Pierrick TRIOULAYRE
University Lyon 3
ESE-IER Poisy
Internship report IER3

Internship Supervisors: Mr BONNET
Mr COMBY

Management and Reuse of Human Organic Matter

les Gandousiers
Service de toilettes sèches

Class # 16
Year 2008-2009

UNIVERSITE JEAN MOULIN LYON 3

IER

Translation in English: Cecile Laborderie

This internship report was written by Pierrick TRIOULAYRE within the Bachelor's degree in Geography and Land Planning (University Jean Moulin, Lyon, France) and within the University Degree in Rural Territories Engineering (European Superior School). For comments, questions or further information please contact him at the following adress : pierrick.trioulayre@laposte.net

Acknowledgment

I would like to thank all the persons who helped me elaborate this internship report. First of all the staff of the company *Les Gandousiers,* Stéphane, Marco, Boui Boui and others and the inhabitants of Saint-Dizier-en-Diois who welcomed me in their village.

I would like to thank Pierre BERTHILLIER, manager of Lyon's storage and composting center for his advice and ideas which we shared with Manon Querel, manager of Paris' center.

I would also like to thank Philippe MEJEAN, manager of the BioValley project in the Drome region, Mr Sylvain FREDERIC, expert in methanation and Mr Franc GOFFINONT, responsible for agriculture and compost within the District Department for Social and Sanitary Affairs (DASS) for taking the time to answer all my questions.

Last but not least I would like to thank Philippe GARIN-MICHAUD for integrating me in his company and for allowing me to discover all the aspects of his special business!

Index

Introduction

This report is the outcome of two months of internship within the company *Les Gandousiers*. This company, located in *Saint-Dizier-en-Diois* in the Drôme region in France (south east of France*), offers hire service of dry toilets to all kinds of outdoor events in France. More than a simple sanitation service, the company commits to provide treatment and reuse of human waste through composting, and to advocate composting systems.

I chose to work within this organisation because it is in line with my professional project. The internship confirmed my interest to work in the fields of water and housing as both fields were at stake.

The activities of the internship were varied but the main activity consisted in field work. I participated in several events such as musical festivals, and local celebrations such as the Bird Festival in *Sainte-Croix-en-Jarez* or the *Dialogues en Humanité* festival in the biggest public park in the city of Lyon (*east of France*[*]). Moreover, I was in charge of proposing solutions to reuse human waste collected during the public events.

Managing and reusing human waste is the main challenge of the company *Les Gandousiers*. French health monitoring agencies have recently become interested in the field of human waste reuse, in particular because there is a legal gap in this field. This is a challenge for the company as they have to anticipate the future promulgation of laws, whereas public authorities have not defined yet a policy.

The purpose of the internship was to redefine the management scheme of the company and make proposals to improve human waste recycling options. This report makes suggestions for improvements and investments the company could make.

[*] * Note from the translator

Context

Industrialisation combined with new lifestyles has resulted in the degradation of environment with worrying consequences. Not so long ago, water was still regarded as an abundant resource (in industrialised countries) but evidence shows that it is becoming scarce and sometimes unfit to human consumption, due to human activity. Water management upstream and downstream has become a new challenge.

Toilets are a good example of the way our modern societies regard water.

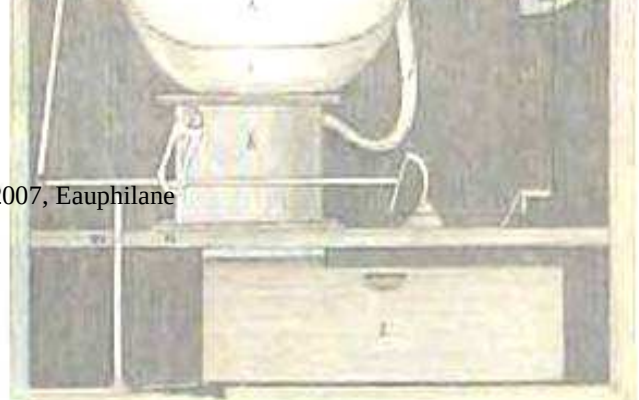
Water-closets were invented in the 19th century by a British plumber named Thomas Crapper. He managed to connect a ball tap to a water tank. At the same time the siphon appears and ensures that the toilets are watertight and odourless.

Detractors already argued that this new system was a waste of water, was polluting the Seine River (main river crossing Paris*), and was a great loss in terms of agricultural fertilisers. But in the 19th century, the medical discoveries of Pasteur helped to disseminate this system as the hygiene promoters were describing traditional pits (*fosses d'aisance*) as mere "virus tanks with foul odour"[†]. In June 1880, the city of Paris passed a law to prohibit traditional pits and to encourage connection to sewers. After the Second World War, sewers and water supply had already become the mainstream system in most large French cities.

But at the same time water borne sanitation also brought its load of problems. For the last 200 years, the same issues have been at stake: waste of water, large volume of waste water to treat and loss of an organic fertiliser for agriculture.

For the last 200 years, French laws have been adapted to the "end of the pipe" sanitation. Indeed, the legal designation of human excreta is "*eaux vannes*". Although faeces are solid, all the laws related to faeces describe it as « water » (*as in English it is called black water**).

For the last decades, dry toilets have reappeared as a solution for individual sanitation and collective events through associations and companies which provide sanitary facilities. However reuse of human excreta has become an issue because of a legal gap and the companies working in this field come across difficulties to find sustainable solutions.



[†] Christophe Elain, *Un petit coin pour soulager la planète*, 2007, Eauphilane

1 Company's profile

1.1 Background

1.1.1 Name

« *Les Gandousiers* » used to be the name given in the region of Lyon to the workers in charge of emptying cess pits and delivering the collected sludge to garden farmers on the city's borders. This name dates back from the 18th century but is still common as garbage men are still called "*gandous*" in Lyonese informal language.

1.1.2 Status

In 2006 the company became an individual business, which means that the capital investment and the income of the company belong personally to its manager, M. Philippe Garin Michaud.

This company is part of the Chamber of Commerce and Industry and not of the Chamber of Trade, because hiring dry toilets is regarded as service to events organisers.

1.1.3 Income

The company *Les Gandousiers* was created in July 2005, by Philippe Garin-Michaud, under the status of a micro business, with an initial capital of 7,000 €. This sum was borrowed to the owner's friends and was refunded one year later, when the company's turnover reached 8,000 €.

In 2006, the company was able to obtain a loan of 10,000 €, as well as a loan from the region (0% rate) and a subsidy of 4,000€, and ended up with a turn over of 54,000 €. In 2007 the company obtained a loan of 8,000€ and resulted in a turnover of 100,000 € with a 25,000 € benefit. In 2008, the loan was 10,000 €, the turnover 150,000 €, and the profit 16,000 €.

1.2 Challenges

Organic waste collected in hired dry toilets is composted in order to be used as a fertiliser.

The company promotes recycling organic waste to the ground, which can replace chemical fertilisers which erode the soil. Water saving is also part of the advocacy campaign, as the company fights the paradox of « shitting into drinkable water" before spending millions of euros into sanitation systems, which are not always reliable.

Through the provision of a service and therefore contact with users, *Les Gandousiers* want to raise public awareness of economical and ecological advantages of such facilities. The company attempts as well to convince the public that these toilets do not stink and are certainly not dirtier than water flush toilets.

The company provides advice and contacts to assist more informed public to install such facilities in individual houses.

It is interesting to point that the 1.5 liter of urine and 0.15 liters of faeces excreted per person daily increase their volume by a factor of 20 to 30 through water addition, to become waste water. The resulting waste water treatment and operating costs in waste water treatment plants is therefore very high.

1.3 Technical and operating aspects

1.3.1 Different models

Les Gandousiers offers hire of 4 different kinds of toilets.

- The « ready to build » toilets (RTBs)

These cubicles consist of a wooden pedestal easy to put up and down and bamboo sticks for the upper structure. The sides and roof are made of cotton canvas *3i* (fire resistant, water tight, UV proof, rot proof, resistant to mold and with breathing properties). The sides and roof are set up on bamboos.

Floor height = 0,10 m
Cubicle width = 1,20 m / 0,70 m
Height = 2,10 m
Sitting type

6 RTBs cubicles assembled
Source : *Les Gandousiers*

- The tepee urinals

The tepee urinal is a module made of 6 independent urinals. The structure assembles 6 bamboos and treated cotton canvas. The different parts are tied together with tine.

Ground diameter = 3.50 m
Necessary access space = 4.50 m x 4.50 m

Assembled tepee urinal
Source : *Les Gandousiers*

- Toilets designed for Persons With Disabilities (PWD)

These toilets are designed for Persons With Disabilities. They are sitting type and are equipped with a metal handle for user's comfort. The cubicle's structure is made of metal and bamboos hold the roof and the sides.

Width = 1.70 m
Length = 2.00 m
Height = 2.20 m
Necessary access space = 2.20 m x 3.00 m

Assembled PWD cubicle
Source : *Les Gandousiers*

- The 4 and 8 toilets modules

These modules are integrated to trailers. They open out on the trailer and are squatting type toilets. These modules are used for large outdoor events with a large number of users.

Assembled 8 toilets module
Source : *Les Gandousiers*

1.3.2 The geographical challenge

High transport and handling costs related to the geographical distance between the warehouse and composting area in *Saint-Dizier-en-Diois* and the location of outdoor events, encouraged the company to set up new sub-branches in 2008: one in Lyon and one in Paris. These two offices provide service closer from the clients than the head office, situated in the (remote*) Drôme district. In each office a manager is in charge of servicing the regional

demand. The storage and composting centers are lent by a horse riding center in Miribel near Lyon and by a vermicomposting (cf. glossary) facility in Paris. Each of the three warehouses stores 10 to 13 RTB units, one or two tepee urinal and 2 or 3 PWD toilets.

The decentralisation of the warehouses helped to unload the work of the headquarters of the company and to provide a service closer from the clients, which is very important for simple toilet renting package, i.e. without service from the company (cf.1.3.3.2.).

1.3.3 Hiring dry toilet: 2 types of packages

1.3.3.1 Package 1: toilet hiring with full service

The company commits to deliver, set up and dismantle the sanitary units. The staff of *Les Gandousiers* stays on site during the event and is responsible for maintaining the toilets (cleaning, restocking paper and saw dust). The staff also provides information to the people attending the event and for those particularly interested in dry sanitation. Communication and information on site are important because they allow the promotion of the system.

The future compost (all the organic waste generated during the festival) is collected by Les Gandousiers.

1.3.3.2 Package 2 : simple toilet hiring

Les Gandousiers offers the possibility to rent the toilets only, without providing any service. The clients have to come by themselves to the warehouse to pick up the units. They get a two hours training on how to set up and maintain the toilets and how to make compost. The clients are then responsible to manage the toilets from A to Z, from setting up the units to composting the waste generated.

This package is cheaper for the client. However, the number of units available for this kind of package is limited to 2 RTBs, one tepee urinal and one PWD toilet. This is done on purpose to avoid toilet management problems and users discontent which could impact negatively on the company's image.

1.3.4 Guidelines for use

Users' guidelines are posted in the toilets. They provide answers to users' potential questions and limit improper use which could hinder the composting process.

In particular, the guidelines mention that the toilet paper should be discarded in a separate bin (and not in the toilet bowl). Indeed toilet paper is totally biodegradable and can be easily composted. Moreover, it contains Carbon, which necessarily needs to be combined to Nitrogen in the composting process. However, degradation time of the toilet paper is longer than the other elements present in the compost. This can be an issue for the farmers who elaborate the compost because traces of toilet paper will prevent good marketing of their product.

1.4 Distinctive features of the company

The company has been offering toilet hire service all over France for the last 5 years and benefits from several advantages.

1.4.1 Geographical situation

The headquarters are located in the village of Saint-Disier-en-Diois on a high land. The village is situated 50 km from the first gas station. Located in a mountain area, the company was able to benefit from fiscal advantages such as income tax exemption during five years.

1.4.2 Strong social cohesion

The initial capital was provided by friends and employees were recruited through the local network. The accountant is from the same village and raises goats as a living, and the only employee having a permanent contract is a colleague of the owner Philippe Garin-Michaud, who helped him to set up the company.

The company is therefore well integrated in the local region.

1.4.3 Communication mode

The communication expenses of the company are very low, because word to mouth works extremely well. Leaflets are distributed during outdoor events (cf. annexes 1 and 2) and

a website provides all information necessary to rent the toilets (*www.gandousiers.com*). These two communication ways work well enough for the company to be fully booked. The staff presence allows direct contact with individuals or organisations interested in this type of service. Mr Garin-Michaud even met a journalist named Tignous during a festival. He was quite enthusiastic about the work of *Les Gandousiers* and published an article about the company in *Charlie Hebdo*, a national weekly magazine. (cf. annexe 3*).*

2 Les Gandousiers' activities

Employees of the company mainly work as service providers during the festivals and other events, but can also be employed to maintain and even build the toilets. This job requires knowledge in the way dry toilets and composting work, since the waste is recycled.

It is important for the employees to have good communication skills and not to be afraid to handle excreta (although not directly).

2.1 Service during outdoor events

2.1.1 Assembling/dismantling

Assembly is a time consuming step. 15 to 20 minutes are needed so set up one cubicle. However, when several cubicles are assembled together more time is needed, because many clamps have to be installed to bind all the cubicles together and provide a sturdy structure.

To start with, the cubicles have to be set up individually and then bound together. The following step consists in installing the electrical system to provide adequate lighting and to connect to the water supply (for hand washing). The inside of the cubicles is then totally cleaned and disinfected (bowl, toilet seat, bin, bucket and shovel).

Then the bottom of the containers in the tepee urinals is covered with a layer of saw dust and a layer of straw. These two layers contribute to the provision of Carbon for the future compost, absorb the fall of faeces and reduce bad odours. Two 60 liters plastic containers are needed per cubicle in order to speed up their replacement once they are full.

Assembling the "Ready to Build" model requires the same steps.

The Tepee urinals are very easy to assemble. They are tied to the ground with metal stakes. When they are used on asphalted ground, the tepee should be ballasted in the center.

The last step is to install the signage.

The following example gives an idea of the time needed to assemble the sanitation on site for an outdoor event. The service requested for the Ysala festival in Lyon included the assembly of 7 “RTB” units, 1 tepee urinal and one PWD unit. Seven hours and 2 persons were needed, including loading the material into the truck.

Operational sanitation during the *Ramdam à Randan* festival.
Source : personal

2.1.2 Maintenance

The added value of the company is the provision of a service. The hire includes staff that regularly cleans up the toilets. It is necessary to disinfect them regularly and to remove the saw dust which accidentally falls between the sawdust bucket and the container. The company uses ecological cleaning products to minimise environmental impact.

The staff also changes the containers receiving solid and liquid waste. During events with many people the 60 liters containers have to be replaced every two hours. The buckets have to be refilled regularly with saw dust, toilet paper restocked and bins emptied.

The toilets’ cleanliness is very important for the marketing image of the company. Users are most of the time very satisfied with the toilets’ cleanliness, especially because they are not used to finding public toilets as clean and maintained. Many users even want to pay for the toilet after use or often handle compliments.

2.1.3 Human waste emptying

The emptying process depends on the location and the size of the event.

Whenever the event is large and far from the company' own composting sites (over 50km), the company works in partnership with local farmers who make compost. If the company fails to find such farmers, then it is possible to deposit the waste to a local Waste Water Treatment Plant, but this solution has seldom been used so far. For each cubicle there are at least 3 containers, in order to have a storage capacity good for one full day. Emptying is done once a day and the containers are cleaned and disinfected each time.

Emptying the containers
Source : personal

For smaller scale events, the company stores the full containers during the event and proceeds to emptying on their own composting site after the event is over.

When the company provides a hiring service on a large festival, expected collection volume is calculated proportionally to expected beer sales. For example, if the projected beer sale is 4,000 liters, then the expected volume of urine which will be collected is 3,000 to 3,500 liters.

2.1.4 Communication

The company generally covers two different types of event. Most of their activity consists in providing hiring service for the first type, i.e. in large musical festivals gathering up to 20,000 persons (*Fest'Route in Ardèche, Rock en Seine near Paris, Chalon dans la Rue in Saône and Loire region*…). The other type consists in smaller size outdoor events featuring stands and opinion groups (the Bird Festival in Sainte Croix en Jarez, *festival Dialogue en Humanité* in Lyon, Salon Primevère at Eurexpo…). The number of staff and the role of *Les Gandousiers* are different according to the event.

For the large musical festivals *Les Gandousiers'* main activity is to provide the sanitary service and advocacy and information activities are marginal. The information stand exists but is hardly visited. The sanitation function is the bulk of the service.

For the second type of events, the company acts more like an exhibitor, exhibits cubicles and shares their experience and knowledge with the public. In that case, information and advice provision take over the sanitation function.

In both cases, the company still provides the full service of assembling/dismantling the cubicles, maintaining the facilities clean and emptying the waste.

2.1.5 Saff security

In order to ensure hygiene and security the staff wears waterproof gloves, masks and security shoes. The number of gloves provided is high to allow the staff to renew them several times during one day. Medical disinfectant is used for hand washing. The mask is used to protect the staff from saw dust fine particles which can irritate lungs after prolonged exposure.

2.2 Building and repairing the toilets

Two employees are in charge of building and repairing the different types of toilets in a workshop located in Saint-Dizier-en-Diois.

2.2.1 Main construction weaknesses

The RTBs cubicles show a couple of weaknesses.

- The metal hinges located under the floor and enabling the stiffness of the cubicle often break. This is due to ill handling during the dismantling step. This happens especially with the simple toilets hiring. The repair consists in welding a new hinge on the metal part fixed to the floor, which necessarily implies returning the cubicle to the workshop in Saint-Dizier-en-Diois.

Weak hinge
Source : personal

- With wear and tear, the screws fixing together the different pieces of wood end up by pulling off.
- For the same reason, the bamboo sticks often split and lose their sturdiness. It is then necessary to replace them.

2.2.2 The new cubicles

Most of the cubicles are constructed during the low season between October and April, but sometimes construction is needed in high season to service exceptional demands. A week and a half is needed for 3 persons to build 4 cubicles.

The main tasks I undertook during my internship were manufacturing metal pieces, applying anti rust paint, varnishing wooden parts and assembling the pedestal.

Canvas is cut and sewn by a tailor in the workshop.

2.3 Logistics

2.3.1 Creating a check list

After working for a while on festivals and gatherings for *Les Gandousiers* I found out that logistics could be improved, especially to make sure nothing was forgotten during the equipment preparation step. Therefore I created a check-list (*annex 4*), listing down all the necessary items to pack up for a good service provision. The equipment is classified by type: wooden structure, canvas, maintenance and cleaning products, other items, etc.

This check list will help to prevent forgetting items , which can become a real problem on site. It is also quite helpful for the simple toilet hiring service because it allows the staff to control that all items have been returned. Last but not least it is an important tool for stock management.

2.3.2 Creation of a referencing system

2.3.2.1 Origin of the need

After setting up the check list, I suggested the creation a referencing system of all the toilets parts. To understand better, it is important to know that out of all the units, there are approximately 20 units which can be built with their own parts only. For example all the part of cubicle N°4 are identified and always mounted together.

This simple referencing causes storage problem because all parts have to be stored together which takes a lot of space and it is hard to find a specific part quickly. Moreover, during transportation, parts of different cubicles have to be mixed to maximise space in the truck. In spite of these problems, these toilets have at least the advantage to have a referencing system.

The new generation of cubicles has been built on the same model but it is possible to exchange the parts. With this new system there is no more problem of storage but problems during maintenance still occur. As it is long and difficult to identify broken pieces, they are sometimes loaded again in the truck for a new event when they need servicing. That is why a referencing system had to be created.

Another situation in which the referencing is useful is when units an equipment originating from the two or three warehouses are used together on a single event, it is then impossible to return exactly each item to the warehouse it belongs to.

2.3.2.2 Implementation protocole

In order to identify the warehouse, the reference bears a letter: P for Paris, L for Lyon and D for Saint-Dizier-en-Diois.

The cubicle is made of two parts: a wooden base *(« socle » in French*) and the canvas (*« toile » in French*) designated respectively by the letters S and T.

Each part of the base is identified by a letter (from A to H) and each part of the canvas is identified by a number (from 1 to 5). The roof is designated by the letter T (*roof is "toit" in French*)

The list of references is in *annex 4*.

The roof is made of several parts but with the same reference (T) because if one of them is broken, then the whole roof cannot be used.

For example :

- A frame without a door from the Lyon warehouse will be referenced as follows:

L SA +serial number

- A roof from Paris warehouse will be referenced as follows:

P TT + serial number

The new parts replacing broken ones will take their reference number. The reference will be pyrographed in order to resist humidity and wear and tear.

Ancient models will keep their number and will integrate the new reference system. Serial numbers of the parts of the new models will start at 20.

For PWD toilets, the system is the same. Only the definition of the parts changes. PWD toilets are marked with the letter H (« handicape" in French).

The tepee urinals are designated by the letter U, the serial number and also the letter designating the warehouse.

2.4 Guidelines for simple hiring service

Due to numerous break in the simple hire package, it was necessary to create a guideline for setting up and assembling the units (cf. annex 5) explaining clearly the different steps to set up correctly the "RTB" units. These guidelines will be part of all contracts for simple hiring.

3 Technical aspects

After five year of activity the company *Les Gandousiers* wants to improve waste management process. The company would like to study different options to treat and recycle human organic matter. Laws currently being elaborated in the field of human waste, management issues and emerging competition all push the company towards improvement of their operational activities.

In this context, the company would like to improve its competitiveness and to prepare itself to expected legal restrictions. In this study the challenge is double. First human waste should be managed more efficiently. This means to find new logistical solutions to transport the equipment and human toilet deposits.

Secondly, this reorganisation should then be integrated and adapted to recycling possibilities in existing composting centers. The management scheme and recycling process should also take in account the (not yet defined) legal aspects in order to ensure coherence and sustainability.

3.1. General data

The following paragraph provides general information about human waste and treatment options.

3.1.1. Study of the company's collected matters

3.1.1.1. Urine

- Composition and aspect

Urine is produced by the kidneys. It is made of water (95%) and of residues of metabolised elements such as NaCl and other mineral elements (5%). Urine also contains organic matter (Nitrogen), enzymes and hormones. Normally urine has a pale yellow colour, a saffron like and lightly acidic smell.

Composition	%
Organic matter	65-85%
Nitrogen	15-19%
Phosphorous (P2O5)	2,5-5%
Potassium (K2O)	3-4,5%
Carbon	11-17%
Calcium (CaO)	4,5-6%

Urine composition
Source : e-santé

- The metabolic role of urine

The physiologic role of urine is to eliminate waste from the body such as urea, creatinin (contained in the muscles and in the blood), medicines and toxins.
The kidneys maintain body constants by regulating water and mineral salts through urine excretion.

- A couple of figures

A human being urinates in average 5 to 7 times per day. Each day, we produce between 0,5 and 2 litres of urine. These figures vary depending on the person's age, sex, quantity of fluids absorbed, food habits, temperature, emotions… During festivals and outdoor events, the figure used to plan urine collection is that people produce approximately the same quantity of urine as the quantity of beer they have drunk. In case of sickness urine's odour or aspect can change.

- Use

Urine has been very much used throughout time. There is even a science dedicated to the use of urine: urinotherapy. It deals with internal and external uses of urine with a therapeutic aim. Urine is known to have strong anti bacterial properties. In Bolivia, doctors make medicines with fresh or fermented urine. Even in the pharmaceutical industry horse urine is used as an ingredient in certain drugs. Cow's urine was successfully used to fight against fungus that decimated pineapple plantations in 1997. Urine is also used to soften

hands, wash hair, whiten skin, get rid of freckles, fix dyes, whiten pearls, pickle metal, clean , etc. But the aspect which will be studied in this report is related to its fertilising properties.

Fresh or upon storage, urine is most of the time applied diluted with water (1/5). Neat urine could cause root or foliar burn. Urine is also best used to fertilise vegetables which have a high need in Nitrogen. Percentage of N in urine varies but as a rule of thumb urine contains 3 to 7 g N/l. For example, the urine produced by one person can fertilise $1m^2$ of vegetables growing in a kitchen garden during the growing season. Yields can be improved for most of vegetables by increasing this amount up to four times, rate beyond which additional fertiliser application becomes toxic.

Impact of hormones, pharmaceutical residues and other harmful compounds is not well known but existing studies suggest that these elements are most likely to degrade better in the ground due to micro organisms' activity than in water. Tests on compost undertaken in Norway in 1979 show that unless used at very high dose, antibiotics do not have a significant impact on compost. The quantity of heavy metals in urine being relatively small, the risk of heavy metal contamination is as well very limited.

Urine can be used in compost. It twill then act as an activating agent, especially when the compost is rich in carbonated elements (leaves, shredded branches, etc.)

3.1.1.2. Faeces

- Composition and aspect

Faeces contain mainly water (65 to 80%). Mineral elements and organic matter appear under the form of non metabolised food residues and of desquamated enteric cells. Faeces also contains a couple billions micro-organism and other various compounds.

Faeces can appear from yellow to dark brown, have a hard or liquid consistency and have various odour based on diet (a vegetarian will produce more faeces with a softer consistency than a carnivore who will produce smaller and more dense matter).

Composition	%
Organic matter	88-97%
Nitrogen	5-7%

Phosphorous (P_2O_5)	3-5%
Potassium (K_2O)	1-2,5%
Carbon	40-55%
Calcium (CaO)	4-5%

Composition of faeces
Source : e-santé

- A couple of figures

In average, humans excrete faeces once a day. Weight is between 100 and 300 g. These characteristics depend on age, diet and potential physical or psychological disorders. The company manages most of the time much larger quantities of urine than faeces, due to service provision to festivals.

- Use

As for urine, some doctors use faeces as drugs: they are called stercoral doctors. In the XIXth century they could order sheep excreta to cure whooping cough, horse manure mixed with bear to fight against weaknesses, pigeon droppings to cure baldness or fresh human manure against raging toothache. Nowadays nightingale droppings are still ingredients of certain hydratating creams.

Certain animals also feed on faeces, such as insects, dogs, pigs … It is used in fisheries especially in Asia.

In Afghanistan and in Kenya, cow and camel dung is used, mixed with mud and straw to build houses.

As for urine, faeces can be used as fertiliser after composting.

3.1.2. Composting

3.1.2.1. Definition

Composting aims at reproducing a natural process but with a higher control and speed. It consists in an aerobic transformation, generally considered as a fermentation (because some reactions are typical of fermentations). Composting enables organic matter to transform into stabilised soil amendment, rich in humus. The word « compost » designates the heap and the

final product. Compost is used to enrich and fertilise soil, i.e. to improve its structure, to increase water holding capacity and soil's capacity to provide nutrients to plants. Some nutrients will be immediately available for plants but for most of the nutrients, compost allows a slow release, hence ensuring balanced plant nutrition. Compost stability and progressive release avoid or at least minimise nutrient waste and pollution which are often generated by chemical fertilisers use.

Agricutural compost heap
Source : smra68.net

In composting process, the main actors which intervene in the different transformation steps are micro-organisms such as bacteria, mushrooms, actinomycetes (intermediate organism between bacteria and fungus) and macro-organisms such as manure worms and insects… The objective of composting is to provide favourable conditions for the proliferation of active organisms in order to obtain the best fermentation. The main parameters consist in aeration, moist, temperature and C/N ratio.

3.1.2.2. C/N ratio

Micro-organisms thrive on organic matter in which they find compounds necessary for their cellular growth: Nitrogen, Carbon, and Phosphorous. However, Carbon is the main source of energy for micro-organisms. Their need in Carbon is 30 times higher than that of Nitrogen.

Each type of organic matter can be characterised by its C/N ratio.

To provide the best composting circumstances, all the compounds gathered in the compost heap should tend towards a C/N mix of about 30 to 1. Results remain good as long

as the C/N ratio is situated in a range between 25 and 50. It is also necessary to aerate the heap to mix up the different compounds and feed uniformly living organisms.

The following table indicates the C/N ratio of carbonated elements. Urine and faecal matter both have a very small C/N ratio. It is therefore necessary to add up carbonated matter such as straw or saw dust. Saw dust is regarded as waste and discarded by some sawmills. It could be interesting to use this saw dust as a source of Carbon to compensate the lack of carbon in human waste.

Material	C/N ratio
Urine	0,8
Faeces	6 to 10
Kitchen waste	20 to 25
Garden waste	20 to 60
Cut grass	10 to 20
Leaves	25 to 60
Straw (from cereals)	50 to 150
Saw dust	150 to 500
Card board	200 to 500
Bovine manure	20
Horse manure	25
Manure and straw	23 to 30
Peat	30 to 50
WWTP sludge	11

3.1.3. The legal framework

Existing laws related to recycling human waste from dry toilets lead to two main difficulties:

- The French legislation implicitly states that human matter should be discarded through the mainstream flushing system. The legislation applies to « waste water treatment » and « residual water». According to the law, faeces and urine can only come out of a building through the water channel. This shows the persistence of the hygienist trend which appeared two centuries ago.
- Therefore, organic matter coming from dry toilets has no legal status.

As a consequence, human toilet deposits are regarded as domestic waste and are channelled through the normal sanitation network, individual or collective.

3.1.3.1. A couple of legal definitions

- Waste: *"any residual compound from a production, transformation or utilisation process, any matter, product or more generally any harmful good, already discarded or meant to be discarded by its owner…"* (Law of July 15th, 1975).

- Human waste (*dejection* in French / *faeces* in English*): no legal definition.

- Compost, fertiliser, agricultural carrier :

The legal memo (*circulaire*) of January 17th, 2002 related to the composting process in animal production:

« Composting is an aerobic biological process which provides biological oxygenation of a growing medium's organic matter. It produces gas (Co2 and Nitrogen volatile compounds), a high concentration in phosphorous and heat. The final product is more stable than the initial manure or than the average initial waste.
This process consists in aeration of organic matter which leads to a quick development of aerobic flora, proper to the growing medium and enables its stabilisation through degradation of organic matter.
The following steps have to be enforced:

- *Forced aeration or a minimum of two turnovers.*
- *A temperature over 55°C during 15 days or 50°C during 6 weeks.*

Moreover the products obtained shall be protected against recontamination through contact or through mixing with non composted inputs.

Composting goes with:

- *A temperature rise resulting from biological degradation of organic matter.*
- *A decrease of organic matter due to mineralization process and gas production (Nitrogen, ammonia and other volatile elements),*
- *Water evaporation due to heat.*

Final compost has humus like odour, is more stable than the initial waste and is agronomically valuable. Generally it does not necessitate any other Nitrogen source to be taken up by plants.

The January 7th, 2002 Order related to the definition of a composting plant or composting facilities is more precise:

« A composting facility is a facility which, based on a controlled biological aerobic process enticing temperature rise, enables sanitisation and stabilisation through degradation/reorganisation of organic matter, and generates compost intended to be sold or used as fertiliser or as raw material to produce a fertilising compound or a growing medium.

.

The facility should include at least:

- *An area for delivery/segregation/control of incoming products,*
- *An area or a facility for raw materials storage adapted to the nature of these materials,*
- *An area for preparation, if needed,*
- *One or several areas (or one dedicated facility) for composting,*
- *One area for maturing and sifting, if needed,*
- *One area to store final compost.*

The standards issued by AFNOR (the French Agency for Normalisation or Standards*), tackles the issue of human waste but once again under the chapter of « waste water »:

NF U 42 001: « fertiliser››
NF U 44 051: ‹‹organic soil improvement››
NF U 44 551: « growing medium »
NF U 44 095: « compost containing fertilising matter stemming from water treatment»

The Order from December 8th, 1997 (cf. annex 6) related to spreading sludge from Waste Water Treatment Plants. This order does not exclude the mixing of other waste as long as these waste have fertilising properties.

3.1.3.2. The legal gap

The entire legal framework related to sanitation, and in particular May 6th, 1996 Order regulating individual sanitation process and control, suppose that faeces and urine are

discharged through conventional water based sanitation. Discharge necessarily generates « waste water » (*eaux vannes*). Human waste has a legal existence under a liquid form only. Discharge and recovery of solid matter is not reckoned by the law.

However, a ministerial order from July 2008, related to non collective/household sanitation defines the technical process. This order has not been ratified yet and can still evolve. An extract of Article 10 is as follows:

« Dry toilets are operated:

- *Either to treat together urine and faeces. In that case, they are mixed together with organic matter to produce compost.*
- *Or to treat faeces through a drying process. In that case urine should be discharged in the domestic waste water network. The sizing of domestic waste water should be adapted accordingly. »*

The integral version of article 10 is in annex 7.

In the same ministerial order, article 16 deals with the elimination and spreading of residual waste and by products treated through dry sanitation as in article 10:
« The elimination of residual waste and by products issued from sanitation should be done according to legal provisions. These products and by products should be recycled on the land plot, in compliance with the law in force and should generate no nuisance nor pollution for the neighbourhood. These products and by products can be in a solid or liquid form and have to abide by the conditions defined in Article 10."

Two points should be underlined in this ministerial order:

- It only takes in account « domestic use », i.e. regular use in a single house.
- Recycling to the earth is a recommended way for treatment, which means that residual waste from dry sanitation would have a special status and would not be tied to the conventional sanitation system.
- This treatment mode necessitates sufficient land.

Although a legal framework is currently being prepared and will give a status and recommendations for the treatment of disposal issued from dry toilets, the specific use in public events is not taken in account. The legal framework seems to encourage recycling to

the earth. Moreover there are other similarities with existing laws and decrees on the spreading of agricultural compost and Waste Water Treatment Plant sludge. It is possible that the legal framework for dry sanitation waste will be the same.

3.1.3.3. In Europe

In Germany the legal framework in this field is issued by the Landers. But it is interesting to point out that the sanitation of a few urban districts totally relies on composting toilets. Similar cases exist in Sweden.

3.2. Composting at local level (close from the festivals)

The choice to proceed to the treatment of residues in the company's own storage and composting centers or near the events' site depends on the distance between one of the centers and the event where the service was provided. If it is less than 50 km, then composting will be done by the company. Over that distance, the company will work with a partner. The three centers are different and treatment of waste is also done differently in each of them.

3.2.1. Description

3.2.1.1. In Paris

The composting area is lent to the company by a private individual who makes vermicomposting on his private land. This is an asset for the company which is able to subcontract the treatment of the collected matter.

3.2.1.2. In Lyon

The storage and composting unit situated in Lyon is lent by the horse club of the city of Miribel. The cubicles are stored in 4 horse boxes which are out of use. Full human waste containers from the dry toilets are emptied on the horse manure heap. The manure is then collected by a private company which transforms manure into compost. Les Gandousiers pay 50 € per ton of waste discharged. The center provides also an asphalted slab to clean the cubicles and the containers. Wash water is drained to the manure heap.

The horse club has a lot of unused land and the managers are ready to lend a field for the company to set up a composting unit. Moreover, Miribel center is well situated, close from a major road network around Lyon and towards Paris.

3.2.1.3. In Saint-Dizier-en-Diois

The composting area is situated in this very small village and close by events are very rare. Composting takes place in the middle of a field where cattle gaze. The compost heap also receives organic waste and excreta from some of the villagers and from a farmer. The heap is located more than 500 meters from a water body. The slope of the field is approximately 5% which is accepted to make compost.

3.2.2. Proposed recovery modes

Considering that the three composting areas are different, several treatment options are possible. These options depend on the fields' characteristics and on environmental factors. Some recovery modes require urine and faeces separation before collection. This report proposes 6 possible recovery modes.

3.2.2.1. Separation of urine and faeces

For urine the main problem at stake is volume, and for faeces the main issue is public health (hygiene). Separation at source addresses both problems because it enables to treat independently each kind of waste. When urine is collected separately the large quantity of fertilising elements enables a quick and easy recovery. Moreover faeces and urine have their own recovery ways.

3.2.2.2. Conventional composting

Conventional composting was described in paragraph 3.1.2 and is the treatment mode used in Sain Dizier-en-Diois. This composting mode seems to be authorised by July 2008 ministerial order but there is a lack of information for "corporate" composting (vs. individual composting at household level). Besides, private treatment of human manure is regulated by the law. As a consequence it is possible that composting human manure from collective event could be illegal unless human excreta are considered as sludge of as agricultural waste. In any

case this mode of treatment is likely to be soon regulated with the risk that the new regulation will forbid it. It might be a good idea to find another treatment process before it becomes illegal.

3.2.2.3. Vermicomposting

In conventional composting, earth worms complete the work already started by micro-organisms. In the case of vermicomposting, conditions are created so that the worms carry out most of the degradation of organic matter themselves. Worms can live and feed on faeces only but preferably on partially dehydrated faeces for efficiency reasons. Worms can digest up to 100% of their own weight daily and can reduce organic matter's volume by 80%. The compost obtained by vermicomposting has a high quality.

Picture taken inside a vermicomposting unit

3.2.2.4. Methanation

Composting can be combined with another technique: biogas recovery through fermenting. This recycling process cannot be done at household level (unless animal manure is added) because the quantity of waste would not be sufficient to provide cooking gas for all the family. However, in a public building (like a school or a collective building), or in the case of *Les Gandousiers*, where human waste is abundant, this technique is attractive.

Fermentation consists in organic matter degradation to simple gaz and mineral compounds and produces « biogaz », which can be used as fuel. Fermentation results from microbial activity and is a two steps process:

- Hydroloysis : macro molecules are degraded in more simple compounds. It consists in liquidification or gasification of the molecules into fatty acids or even gas,
- Acid, salt or gas transformation in methane or in other gazes.

Fermentation results mainly from methanogen bacteria. These bacteria are often found in natural sediments, in leach fields, in cattle stomach, in waste water…

To recover methane from compost, a dome is constructed over the composting using with collectors placed inside the compost heap which record temperature and hydrometry. The more time the composting process will take (if the conditions are not optimal), the less methane will be produced. As methane is lighter than air it will rise under the dome where it will be simple to collect it (*cf. annex 8*)

It will then be purified to take out undesirable elements such as dust through the use of physical and chemical filters (water curtain, earth filter…)

Possible biogas uses:

- To heat up air or water. No transformation is needed. As combustion is almost complete, if the system is well built there will be no harmful emission.
- To run cars: cars with diesel engines can be equipped with a tank and use biogas. Autonomy can reach 120 km with an 80 liters tank filled with compressed biogas.

3.2.2.5. Hybrid system: composting on a slab and planted filters

Composting on a slab is very similar to conventional composting, except that compost is not in contact with the ground. The advantage of this system is to limit leachate and soil pollution.

Planted filters use the treatment properties of aquatic plants. Aerobic bacteria (which need oxygen and do not produce bad odours) transform organic waste into mineral waste readily up taken by plants. Aquatic plants release oxygen through their roots and provide it to the bacteria.

Treatment steps:

- Pre-treatment (grease trap): eliminates the biggest particles and avoids pipes clogging.

- Water flows in different tanks filled with draining substrate, stones, gravel bed, pozzolona and plants which act as a growing medium for aerobic bacteria and other micro-organisms which convert organic matter.
- Aquatic plants develop a root system and rhizomes which grow into the substrate and allow aeration and good filtration.
- UV beams have a disinfection action and efficiently supplement the treatment by plants.
- The treatment can be completed by a settling pond for further polishing.

Due to the company's activities, the flow of input material is seasonal so solutions should be found to maintain the plants (e.g. by feeding the compost regularly). But this treatment option has many advantages. Construction and maintenance costs are relatively low and this kind of unit can even be built by individuals.

This treatment system is also flexible because it is possible to treat faeces and urine separately or mixed. Urine overflow gravitates directly in the plant filter.

3.2.2.6. Water hyacinth and water lentil cultivation on urine stream bed

As the company collects important volumes of urine, it would be interesting to be able to treat urine independently. Water hyacinth and lentils are aquatic plants which withstand high urea and high nitrogen concentrations.

Water hyacinths are already used in WWTP for water treatment.

- Water hyacinth grows rapidly and therefore has a high biomass production which can be reused as food for fisheries or can be burnt to recover energy. But it is an invading plant which can cause eutrophication of water bodies. Therefore its cultivation should be done in separate ponds.
- The water lentil has many properties, including purification capacity but is less prone to proliferation. Its growth is impressive as it doubles its weight in two to four days. Its exponential growth is like the growth of micro-organisms than that of a macrophyte. Moreover water lentil is common in France. Its protein value is approximately 35% of its dry weight, which is comparable to soy. It is a good

nutritional supplement for fisheries and for bovine cattle raising. Lentils are used in some WWTP in United States.

A water tight lagoon has to be built to cultivate lentils. No other treatment is necessary and lentils are harvested on the water surface.

If lentil or hyacinth cultivation cannot be done immediately it is still possible to compost the collected matter to close the loop.

3.2.2.7. Alguae cultivation

Commonly called «pond foam», stringy algae grow in floating patches on the surface of ponds and have been up to now regarded as weeds. Recently they have become the center of advanced research because they have several advantages.

If used as bio fuels, they are not controversial because they are not traditionally used to feed the population and do not use arable land to grow on. Their growth rate is incredible: these unicellular organisms are able to double their biomass in a few hours only, contrary to traditional plants such as soy or corn. Their lipids can be transformed into bio fuel or bio diesel and they absorb Co2, Nitrogen from waste water, and industrial pollutants such as N02.

To live, algae only require Carbon, sun and water. They withstand easily dirty or salty water. Some species contain as much as 50% of their weight in fuel, a performance between 30 and 100 times superior to other conventional cultures. Laboratory tests show that algae can produce up to 19 000 litres of bio fuel per acre and per year. By comparison, on the same surface and during the same time, soy produces 190 liters of fuel, maize 110 liters and palm tree 2 500 litres.

Cultivation requires an important surface in order to obtain a sufficient volume of micro algae to be processed. In France, there is no existing research center in this field.

3.2.3. Treatment and reuse options in the company's centers

3.2.3.1 In Paris

The storage and composting center near Paris is small and the company does not own any land in this area. However, it is an option to increase the size of the vermicomposting unit to fit the volume of input material collected, in partnership with the owner. Adapting the existing unit to allow a more efficient treatment would entail limited labour costs only. Considering the current characteristics of the land, no other option can be reasonably considered.

But, with the future issuing of a legal framework on human waste composting, the company might be forced to purchase new plots in Paris area, as plots will most likely have to be located at least 100 meter from any household and 1.5 meters above the water table.

3.2.3.2. In Lyon

In Lyon the horse club is ready to let for free a part of their land or building to help *Les Gandousiers* in their activity. A 250m^2 building is unused and would be a perfect location to create a treatment unit. All the treatment options listed in 3.2.2 can be implemented on that site.

The most interesting option for treatment and increased added value is methane production because it links biogas production and compost. The disadvantage of this method is that it needs capital investment to build large infrastructures and that the feed flow for the compost should be continuous. Moreover the capital investment and maintenance costs are too high for the company alone. However, the company could make a partnership at different political levels (city, region and State) to start such a unit.

In the mean time, composting on a slab coupled with a plant filter (paragraph 3.2.2.5.) looks as the best option to obtain good result in compost production with minimum maintenance and with ground protection. It also allows urine and faeces mix as urine overflow will gravitate directly into the planted bed. Low feed periods will give enough time for the compost to mature which is a definite advantage compared to other techniques.

This system is autonomous, but it would be interesting to undertake other options as pilot projects and to partner with University Research Centers.

Urine stream bed cultivation of water hyacinth and lentils is currently being experimented in Canada, United States, Argentina and Palestine. It would be a good opportunity for the company's image and future development to set up experimenting ponds in partnership with Universities and laboratories in the region. The main substrate for this cultivation is urine, which is the most abundant collected matter due to the company's activities.

Moreover, the center in Lyon is the most active one with most of the patrons and service provision, land is much cheaper than in Paris, and the city of Lyon is well situated geographically (roads, universities, etc.).

3.2.3.3. In Saint-Dizier-en-Diois

This site collects the smallest quantity of human waste. The compost heap as it is currently is in line with the current norms on compost. Besides, it is supplemented by the villagers. But, depending on the future legal framework, the company might be obliged to set up a separate system for human manure composting.

Drôme valley municipalities, where the site is situated, are currently setting up the BioVallée® project. The project aims at improving the living environment of the area. The municipality of Saint-Dizier-en-Diois is part of this project and there are several opportunities between this project and development options and needs of *Les Gandousiers*.

The BioVallée® project aims at:

- composting 100% of organic waste by 2014,
- promoting environmental building (dry toilets ?),
- decreasing by half chemical fertiliser use.

The Biovallée plans to set up several composting sites which will eventually accept dry sanitation residues. Projects should be submitted by private businesses or by public organisations. Several composting units will be created and will potentially accept dry toilets residues. These projects have to be submitted by businesses or public organisations. *Les Gandousiers* is currently drafting a project to create a green composting site on the municipality of Barnave. The goals of the composting platform are to compost a part of the BioVallée®'s organic waste and dry toilet residues, to include an educational module and to propose training sessions on dry toilet's and composting. This site should be operational by

2012. Moreover a methanation plant accepting dry toilet residues is already operational in Rémuzat.

3.3. Urine management on site (of festivals, gatherings etc,)

Currently the company collects urine and faeces in (60 liters) plastic containers. The advantage of this system is that it is very simple and that collected matters can be treated together. But this system is not perfect because it does not allow (except for the tepee urinals containers which receive urine only) to recycle urine and faeces according to their properties Only the tepee urinals' containers collect urine only (cf. 3.2.2.1.).

3.3.1. Towards space and transport savings

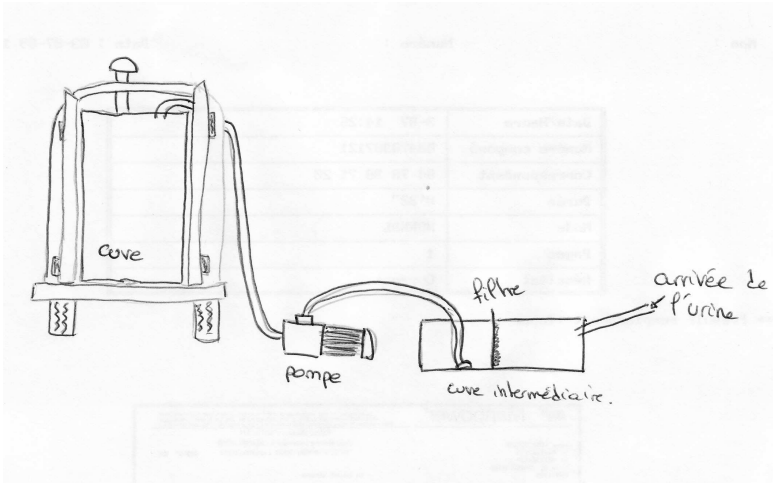
The choice to use 60 liters containers to collect the toilet deposits has shortcomings especially when it comes to handling. Indeed, during large events each of the 15 toilets can fill up 4 to 5 tanks each which totals up to 75 tanks and 4000 liters of collected matter (the containers are never full). 80% of the content is urine. The tanks are carried from the site of the event to the vehicle and from the vehicle to the emptying platform. The handling process is physically very difficult for the staff as well as time consuming. On top of carrying and emptying, each tank has to be cleaned to ensure pathogens elimination. Moreover a large number of containers have to be available at all times to have 24 hours autonomy. The company could save on labour and transport (with regards to volume) by changing its collection technique.

3.3.2. Technical aspects

Transferring the collected matter from the toilets to the vehicle could be done by water tight pipes.

A proposed solution would be to put up a tank of 2 to 3 m^2 at the back of the vehicle to collect urine only. The company vehicle is a $12m^3$ van. The tank would eat space at the back of the van but would decrease radically the number of containers. Urine would be pumped with an electric pump with a 150l/hour capacity. The pump should adapt the flow to urine quantity. To ensure a good operating mode and absorb peak uses and production a 200 liters

tank should be placed before the pump. This tank would act as a buffer for cubicles and tepee urinals liquid production and should be equipped with a filter.



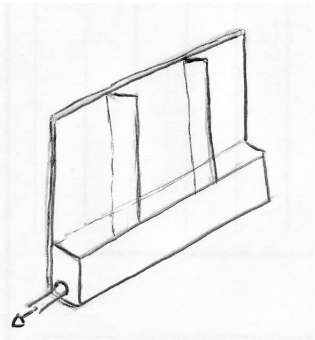
System for urine storage
Source: personal

Cuve = tank
Pompe = pump
Cuve intermediaire = buffer tank
Filtre = filter
Arrivee de l'urine = urine inlet / incoming flow

3.3.2.1. Tepee urinals

The containers used in the tepee urinals receive urine which can be easily pumped. This means that the urinals design should be modified. Several solutions are possible :

- Conventional design: easy to design, build and maintain.



Simple urinal design
Source : personal

- Adapting the current design so the plastic container has a collection function only and no more storage function. The tepee urinal is important for the image of the company so it could be a good idea to keep it for marketing purposes.

3.3.2.2. RTBs

RTBs receive excreta and urine in a single plastic container.

Toilet models separating urine and excreta exist. The pans are designed to divert urine from faeces directly. A little urine might flow into the faeces bowl without causing any

problem because if added to faeces in small quantity, urine activates the composting process. This system could be used in the existing cubicles without minor changes:

- Resize the pan,
- Change the bowl (install a diverting bowl with a separation)
- Make large slits in the structure for urine pipes (the structure will not be weakened because the supporting structure will not be damaged.)
- Use flexible piping for fittings.

Faeces will fall directly in the containers already used by the company. Urine will be bypassed from the conventional flow.

3.3.2.3. PWD cubicles

PWD cubicles are seldom used and a small quantity of matter is collected. It is therefore unnecessary to install a diversion system. Collected material will be treated with faeces.

3.3.3. Advantages of Urine Diversion system

Source separation allows diverting urine and liquids in view of a separate and efficient recycling process. It is always possible to mix urine with faces afterward if needed for a total composting. Separation, followed by adapted collection allows saving space and time. A tank with a $2m^3$ capacity replaces 32 containers and saves space and maintenance (cleaning, handling …). Besides, the system is more autonomous so that the staff can spend more time on communication and cleanliness of the facilities. This system needs a smaller technical space and permits better ventilation.

Another advantage consists in fossil energy savings. Except for the use of a generator, the number of trips between the event's location and the emptying site will be reduced. Carbon footprint is finally better.

Without urine diversion, the 150 m^3 of mixed matter collected need to be supplemented with a $100m^3$ of high carbon content matter to obtain a good C/N ratio for composting. With the diverting system the $30m^3$ of collected faeces only require $15m^3$ of high carbon content matter to be composted.

3.3.4. Disadvantages of Urine Diversion system

It requires mechanisation and therefore possible technical problems. Besides the pump will need electricity, which is most of the time provided by the event organiser but it will be preferable to purchase a generator in case of breakdown. The use of the generator can have a negative impact on the ecological image of the company.

Installing a tank in the van will limit available space for other uses and purchasing a new vehicle might be an option. Besides, the vehicle will have to be in the proximity of the toilets when they are in use.

Adopting a diversion system entails a change in the design of all the company's facilities, which might not be possible now. However the shift can be done in two steps. A new design for the urinals in a first step, because they generate the biggest volume of urine and could save 50% of the existing collection containers. It is also the easiest system to implement.

3.4. Management mode of the company related to recycling mode

3.4.1. Urine as natural fertiliser (cf. 3.1.1.1.)

Les Gandousiers collects in average 120 m^3 of urine every year. This amount can be spread in fields to fertilise between 5 and 10 ha, with prior urine dilution (1/5 which corresponds roughly to 600 m^3). The surface which can be fertilised is therefore quite limited.

Urine can also be mixed with saw dust and be spread as such.

In any case urine is a sterile material, which normally does not contain any pathogen organisms. It can be spread without any sanitary problem. In some Scandinavian cities conventional toilets were even forbidden 7 years ago to promote diversion toilets. Urine is then systematically spread by farmers. (*cf. annex 9*).

3.4.2. In the proximity of the company's storage and treatment sites

When the events are close from the storage and treatment sites, all the solid material is composted. For urine, the recycling process varies. In Paris, if urine is not spread, then it is mixed with saw dust and with organic waste in order to be vermicomposted.

It will be possible to recycle all collected matters in Lyon with the existence of an experimental site and with the composting system.

3.4.3. Far from the company's storage and treatment sites

When the event takes place far from the company's storage and treatment sites, the process will depend on volumes collected. The volume of collected faeces is often small enough to be systematically transported back to the composting site. For urine it will depend on how full the tank is, but it is always preferable to recycle it on site, rather than transporting it on a long distance.

Conclusion of the study

The management of human organic matter is complex considering the number of constraints imposed to this type of service. The company has to juggle between 3 storage and treatment sites and service provision to events taking place everywhere in France.

Moreover, it is a real challenge to manage and recycle material which still has no legal status and with yet unknown commercial possibilities. This study is based on the hypothesis that the law will evolve. However, it might take time since thorough studies on potential sanitary and environmental risks are still lacking. The Scandinavian experience proves the efficiency of urine spreading for the last 7 years and we are still far for this model. Different volumes, geographical location of each event and recycling possibilities oblige the company to manage each event case by case.

Conclusion

The company *Les Gandousiers* provides in the end more than a mere sanitation service. It promotes old treatment and recycling methods which have long been put aside. More than collecting pee and poo, the company raises public awareness on important challenge such as water scarcity and arable land destruction through large use of chemical fertilisers.

Five years after its creation, the company has to take a new turn for several reasons. Sanitary services are starting to pay attention to the management process of collected waste, but as the legal knowledge in the field is still limited a legal gap remains. Moreover, the company's turn over was multiplied by 20 since the first year and the number of clients keeps increasing. The company has grown and should adapt its management to the size of its client book. Last but not least the number of dry toilets service providers has increased to approximately 30 companies and associations in France and the company now has to deal with competition.

Unlike most of its competitors who work locally, *Les Gandousiers* have a good geographical extension with its three storage and treatment sites (Paris, Lyon and Saint-Dizier-en-Diois). It gives the company a good geographical coverage but also demands a perfect management of equipment, staff and collected matters. The more the company will grow, the more it will need labour. It might then be necessary to find technical solutions to limit labour expenses as labour already represent a good share of the toilets' hiring price.

Many techniques to recycle organic matter exist and have each their advantages and shortcomings. But in any case, only those approved by the law will be authorised for implementation. One should not forget that human faeces, unlike cow manure for example contains pathogens, and that therefore composting is compulsory. Urine being sterile do not present any risk if used directly.

The future of the company depends on future decisions with regards to recycling of human organic matter and use of compost.

Glossary

Vermicomposting (*lombricompostage*)

www.ecojm.org

Aerobic transformation (*transformation aerobie*)

Sifting (*Criblage*)

Leachate *(Lixiviat*)

Pozzolana (*Pouzzolane*)

Lagooning (*Lagunage*)

Acre (*acre*)

Annexes

1 - The Gandousiers leaflet

2 – Informative handout

3 - Charlie Hebdo article

4 - Check-list

5 – Instruction for assembly

6 - Sludge : December 8th, 1997 decree, January 8th, 1998 order

7 - Article 10 of July 2008 ministerial order related to dry toilets.

8 – Principle of methanation

9 – Conventional water closet prohibited

1 – Les Gandousiers Leaflet

Pourquoi des toilettes sèches

Respecter l'eau
Ne pas la gaspiller et ne pas la polluer.

Nourrir la terre
Le compostage valorise les matières en amendement et fertilisant naturels.
Nos excrements sont des ressources !

Assurer l'hygiène et le confort
Nos toilettes sont propres et sans odeurs.

Modules

Des toiles épaisses, tendues sur des bambous.
Des sièges en bois, sur des fûts recevant les matières.

- Toilettes sèches prêtes à monter (PAM).
- Urinoirs (Tipissotières).
- Toilettes pour Personnes à Mobilité Réduites (PMR) et jeunes enfants accompagnés.

Cabines séparables prêt à monter modulables.

Les prestations, Service Gandousiers

Livraison, montage et démontage des toilettes sèches.
Maintenance (nettoyage, papier, sciure).
Prise en charge du futur compost.
Lave-mains.
Accueil du public (documentation, expo, conseils).

Une utilisation simple

Au lieu de tirer la chasse, l'utilisateur ajoute un peu de sciure qui absorbe les liquides et neutralise les odeurs.

Location Simple

Enlèvement du matériel au dépôt des Gandousiers
Mini Formation (montage, maintenance, compost)
Gestion complète (compost) à la charge du client.

La tipissotiere

2 – Informative handout

Toilettes sèches ?

Imprimé par nos soins

Pourquoi ?

Parce que nos toilettes sont propres, naturelles, et sans odeur.
Parce que l'eau est précieuse et qu'elle le sera de plus en plus.
Parce que le compostage permet de récupérer les matières afin de fertiliser nos cultures naturellement.

Comment ça marche?

Au lieu de tirer la chasse d'eau, le public est invité à rajouter un peu de sciure, qui absorbe les liquides et les odeurs, et apporte ainsi le carbone nécessaire à un bon compostage.

Compostage?

Le mélange excréments/copeaux après un certain temps et quelques opérations (brassages) devient du compost.
Le principe étant le même pour l'urine et la paille.
Le tout pouvant être mélanger à du fumier animal, (cheval, brebis...) permettant ainsi un meilleur rendement.
Le compost ainsi obtenu peut être utilisé pour les cultures comme fertilisant .

les Gandousiers

Service de toilettes sèches
Solution naturelle pour tout rassemblement.

DROME (Siège social)
Philippe Garin-Michaud
le village
26310 St Dizier en diois
06 27 74 49 76
philippe@gandousiers.com

LYON
Pierre Berthillier
20 rue de flesselles
69001 LYON
06 14 27 43 23
pierre.berthillier@neuf.fr

PARIS
Manon Querel
11 rue leon Frot
75011 Paris
06 34 3104 31
lesgandousiersdeparis@yahoo.fr

www.gandousiers.com

3 - Charlie Hebdo

4 - Check-list

Les Gandousiers

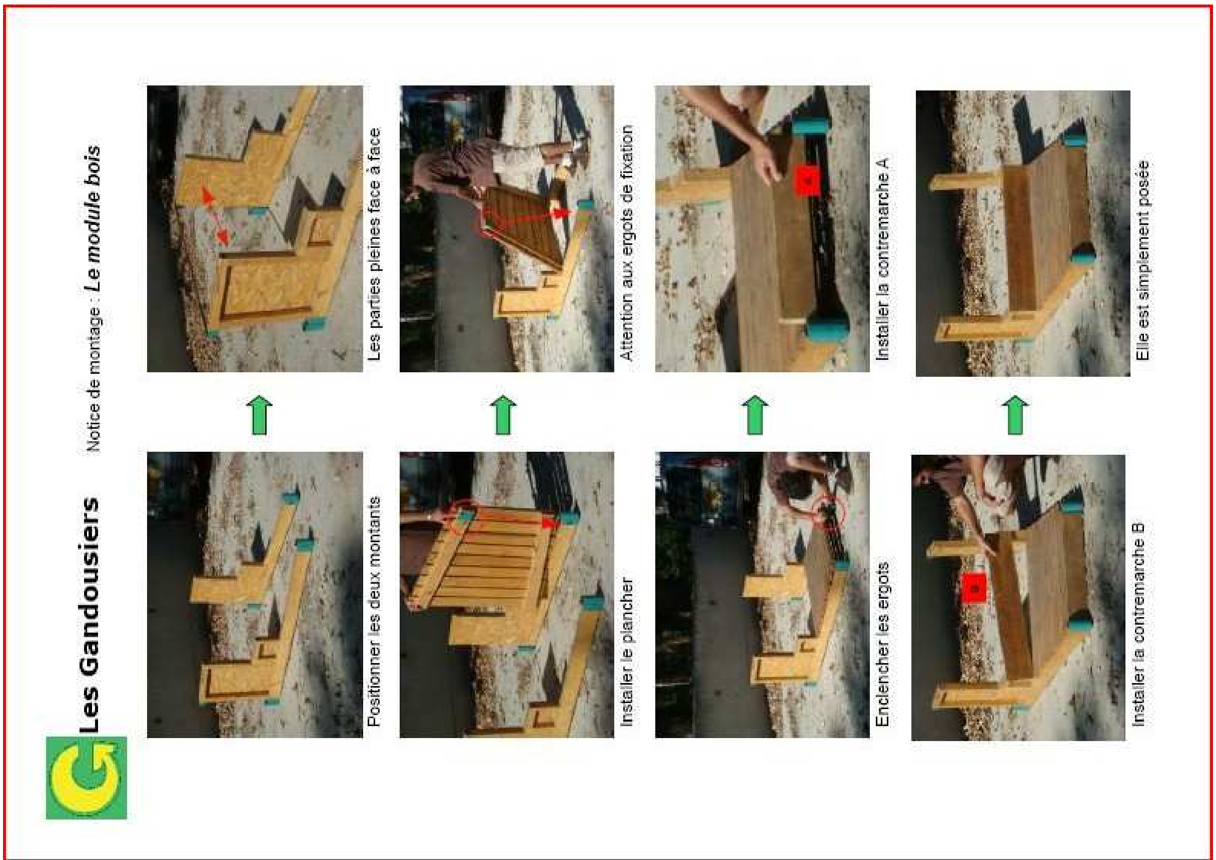
Check-list PAM

Dépôt :

Responsable :

structure bois	référence	loué	rendu	casse
A - bâti1 (sans fixation porte)				
B - bâtit 2 (avec fixation porte)				
C - contre-marche 1				
D - pallier				
E - contre marche 2				
F - marche				
G - contre-assise				
H - assise				
Package toile				
T - toit				
1 - bambou 1 (devant)				
2- bambou 2 (derrière)				
3 - toile				
4 - bambou libre				
5 - bambou libre				
Porte (T)				
Matériel/PAM				
poubelle				
réceptacle				
sceau				
truelle				
lunette				
Fournitures				
papier toilette				
sciure				
paille				
savon				
Signalétique				
Entretien				
nettoyant WC				
désinfectant				
gants				
sac poubelle				
boîte à outils				
guirlande électrique				
ralonge				
lavabo				
géricane				
ficelle				
publicités/fly				
exposition				

5 – Instructions for assembly



Les Gandousiers Notice de montage : ***Le module bois***


Positionner le marchepied


Installer la contremarche C


Installer l'assise

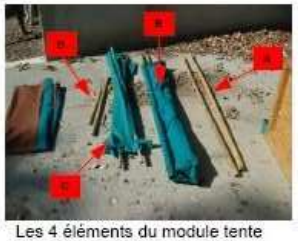

Attention aux ergots de fixation


Les ferrures à l'extérieur


Le module bois est monté

Les Gandousiers Notice de montage : ***Le module tente***


Le module tente


Les 4 éléments du module tente


Installer les montants A


Fixer la toile B


La toile B est montée

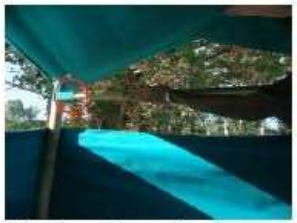
Les Gandousiers Notice de montage : ***Le module tente***



Fixer le toit C aux 4 montants



Le toit C est monté



Fixer les raidisseurs D — A l'arrière du module



A l'avant du module

Les Gandousiers Notice de montage : ***La porte***



Présenter la porte — Le loquet comme ci dessus



La tige basse à l'extérieur



fixer la tige dans le gond haut — Dans le gond bas


Le module est monté

Les Gandousiers Notice de montage : ***La lunette***

Enclipser la lunette sur son support

Fixer la bavette dans l'ouverture

L'ensemble est monté

Glisser le réservoir par l'ouverture

Positionner sous la bavette

Poser le seau de sciure et la poubelle

Verser quelques louches de sciure

6 - Sludge : December 8th, 1997 order, January 8th, 1998 order

« **Art. 1** – The aim of the current order is to define the conditions under which residual sediments from waste water treatment or biological, physical or chemical preliminary treatment facilities, hereafter called « sludge », can be spread on agricultural or forest land or soils under recovery or under revegetation.

Art. 2. – Sludge is considered to be waste, as defined by July 15th, 1975 Law.
Authorisation or declaration are defined by chapter IV hereunder.
The current order does not apply to:

- Sludge or sludge containing compounds which as per July 13th, 1979 Law are homologated or have a temporary sales or importation authorisation or are conform to an established norm.
- Sludge which spreading already falls under the July 19, 1976 Law.

Art. 3. – Provisions of the current order define general hygiene rules and other rules which aim at protecting health as per article L1 or the Public Health Code, related to manure spreading. They overrule previously existing sanitary orders.

Art. 4. – Material issued from cleaning waste water collection facilities can be considered as sludge only after undergoing a treatment to eliminate grease and sand. Without this treatment, spreading is not authorised. Mixing sludge from different treatment facilities is prohibited. However the prefect has the power to authorise the gathering of sludge in storage or treatment facilities, if the content of this waste abides by the conditions defined in chapter 3.
The prefect can also, under the same condition, authorise the mixture of sludge and other waste, if this mixture aims at improving the agricultural characteristics of sludge spreading. Material issued from individual sanitation facilities are considered to be similar to sludge issued from Waste Water Treatment Plants under the present order.

7 - Article 10 of July 2008 ministerial order related to dry toilets

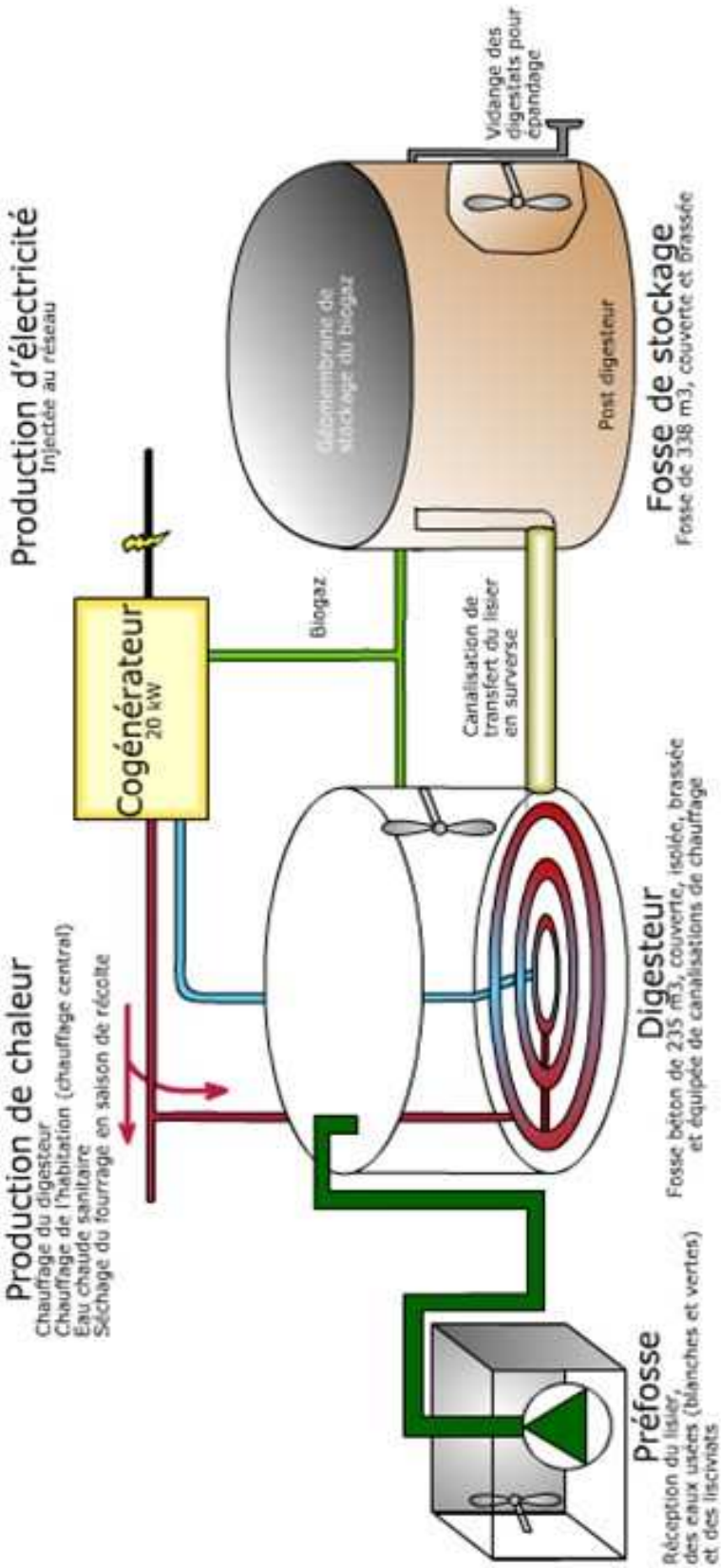
Dry toilets can be used:

- Either to provide treatment to urine and faeces together. In that case they shall be mixed with organic compound in order to produce compost;
- Or to treat faeces through a drying process. In that case urine shall be treated together with domestic waste water, as per the provisions of articles 5 to 8. Domestic water network provisioning shall be adapted.

Spreading of sanitation by products is only possible under the following conditions:

- Spreading, emptying or rinsing is not authorised within 50 meters of water points, drainage, manholes and within 100 meter of recreational waters, fish farming, conchological areas and water collection areas for human or animal consumption. A higher distance shall be respected in conformity with the regulations related to classified facilities for environmental protection, to water laws, to water catchments for human consumption, including natural mineral water or to district sanitary regulations.
- Preventive measures shall be taken to avoid risks of wash out by surface run-off or underground leachate. In particular manure spreading, emptying or rinsing are banned when the ground is frozen or heavily covered with snow, on high slopes fields, on highly porous grounds or with cracks. Spreading shall be undertaken on soils which have the capacity to absorb domestic waste water out of specific periods of water saturation or drought.
- Spreading, emptying or rinsing on one designated area is possible only once a year.

8 - Methanation



9 - Conventional toilets forbidden

Source : Christophe Elain, *Un petit coin pour soulager la planète*

WC CLASSIQUES INTERDITS

À Tanum, en Suède, les 12 000 habitants se répartissent entre plusieurs zones urbanisées et un habitat dispersé dans la campagne ou sur la côte. En janvier 2002, la réglementation en matière d'eau et d'assainissement a été revue afin de diminuer les pollutions provoquées par les eaux usées rejetées et insuffisamment épurées. Ainsi, la mise en place de WC classiques est maintenant interdite dans les nouvelles zones d'habitation et les réhabilitations de maisons en campagne. L'objectif visé, c'est que l'urine ne soit plus évacuée avec les eaux usées. Du même coup, l'essentiel des éléments azotés que ces eaux contiennent habituellement est retiré puisque la plus grande partie est apportée par l'urine. Il y a maintenant obligation de s'équiper soit de toilettes à compost sans séparation, soit de toilettes à séparation. Fin 2004, 500 maisons sont équipées de toilettes à compost qui permettent de gérer la totalité des excréments sur place. À cela s'ajoutent 300 maisons qui récupèrent et stockent leurs urines. Parmi ces 300 maisons, la moitié composte les matières fécales tandis que l'autre moitié les évacue au moyen de l'eau (leur destination étant alors une fosse toutes eaux ou le tout-à-l'égout là où il est présent). Chaque logement qui pratique la séparation est équipé d'une cuve de stockage de 3 m^3. Plusieurs habitations peuvent se raccorder à une même cuve, la taille de cette dernière est alors prévue en conséquence. Stockées pendant un an, ces urines sont ensuite récupérées par des agriculteurs (sept actuellement) qui les utilisent comme fertilisant dans leurs champs. Pour le service rendu, les habitants versent chaque année entre 70 et 110 euros à l'agriculteur qui vide leur cuve. À la bibliothèque et au lycée de la ville, des toilettes à séparation ont également été installées. Lors d'un sondage, 65 % des utilisateurs se sont déclarés satisfaits de ce système. D'autres villes en Suède sont actuellement en train d'étudier la mise en place d'une réglementation identique.

À Tanum, en Suède, les agriculteurs épandent les urines collectées.

Bibliography

Ouvrages :

Christophe Elain, *Un petit coin pour soulager la planète*
Association Toilettes du Monde, *Des toilettes sèches…à la maison !*
Kathleen Meyer, *Comment chier dans les bois*
Dominique Laporte, *Histoire de la merde*
Thierry Salomon et Stéphane Bedel, *La maison des (néga)watts*

Sites internet :

www.verslaterre.fr
www.energierenouvelables.com
www.smra68.net
http://biogaz.free.fr/
www.eautarcie.fr
www.eauvivante.free.fr
www.fondationensemble.org
www.gandousiers.com
www.toilettesacompost.org
www.tdm.asso.fr