DEMONSTRATION PROJECT:

Composting Toilet Technology in Urban Apartments & Agricultural Trials for Beneficial Reuse of Residues

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Executive Summary

The authors (and other team members as noted in the acknowledgements) have conducted a feasibility study as the first stage of a proposed 5-year project to design, build, demonstrate, monitor and assess dry composting toilet (DCT) technology applied in urban areas (inner city apartments), leading to potentially more ecologically sustainable solutions for urban sanitation.

The project addresses minimisation of water use and pollutant or nutrient discharges to the environment. The project design involves urine separation and nutrient recovery plus management, transportation and agricultural trials for beneficial reuse of nutrients (as dry compost and liquid residues).

The Victorian Smart Water Fund and the project team members jointly funded the studies, conducted between July and November 2003 and build on earlier work by Jonathon Crockett (Crockett, 2000). The project design stage is still to commence, as funding has not yet been secured. The project participants are currently seeking funding and welcome any leads.

Composting toilets have become the technology of choice for permanent public toilet facilities in national parks and for many isolated roadside rest areas and houses. The technology potentially has wider application for unsewered towns and for suburbs within established sewered cities and is already being adopted more broadly in other countries. DCTs are compatible with other water saving technologies such as grey water recycling, waterless urinals and rainwater capture.

The potential advantages of composting toilets over conventional water-flush toilets include

- 15% to 28% savings in household indoor water use
- over 65% reduction in nutrient loads to sewer
- 25% reduction in BOD to sewer
- 50% reduction in salt load to sewer
- recovery of safe to handle nutrient rich fertilizer replacement (enhanced by urine separation)
- increasing longevity of existing sewer systems (by reducing loads and rates of increases)
- reduction in overall lifecycle and economic cost of new centralized sewer systems
- provision of sustainable solution for eco-conscious residents

These advantages can be achieved without increasing energy consumption for sanitation. Market research indicates that there is demand for such a technology. A demonstration project involving equipping 12 new inner city apartments with DCTs in combination with an agricultural compost and urine recycling trial is proposed.

DCTs when combined with urine separation and grey water discharge to sewer, have potential to be an economical and practical sanitation option in an urban area, particularly if existing sewer systems have capacity for the additional greywater, or for remote unsewered areas.

Sustainability and Ecological Footprints

Sustainable development has been a focus for environmental professionals and others in recent years. One indicator of personal, household and corporate impact on the environment currently gaining support is the ecological footprint, which is a measure that provides a conservative estimate of humanity's pressure on and usage of global ecosystems. A footprint is given as the area of bioproductive land required to support human activities.

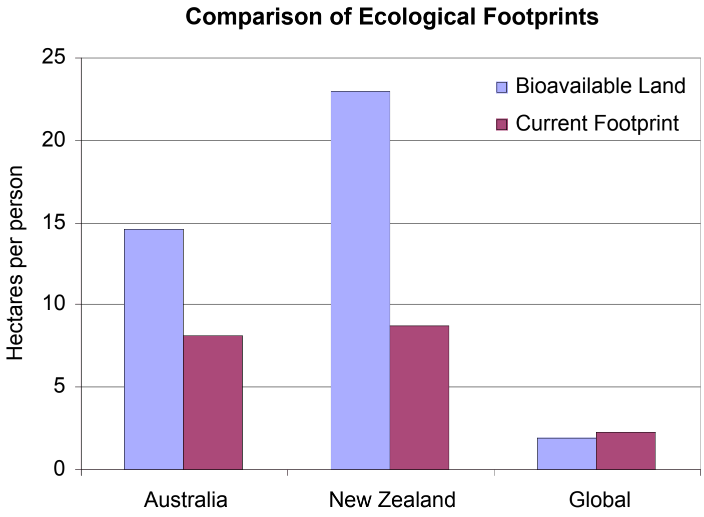

Figure 1

Figure 1 shows the currently bioavailable surface (which includes bioproductive land and near shore productive surface water) and ecological footprint per person in Australia, New Zealand and the world (Wackernagel et al., 2002). Although each of the national footprints do not exceed the bioavailable land, on a global scale human activities still exceed the land's capacity to support them.

Figure 2 shows some footprints developed using the Victorian Environment Protection Authority's online calculator (EPAV, 2003a). For achieving global sustainability on an internationally equitable basis it can be argued that the average footprint needs to be reduced to below the currently available 1.9 hectares of bioproductive surface (land and sea) per person globally. However if it were possible to 'draw a line' around Australia, for example, a sustainable figure might be closer to 4 hectares per person out of the 14 ha per person available in Australia. This would leave the remaining 10 ha available to support other species. There is no agreement and little literature on the proportion of bioproductive surface that humans should claim for their own, this figure of 4 ha is used to illustrate how ecological sustainability measures can be used for making the point that humans currently are mining the planet.

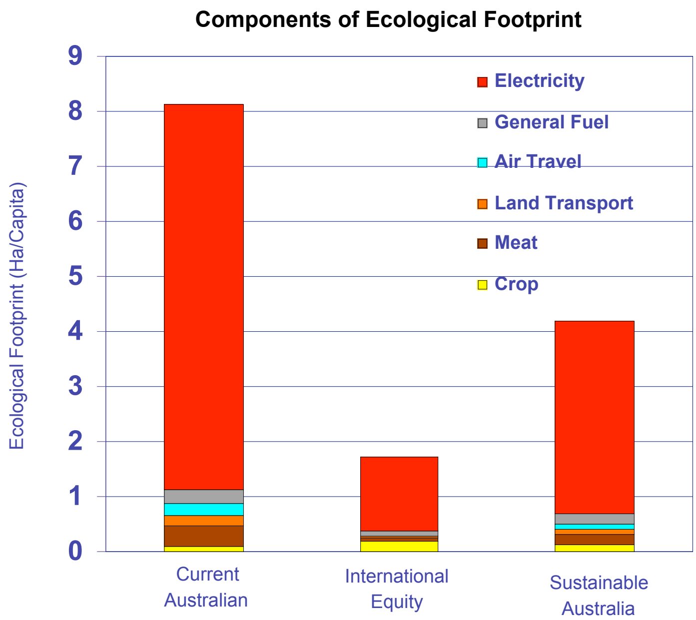

Figure 2

What impact would adoption of dry composting toilet technology have on our ecological footprints? Energy usage (in Australia particularly electricity generated from coal) is by far the largest contributor to our everyday impact on the environment (**Figure 2**), so any alternative sanitation technologies must have equivalent or reduced energy requirements in order to approach sustainability. The feasibility study showed that reduced energy usage can be achieved for composting toilets in an urban environment (even where additional heating of the compost was required), and for remote installations where passive solar heating (using appropriate building design and orientation) could be employed, energy usage may actually be reduced.

Composting toilet technology provides an opportunity for individuals to reduce their impact on the environment via reduced water usage, reduced reliance on large-scale infrastructure, reduced waste-water treatment and recovery of valuable nutrients in a safe manner from human waste. Environmental advantages of composting toilets over conventional water-flush toilets include:

- 15% to 28% savings in household indoor water use;
- over 65% reduction in nutrient loads to sewer;
- 25% reduction in BOD to sewer;
- 50% reduction in salt load to sewer;
- recovery of safe to handle nutrient rich fertilizer replacement (enhanced by urine separation);
- increasing longevity of current sewer systems and treatment plants (by reducing loads and rates of increases);
- reduction in overall lifecycle and economic cost of new centralized sewer systems; and
- provision of sustainable solution for eco-conscious residents.

The Demonstration Project Development

The Demonstration Project

While composting toilets are not at all new, application in inner city (medium to high density) residential apartments in Australia is new. A development in inner Melbourne is proposed consisting 12 new premium quality apartments with a strong sustainability slant. The apartments will face onto a parkland area in a two-story single row layout. Each will have two toilets serviced by one rotary dry composting unit at basement level to collect solids. Urine and compost leachate will be collected in two separate centralised storage tanks and all waste will be periodically removed and taken to an agricultural reuse trial site.

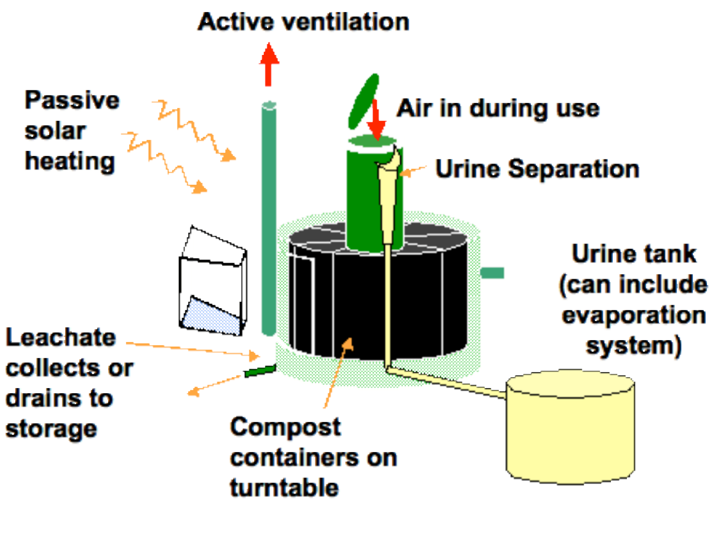

Figure 4

A rotary DCT is proposed for the demonstration project because it eliminates the need to handle un-composted material. **Figure 4** shows the general arrangement of this type of unit. The proposal is to use the Australian Rota-Loo® of which there are several thousand currently in use. The key element is the carousel on which compost bins are located and rotated. Within the front of the toilet bowl is a compartment for separately collecting most of the urine.

Various components of the project will be monitored, including the apartments site and at the agricultural reuse trial site, to demonstrate viability and collect further useful data and anecdotal information. The reuse trial is aimed at assessing the health risks, practicalities and effectiveness of compost, urine and leachate fertiliser as a replacement for dry-land grain and oil seed crops.

Proposed layout & costs

Figure 3 shows the proposed arrangement for the demonstration in a two storey, high-density urban development in inner Melbourne. Cost of the building structure is increased compared to a standard conventional structure. This is due to the requirement for access to the compost chambers below floor level and the space required to accommodate ducting between pedestals and composters. This increased cost can be reduced for single storey applications.

In the proposed trial, each apartment will have two toilet pedestals, one on the ground floor and one on the first floor of the apartment unit, both attached to one composting unit. The waste chutes will be opposite each other and feed into separate bin compartments. Overall the installation will increase the apartment cost by around $3 500 compared to conventional sanitation however some of this cost may be offset by reduction in sewerage costs and headworks charges. Plumbing will be arranged to allow for future replacement of the compost unit and installation more conventional system to ensure apartment marketability.

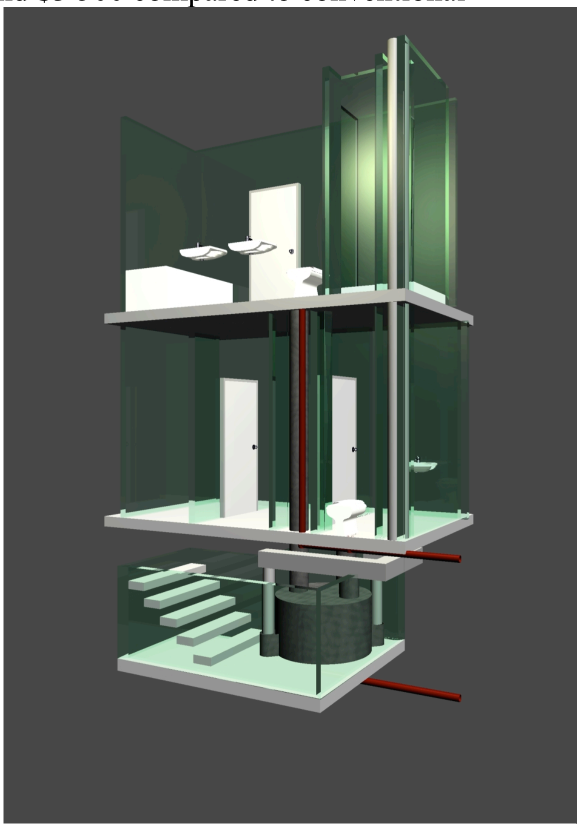

Figure 3

Dry Compost Toilet Technology

DCTs rely on aerobic biological breakdown of solids in human waste (and any other added organic matter including toilet paper, vegetable scraps, wood shavings and sawdust), by bacteria and other organisms. Earthworms are sometimes used for composting in cooler climates.

The composting process can inactivate pathogenic bacteria, protozoa and virus and reduce numbers of infectious ova. The final product is a humus-like material, about one third of the mass of the raw waste, that can be applied to land. Recent development has shown that separation of urine within the toilet bowl is beneficial to compost toilet operation and can recover up to 60% of urine in a relatively sterile state for direct use as a phosphorous fertilizer.

For optimal composting in the chamber, airflow is required to maintain aerobic conditions and the chamber temperature should be kept at or above 20 ^{o}C (except when using worms, which prefer a cold environment). During cooler periods this may require supplementary heating, traditionally solar generated.

Gases generated from composting include carbon dioxide, limited amounts of oxides of nitrogen, hydrogen sulfide, ammonia and amines. An energy efficient air extraction system is necessary to provide a constant negative air pressure at the toilet seat and hence prevent any odour from entering the toilet cubicle.

Around 60% of urine is captured separately via a urine-separating compartment in the front of the bowl and collected in a tray below the rotary unit for evaporation, or diverted to a tank as for the demonstration project. The remaining liquid drains through the compost and is either evaporated or collected separately as leachate. It is advantageous to maximise the urine separation to eliminate over-saturation of the compost. Saturation limits aeration and leads to anaerobic conditions, odour, unfavourable carbon to nitrogen ratios and slowed microbial growth. The urine is relatively sterile and it has been found in extensive trials in Stockholm (Johansson, 2000) that a high percent of pathogens are inactivated during storage

The composting unit and key operational aspects

The toilet lid is kept closed when not in use and a ventilation system using a fan creates a downdraft through the pedestal during use. This prevents odour emission into the indoor room, a distinct advantage over a conventional water-flush toilet.

All solid organic matter collects in one of several perforated compost containers on a turntable within the compost chamber. Mixing of the compost and addition of worms or fibrous matter is not necessary with this design. Insect breeding and escape is controlled by a combination of ventilation and insect screening.

A full compost container remains on the compost chamber turntable for one revolution, taking about one year (or a half revolution over six months if two toilets share one compost unit). By this time the mass has reduced to a third and the solids have become stable and relatively dry.

Toilet bowl cleaning

The DCT bowl is cleaned by periodically with a cloth or brush dipped in weak vinegar solution. This requires a cultural change. Cleaning is easier than with a conventional toilet bowl because of the absence of a U bend.

Challenges

Technology for modern composting toilet systems, including urine separating pedestal designs have advanced sufficiently to combat many of the drawbacks of the earlier models, including aesthetics, smell and men having to sit to urinate.

One fundamental challenge for composting toilet technology application in urban areas is the requirement for adequate space to reuse compost and urine products. Sustainable on-site reuse of end products is not possible in a high density urban environment (whereas it may be possible in a rural or low density area), due to high nutrient levels in human waste and potential risk of contamination to stormwater and groundwater, particularly during wet periods. Further more current Australian current legislation has restrictive requirements for burial and application of the compost.

For this application, the urine-separating pipework needs care, as blockage with scale and hair can occur if the piping is not properly designed or maintained.

The use of DCTs has generally been limited by the following challenges:

- perceived operating problems (odour, difficult operation, health risk)
- residue disposal opportunities and restrictions
- legislation, planning, approvals and design requirements (where they exist)
- ventilation to prevent odour
- insect and pest prevention
- significant additional cost to the household compared to installation of a standard toilet,
- difficulty of retrofitting in existing buildings,
- cultural acceptability
- institutional discouragement
- transportation & System Maintenance (including ventilation, composter bin rotation, liquid pipe work)
- user acceptance (including for selling the apartments)
- alteration of user habits, including toilet cleaning process
- beneficial reuse of by-products (including design and operation of the agricultural reuse trial to capture useful data as part of the demonstration project)

The demonstration project is intended to show that these issues can be overcome and that the technology is appropriate, marketable, environmentally beneficial and economically feasible for an urban apartment.

Marketability of Apartments with Composting Toilets

A survey to assess potential market viability was circulated to the developers' customer base. Responses indicated a consumer desire for sustainable design to be incorporated into housing. This was particularly significant since it was coupled with an apparent willingness to pay more for these features in a majority of cases.

The results showed a genuine interest in DCTs as a viable, ecologically sustainable sanitation system with over 90% of respondents indicating a willingness to consider purchasing an apartment with DCTs and with a majority saying they would be willing to pay up to $5 000 more for an apartment incorporating resource-conserving features. It was clear, however, that specific attention would need to be devoted to consumer education for awareness and benefits of DCT systems.

Monitoring at the Apartments

The project is proposed for research and development, therefore extensive monitoring facilities will be installed at the apartments including water and grey water flow metering and automated recording, off-gas monitoring and energy metering. The monitoring program is planned to run for at least 12 months at the apartments. It will also include log sheets which occupiers will be encouraged to keep (on a voluntary basis with appropriate incentives). The project will provide valuable and independent data on a wide range of important factors related to water use and grey water, urine and compost generation, energy use and data that is not currently available on air emissions from DCTs.

Transport

A DCT system does not connect to sewer and ggiven that the demonstration trial is proposed for a medium-high density urban application without potential for reuse of residues on site, collection and transportation off-site by road will be necessary.

The Environment protection Authority (EPA) would be the authorizing authority for this aspect in Australia and enquiry determined that while there are no specific regulations for the carriage of composted human waste, urine and other waste liquids, this would almost certainly fall into the same category as for transporting septic tank waste.

Discussion with transport operators addressed the logistics of a dedicated vehicle, with a specifically designed lift-off truck deck assembly to store, cart and transfer the wastes. The estimated cost for manufacturing a specialized unit was in the order of $30 000 and operational costs estimated conservatively at $6 750 per annum to transport the residues. Therefore the study concluded that transportation, while it will benefit from economies of scale is not an obstacle to either the demonstration project or future broad scale application. Apartments will need to be serviced by a transport contractor approximately every three to six months.

Transport contractors are interested and would assist in setting up the transport equipment and system for the demonstration project.

Urine will make up the major part of the mass load to be transported (64%) and the leachate will account for some 30%. For the 12 apartments proposed for the demonstration project an estimated 12 tonne of urine, leachate and compost will need to be removed per year made up of approximately 11.3 tonne of liquid. Evaporation on site is an option, however this would incur significant energy and maintenance input and was therefore disregarded. Handling collected urine (which has received the equivalent of ultra filtration in the human body and is hence usually sterile) requires clean and controlled conditions for storage and transportation.

Resource Recovery & Beneficial Reuse – the Agricultural Trial

Demonstration of the practicality and safety of agricultural recycling of the residues is a key element in the proposed demonstration project. The proposal is to set up a 2 ha agricultural recycling trial site including monitoring facilities and agricultural equipment for application of the residues to dryland grain and possibly oil seed crops including control crops.

The idea of the reuse trial closes the loop to a large degree, in terms of sustainability. After capture and composting of the wastes, beneficial reuse in agriculture provides a potential significant benefit in terms of embodied energy capture, a significant reduction in waste to sewer and the associated energy, water and chemical requirements for transport and treatment.

Waste recovery is not a new concept, with other solid and liquid wastes recycled both in the public domain and within industry. The need for cost cutting, tighter regulations, etc have encouraged (or even forced) innovative to minimise usage and recover resources across numerous industries (i.e. water, food, timber, paper, plastics, cans, glass, heat, chemicals, etc).

Calculations comparing the nutrient loads in human excreta and traditional fertilisers showed that between 4.9 and 6.4% of total fertiliser use in Australia could be potentially recovered from human excreta. These figures were based on investigations into the total annual nutrient consumption (as fertiliser) of nitrogen, phosphorus and potassium (NPK) in Australia and quantification if the proportion of fertiliser that could potentially be sourced from human excreta. Nutrient recovery has been the driving force behind composting and urine separating toilet technologies in Europe and Scandinavia, where flushing toilets are being trialled with urine separating pedestals to recover urine for agricultural use.

Current guidelines prevent use of compost on consumable crops and require burial of material 100 mm below ground. This may be too conservative and the agricultural recycling trial proposed as part of the demonstration project will assess risks associated with application to dry land grain an oil seed crops. There are no guidelines for use of urine.

Urine is high in nitrogen, phosphorus, potassium and salt and direct application as fertiliser to grain crops has been successfully trialled in Stockholm. Health risk from use of urine has been assessed quantitatively and found to be negligible (Hoglund et al, 2002).

A potential agricultural trial site has been identified at the Melbourne Water Western Treatment Plant site, and a preliminary design for the trial has been prepared and reviewed by agricultural specialists.

The agricultural trial will involve monitoring of residue and crop quality, soil and crop response and microbiological and chemical quality. The monitoring will run for at least two years at the agricultural trial site.

The recycling trial as designed is estimated to cost around $0.3M and will investigate health, agricultural and environmental aspects associated with use of the olid and liquid residues.

There are several challenges associated with establishing this industry including:

- Coordinating with the Agriculture industry to use the product
- Small scale initially cannot compete with commercial fertiliser scales of economy
- Market research is required
- Refining the science.

In addition the trial itself will involve careful design to ensure adequate useful data can be captured to demonstrate viability assess health risks,

Application in Remote Regions

At low urban densities of up to 4-6 persons per ha, sustainable application to land of urine, leachate and compost within the urban area is possible because these residues can be stored during wet, low growth rate periods and necessary application rates would not exceed plant demands. However, even at this low population density, grey water disposal or recycling remains an issue in wet periods when there will be runoff.

If grey water is handled on site in a low-density fringe area or small country town, then DCTs and on-site grey water treatment offer a lower cost approach to sanitation than sewerage. However, the impact of on-site grey water treatment in wet months is not considered to be as environmentally acceptable as centralised treatment, storage and dry season recycling of grey water.

In dense urban environments of more than 30 person/ha, a grey water sewerage system is essential and compost, urine and leachate generated from DCTs would have to be largely disposed of off-site on agricultural land to avoid groundwater or surface water pollution (through elevated nutrient concentrations).

Economic Feasibility

Cost scenarios were developed during the feasibility study to explore the potential advantages of adoption of dry composting toilet technology. Scenarios considered both urban and low density applications in the following broad categories:

- Standard toilet systems and conventional sewerage in a dense urban development, where existing capacity was sufficient (ie: no sewerage upgrades required to handle growth of population).
- Standard toilet systems and conventional sewerage in a dense urban development, where existing sewerage capacity was insufficient (ie: upgrades required, including treatment plant) or non-existent (eg: new housing development).
- Dry Composting Toilets, with discharge of greywater to the sewerage system.

More detail is available in the full study report (December 2003), however general conclusions of the economic evaluations were:

- The composting toilet with grey water sewerage option is more capital intensive than conventional sewerage for a dense urban development due to the additional cost of composting toilets installation and the possible need to provide solar-driven ventilation (solar driven ventilation was included to reduce the mains power requirements, however this increases the capital costs).
- If a significant sewer upgrades were necessary to service a new subdivision or population growth, then composting toilets and a grey water sewerage system offer an attractive alternative to conventional sewerage. Composting toilets with grey water sewerage potentially offer a less expensive option to a dual reticulation system using recycled sewage for toilet flushing;
- The cost advantage of composting toilets becomes greater if water and energy prices increase in future. However, if no upgrade of the sewerage system is required, the water savings achieved with composting toilets are not sufficient to cancel out the additional capital cost of composting toilets.

It is considered however, that the environmental and social advantages of composting toilets are potentially the more significant feature, rather than any cost savings that may be achieved with a carefully designed system.

Policy Setting and Regulatory Requirements

Australian and Victorian Requirements

Restrictive policies and regulations have potential to be a major barrier to adoption of any alternative technology, particularly where there are perceived human health risks. Recognising this, the feasibility study included a thorough investigation into relevant guidelines, legislation and regulations to identify any legal requirements and constraints. The requirements fell into three broad areas:

- Installation of composting toilets in the development itself;
- Removal and transport of the human excreta from the development to the reuse trial site; and
- Application of the urine and composted matter to land at the trial site.

The study did not cover the implications of food-standards regulations on use of crops fertilised with residues, although human health risks were investigated as part of the reuse trial development. It is considered that an agricultural trial such as the one proposed in the feasibility study would have significant potential to provide information on human health risks to aid in specific regulation and guideline development.

In Victoria, the EPA reviews and approves composting toilet systems for use in Victoria, but is not involved in approving them for installation at individual sites. The relevant local council approves on-site wastewater treatment systems (including composting toilet systems) for individual sites, in accordance with EPA guidance.

Collection of the liquid and solid excreta from the apartments and transport to the reuse site is unlikely to require specific approval since it falls under the same category as septic tank pump out and therefore does not require specific approval or licensing of contractors. Containment of the compost, urine and leachate during transport would be necessary to minimise the risk of pollution or nuisance.

The likely approval required for the reuse site in Victoria is an EPA Research, Development & Demonstration Approval. Involvement of the Department of Human Services to review and monitor the health aspects of the trial is anticipated but no specific approval is required from DHS.

Initial discussions with the local council for the proposed development indicated that the planning process does provide for assessment and installation of composting toilets, and includes referral of the application to their Environmental and Public Health units for approval. Where required, the council would seek out guidance from the EPA. A component of the approval process is a land capability assessment, which assesses the capability of the site to sustainably manage wastewater (or in this case waste residues) within the site boundaries (EPAV, 2003b). Some adaptation of council processes may be required for a higher density development, since the residues would not be reused on the residential block.

New Zealand Requirements

Section G19 of the New Zealand Building Code sets out "approved solutions" for wastewater, of which composting toilets are not one. The New Zealand Building Code (Condition G13) specifies that where connection to a sewer is available, wastewater disposal is to be by connection to the sewer. A Local Authority would need to waive the relevant section of the Building Code in order to approve a composting toilet in a sewered area. The Building Act does make provision for a Local Authority to waive this requirement, and it is not without precedent. However it is true to say that Local Authorities in New Zealand would generally not approve composting toilets in sewered areas. In some cases Local Authority bylaws explicitly prohibit the use of onsite sewage treatment in sewered areas.

Australian, New Zealand and Overseas Experience

Composting toilets have been installed in a variety of situations across the world. The success of the installation usually depends on the commitment of the residents or users to the maintenance and operation of the system. The majority of examples of use in more densely populated residential areas come from Scandinavia, the US and Canada.

There is growing interest and use in the urban setting in Australia and several water authorities and councils have permitted use of composting toilets within urban areas in recent years.

Australian Installations

An installation of 25 composters and 47 toilet pedestals at the Thurgoona Campus of Charles Sturt University is the largest identified application of composting toilets in Australia. This site is an excellent example of effective composting toilet application combined with energy efficient building heating and ventilation systems. Both users and maintenance staff report that the system functions well, without odour, and is accepted by visitors to the campus.

CERES, a community environmental park in Brunswick, Victoria, has had several composting toilet units in operation for about 4 years. The units service all park visitors, including school and community tour groups, and patrons of the café located on the property. The compost units are not heated, but have had worms added to aid in the composting process. Generally, visitors accept the toilets well, and odour is rarely noticeable in the toilet area.

New Zealand Experience

Composting toilets are commonly used in backcountry areas (for example for unmanned huts) by the Department of Conservation and other land managers. The use of composting toilets is much less common (although not untried) in unsewered rural areas, on 'lifestyle blocks' and for weekend 'Baches'. Local Authorities in New Zealand have differing attitudes to the use of composting toilets. Only a very limited number of composting toilets in urban (sewered areas) are known to exist in New Zealand.

Overseas

The drive behind alternative sanitation and composting toilets in Sweden was an interest in recycling of nutrients, and to a lesser extent, minimisation of water used for flushing toilets (Hedberg, 1999). Composting toilets have been installed in several eco-villages, and urine separating micro-flush toilets in apartment buildings.

A Swedish example is the eco-village Toarp, which was constructed to house 150 inhabitants in 37 houses, and trialled three varieties of composting toilets (Fittschen, 1997). The most successful system was the rotating chamber system. This reported the least number of incidences of odours outside, and had no odour issues inside. It also achieved an end-product that looked and smelt like earth. Residents were generally more satisfied with urine-separating toilets.

In Canada, composting toilets were installed in a multi-level office building at the University of British Columbia – the C.K. Choi Building. Several toilet pedestals feed into each composting unit, and a building maintenance officer operates and maintains the system (similar to the maintenance contract proposed in this project). A post-occupancy survey was conducted of users of the building, with the following conclusions relating to composting toilets:

- Users were generally satisfied with the toilets, although regular users were more accustomed to them;
- The maintenance officer found it necessary to clean the toilet bowls reasonably often (especially during a conference or similar event) to remove visible faecal matter;
- Maintenance of the compost bins was aided by addition of woodchips and sawdust, as well as regular watering (1 minute per day) to keep the pile moist. Note that watering of compost is a somewhat unusual requirement, particularly since these toilets were not urine separating, but may be related to the addition of organic matter in this case.

Extent of the Full Feasibility Study

Key engineering, environmental & architectural issues addressed in the study

The key wastewater engineering, financial, economic, environmental and social issues addressed in the feasibility study included:

- water saving potential

- odour, ammonia and other gaseous emissions
- risk to health of occupants and to maintenance, transport, and agricultural workers who apply residues to land
- capital and operating cost (including comparison of options for full-scale scenarios)
- energy use compared to conventional sewerage
- maintenance issues
- reliability of operation
- value of the products for replacement of synthetic fertilisers
- practicalities and requirements for a high density application
- market demand and acceptance

The feasibility study also identifies gaps in information that should be addressed in the demonstration project.

Key architectural and building issues investigated included: building heating and ventilation; maximising passive solar heating and natural ventilation; access for maintenance and aesthetics. These issues were investigated by means of preliminary design development, literature review, discussion with other users and researchers, field inspections and preliminary design calculations.

Issues Requiring Further Research

An issue that has not been solved entirely is control of insects, particularly various varieties of flies. During the study several facilities were visited, and the question was asked whether insects had caused problems. Only in one case did and owner (an individual householder) report that there had been a fly problem. In this case putting finer screens over the ventilation inlet and outlet solved the problem. In another case, regular clearing of spider webs was required to maintain airflow. Others have reported insects as a reason why composting toilets in households have been removed (Keenan, 1998).

Conclusion and Summary

The feasibility study was the first step into a research and development project for investigating DCTs in inner city apartments with potential for major scale application. Key conclusions of the study include:

- composting toilets combined with nutrient recovery and reuse provide an opportunity for individuals to reduce their impact on the environment
- the demonstration project is economically and environmentally viable
- composting toilets with urine separation offer potential economic and environmental advantages compared to conventional sewerage systems or grey water reuse for toilet flushing
- future increases in water price will amplify the cost advantage of composting toilet systems
- broader application of composting toilets has potential to extend the life of existing sewerage systems by reducing loads and flows
- the technology does not avoid the need for grey water sewerage provision in dense urban developments by may do so in low-density areas where grey water can be sustainably applied to land
- if funded the project will provide extensive, independent and reliable data on reductions in water, nutrient and BOD loads to sewer that can be achieved

- there is growing market demand for such technology
- the trial will provide a practical demonstration of user-acceptability
- the technology is proven and, for the householder, provides a sanitation solution having no odour and requiring no more maintenance than a conventional water-flushed toilet.
- maintenance of the infrastructure and systems in an apartment setting is best addressed as a contracted service
- transportation of wastes from the apartment site can be managed, provided adequate provision is made for truck access and removal of compost bins
- to achieve a fully sustainable solution the compost and liquid residues need to be beneficially reused and application as fertiliser to crops is considered the most practical current solution
- an agricultural trial is necessary to investigate the potential for compost and liquid residues as fertilizer and provide useful data on health risks, agricultural benefits and potential savings in chemical fertiliser.

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Project Team

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