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Your Sweet Spot Life

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Towards a Greener Festival: Best-Practice Guidelines and Detailed Instructions for an Eco-Friendly Three-Day Festival

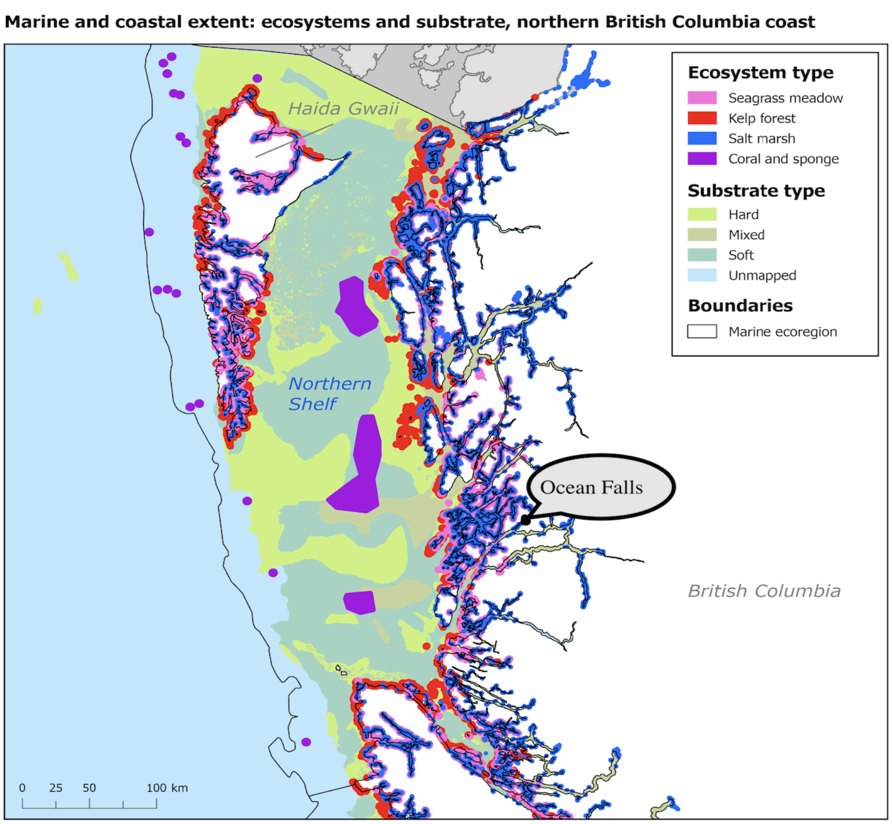
INTRODUCTION

This report evaluates innovative waste management and water treatment techniques and proposes recommendations for waste and water management systems for the 3-day festival and beyond. It also evaluates the impact of the festival on the surrounding environment.

LOCATION

Research:

The main type of ecosystem on the Ocean fall coast is the salt marsh (see figure).



Salt marshes are coastal ecosystems that play a crucial role in supporting healthy fisheries, shorelines, and communities. They offer shelter, food, and nursery grounds for over 75% of coastal fisheries species, such as shrimp, crab, and various finfish. Additionally, salt marshes safeguard coastlines from erosion by serving as a buffer against wave action and by capturing soils. In flood prone regions, they mitigate floodwaters and absorb rainwater. Moreover, salt marshes enhance water quality in coastal bays, sounds, and estuaries by filtering runoff and excess nutrients. Furthermore, these marshes, along with other coastal wetlands, act as "carbon sinks," storing carbon that would otherwise contribute to climate change by being released into the atmosphere. (National Parks Service, n.d.)

Pollution

The impact of pollutants on salt marshes is significant and diverse. Various substances such as nutrients from urban and agricultural runoff, oil from spills, and heavy metals from sedimentation and precipitation of wastewater negatively affect these environments. Salt marsh soils can filter and retain some pollutants, but increased inputs harm their condition.

Nutrient pollution alters salt marsh vegetation communities, as plant growth is primarily controlled by nitrogen and phosphorus availability. This pollution can lead to increased vulnerability to invasive species and decreased root production, causing soil erosion. Additionally, marine waters with excessive nutrients or algal blooms indirectly harm salt marsh vegetation.

Oil spills cause lasting decreases in vegetation cover, disrupting the entire ecosystem. Although salt marsh plants are tolerant to metal toxicity, if they are saturated with heavy metals, they can release them back into marine ecosystems, impacting coastal habitats.

Surface elevation

Salt marsh surface elevation dynamics are influenced by various processes, both above and below ground. Sediment and plant matter can accumulate (accretion) or erode from the marsh surface, while decomposition and compaction occur below ground. These processes, affected by sea-level changes and climate, determine whether marshes maintain a suitable elevation relative to sea level for vegetation survival.

Salt marshes respond to coastal changes like sea-level rise through landward migration (horizontal growth) and accretion (vertical growth), assuming adequate sediment supply. Changes in accretion processes, such as altered sediment supply from construction or increased primary production, can disrupt this balance, impacting marsh topography and hydrology.

Decreases in depth can allow terrestrial vegetation to invade the marsh, converting it to terrestrial habitat and causing it to change from a carbon sink to a source as soils become more oxygenated and decomposition rates increase.

Recommendations:

1. Reduce the release of 1) nitrogen through the composting facility, 2) heavy metals through the water treatment facility, 3) oil spills through the cruise ship. Avoid depositing sediment in the salt marshes.
2. Work with local environmental and wildlife charities and organizations to ensure minimal land and wildlife disruption

WASTE

Research:

Sustainable materials

- Paper

Paper is recyclable if clean and compostable if soiled. During waste segregation, it is important that paper and cardboard are separated by whether or not they have been soiled. Paper can be fragile and could be easily damaged by water.

- Glass

Glass is a fine alternative to plastic bottles and containers and can be used for beverages, sauces, and cosmetics. It is 100% recyclable without any loss in quality. It is also transparent, which allows consumers to see the product. However, it can be fragile and prone to shattering.

- Metal

Metal packaging, most commonly composed of aluminum and steel, is durable and preserves the freshness of the product. They are used for canned goods and beverages, and are infinitely recyclable. Their resistance to high temperatures makes them suitable for food products.

- Biodegradable

Biodegradable packaging materials are sourced from plant starches or sugarcane and naturally decompose. They are used for items such as cutlery and plates.

- Cloth and Fabric

Reusable, stylish, eco-friendly and customizable, they are a favoured alternative to plastic bags.

- Beeswax Wraps

Beeswax wraps are a natural alternative to plastic packaging and foils. They are made from cotton infused with beeswax. Thus, they are pliable and can be shaped to cover food items and to preserve their freshness. They are washable and reusable.

- Edible Packaging

These packages can be consumed along with the product, completely eliminating waste. They are particularly suitable for snacks, condiments, and sweets.

- Mushroom Packaging

Mushroom packaging, or mycelium packaging, is formed using fungal mycelium and agricultural waste. It is biodegradable and is used to protect delicate items during transportation. Its decomposition is quick and does not harm the environment.

- Jute and Hemp Packaging

Jute and hemp packaging are natural fibers that are robust, durable, and biodegradable. These materials are widely used for bags, sacks, and even clothing. Jute and hemp packaging not only offer sustainable alternatives to plastic packaging but also support rural economies where these crops are cultivated.

Small-scale plastic re(up)cycling for local artisans

The shredder cuts plastic into flakes for input into the other machines. Then, flakes are fed into the hopper and extruded into a line of plastic which can be used to make new raw material, granulated plastic or spun around a mould. Then, flakes are fed into the hopper of the injection moulder and the manual handle provides the leverage to inject the heated plastic into the mould. Then, plastic is heated inside the sheet press and slowly pressed into a mould with a car jack. This machine is suited for making larger objects.

HDPE (high-density polyethylene) such as bottle lids and rigid containers constitute a significant portion of marine debris due to their buoyancy. It is represented by the number 2 out of the 7 plastic recycling categories. HDPE has a low melting temperature (180 °C) and contracts when it cools, facilitating removal from molds. Products involving simple moulds include chalices, bowls, coasters, and tiles, which are marketed to tourists. Other products include rulers for local schools and construction beams and pipes for furniture, guttering, and other building materials.

To ensure the health and safety of community members, it is crucial to avoid burning plastic. Burning PVC, for instance, releases dioxins, highly toxic compounds linked to cancer, reproductive issues, and immune system damage. PP and PE are preferred plastics for their low toxicity.

By melting HDPE instead of burning it, the process emits fewer toxic fumes, improving safety for community members operating the plant. Personal protective equipment, including heavy clothing, gloves, boots, and industrial masks, needs to be provided to safeguard workers.

Recommendations:

Reduce waste

1. Provide venue summaries and maps electronically wherever possible, on an app or through a web page.
2. Offer reusable mugs or water bottles on site at the festival.
3. Use recyclable or re-usable name tags for volunteers and staff where possible.
4. Do not sell any disposable water bottles

5. Re-use products wherever possible – waste paper for note taking, old sheets for painting etc.
6. Collect used maps and guides with a drop box strategically located at exits to reuse for other visitors
7. Encourage food providers to use ceramic dishes or when necessary to provide disposable containers, ensurethey are biodegradable

Manage waste

1. Plastic recycling could be done at a local level, so that the process is directly benefiting the local economy through the selling of recycled products.

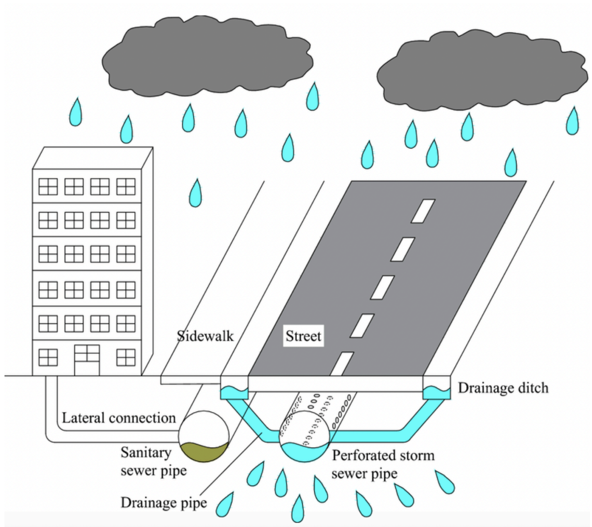
WATER

Research:

Wastewater diversion

Grey water can be used to water grounds or plants, and other non-potable applications.

Perforated storm sewer pipes can be used to divert rainwater from entering into the sewage system and being contaminated. Instead, they are released back into the environment.

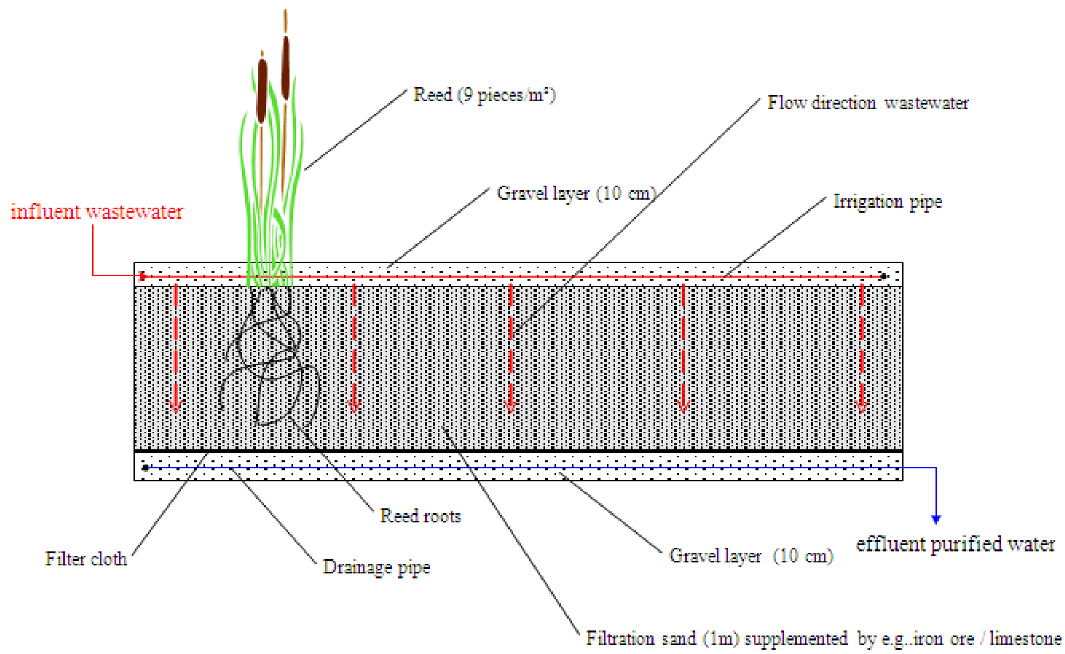


Wastewater categories

Wastewater refers to water containing waste from households, industries, institutions, hospitals, and agriculture, often mixed with groundwater, surface water, or stormwater. Domestic wastewater from households, schools, or offices can be categorized into three groups. Black wastewater is contaminated with human or animal excreta, carrying high pollutant concentrations and posing a significant public health risk. Within black wastewater, two distinct streams are identified: brown wastewater, consisting of faecal matter and toilet paper, and yellow wastewater, which contains urine and can be separately collected using specific toilets. Grey wastewater, on the other hand, originates from kitchen, shower, bath, sink, and laundry sources within a building. Each source contributes specific pollutants in varying concentrations. Grey wastewater is less concentrated than black wastewater, containing a higher proportion of heavy metals but fewer pollutants (or nutrients, depending on the treated wastewater's use) found in domestic wastewater. Municipal wastewater, produced by municipalities, includes domestic and industrial wastewater (with proper discharge permits) and sometimes rainwater.

Wastewater recycling

- Plant systems

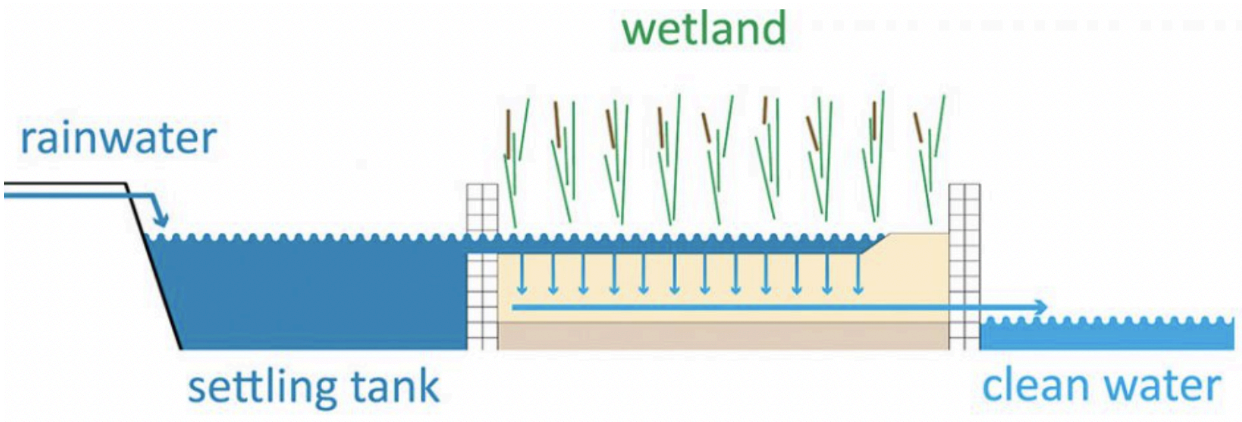


Natural water purification relies on the inherent processes of water, soil, and plants for self-purification. This wastewater treatment method requires no additional artificial energy or substances. Traditional natural water purification is categorized into two main types: purification in macrophyte beds and helophyte filters.

Macrophyte beds utilize water plants such as water hyacinth and duckweed for purification, typically in shallow basins to accommodate floating plants. These beds are often divided into compartments to protect the plants from wind displacement. They are commonly implemented in warmer regions but can be sensitive to seasonal changes. They effectively reduce phosphorus levels in water, making macrophyte beds a privileged choice for reducing shoreline eutrophication.

Helophytes are rooted plants with significant surface area above the water surface, including tule, bulrush, and reed, with reed being favored for its effective water purification properties. Reed's extensive root network and biomass provide a large surface area for bacteria and microorganisms, which play a key role in the purification process.

Helophyte filters come in three types: 1) Sewage fields: surface flow helophyte filters



2) Root-zone fields: underflow helophyte filters
3) Percolation or infiltration fields: vertical flow helophyte filters

The biobed, a special type of helophyte filter, uses coconut material layers instead of sand to retain wastewater while allowing oxygen introduction into the system. Like reed fields, purification occurs through filtration, nutrient uptake by plants, and biological activity. For effective implementation, pre-sedimentation methods like septic pits are recommended to remove suspended matter and prevent system blockages.

Due to the low energy consumption (pumping) and the natural appearance of the system, the helophyte filter is an appealing technique for small-scale water purification. The system requires little maintenance or follow-up. There is no sludge production.

One of the disadvantages of this system is the long start phase needed to form a suitable root system. Furthermore, the free space needed is relatively large (up to 5 m²/IE for a root-zone reed field), where IE stands for a resident's equivalent of a theoretical volume of 150 litres per day and a daily load of 90 g Suspended Matter (SM), 135 g Chemical Oxygen Demand (COD), 60g Biological Oxygen Demand (BOD), 10 g nitrogen (N) and 2 g phosphorus (P). Moreover, the purification effect is determined by the seasons and the plant system must be subject to thorough maintenance once a year.

The wastewater is often subject to purification prior to the plant system. This consists of a septic tank and possibly a fat/oil separator.

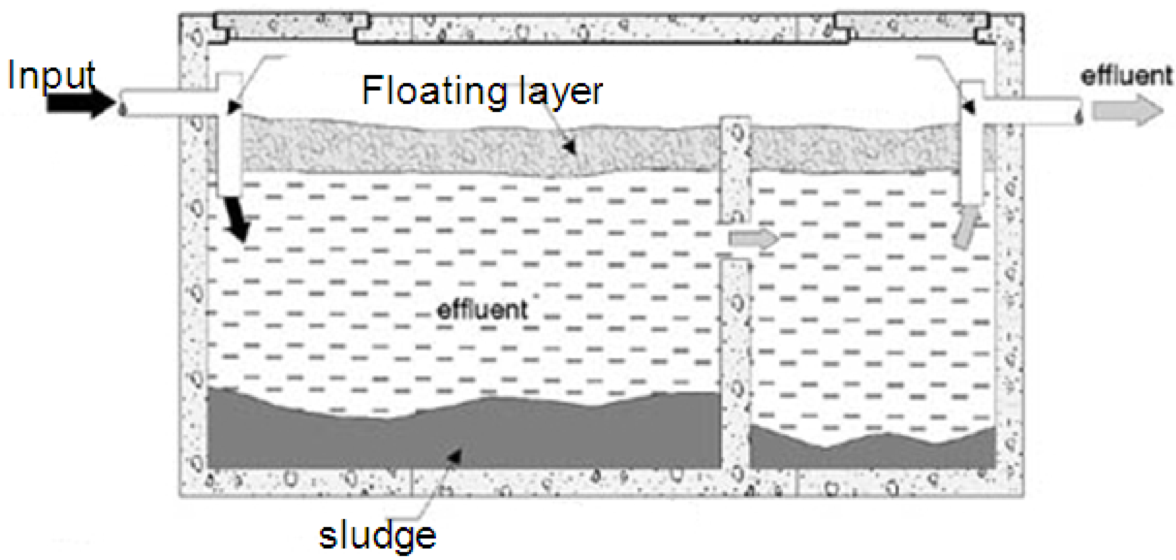
A helophyte filter is primarily intended for the removal of suspended matter (SM) and organic load (COD and BOD), where COD is a measure of the oxygen equivalent of the organic matter in a water sample that is susceptible to oxidation by a strong chemical oxidant, and BOD is the amount of oxygen consumed by the organism in the process of aerobic biological decomposition of an organic waste, which continue until all of the waste is consumed if the oxygen is present in sufficient quantities. Aerobic digestion of organic material in water is crucial, since anaerobic (without oxygen) digestion would trigger the release of methane, a GHG, as a product. Systems are dimensioned depending on the type of application. A system for tertiary purification will, for example, be dimensioned for far-reaching removal of SM, residual BOD and P.

Plant systems can be implemented for the removal of the following parameters (among others): COD (85-90%), BOD (90-95%), SM (70-90%), N (>50%) and P (25-65%). The purification yield is greatly determined by the dimensioning (size of load).

The purification efficiency is season-related. The highest bacterial and vegetative activity is found in summer and autumn. During winter and spring, the yield can drop by 40-50%. This is not always noticeable in every plant system.

In certain cases, lime, Fe or Al shavings are added to remove extra phosphorous.

- Septic Tank



The septic tank is a wastewater purification technique based on three processes: separation of sedimentary matter, separation of suspended matter (e.g. oils) and anaerobic degradation of organic pollutants. They are pre-fabricated using concrete or plastic, and are placed underground. The structure of a septic tank can vary from 1 to 3 compartments and between with or without air ventilation and air treatment. Most sedimentary matter is separated in the first compartment, where the sediment slowly forms a layer at the bottom. This is primarily organic matter, and is subject to anaerobic fermentation resulting in (among others) the formation of CO2 (carbon dioxide), CH4 (methane) and H2S (hydrogen sulphide). The formation of hydrogen sulphide gas is normally prevented because sulphide precipitates with the present metals. Fats and floating substances are also separated, while the wastewater flows through to a possible second compartment. The sedimentation and floating process then repeats itself.

A septic tank must be emptied on a regular basis. A limited layer of sludge must always remain present as a source of bacteria. The removed mass is normally discharged into a sewer-water purification system. It also must be cleared on a annually. Each time the septic tank is emptied and cleaned, it must be completely filled with water before it is put into use once again.

Septic tanks are very easy to implement, require little maintenance and are cheap to operate. The theory is primarily based on the separation of sedimentary and suspended matter. A septic tank has a limited purifying capacity (25-45% for BOD and 20-90% for SM). Due to the limited purification capacity, it is normally not possible to discharge the wastewater after a septic tank; thus an extra treatment is needed. Because fermentation is a biological process, biologically degradable cleaning products are preferred. Toxic products may disrupt the biological equilibrium in the tank.

Septic tanks are often implemented in remote locations where there are no sewers, such as agricultural businesses, restaurants and camp sites.

Stabilised sludge is released as a by-product. Additional measures may be necessary to address odour problems.

Recommendations:

Water use reduction

1. Have a water truck that will provide free drinking water
2. Water plants or grounds early in the day or late in the evening to minimize evaporation and water use.
3. Install faucet and shower head aerators and low-flush toilets where appropriate
4. Use automatic taps to reduce water consumption by up to 70%

Wastewater treatment

The use of plant systems is recommended since they present minimal disruption to the environment and are decentralized for community use. They are also efficient, visually pleasing and release minimal odor. Even when they are less efficient in winter and spring, they are still roughly as efficient as septic tanks.

FOOD & ORGANIC WASTE

Research:

In B.C., organic waste currently represents 40% of material sent to [...]landfills. The decomposition of food waste in landfills releases harmful greenhouse gases. Organic waste generally refers to biodegradable, compostable waste from homes, businesses, institutions, and industrial sources. Examples include food scraps, yard and garden trimmings, food-soiled paper products and biosolids. Food waste refers to food that is intended for human consumption that is discarded without ever being eaten (Ministry, 2022). Although the product has been sold and the cost already covered in that sale, plate waste consists of food that is not consumed or enjoyed by the customer represents a cost that does not provide value – in essence, an investment with no return. By eliminating unnecessary plate costs, operators gain greater price flexibility in a competitive market, or increased contribution to profit. In this respect, plate waste has a direct impact on profit and may be considered a controllable cost of business. Food waste may be controlled through all the steps of food production, including planning, purchasing, storage, preparation, service and consumption.

Compost systems

Food scrap recovery can be done at many levels. Notably, source reduction, edible food rescue, food to animal feed, residential backyard composting, small-scale, decentralized and locally based composting and centralized composting. Smart disposal of organic material could benefit the community, forming a locally based and closed loop that enhances local soils, supports local food production, and conserves natural ecology by improving soil structure and maintaining nutrients, carbon, and soil microorganisms. Composting infrastructure is diverse and can be scaled to meet the needs of a community. Compost programming engages and educates the community in food systems thinking, resource stewardship, or community sustainability, while providing solutions that empower individuals, businesses, and institutions to capture organic waste and retain it as a community resource.

Several basic types of composting configurations are used by community-scale and farm-scale operations: 1. Turned windrow composting 2. Bin systems 3. Aerated static piles 4. Passively aerated static piles 5. In-vessel 6. Static piles 7. Vermicomposting.

1. The turned windrow method consists of an elongated pile, which is generally turned or “rolled” from the side by hand or with a bucket loader, tractor, or a specially engineered machine called a windrow turner. The long shape of a windrow makes the piles easy to turn and provides surface area for passive airflow into the compost.
2. Composting bins are utilized in both larger-scale and home-based systems, providing contained spaces to efficiently manage compost materials. These bins can take various forms, such as wire constructions or enclosed bays, designed to maximize vertical space usage. Material inside the bins is aerated by turning it with a pitchfork or specialized auger, accessible through open sides or doors for loading and unloading. For effective composting, bins should ideally have a volume of at least 3’x3’x3’. This size allows the material to reach temperatures between 120-150 degrees Fahrenheit, crucial for reducing pathogens, eliminating seeds, and accelerating decomposition. Commonly known as "Cube-based" bins, these structures are typically constructed from wood combined with chicken wire or hardware cloth, often utilizing repurposed materials like pallets or concrete blocks. Once a bin is filled with compost material, it becomes a "batch" and no additional material is added unless adjustments are needed. Batches are systematically rotated through multiple bins in succession, typically with three bins in use. The first bin receives fresh materials, which, once full, undergoes composting and is then transferred to the second bin, followed by the third, based on input rates. In colder climates like Vermont, insulating the bins can help maintain high temperatures, even during winter months. On a larger scale, composting bins are integrated into aerated static pile (ASP) systems, providing an organized approach to managing composting processes efficiently.
3. Aerated static piles (ASP) are composting systems that utilize perforated pipes or ductwork beneath the compost pile to actively aerate the material with blowers, either by

pulling (negative aeration) or pushing (positive aeration) fresh air through it. This airflow is distributed evenly throughout the pile, facilitated by controls like timers and temperature sensors that operate the fans to supply oxygen and regulate temperature.ASP systems can be implemented at various scales and can be custom-built or purchased as fully engineered systems. Despite their significant benefits, ASP systems come with a learning curve, particularly in managing temperature and moisture levels. While ASP systems reduce the need for manual turning, some periodic turning is still recommended to ensure optimal composting conditions.One of the primary advantages of ASP systems is labor and equipment savings over time, as well as space efficiency. The active aeration accelerates microbial activity, significantly shortening the composting process—sometimes cutting it in half. This efficiency allows for quicker turnover of finished compost and maximizes throughput capacity by consolidating material into less space. Another space-saving feature is the ability to stack material closely, minimizing the need for additional workspace. Contained food scraps within ASP systems have time to break down without exposure during turning or movement, reducing the risk of attracting pests and animals. Well-designed ASP systems can maintain compost pile temperatures within the ideal range of 140-150 degrees Fahrenheit. Most ASP setups include a biofilter layer made of natural media such as finished compost or high-carbon material, which helps mitigate odor issues by filtering air from the composting process. However, ASP systems also have drawbacks, particularly for community composters. Challenges like managing particle size, moisture levels, and material homogenization are more complex compared to turned windrow systems. Additionally, external biofilters in ASP setups must be thicker than those used in turned windrow systems. In winter, ASP systems require careful attention as cold ambient air pushed by blowers can adversely impact pile temperatures.

4. Passive aeration of compost is the process that all composting methods rely on when not being actively aerated through turning or forced aeration with blowers. This process relies on the porosity of the compost's "organic matrix" and the processes of convection, the movement of particles through a substance, and diffusion, a net flow of matter from a region of high concentration to a region of low concentration, which is why large particles that create a porous architecture are such an important factor in any composting recipe. As compost heats, it creates a "chimney effect," pulling fresh cool air into its base passively. Designs of the base of the compost pile are highly variable and can be as simple as piling the material on a pile of coarse wood chips (which can have as much as 50% pore space) or building air channels with ductwork as one would with an ASP system. Particularly with larger systems that are serving the public, make sure that the channels are not providing an access point for critters. Cover the ends of plastic pipe with hardware cloth for example, allowing for air to flow while blocking rodents. As with every system, turning periodically will decrease the likelihood of critters taking up

residence. Controlled composting optimizes efficiency and quality and minimizes odors and rodents.

5. In-vessel composting systems encompass a variety of enclosed setups, ranging from small-scale plastic tumblers to large rolling drums, containerized ASP systems, and auger-turned systems. These systems can be either continuous flow or batch-based. Batch systems may require multiple units if there's a constant influx of food scraps to ensure fresh material isn't added to nearly complete batches. These systems effectively manage compost material, mitigating odors and pests through containment, aeration, and biofilters. Despite this, most in-vessel systems necessitate a secondary composting phase as the output isn't mature enough for most applications, although it does break down visible food scraps and odorous compounds. Manufacturers tout the efficiency and control of in-vessel systems, which can also be custom-designed on-site using repurposed materials at a lower cost.
6. Vermicomposting, also known as worm composting, involves using specific worm species like Eisenia fetida (red wigglers) to decompose organic materials into nutrient-rich humus. In larger community settings like gardens or urban farms, successful vermicomposting typically involves red worms feeding on partially composted materials from an initial hot composting phase, which helps deactivate weed seeds and pathogens, resulting in upgraded compost. The worms produce vermicompost, which is a blend of organic matter, soil microbes, and worm castings. Vermicompost is prized for its high-quality organic matter and microbial diversity. It contains elevated levels of plant-available nitrogen and natural hormones beneficial for plant growth. Additionally, worms engage people of all ages, making vermicomposting an excellent tool for public education and engagement. Various vermicomposting designs and methods exist, but user-friendly systems leverage worms' natural behavior of feeding in top layers of soil with fresh organic matter. Continuous flow vermicomposting beds, resembling open boxes, allow continuous feeding at the top and harvesting finished compost from the bottom. While suitable for small-scale composting, these systems require substantial space for larger volumes, making them less practical for extensive operations unless space is abundant. Additionally, they may need cover and potentially heat depending on climate conditions, although some operations in colder regions like northern New York State operate without additional heating.

Carbon: Nitrogen Ratio

The ideal carbon-to-nitrogen (C:N) ratio for composting is typically around 25-30:1. When the compost pile reaches a sufficient height to trap heat, this ratio supports thermophilic (heat-loving) microbes, enabling temperatures of 150°F or higher. Achieving this ratio often involves using equal volumes of nitrogen-rich green waste and carbon-rich brown waste.

Compost piles with higher C:N ratios will decompose more slowly, whereas lower ratios can lead to rotting, ammonia release, and unpleasant odors.

In contrast, vermicomposting operates differently and allows for a broader acceptable range of C:N ratios. For larger worm bins, it's advisable to avoid ratios at or below 25-30:1 to prevent promoting thermophilic composting, as worm bins should ideally remain between 50°F and 90°F to support a conducive environment for worms.

For vermicomposting, aiming for a C:N ratio of 50:1 or higher is preferable. As microbes break down carbon materials and convert nitrogen into plant-available forms like ammonium (NH_4^+) and nitrate (NO_3^-), the C:N ratio gradually decreases over several weeks, assuming no additional brown or green materials are added.

Compost content

Common examples of green waste are: kitchen scraps, coffee grounds, manures, grasses, hays and vegetable trimmings, while examples of brown waste are: leaves, wood chips, sawdust, straw, corn stalks, paper and cardboard.

The following factors will have a significant impact on the C:N ratio and the performance of the compost pile or vermicompost bin.

C:N Variability: some ingredients have a wide variance in C:N ranges. For instance, fruit waste in particular can have C:N as low as 20:1 and as high as 50:1.

Particle Size and Composting Efficiency: Composting and vermicomposting are aerobic processes. Diverse particle sizes allow for greater pore spaces to allow oxygen to enter the compost pile.

Bulk Density: Bulk density is the measure of dry weight per unit of volume, often expressed as pounds per cubic foot. This is a great example of why only considering volume when it comes to your mixture of browns and greens may lead you down the wrong path.

Water Content: Composting and vermicomposting should both occur at moisture content between 50-70%. Below 40-50%, microbial activity slows and composting stops. Above 70%, the risk of anaerobic conditions increases as moisture displaces air in the pore spaces of the compost, at which point the microbes consume the available oxygen without an avenue to re-oxygenate the pore space.

To measure the water content:

1. Weigh an ovenproof container to determine its tare weight.
2. Place a small sample of your bedding or vermicompost in the container and weigh it.
3. Subtract the tare weight to determine the wet weight of the sample.
4. Put the sample and container in an oven at 220°F and let it “cook” for 24 hours to completely dry it out.
5. Weigh the dried sample and subtract the tare weight. This is your dry weight.
6. Determine the moisture content of the wet sample using the following equation.
   ((Wet Weight — Dry Weight)/Wet Weight)) x 100 = Moisture Content

Odor control and rodent prevention

Community composting initiatives face significant challenges related to odor control and rodent prevention. In-vessel systems, ranging from small tumblers to larger rotating drums, are generally favored over open systems due to their ability to better manage odors and deter rodents. However, effective management practices are crucial regardless of the composting system used.

Proper aeration, ensuring adequate oxygen levels throughout the composting process, is essential to prevent anaerobic conditions that can lead to unpleasant odors. Windrow composting, where materials are formed into long, exposed piles, requires meticulous construction and turning to minimize odors. By incorporating all food scraps, sealing the windrow to a uniform depth of at least 6 inches, and positioning it in an open area devoid of potential rodent habitats, windrows can be relatively rodent-proof compared to enclosed bins.

Bins and containers, when properly filled with a balanced mix of nitrogen and carbon materials, also produce minimal odors. However, managing these systems can be challenging, particularly with plastic containers where turning the material can be cumbersome. Plastic containers should be placed on a suitable foundation to manage "contact water" efficiently, such as using wood shavings on cement to absorb excess moisture that could lead to odors over time.

Rodent prevention is critical, as rodents can easily infiltrate composting systems. Enclosed bins and containers should be wrapped with at least ½-inch hardware cloth to prevent access to food sources. Additionally, creating an inhospitable base, such as using cement or digging a pit filled with sand, helps deter rodents from establishing habitats beneath the bins.

While plastic containers offer some advantages, rodents can still chew through them. Investing in a rodent-proof tumbler, despite the initial cost of hardware cloth, may be a more effective long-term solution for both odor control and ease of material turning.

Food to animal feed

As the focus shifts towards viewing food scraps as a valuable resource rather than waste, there is a growing interest in using community-collected food scraps to feed animals, particularly chickens. Historically, feeding scraps to animals was common practice and is still prevalent in many areas today. Recycling food scraps back to local animals represents an environmentally and agriculturally beneficial approach.

Some consumers prefer eggs from hens fed on food scraps due to the associated environmental and health advantages of avoiding solely grain-based diets. While feeding food scraps to laying hens is generally considered safe, there are concerns about using them for meat birds or pigs due to potential pathogen risks. In certain states like Vermont, regulations prohibit feeding certain types of food scraps to pigs unless they have been pasteurized or have not come into contact with meat.

Feeding practices for laying hens vary based on location and scale. Some systems involve composting food scraps before letting chickens forage on the compost. Others utilize designated feeding areas with bedding, removing uneaten scraps for composting elsewhere. The chosen approach should accommodate the laying operations while efficiently managing uneaten scraps for composting purposes.

Estimated food waste

The average volume of a meal is 650ml, or 650cm^3. In an average restaurant, 34% to 50% of food is wasted. If food waste is minimized, it would be safe to expect around 20% waste. That would make 130 cm^3 food waste per meal per person. One person eats 3 meals per day, and there are around 200 people without a cruise ship and 500 people with a cruise ship. The festival lasts for 3 days. For the first possibility, the food waste produced would be 234,000cm^3, or 8.264 cubic feet. For the second possibility, the food waste produced would be 585,000cm^3, or 20.659 cubic feet. If equal volume of brown waste is matched, the volume would be around 41 cubic feet, which is approximately 3½' x 3½' x 3½', or 1m^3.

Recommendations:

Source reduction & edible food rescue

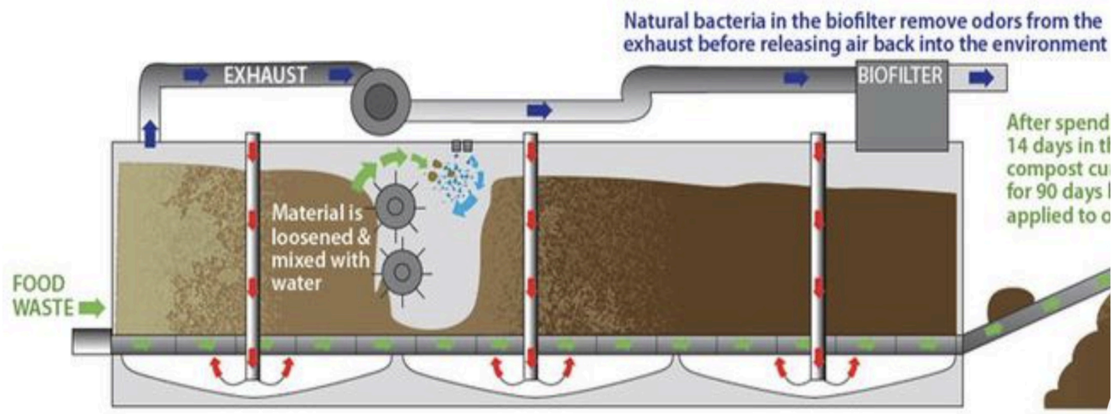
1. Develop menus and offerings that resonate with consumers and encourage sales while minimizing the risk of returned food.
2. Regularly evaluate sales data to identify and address underperforming items by either refining or removing them from the menu.
3. Offer a diverse selection of items while keeping the overall number of offerings manageable to streamline preparation and reduce wastage.
4. Incorporate common ingredients across multiple recipes to optimize ingredient turnover and storage efficiency.
5. Select ingredients with adequate shelf life and purchase quantities that align with usage to prevent spoilage.
6. Utilize trimmings or leftover ingredients from other recipes to minimize waste.
7. Ensure that dishes can be consistently prepared using available equipment and within the skill level of the staff.
8. Provide value to customers without serving excessively large portions.
9. Set up an incentive plan, for example discounted stall fees, or an awards scheme, to encourage stallholders to switch to more sustainable products such as local, organic or Fairtrade foods. You could also reward your most ethical traders by including discount vouchers for their food in your programme, to encourage other businesses to follow suit.
10. Donate leftover food to a charity.

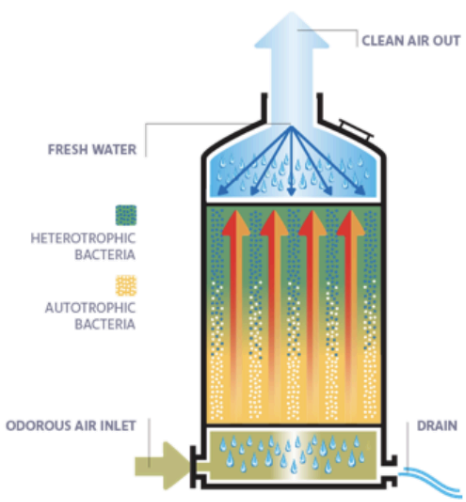
Composting

Considering the scale of the community composting facility, the limited financial resources and the concern of wildlife and rodent activity, the following recommendation is concluded:

1. Advise against throwing meat, dairy and heavily seasoned food to the designated composting bin.
2. Try to keep a ratio of 70 percent brown matter (paper, wood, dried and dead plants) to 30 percent green matter (food scraps, young plants and wet leaves).

3. Start with 3 small scale composting bins of a volume of $1m^3$.
4. The suggested design is as follows: three wire construction bins to allow for passive aeration, which is as effective as active aeration (Barrington, 2002) but much more cost-efficient. Top doors for loading. Use repurposed wood pellets for structure. Locate this on concrete flooring, or another kind of flooring inhospitable to rodents. Use a metal cage to protect from wildlife whose height is larger than 5-7 cm. Turn the batch every 4 days by rotating the batch to the next bin.
5. After 12 days, transfer the compost to a continuous flow vermicomposting bed. Add 1 pound of red wigglers per square foot of surface area.
6. Collect the compost periodically from the bottom of the bed when it is a deep blackish brown color, and is moist.
7. If successful, this model could be extended to community-wide in-vessel composting, which avoids contact with wildlife. Biofilters like the one below can be used to avoid odor that attracts wildlife. (https://www.ohio.edu/sustainability/programs/compost.cfm)





8. In this biofilter, water is sprayed downward through the media as the foul air is forced upward. The biology within the media consumes the odorous compounds. The remnants of those compounds are rinsed away by the water and clean air is released into the atmosphere.

(https://www.bioairsolutions.com/examining-efficiency-biofilters-air-pollution/)

References

Akhzar, P. (2023, November 8). *12 alternatives to Plastic Packaging: Sustainable Shift*. Arka. https://www.arka.com/pages/alternatives-to-plastic-packaging

ANDREWS, H. (2020). Small-scale plastic recycling. *ReNew: Technology for a Sustainable Future*, *152*, 40–44. https://www.jstor.org/stable/48587559

Barrington, S., Choinière, D., Trigui, M., & Knight, W. (2002, October 29). *Compost convective airflow under passive aeration*. Bioresource Technology. https://www.sciencedirect.com/science/article/abs/pii/S0960852402001554

Biochemical oxygen demand. Biochemical Oxygen Demand - an overview | ScienceDirect Topics. (n.d.). https://www.sciencedirect.com/topics/engineering/biochemical-oxygen-demand

Chemical Oxygen Demand. Chemical Oxygen Demand - an overview | ScienceDirect Topics. (n.d.). https://www.sciencedirect.com/topics/earth-and-planetary-sciences/chemical-oxygen-demand#

Churchill, S. (2022, August 17). *How to measure moisture content in compost and vermicompost*. Urban Worm Company. https://urbanwormcompany.com/how-to-measure-moisture-content-in-compost-and-vermicompost/

Compost calculator. Urban Worm Company. (2022, August 2). https://urbanwormcompany.com/composting-calculator-carbon-nitrogen-ratio/

Government of Canada, S. C. (2022, March 25). *Environmental thematic maps and graphics*. Marine and coastal extent: ecosystems and substrate; northern British Columbia coast. https://www150.statcan.gc.ca/n1/pub/38-20-0001/2021001/m02-eng.htm

A Guide to Community Composting. (n.d.-a). https://ilsr.org/wp-content/uploads/2014/07/growing-local-fertility.pdf

Hunt, J. N., & Stubbs, D. F. (1975, February). *The volume and energy content of meals as determinants of gastric emptying*. The Journal of physiology. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1330851/

Mettler, A. (2023, September 30). *Food waste in restaurants: What we know - fourth*. NOAM. https://www.fourth.com/article/how-much-food-restaurants-waste

Ministry of Environment and Climate Change Strategy. (2022a, August 31). *Food and organic waste*. Province of British Columbia. https://www2.gov.bc.ca/gov/content/environment/waste-management/food-and-organic-waste

Ministry of Environment and Climate Change Strategy. (2022b, November 1). *Food Waste Prevention for Businesses*. Province of British Columbia. https://www2.gov.bc.ca/gov/content/environment/waste-management/food-and-organic-waste/prevent-food-waste/prevent-business-food-waste

Nanninga, T. A. (2011, July). HELOPHYTE filters: Sense of Non-Sense. https://edepot.wur.nl/173549

Rooney, N., Kalff, J., & Habel, C. (2003). The role of submerged macrophyte beds in phosphorus and sediment accumulation in Lake Memphremagog, Quebec, Canada. *Limnology and Oceanography*, *48*(5), 1927–1937. https://doi.org/10.4319/lo.2003.48.5.1927

Small-scale wastewater purification. EMIS. (n.d.). https://emis.vito.be/en/bat/tools-overview/sheets/small-scale-wastewater-purification

U.S. Department of the Interior. (n.d.). *Salt marshes*. National Parks Service. https://www.nps.gov/subjects/oceans/salt-marshes.htm

Use of perforated storm sewer in rain and sewage ... (n.d.-b). https://www.researchgate.net/figure/Use-of-perforated-storm-sewer-in-rain-and-sewage-diversion-to-improve-the-rainfall_fig1_352259779

Vermicomposting 101. FoodPrint. (2020, August 6). https://foodprint.org/eating-sustainably/composting-and-food-waste/vermicomposting-101/

Worms, M. (2023, November 17). *How many worms do I need for my Worm Bin?*. Meme's Worms. https://www.memesworms.com/blogs/news/how-many-worms-do-i-need-for-my-worm-bin