and decompose the waste materials is a crucial step. This includes monitoring temperature, moisture and oxygen levels and turning and de/watering piles as required. A summary of optimum composting conditions is presented in Table 1. **Many parameters are adjusted through turning the windrow pile. For example, if moisture is low, turn and add water, if too high, turn without adding water. If oxygen is low, turn, if temperature is high or low, turn**.

Where the resultant compost material is to be used exclusively as landfill cover, the option exists of utilising septic waste as a moisture and nutrient addition to the active composting windrows. This will reduce expense and impact of sourcing fresh sweet water for this purpose. When controlled properly, with the composting process meeting the minimum Processes to Further Reduce Pathogens (e.g. compost temperature to be maintained at 55oC for 15 consecutive days and turned minimum of 5 times during this period) the heat from the composting process will actively kill off faecal coliforms and other pathogens, providing a more appropriate and controlled treatment solution for the septic waste than applying direct to landfill. This must be regulated carefully to ensure minimal aerosol of raw septage and prevent uncontrolled run-off during application.

Table 1: Summary of optimal composting conditions[1]

Parameter	Composting Phase		
	Active composting	Curing	Product Storage
Oxygen concentration	13 to 18%		
Free Air Space	40 to 60%		
Particle size	A mixture of particles between 3 and 50mm		
C:N Ratio	25:1 to 30:1	18:1 to 23:1	15:1 to 20:1
Moisture Content	55 to 65%	45 to 55%	40 to 45%
Temperature	55 to 60°C	Less than 50°C	Ambient
pH	6.5 to 8		

Step 5: Compost curing – Following main active decomposition, the resultant compost is left (without turning or aggressive management) to "cure" until microbial activity slows right down, temperature returns to ambient and material is stable and ready to apply to land without damaging crops. This stage includes quality control testing.

Step 6: Product screening – Following curing the material is sifted / screened with fine particles falling through the screen. The larger items passing over the screen can be returned to step 3 and blended with new waste as a bulking agent / microorganism "seed" if free of contaminants, or further processed into a mulch / soil cover material.

Step 7: Finished product– If quality tests are passed, fines from the screening step can be used / marketed as compost material (may include bagging or bulk sales / use) and larger woody material marketed as a mulch / soil cover material. If quality test is not passed, then the product can still be used as a very beneficial cover material on the landfill site (the relevant government agency may also approve it for use in other applications depending on quality standard achieved, this may include infill or road embankment cover). Other products may also be produced, including firewood or charcoal.

Figure 2 presents a typical layout of a composting facility from drop-off to finished product stockpile. The sizing of such facilities depends on the volume and type of feedstock material arriving at the site per week (maximum and minimum in any one week in the year should be considered) and the speed of decomposition (influenced by local climate conditions and management technique).

[1] https://www.canada.ca/content/dam/eccc/migration/main/gdd-mw/3e8cf6c7-f214-4ba2-a1a3-163978ee9d6e/13-047-id-458-pdf_accessible_ang_r2-reduced-20size.pdf

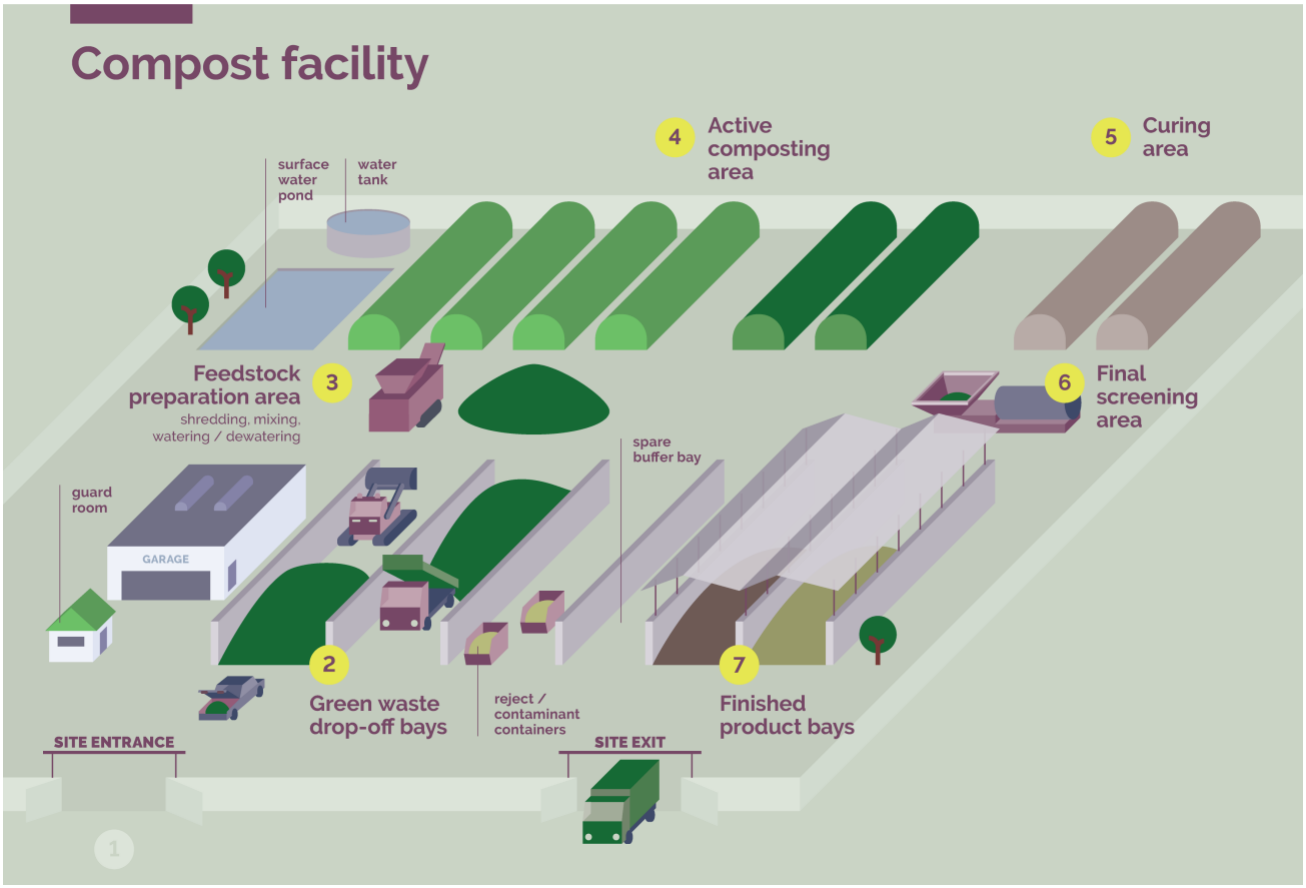

Figure 2: Example green waste drop-off and composting facility

An estimate of total green waste quantity being produced in the target catchment area, along with estimated facility size (for a single composting facility) requires to be assessed. From this, a calculation can be made for the area of land required for composting the average green waste volumes currently going to landfill. This will include areas for green waste drop off and material pre-treatment area, area for active windrow and manoeuvring area, and an area for product preparation and storage area. Where a distributed green waste drop-off locations plan is adopted, the land area requirement for each of the proposed sites and associated composting facilities requires to be calculated based on the specific catchment area (and associated green waste / feedstock volume) of each site. This can be achieved using the supplied spreadsheet calculator. An additional useful guide is available at:

https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/ANR%20Sizing%20Your%20Composting%20Pad.pdf

Without developing the entire system, the risk that collected green waste is just dumped either at the drop-off locations, illegally in the environment, or back in the landfill is high. In such cases the dumped green waste becomes a breeding ground for vermin and disease vectors, become anaerobic and smelly, become uncontrolled dumpsites for all waste materials, all of which are at high risk of ignition and creating large uncontrolled fires. Proper planning and investment in the service is essential from the outset.

Note that both green waste drop-off and composting facilities should be established on dry firm land (preferably a hard standing or lime stabilised soil to prevent leachate infiltration to soil/ground water) with a 1 – 2 % grade across entire site to facilitate positive water flow into the surface water pond / swale. All site roads must be maintained and kept rut free at all times to facilitate access and prevent ponding of water on site.

1.2 Green waste composting equipment provision and available

The following table presents a list of example minimum equipment required to get started with composting. This equipment list was developed for a pilot project to pilot source segregated collection of green waste and associated composting trial.

Equipment item	Use	Requirement	Photo
Roadside clearance reusable containers and / or Green Waste Public Drop Off / Civic Amenity Site Container	Robust reusable sack for collection of green waste and other segregated waste materials during manual roadside clearance operations in Saint Lucia. To be made to withstand multiple (minimum 100) loadings and unloads.	• Reusable green waste sack for roadside clearance. • 110 litre capacity • Robust woven material with durable stitching • Double stitched carry handles on both sides and one at base • Stiff and robust plastic ring around upper opening to hold bag open during filling	
Front end wheeled bucket loader (Agricultural tractor >75 HP with front-loader also an option for smaller work)	Moving green waste, loading shredder, creating windrows, turning windrows, rolling cover material over windrows, loading screen, moving product.	**Essential.** Critical equipment able to manage all tasks required. A back-hoe loader or excavator is also adequate. Assumed available on site already.	
Water pump (trash pump) and hoses	Self-priming roller pump, minimum 100 litres per minute, 30-meter heads, with 2 x 100 m of hose included Water hose (suction pipe) - 10 metre length; 3" Rigid PVC Suction Hose with spiral reinforcement Water hose (discharge pipe) - 2 times 100m long 3 inch diameter discharge pipe to be fully compatible with supplied trash pump.	**Essential** Required to pump water from store to windrows.	

	Spray nozzle with integrated shut off ball valve		
Windrow composting **Temperature Probes**	Robust, heavy duty accurate windrow compost temperature probes (10 pieces) analogue or digital reading, 0°C to 85°C temperature graduating minimum with sealed fogless capsule	**Essential** Required to monitor microbial activity in windrow composting piles and indicates when to actively manage the pile, including when to turn the pile, when to add water, and whether pathogen die off conditions are being achieved.	
Chain saw and Log splitter	For cutting up tree branches and other uncontrolled green waste. Log cutter to efficiently and effectively slice wood and branches into 300mm long pieces	**Highly recommended** Helps reduce large materials to a manageable size and shape. Also, useful if firewood production is a viable and marketable product from the green waste materials. Feasibility study required first.	
Shredder / Grinder (small mobile for collection, larger hammer mill or tub grinder at compost facility)	Shredding / size reduction of larger green waste items (tree branches etc). Also mixing and blending different materials together as they pass through the shredders to stimulate more rapid decomposition which takes longer the larger the particle sizes.	**Highly recommended** Greatly improve transport efficiency and expediate decomposition times. A large, more mobile shredder is recommended. A larger tub-grinder at compost facility would also be beneficial. (the example here was already owned by the pilot project authority, larger chippers / grinders have significant benefits)	

Material Screen / Soil Sifter	Mechanical (rotating drum / Trommel) or static inclined screen, for compost materials in windrows to screen out any residual poor-quality materials greater than 1cm in diameter.	**Highly recommended** Assists sift contaminants (plastics, stones, etc) and over-sized (not completely decomposed) particles from the finished compost allowing a fine marketable product to be recovered and over-sized particles to be returned to the composting windrows to aid air circulation and microbial populations.	
Windrow Compost geomembrane / fabric Cover	Geomembrane cover for compost piles - prevent moisture loss (in wet conditions will shed excessive rainfall and reduce the leachate. In dry conditions it will reduce moisture loss. The breathable membrane makes the cover permeable to oxygen, carbon dioxide and water vapour. The cover also assists with reducing odours	**Optional - Recommended** Saint Lucia can experience hot dry periods as well as prolonged heavy rain. Regulating decomposition through keeping rain out and keeping moisture in the piles as required is recommended through purchase and use of windrow cover membranes on all piles. Such membranes work particularly well when used in combination with **air blowers (an additional optional item of equipment**) within the windrow to create positive airflow through the pile reducing the need for turning and expediting decomposition.	

Recommended Steps to Implement Green Waste Management Services

To establish and implement the example green waste source separation and management service outlined in this report, the following recommended steps represent the key potential system design and implementation activities required to progress up the service delivery growth spiral.

1. Identify the main green waste producers to be approached in the first instance.

   Major producers to be targeted first often includes the Public Utilities departments who conduct vegetation clearance operations under power lines and water treatment locations. Garden services companies that currently dispose homogenous waste loads at Landfill. Hotels and resorts that don't have their own composting facility. Land developers who conduct land clearance.

2. Information, Education and Communication campaign

   IEC campaigns are one of the most important aspects that requires long-term sustained activities. Sensitize the target waste producer of the need and reasons to divert green waste from landfill, the need for segregating green waste and the plans being established to impose a ban of landfilling homogenous vehicle loads of plant materials and imposition of a gate fee for mixed loads containing plant materials mixed with other wastes going to Landfill. Communicate the requirement for garden service companies to become licensed by the National Solid Waste Management Authority or equivalent regulator to be green waste haulers and users to only use licensed companies.

3. The Government should consider establishing a small grants programme or tax relief to assist entrepreneurs (particularly garden services companies) invest in green waste shredders and equipment. Grants to be offered to companies that successfully become licensed by the regulator as green waste haulers (optional step).

   Such assistance enables small garden services companies to offer a higher value of service which has wide reaching environmental, social as well as financial benefit to the wider society. The initial financial cost to government of supporting these grants/tax relief must be weighed up and off set against these wider societal benefits. Small composting companies have proven to be successful small to medium sized businesses in some Small Island Developing States, see for example "Grow Antigua Compost Factory" http://growantigua.com when given the means to operate.

4. Waste Management Authorities or equivalent department should work with key stakeholders to identify potential service providers and composting facility locations, conducting pre-selection of sites that meet composting facility licensing and Environmental Impact Assessment criteria.

An interim solution is to utilize an area within existing waste management facilities / landfill areas for initial composting activities. However, in the long-term, it is important to establish clear licensing conditions for composting facilities to be able to operate and only license facilities that meet those standards. This ensures legitimate operators that serve the wider societal benefit and invest time and finances into their operation are not undercut and losing business to rogue companies that cut financial corners to the detriment of the environment and society.

5. Government departments should Tender and award contracts (minimum 1 year) for bush clearing / treatment services to include condition that material is shredded on site and composted in a licensed facility.

   Government and large agency procurement and contract management systems are important opportunities that enable government to clearly specify goods/services that are beneficial to society without the need for law amendments or grants. Contracts are often awarded by the Government for vegetation clearance which generate large quantities of material that currently go to landfill which ultimately cost society to manage. In procuring services that mandate licensed contractors and composting of cleared vegetation, this stimulates the commercial sector to invest in composting operations and divert green waste from landfill without requiring additional regulations. Once services are established through these means, the service can be built upon by introducing landfill bans for green waste from other producers as the alternative treatment facility has been established by the service providers.

6. Assist establish compost markets through government procurement of compost.

   Similar to step 5, the establishment of the commercial composting facilities can be assisted without grant financing or additional regulatory control through guaranteed government procurement of compost materials to be used in applications that have wider societal benefit. This is particularly useful in the start-up phase when the operator requires to gain experience to produce good quality compost and mulch. Landfill Operators require substantial volumes of cover material at Landfills and other waste sites requiring rehabilitation. Establishing a guaranteed rate and quantity of compost procurement provides the compost operator with incentive and security to invest in producing the material. Output to be procured can include:

   1. Low grade compost (including ditch and road verge clearance with heavy metal contamination) purchased by Landfill Operator for landfill cover (this could be mixed with shredded tyre wastes to provide a robust and resilient cover on the landfilled waste).
   2. Medium grade for mulch, for agriculture and plant nurseries.
   3. Fine grade compost for beautification projects.

7. Apply a high gate fee on green waste (that subsidizes composting operation / contract) with a higher fee for loads containing mixed green and other wates with the eventual aim to ban green waste from going to landfill.

Incrementally introduce fees and ban as government and large agency procurement systems assist the establishment of composting facility and facilities gain experience and capacity to accept more clients and materials. Ultimately, without a well enforced ban or fee for landfilling that is more than the cost of composting, the producers will default to the lowest financial cost option, which should not be dumping or landfill.

8. Enforce ban and illegal dumping

   To ensure item 7 has the required impact of stimulating composting facility use, there is a vital need to prevent illegal dumping and heavily punish offenders to ensure green waste producers utilize the composting service.

8. Resorts and Householders see garden services chipping service as cheaper than landfill gate fee / ban and engage service providers. Waste management regulator shall require and enforce resorts and households etc. to prove they manage their waste responsibly (i.e. by having contract with licensed garden service provider or evidence of on-site composting facility).