# An investigation into waste management in Australian production nurseries

This is the final report for the Nursery and Garden Industry Australia project 'Assessing waste streams in Australian production nurseries (NY13003)'

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# Contents

# 1.0 Introduction

## 1.1 Waste management: an issue for all nurseries

All business and production processes will generate waste in some form. In the past, the accepted disposal method was to bury waste in a landfill. Now, waste management and disposal is no longer a secondary issue, but a crucial part of running a successful business. The cost of infrastructure to collect, transport and dispose of waste combined with the potential environmental impacts of traditional waste disposal have led to a change in attitude about what is considered waste and how waste is managed or disposed. The development of new recyclable materials with a higher residual value and increasing concerns about environmental sustainability have led to a greater focus on material recovery and recycling programs.

For production nurseries, increases in biosecurity controls, product packaging and single-use disposable products are increasing the volume and cost of waste disposal. However, dispersed population centres and high transport costs have limited the development of a recycling network to keep up with the development and increasing use of new recyclable materials. Businesses need to find alternatives for waste disposal or resource recovery options and develop new waste management practices to reduce disposal costs. Embracing new waste management practices and alternative waste disposal options can not only reduce waste disposal costs, but also increase resource use efficiency and increase the business's marketing image or 'green credentials'.

## 1.2 A project to investigate waste

For decades the Nursery and Garden Industry of Australia (NGIA) has been actively developing best management practices to ensure the industry remains progressive and sustainable. The introduction of industry specific environmental guidelines (EcoHort) and accreditation programs (NIASA) highlights the industry's commitment to environmentally sound practices and natural resource stewardship. This commitment has set the industry on a path of continuous improvement of best management practices as the industry, legislation and social expectations change. Improving waste management practices is part of this progressive development of updating management guidelines and promoting the industry's environmental responsibility.

Changes in government and community attitudes to waste disposal and concerns from nursery managers regarding an increase in waste disposal costs prompted NGIA to commission a project to investigate waste management. Production nurseries generate a variety of organic waste but the introduction of new packaging materials and production processes has led to a change in the composition of waste materials needing disposal. Currently there is limited industry specific information about the change in waste types and quantities being generated or how new waste management strategies can be implemented to help nursery managers minimise waste to landfill.

The objectives of this project were to: assess waste management and disposal practices within the industry; quantify waste types and to provide baseline data on waste generation; identify any alternative waste disposal options that can help to reduce waste disposal costs by increasing waste minimisation, recycling, reuse or diversion practices; and develop an industry-

specific waste assessment information package to assist in the uptake of this multi-directional waste management approach.

Adopting a multi-directional waste management approach will assist nursery managers to reduce waste disposal costs while providing other business, social and environmental benefits. With more reliable information about nursery waste generation and alternative disposal methods, the nursery industry will be in a better position to develop new waste management practices and foster cross-industry links to help turn waste into a tradable commodity.

### 1.3 Report structure

This project has investigated and collated information from various sources on several waste management topics and presents this research in separate sections covering an overview of how waste is identified, the value of waste, and the results of an industry-specific waste survey. It discusses the current disposal methods and explores the limitations of waste disposal with a focus on alternative waste management strategies currently being used by some production nurseries. Later it discusses the process of developing new waste management practices and provides a step-by-step guide on the waste auditing process. The results of a nursery case study exploring alternative waste management practices with a cost benefit analysis report is provided to demonstrate the benefits attained by embracing alternative methods of dealing with a wasted resource.

## 2.0 Project Methods

The methodology of the project was comprised of the following broad areas of activity:

- Research and review the published literature and available industry information relating to what constitutes a waste in production nurseries.
- Define the categories of waste materials associated with production nurseries.
- Research and identify waste management strategies and disposal practices within production nurseries to provide baseline data on waste generation and current disposal methods.
- Identify current issues nursery managers face regarding waste management and disposal.
- Develop a simplified waste auditing process for nursery managers to assess production waste and determine the actual costs incurred for waste management and disposal.
- Identify alternative disposal options to increase materials reuse or add value and generate an income.
- Conduct a waste assessment of a production nursery and develop an economic case study to demonstrate alternative waste disposal or diversion options.
- Develop extension materials to assist in the delivery and uptake of the project results to production nursery managers.

This report focuses on the wastes generated by production nurseries and the disposal methods available. It does not explore the inefficiency of individual production processes or general

purchasing practices. Where applicable, specific management practices related to waste reduction are discussed and examples given.

## 2.1 Research and industry consultation

In order to quantify wastes, identify options and provide an industry-specific assessment package, a desktop review of past and current waste management practices and procedures from various industries was undertaken. Reports from the Australian Bureau of Statistics, government regulations and industry best practice guidelines were reviewed to provide an overview of the current waste management and disposal industry in Australia and to identify any restrictions associated with diverting nursery waste for alternative uses.

An online industry survey was conducted to gather baseline data of waste generation within the industry and obtain details of waste management issues from a nursery manager's perspective. Several waste management and recycling companies were contacted to provide background information on the collection and processing practices of waste collection. Waste industry equipment suppliers were also contacted to obtain details and determine the efficacy of implementing waste separation equipment at the nursery level.

This research provided information relating to the economics of waste disposal, the final disposal destination of waste items, and the changing attitudes relating to waste recycling and resource recovery. Specific recycling companies were contacted to discuss the potential for recycling or redirecting the waste of certain production nurseries for alternative uses. The information and details gathered during this process was consolidated to develop a waste assessment process and decision tools for use by Australian production nurseries to identify alternative disposal options at the local level.

## 2.2 Survey of nursery businesses

To develop an understanding of the current waste management and disposal issues faced by production nurseries, an online survey was conducted. The survey provided information on waste types and quantities generated, disposal costs and practices, and some alternative disposal options being implemented by the nursery industry. A copy of the survey questions is available in Appendix A or at https://www.surveymonkey.com/s/NurseryWasteSurvey. The survey was conducted over a four-month period using the Survey Monkey service and promoted via the NGIA communications network. The survey was supplemented with phone and email discussions with nursery managers to clarify and refine survey responses. In total 34 production nurseries provided waste management and disposal information for analysis. This information was combined with the results of a case study nursery waste assessment to provide baseline data of waste generation within the industry. The survey summary presents the data collated from the survey and participants responses from all communications.

### 2.2.1 Response interpretation

The answers and waste estimates provided by the survey respondents represent a wide variety of waste management practices, waste types, and waste quantities generated by production nurseries. However, the waste quantities provided are only estimates and were not obtained by conducting actual waste audits. Some assumptions were applied during the interpretation process. For example, where monthly waste estimates were provided using bin size and level of fullness at collection, it was assumed that the estimated quantity did not change over

collection periods, or the frequency of bin collection remained consistent over 52 weeks. The estimated quantity of infrequent waste, such as greenhouse cladding, rubber or weed matting, was assumed to be generated at similar intervals as recorded by the survey.

Also, several survey respondents provided estimates of each waste type generated but stated that due to a lack of local recycling services, some recyclables are disposed of via the general waste stream. Where this was stated, general waste quantity for that nursery was adjusted to limit duplication and provide a more accurate representation of waste categories in the survey summary. Finally, not all survey respondents provided answers for every question and where possible, survey respondents were contacted to obtain missing information or to clarify any ambiguous survey answers. Any ambiguous survey answers that could not be clarified due to a lack of contact details were discarded.

### 2.2.2 Conversion convention and compaction

The accepted convention for reporting waste in a waste audit is by weight rather than volume, but some survey respondents recorded waste estimates as a volume (litres) or as bin equivalents (cubic metres). These values were converted to a standardised measure of weight for collation and comparison. Industry-defined conversion factors were used to minimise any conversion errors. A list of the waste materials and the conversion factors used is available in Appendix B. However, the weight of waste materials can vary considerably depending on whether the waste has been compacted. Compaction can be simply the natural settling of material over time, the manual breakdown of items prior to placing in the bin, slight compression using physical force, or by a specific compaction device. Conversion from volume to weight therefore varies depending on whether the waste has been compacted or not and the method of compaction.

In some cases the level of compaction may be estimated in related to the size of the business and type of waste. Studies conducted by DSEWPC (2012) found that large businesses are more likely to report waste amounts as an actual weight and use some form of compaction to keep disposal costs down, while smaller businesses are more likely to only compact waste lightly due to staff and equipment limitations. Therefore, where an indication of compaction was given by the survey respondent, a conversion factor relevant to that compaction level was used. These conversion factors have been collated from several sources into three basic compaction levels: uncompacted, lightly compacted and highly compacted materials. Where no indication of waste compaction was given by survey respondents, a ‘lightly compacted’ conversion factor was applied to bins reported as full or over-full at the time of collection and an ‘uncompacted’ conversion factor was used for bins reported as being less than full at the time of collection. Where waste items were reported in discreet counts and no size information was provided, a standard medium weight was used. For example, a battery recorded without any indication of it being a light, medium or heavy duty battery was allocated a weight equivalent to a medium duty commercial battery.

## 2.3 A waste self-assessment pack

The waste self-assessment pack comprises the *Nursery waste self-assessment form*, a *Waste management cost estimate worksheet*, a *Waste management cost calculation spreadsheet*, and the *Steps to reduce waste management and disposal costs* document. These have been

developed from reviewing various waste management journals and waste industry protocols, as well as local, state and federal government waste management regulation and guidelines. Information and details were further refined through discussions with nursery industry representatives, waste collection services and recycling organisations. The documents provide a basic step-by-step process for nursery managers to assess wastes generated and calculate the cost of waste management. The waste self-assessment pack including all documents can be found in Appendix C.

The information in these documents is general in nature due to variations in legislation and biosecurity control laws across jurisdictions. Location-specific information is not included. Nursery managers are advised to check local regulation or contact local councils regarding any location-specific auditing requirements and the storage, transportation or processing of waste materials. A list of several regulation reference websites and organisations that can be checked is listed in Section 6.0, *Waste management and information websites*.

### 2.4 A nursery case study

To provide a more accurate overview of waste generation and test the waste self-assessment survey, a waste audit was conducted at a large production nursery to record actual waste data for comparison to survey respondents. Waste management practices and financial data were collected to develop a case study of the nursery. In conjunction with existing reuse and diversion strategies, several alternative waste management options were identified and an economic analysis completed to indicate potential benefits. The waste management changes implemented at the case study nursery and the results of the economic analysis are presented in a separate report titled *An analysis of changing waste management and disposal practices in an Australian production nursery*.

## 3.0 Project Results and Discussion

### 3.1 Defining waste and its value

Everyone will have some understanding of what waste is, but research conducted during this project has highlighted that not all organisations define waste the same way. Many private and government organisations will define or classify what constitutes a waste item or material in relation to various regulations and jurisdiction. For most wastes there is an accepted generic definition, but the disposal method may change due to local, state or federal environmental regulations and biosecurity controls (DSEWPaC 2012b). It is in the best interest of every business to not only understand the definition of waste relating to their business but also the regulations controlling disposal in each area.

#### 3.1.1 What is waste?

Waste can be broadly defined as any material, effluent, surplus substance or item that does not function or is no longer required for the intended purpose. The term waste also encompasses the inefficient or inappropriate use of raw materials and resources or any actions that hinder production and redirects labour. In recent years the definition of waste has expanded to include environmental emissions, or 'greenhouse gas' emissions.

Anything can be declared a waste if it is not 100 per cent used for the original purpose, or deemed an economical waste if an item, action or procedure does not contribute to an increase in productivity or financial gain.

Basically a waste is any by-product or surplus material that is no longer required for production. For production nurseries this can also include:

- the loss in production time due to equipment failure or staffing issues
- water lost from the irrigation system due to leaks and faulty equipment
- energy used to operate equipment at less than optimum efficiency
- electricity used by equipment when left on but not in use.

A material or resource is declared a waste by and at the place of generation whether or not it has a residual value or is intended for sale, recycling, reprocessing or recovery. However a waste material can be reclassified as a waste product if it is diverted from disposal for another purpose. A waste material is classified as a waste product if:

- it is ready and intended for immediate use for another purpose
- it is not listed as a waste in legislation
- it has undergone a process to purify, recycle or recover materials
- it complies with all state and federal legislation, regulations and industry standards as a resource for use
- it is not harmful to humans or the environment during storage, transport or use
- the waste generator receives an income from the waste.

(ABS 2013; EPA 2009, DCCEE 2012, DSEWPaC 2012a, APC 2013)

### 3.1.2 The changing value of waste

A change in the way we value waste is driving a change in waste management practices and the waste collection industry itself. Originally waste had little value and was buried in landfill to address potential health and public safety issues. In the 1980s the greater Sydney area had 20 landfill sites to accommodate waste disposal but an increase in waste generation from an expanding population, a reduction in available land for housing and the rise in environmental awareness triggered a change in attitudes about disposing of waste in landfill. In the 1990s concern of the long-term environmental impacts of landfill sites and a change in packaging materials raised questions about the true cost of waste disposal and resource loss. By 2007 waste generation in Australia had doubled, with most of this waste still going to landfill. By 2012 waste generation had increased by 145% but waste to landfill had decreased due to the adoption of recycling and diversion strategies. Now, the greater Sydney area only has three landfill sites and 58% of all waste generated in Australia, valued at approximately $5.4billion, is recycled, reprocessed or diverted (ABS 2013).

This move from a landfill approach to a resource recovery focus has changed the way we value waste materials. Many wastes are now being reclassified as waste products with a trading value. The development of modern materials and manufacturing processes has also produced more durable products that can be reused or recycled several times. These products or materials now have a collection value attached to them at the end of their original use period. The increasing value of waste and the adoption of a multi-directional disposal approach are

providing more waste management strategies and disposal options for waste generators. The introduction of the product stewardship legislation in 2012, and life-cycle management principles, that state anyone involved in producing, selling or using a product must share in the responsible disposal of that product, are further driving changes in waste disposal options.

A greater adoption of resource recovery and recycling strategies is continuing to increase the value of waste, and is providing opportunities for waste materials to be traded. An increase in resource use and consumerism is slowly driving up the demand for reclaimed materials because of the lower cost compared to extracting and processing virgin materials. Resource recovery is now being seen as a professional and sophisticated mainstream industry, with worldwide waste trading companies being developed for manufacturers to source reclaimed materials (Brulliard et.al. 2012).

Proactive industry leaders with assistance from non-government organisations and government agencies are supporting a wider variety of recycling campaigns that are driving this change in the way we value waste. Ongoing development of the resource recovery infrastructure and an increasing demand for reclaimed materials will further increase both the trading value and collection value of waste materials.

### 3.1.3 The trading value of waste

To waste collection companies, waste is a commodity to be sold on for recycling or reprocessing. Each waste type will have a different trading value. The trading value fluctuates with market pressures and is influenced by several factors, such as type of material, quantity available, transport costs, contamination level, and the international trading price. Due to the relatively small population of Australia and the limited demand for reclaimed materials, a large proportion of these materials are shipped to other countries, mainly China but also Europe, for processing and re-manufacturing. For many recyclable materials the international trading price dictate the Australian trading price.

Some companies do process and re-manufacture within Australia but the percentage of recyclable materials processed is only small compared to what is generated. One reason for this is transport costs. A materials recovery facility (MRF) requires a return on recyclates at the gate of between $25 and $65 per tonne, depending on the material, to be economically viable. This is achievable in cities and to a degree some coastal areas but not in rural or remote areas. The increased cost of transporting the recyclates from rural areas to a processing facility can be double or triple that of urban areas. The trading value of the waste product is further reduced if the waste is contaminated with unwanted materials. Low value waste materials may be sent to landfill or consolidated for export (Johnston 2009). Although waste generators cannot influence the trading value of waste materials, they can influence the collection value.

### 3.1.4 The collection value of waste

The collection value of waste refers to the value that the waste or recycling company puts on the collection of specific waste. This value depends on the costs they incur during the collection process. It is determined by the cost of transporting and processing the waste, as well as the trading value of the waste product. The waste generator can influence the collection value of certain waste materials by implementing alternative waste management practices. These are discussed in more detail elsewhere in the report. These practices increase

the collection value of recyclates by separating and consolidating similar materials to provide a large quantity of uncontaminated recyclable material. The larger the quantity that can be supplied the higher the collection value and the greater the chance of having the material collected for free or receiving payment.

How much the collection value can be increased will depend on the location of the nursery and the level of investment. Nurseries within the collection area of a recycling company may have smaller quantities of recyclable material collected for free. Nurseries outside of a collection area will need to offer a larger quantity of clean material to attract free collection. The difference between generating a high value recyclable material and the costs incurred must be considered in conjunction with the reduction in general waste disposal costs.

### 3.1.5 The future of waste

The future of recycling or materials recovery in Australia is likely to develop into an industry that is financially sustainable as well as profitable as seen in America, Europe and China. However the size of the Australian population, the large transport distances, limited demand for reclaimed materials, and a perception that products made from reclaimed materials are inferior is slowing the uptake of new products from and uses for reclaimed materials. These factors also keep the purchase price of products made from reclaimed materials high and limit the development of new products. To increase the uptake and value of reclaimed materials the acceptance of products made from reclaimed materials needs to be encouraged. This will help to transform what is currently considered a costly burden on business for waste disposal to potentially an income stream from trading waste materials.

Some community and environmental groups are already addressing this by setting up suburban recycling markets to redirect surplus materials from manufacturing processes. Although these groups are slowly changing community attitudes to the value of waste, these businesses cannot process or distribute commercial quantities of surplus materials that are generated in businesses like a production nursery. Green waste, plastic pots, timber pallets and soft plastic packaging represents a large proportion of nursery waste that could be recycled or re-directed for other purposes but it needs to be dealt with at a commercial level. Industry leaders must continue to be proactive in developing a demand for reclaimed materials, to increase the collection value and support the development of a better waste distribution network.

The implementation of industry-specific closed-loop recycling programs will help to advance the uptake of products manufactured from reclaimed materials. Some examples of this include the collection, processing and remanufacturing of nursery growing containers by Garden City Plastics, and the Tapex Australia's 'PlasBack' program that collects and remanufactures greenhouse film, weed matting and silage covers in parts of South Australia and Victoria. More broadly, another example is the collection of plastic grocery bags by the RED group for remanufacturing into plastic fencing, flooring and signage by RePlas Pty Ltd. Most of the plastics these businesses reprocess are of the same type; unfortunately these programs only capture and recycle a small percentage of what is discarded each year. These programs highlight the potential for industry-driven closed-loop recycling programs.

It is up to all industry managers to be aware of what wastes are being generated and what alternatives there are to recycle, reuse or redirect these materials in each location. No matter

how waste is currently managed, the one thing that we know for sure is that waste is a by-product of production and that disposal costs will continue to increase if we cannot implement waste minimisation practices or turn our waste into a tradable commodity. To do this we need to change the way we value waste, encourage the development of greater waste recycling infrastructure, and purchase products made from recycled material.

## 3.2 Waste types and disposal options

Production nurseries generate a variety of wastes on a daily, weekly, monthly or infrequent basis. How this waste is managed and disposed of will depend on the location of the nursery and what waste collection or recycling services are available in that location. Some areas may not have a recycling service for all materials but this does not mean waste materials have to be a burden. Materials with a high collection value can justify collection and transportation costs if a commercial quantity is accumulated. Understanding the value of materials and the quantities needed to warrant free pick-up by a recycling service can help to reduce waste disposal costs. Identifying which waste materials have the potential to be recycled or diverted is the first step in the process.

Below is a brief explanation of waste types generated by production nurseries and where possible, some examples of alternative disposal options are provided. For all waste types other than general waste, the business recycling search service at http://businessrecycling.com.au/ can be used to locate specific services in an area. Also waste service providers can be asked who they recommend if they cannot help. Another option for nursery managers is to check with their local environmental or community group as to what recycling programs they support.

### 3.2.1 General waste and non-recyclable materials

General waste is the most common waste type and for most businesses incurs the greatest waste disposal costs. It is the traditional catch-all category for waste items that currently have no reclamation value or collection infrastructure in place and is usually buried in a landfill. It also includes controlled or hazardous waste materials. There are only a limited number of ways to reduce general waste costs, including:

- negotiating with the local waste collection services to obtain the best price for waste collection
- avoiding waste generation by changing purchasing practices to reduce the amount of material being imported to the business
- reducing waste generation by assessing production processes to increase resource use efficiency and reduce surplus materials
- redirecting waste materials from the general waste stream for reuse, recycling or diversion to another industry.

To determine which method is best for each business, a waste audit should be conducted to identify the type and quantity of waste generated and the processes that generate the most waste.

### 3.2.2 Controlled or hazardous waste

Controlled or hazardous waste is disposed of via landfill or incineration and is any solid, liquid or gaseous waste generated from any industrial process that poses either a substantial or potential threat to a community's health or to the environment when inappropriately disposed. A waste is deemed hazardous if it is explosive, flammable, poisonous, toxic or infectious.

There are very strict laws and procedures associated with storing or disposing of hazardous waste. Small quantities of certain controlled wastes, such as pesticides, fertilisers and paint, can be dropped off at the local council waste transfer facility but commercial quantities will require a dedicated collection and disposal service. Local councils, industry association or waste collection service can advise on correct disposal method. Inappropriate disposal leading to environmental contamination can result in large fines and jail sentences, as well as incurring the cost of cleaning up any contamination.

### 3.2.3 Greenwaste

In many nurseries, greenwaste is the second largest waste type generated on a weekly basis. It includes plant cuttings, rejected plants and used growing media. The most common disposal methods for small quantities is to compost, mulch or landfill onsite. Large quantities can pose a greater disposal issue but there are several commercial composting facilities or resource recovery facilities that process greenwaste into commercial products. These companies will pick up large quantities of clean greenwaste for free depending on the nursery's location. Some will accept private deliveries of smaller quantities at no charge but will only accept organic material and may have restrictions relating to the use of growth regulators or agrichemicals during production. Knowing the composition, density and any possible chemical contamination of the greenwaste will help when dealing with composting facilities.

Depending on the composition of the greenwaste, separating the different components can provide alternative disposal options. Some examples include: separating and selling used or discarded growing media to a garden centre to generate a small income; partnering with local landscape companies or a park manager who collects the greenwaste for free and mulches or composts it for later use on gardens. One large production nursery has implemented a growing media recovery and steam sterilisation system. The growing media is separated from plant material, stored in large bins and steamed, then used for other production purposes. The reduction in growing media purchase costs justifies the cost of implementing the system.

One less common method of disposal is to use greenwaste as a biofuel in a co-generation system to produce electricity and heat for protected cropping. More recently, woody greenwaste has been used as a feed source to produce biochar for specific industries. To find alternative disposal options check the business recycling website, contact local landscaping businesses, or check local council websites for disposal options.

### 3.2.4 Plastic waste – Growing containers, product packaging and pallet wrap

Most plastics are made from finite natural resources, such as oil, gas and coal. Development of bioplastics is offering a more environmentally sustainable resource, but current production capacities are limited. Until bioplastics are widely available, using recycled plastics to manufacture new products is the best option as it reduces energy requirements by

approximately 30 per cent compared to using virgin materials. The savings obtained from recycling plastics are more than just economic. Plastics are not biodegradable; they simply break down into smaller pieces of the same plastic and persist in the environment for thousands of years. These small pieces have been found to cause death to many wildlife species at all levels of the food chain, both terrestrial and aquatic. Recovery programs have been introduced by a wide variety of organisations to increase the collection value and reduce the environmental impact of plastic. However, the high cost of collecting and processing the material and issues with contamination by other substances is limiting recovery (PACIA 2014, Goodyear 2014, European Bioplastics 2015).

Basically plastics can be separated into hard or rigid plastics and soft plastics. In many cases both hard and soft plastics are made from the same raw material using different production processes. From example, many growing containers are made from polypropylene (plastic code 5), the same material used to make carpets, home appliances, auto parts, toys, buckets, bottles and furniture. High-density and low-density polyethylene (HDPE code 2, LDPE code 4) are two plastic types widely used. HDPE is used to make shopping bags, milk bottles, milk crates, greenhouse films and agricultural pipe. LDPE is used for garbage bags, sauce bottles, irrigation pipe, builders plastic, weed mat, and pallet shrink wrap. All of these plastics are recyclable and diverting as much as possible to reuse or recycling can reduce general waste costs considerably (PACIA 2014). Identifying which plastics to divert will depend on the type and quantity generated and recycling services in each location.

Small quantities of rigid plastics, including growing containers, can be recycled through the existing local council co-mingled recycling service if clean. Larger items and quantities need to be recycled via one of the commercial waste collection or recycling companies. Some soft plastics are currently recycled via existing plastic recycling program but require larger quantities for free collection. Increasing the collection value of these materials will increase recycling options. To increase the collection value, similar plastic types should be separated and consolidated at the point of generation. The use of a baler or compactor will help to accumulate a large quantity of clean material that is easy to transport. The higher collection value is more attractive to waste collection companies and will usually be collected for free.

Alternatively, reusing growing containers and production trays made from polypropylene (code 5) can help to increase resource use efficiency and reduce purchase costs. The implementation of a growing container steam sterilisation and reuse program by one large production nursery has saved in excess of $50,000 per year in purchase costs. These steam sterilisation systems can be scaled to suit the size of a business and the types of equipment needing sterilisation. Understanding the plastic types and the collection value will help to identify what options can be implemented to reduce waste management costs.

### 3.2.5 Greenhouse cladding, films, shadecloth, bird and hail netting

Greenhouse cladding can be either rigid or soft and may not be a regular issue for some growers, but many are faced with disposing of large quantities of cladding every 3 to 5 years. Many of the materials used to produce cladding today are similar to other plastics; for example, polypropylene (PP), polyethylene (PE), high-density PE (HDPE) and low-density PE (LDPE) all are potentially recyclable. The choice of cladding type and material used will

influence the disposal options and the recycling value at the end of life. Choosing longer life materials with a greater weather resistance may have a higher initial cost but the longer useful period, reduced disruption to production for maintenance and replacement, and usually a higher recycling value at end of life can justify the higher initial cost. Material specifications to consider when replacing greenhouse cladding include thickness, tensile strength, UV stabilised and agrichemical resistance. Cladding that is inherently UV stable and agrichemical resistant will maintain the integrity of the polymers (raw material), increasing the end of life value.

One example of a greenhouse cladding that retains its recycling value is an ethylene–tetrafluoroethylene copolymer (ETFE) film which has been tested in Europe since 1987. This film has shown to have a life expectancy of approximately 15 years, a tensile strength greater than 50% at the end of life, and light transmission losses of only 10 percent over the 15 years. After replacement the material can be reused as a protective covering for equipment storage or transport tarpaulins, recycled or sold on for other purposes due to the quality of material (Stefani et al. 2007).

Some recycling companies are now collecting and recycling greenhouse cladding and films but these are limited to certain plastic types and collection areas. For example, PlasBack (http://www.plasback.com.au/) specialises in recycling plastic agricultural films but only operate in limited areas due to transport costs and market pressures. Also the issue of contamination (e.g. dirt, plant matter or agrichemical residuals) restricts the recycling of these materials and lowers the collection value; care must be taken during removal and storage to reduce the level of contamination to retain a high recycling value (Buttler 2014). Nursery managers can contact their local recycling service for disposal options or check the business recycling website search service.

### 3.2.6 Chemical waste – water sanitation, pesticides, herbicides and fertiliser

Surplus and unwanted agvet chemicals, both hazardous and non-hazardous, can be disposed of through the ChemClear program. Chemicals that are in their original containers with labels intact and are registered, or less than two years from de-registration or expiration are eligible for free collection. Unknown and unlabelled chemicals, or chemicals greater than two years from de-registration or expiration will still be accepted but for a fee. All chemicals to be disposed of via the ChemClear program must be registered on the ChemClear website prior to drop-off (http://chemclear.com.au/). Inventory sheets, storage instructions and collection information are available on the same website. Some farm supply outlets that sell agricultural chemicals may accept and store small quantities of chemicals for collection. Alternatively local councils can be contacted for more disposal and drop-off details.

### 3.2.7 Empty chemical drums and containers

The drumMUSTER program offers a free service to collect and recycle eligible empty chemical containers. Metal and plastic containers from one litre to 205 litres are eligible if they have the drumMUSTER logo on the label or stamped on the container. These containers can be dropped off at any drumMUSTER collection point after registration via the drumMUSTER website (http://drummuster.com.au/). All containers must be rinsed according to the industry standards outlined on the website. Some containers without the logo may still be accepted for a fee. Containers that are not eligible for the drumMUSTER program can be disposed of via other

plastic recycling avenues if empty and clean, but will most likely need to be delivered to a processing facility.

Larger intermediate bulk containers (IBC) are not accepted by the drumMUSTER program, but are recycled by several companies around Australia. The drumMUSTER website and the business recycling website provide a list of companies that will accept deliveries of small quantities or pick up larger quantities. Pick up costs may apply depending on the quantity, condition and if they have been rinsed to industry standards.

### 3.2.8 Office and staffroom waste

The quantities of waste generated in the office or staff room may be small compared to general production waste. However more than half of office waste is recyclable; for example paper products, cardboard, e-waste, printer cartridges and plastic. Introducing recycling and diversion programs can help to highlight resource use and reduce general waste disposal costs. Depending on the volume and type of waste, there may be an opportunity to implement sustainable practices to create a sense of community and ownership amongst the staff. The introduction of separate waste bins for paper, plastic and food scraps can encourage staff to be more aware of resource use (DEHP 2012).

#### *Paper waste (documents and cardboard packaging)*

It is common place these days for office paper to be recycled either through a dedicated office paper recycling service or via the council co-mingled recycling service. Unless the business is large and has considerable office paper to recycle, the most cost-effective method is to shred any sensitive documents and add them either the co-mingled recycling service or the cardboard packaging recycling bins that most nurseries use. Paper use efficiency can be increased by setting the printer default to double-sided draft printing and by encouraging staff not to print unless necessary. Paper recycling can be increased by providing small paper recycling bins at each desk and printer.

#### *Food waste*

Staff can be encouraged to collect food scraps and recyclables separately to reinforce waste disposal practices. This will help to extend these practices to the rest of the working environment. A food scrap collection for onsite composting or a worm farm may be introduced. The fertiliser and compost produced could be taken home by the staff, creating a sense of community and added benefit. Staffroom waste should be disposed of quickly to avoid contaminating the staffroom and attracting vermin (DEHP 2012).

### 3.2.9 E-waste

Australia is ranked in the top ten countries in the world for users of new technologies and has one of the highest rates of electronic device obsolescence. Current estimates suggest that Australians are producing e-waste at a rate three times greater than general waste (businessrecycling.com.au, ABS 2013). E-waste refers to any electronic device, such as computers, printers, printer cartridges, climate and pump control units, communication equipment (phones, tablets and UHF radios), thermostats, light bulbs, and a variety of white goods. These devices have a variety of precious metals, plastics and chemicals that can be toxic for both humans and the environment if not disposed of correctly.

Most local council waste transfer stations will accept all types of e-waste but there are also dedicated e-waste recyclers in most areas. Some charity organisations are now providing an e-waste recycling service and some electronic retailers will provide a disposal service for old and unwanted electronics when purchasing new products. Business owners should ask the shop assistant of their local electronics shop for disposal options. Large electronic items or large volumes of e-waste may need collection by a dedicated service, but the collection value of these items may warrant free collection. The best way to identify an e-waste recycling service by location is to use the search function on the business recycling website 'search for a service'.

### 3.2.10 Timber – pallets, structural and other

Wood is used throughout a production nursery facility for various reasons and purposes. It is one of the most versatile materials used and it retains a residual value even after its original purpose has passed. This residual value varies depending on the age, type and volume of timber needing disposal, as well as whether it has been treated with a fire retardant, preservatives or pesticide. Treated timber can be toxic to both humans and the environment and may require a specific disposal method if highly toxic. Treated timber and timber that is contaminated with nails, paint, oils, resins, or laminated cannot be recycled and should be disposed of via general waste. Untreated timber is sought after by several industries for processing into fire wood, heating pellets, MDF and particleboard (Sustainability Victoria 2012-15). Old-growth hardwood timber has a higher residual value due to a greater longevity and structural resilience, while soft plantation grown timber tends to have a lower residual value. Hardwood structural timber is sought after by furniture manufacturers, hobbyists and demolition yards; the larger the quantity, the greater the collection value.

Timber pallets can be made from both hardwoods and softwoods, and from treated and untreated timber. Some companies will invest in the more expensive hardwood longer-use pallets that have a return dollar value attached to ensure the pallets are returned to the company. Using pallets from these companies will provide many years of useful service and provide a small income or credit from the parent company when returned. If a pallet is not returned and a deposit was paid for the pallet then this equates to a loss in income or operating cost.

Today, disposable or short-life pallets are used to reduce the cost of using and losing pallets. These pallets are made from either treated or non-treated timber. Pallets in good condition or slightly damaged still have a residual value and are collected for re-use or re-purposing. A list of timber and pallet recycling companies is provided in section 6.3 Resource recovery and waste management services. Many of these companies will collect large quantities of pallets. Some pallet recyclers also provide a pallet trading section on their website to advertise pallets available for free. These sites are used by other companies and individuals who are interested in collecting smaller quantities of pallets and can help nursery managers to dispose of excess pallets at no or little cost.

### 3.2.11 Metals – support frames, wire, irrigation fittings and water pipes

Metals are separated into two basic categories, ferrous and non-ferrous, with each type having a different recycling value. Ferrous metals are those that contain a proportion of iron such as

steel, cast iron, wrought iron and most forms of stainless steel. Ferrous metals are generally magnetic in nature and have a high tensile strength. Non-ferrous metals are those that do not have a component of iron, they are not magnetic and can be an alloy of several materials including pure gold, silver, copper, zinc, tin, aluminium, and some forms of stainless steel (Brady, Clauser, & Vaccari, 1997). Metals have been recycled for generations and have an existing recycling infrastructure and trading market that is accessible to all businesses. Most scrap metals sold will offset disposal costs depending on the quantity and delivery method. Some metal recyclers will provide a bin and collection service free of charge depending on the type and quantity of scrap metal being recycled.

The purchase price for recycled metals fluctuates with market cycles and all scrap metal recyclers will have a general mixed metals purchase price and an individual price for clean separated metals (Table 1. Separating and storing metals onsite until a sufficient quantity is obtained has two benefits: 1) metals can be stored for an extended period of time until a sufficient quantity is obtained without losing any recycling value, and 2) the metal can be stored until the market price is high and offers a better sale price.

*Table 1: Recycling price for metals as of Nov 2014*

| Metals | Market Price |
|---|---|
| Mixed metals | $0.50 - $1.50/kg |
| Aluminium | $0.25 - $1.20/kg |
| Brass | $3.00 - $4.00/kg |
| Copper (clean) | $5.00 - $6.00/kg |
| Copper (mixed) | $4.00 - $5.00/kg |
| Lead | $0.70 - $1.10/kg |
| Lead acid batteries | $3.50 - $4.00/kg |
| Stainless steel | $1.00 - $1.50/kg |
| Steel | $0.50 - $1.50 |

Source: http://www.scrapmetal-prices.com.au/
November 2014

The most common metals recycled are aluminium, brass, copper, lead, steel and stainless steel.

Aluminium is highly recyclable in all forms and using recycled aluminium to produce new aluminium reduces energy requirements by 95 per cent. The energy saved is greater than the energy used by an average household in one year (Bureau of International Recycling, 2014). Small volumes of aluminium can be recycled through your local council co-mingled recycling bin; however, large quantities of aluminium should be disposed of through a scrap metal recycling company.

Brass is an alloy of copper and zinc; it has a high recycling value and is accepted by all scrap metal recyclers. All brass items, including irrigation fittings, can be recycled.

Copper can be recycled indefinitely and is highly sought after due to its high recycling value. It retains about 90 to 95 per cent of its raw ore value because it requires 85 per cent less energy and produces 65 per cent less carbon dioxide emissions than manufacturing products from raw ore (Bureau of International Recycling, 2014).

Steel such as galvanised water pipes, framing, trolleys and benches can be recycled together through any scrap metal recycler, but at mixed metal prices. Approximately 40 per cent of all new steel produced worldwide is made from recycled steel. Using recycled steel reduces energy use by 74 per cent, water by 40 per cent, and water and air pollutants from smelting processes by greater than 80 per cent (Bureau of International Recycling, 2014).

Stainless steel can be recycled as general steel but has a higher price when recycled separately. It is highly sought after and can be recycled indefinitely with new stainless steel products comprised of approximately 60 per cent recycled material. There are 150 types of stainless steel that comprise various rare metals. Recycling stainless steel helps to increase resource efficiency and reduce the cost of new stainless steel products (Bureau of International Recycling, 2014).

Any old metal equipment and machinery including whitegoods, potting machines or metal water tanks can be sold as general scrap metal. Some items, such as galvanised pipes, are also sought after by other businesses and some community groups to reuse as structural supports or railings. If a nursery producer has a large quantity of usable galvanised pipe for disposal, advertising it through trade magazines or disposing of it via a scrap steel recycler could provide a small income to offset storage or transport costs.

### 3.2.12 Batteries

There is a wide variety of batteries used in today's equipment which range in size and chemical composition. No batteries should be disposed of via general waste, as the concentration of chemicals can cause environmental and health issues. Whether the batteries are single use or rechargeable, AA, AAA, C, D, button cell, mobile phone, car, truck or cordless drill battery, all can be processed to remove the chemical components. Small batteries used in most commercial and domestic appliances are collected by companies such as Battery World and Aldi Supermarkets, while larger commercial batteries can be dropped off at a variety of businesses throughout Australia.

To find the closest battery recycler, nursery managers can visit the following websites: http://www.recyclingnearyou.com.au/batteries or http://www.cyb.com.au/our-priorities/environment/find-a-recycling-centre

### 3.2.13 Rubber

There is an assortment of rubber items a nursery may need to dispose of over a year, including bumper strips, vehicle tyres, trolley tyres, conveyor belts, mats and various other items. Individually these items only represent a small quantity of waste; however the value of recycled rubber has been increasing over the last decade, with more companies developing new uses or products from reclaimed rubber items. The introduction of a tyre product stewardship program is driving the development of new technologies to process tyres in to new products. This is increasing the demand and value for all reclaimed rubber and the number of companies that collect rubber items for recycling (CoA 2014).

Rubber is a compound that does not biodegrade and remains stable over time. It can be stored for extended periods without losing its recycling value. Separating rubber from the general waste stream and collecting it onsite will reduce the contamination level and increase the collection value. Rubber items can be heavy and take up considerable space in a bin. Removing the rubber from the general waste bins has the potential to reduce the frequency and cost of general waste collection and free up bin space for non-recyclables. As the rubber is not adversely affected by the weather, it can be stored onsite indefinitely until a sufficient quantity justifies collection or delivery to a recycling business.

## 3.3 Principles of waste management

The principles of waste management highlight the change in attitudes towards waste disposal and are the main drivers of a multi-directional waste disposal approach. Modern waste management practices and many government guidelines are developed around these principles. Implementing waste management practices accordingly can help businesses to determine the true value of waste materials, meet expected responsibilities, and reduce waste management costs.

### *Waste hierarchy*

The waste hierarchy is an accepted classification system for waste management strategies. It outlines the progression of waste management options from the lowest cost and greatest environmental benefits to the highest cost with least favourable environmental outcomes. The most cost-effective option is to focus on minimising the generation of waste. These techniques aim to avoid the importation of potential waste materials or reduce waste generation through an increase in resource use efficiency. Waste diversion techniques aim to recover the raw materials or some imparted energy by redirecting waste materials from the general waste stream for another purpose. Disposal is the complete loss of a resource. Which option is available to a business will depend on the waste services in an area and the collection value of the waste materials.

Figure 1 is one representation of the waste hierarchy. There are various interpretations using a pyramid diagram and different terminology, but the concept is the same. These concepts are explored in more detail below.

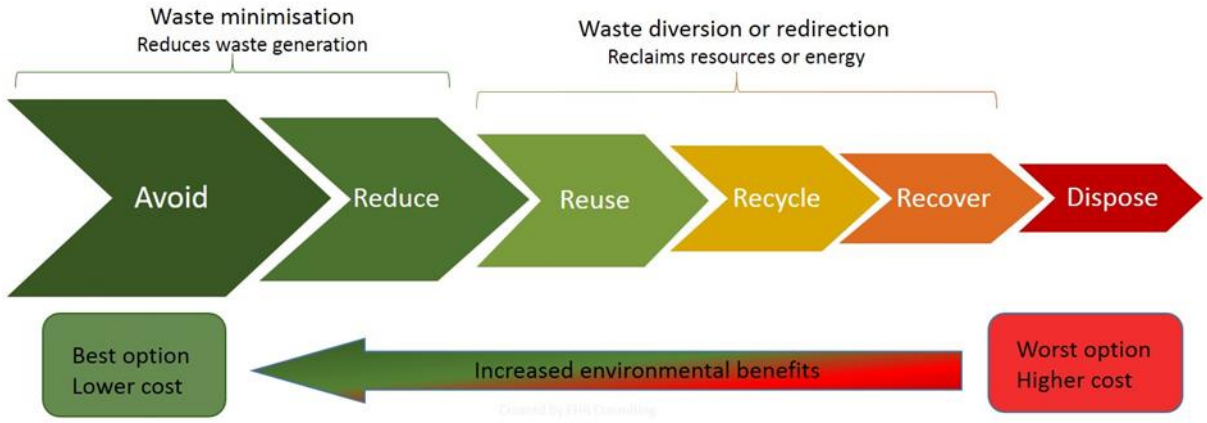


*Figure 1: The waste hierarchy*

### *Life-cycle assessment*

Life-cycle assessment is a method of assessing the environmental impact of a product from cradle to grave. That is, it considers all aspects of a product, from the design stage and raw material choice, to the manufacturing, distribution, use and reuse, recycling or disposal of a product. The aim is to identify any opportunity to redesign, reinvent or divert the product to minimise the waste potential and extend the product's life. Understanding the life-cycle of a

product can help with purchasing decisions by identifying the residual value of the material after use and the most economical disposal options prior to purchase (EPHC 2009).

### *Product stewardship*

Product stewardship is a new regulation and code of practice that is being introduced under the Product Stewardship Act 2011. This act provides a framework to manage the environmental and community impact a product has over its life-cycle. It states that anyone who is involved with the production, sale, use or disposal of a product has a responsibility to manage and limit the impact a product has on the environment and human health. The 'Product Stewardship Advisory Group is an independent group that develops lists of products to be regulated under the Act. The only waste streams currently regulated is the national television and computer recycling scheme, and the national tyre product stewardship scheme. New products are considered each year (EPHC 2009).

There are also several voluntary product stewardship schemes currently in use or proposed. These include the mobileMUSTER, drumMUSTER, Flurocycle, used battery collection program, and the Australian packaging covenant. Although there is no product stewardship scheme associated with production nurseries, under the product stewardship framework all managers have a responsibility to dispose of wastes with the least impact on the environment or human health.

### *Resource efficiency*

Resource efficiency is focused on using a limited resource in a sustainable manner to reduce the environmental impact of producing and consuming a product. It is the optimisation of resources, with the aim to produce more with fewer inputs while increasing the value of the material (EPHC 2009).

## 3.4 Waste management and disposal options

Several waste analysts have suggested that many businesses usually underestimate the true cost of waste management and disposal, and in most circumstances the actual cost can be ten times more than shown in accounting records. This is attributed to a lack of understanding of how waste is generated and the associated costs of waste management. In today's society, businesses must have an understanding of how to identify, classify and quantify waste, as well as having an understanding of the waste management principles to reduce costs (Pearson 2002).

Introducing a multi-directional approach to waste disposal can provide more economical options for waste disposal. Choosing the most appropriate or economic method of waste disposal will be different for each waste type and vary for each nursery in a different location. Business managers need to promote a change in the perception of waste being a 'waste' to it being a 'resource' requiring management to fully extract the residual value. The use of the waste hierarchy and management principles can help to identify which waste option is best.

In this section, waste management options are presented and where possible, examples are given to highlight alternative practices currently used by some production nurseries.

### 3.4.1 Waste minimisation

Waste minimisation is basically the process of avoiding or reducing the generation of waste through education and improved production practices. These practices focus on managing the existing resources, equipment and processes to reduce consumption of resources and increase resource use efficiency. Waste minimisation requires an understanding of why resources are used and how production processes work. It may be difficult to initially identify the actual benefits of minimisation strategies, as savings can be incremental and hidden within other processes. However, minimising waste generation can:

- improve production efficiencies by increasing output for the same or less inputs
- increase profitability by reducing purchasing costs
- reduce waste management and disposal costs by eliminating the generation of waste.

#### *Waste avoidance*

Waste avoidance is about avoiding the generation of waste in the first place. It is the most cost-effective method of achieving savings, as it stops the importation of materials that can become waste. In some communities this is also referred to as 'precycling', which means making a decision to purchase a product depending on the potential waste generated from the purchase. These methods include:

- refining purchasing practices to reduce ordering excess or unnecessary resources
- purchasing products in packaging that is easily recycled or biodegradable
- changing from using disposable items to reusable ones
- updating internal administration procedures to encourage the adoption of electronic ordering, invoicing and stocktaking methods.

A simple example of waste avoidance is changing purchasing practices. For one nursery, an increase in production increased the volume of growing media needed. Purchasing in small, individually-packaged units increased the volume of packaging generated, thereby increasing disposal costs. In this case, changing suppliers and purchasing products in bulk avoided the importation of excess packaging waste and led to reduced disposal costs.

*Figure 2: Increasing plastic packaging on inputs can increase disposal costs.*

#### *Waste reduction*

Waste reduction is about reducing the amount of waste requiring disposal. This can be achieved by either implementing more efficient processes to reduce the amount of resources needed, or purchasing products that do not generate waste. Some examples include:

- only printing what is needed and using double-sided copies when possible
- ordering products with less packaging or buying in bulk to limit packaging
- purchasing products packaged in recyclable materials
- incorporating eco-friendly equipment to reduce resource requirements
- reviewing and redesigning production processes to increase resource use efficiency.

An innovative example of reducing waste by one nursery was the development of a photo-sensitive and biodegradable delivery label or sticker for transport trays. The transport trays were used for delivering products to several chain stores, which were collected and returned to the nursery at the next delivery. The supply contract required all product and trays to have the client's name and logo displayed on the label. Using the original permanent delivery stickers required the use of separate trays for each chain store, or paying a staff member to scrape off the identifying stickers prior to reuse. This increased the production costs, created a health and safety issue around using chemicals to remove the stickers, and generated a waste that was difficult to contain. The introduction of the new delivery labels did incur the initial cost of purchasing new label printers and a slightly higher cost for the biodegradable labels, but the long-term benefits included:

- reduced staff labour required to sort and clean the trays
- the removal of the health and safety issue of using cleaning chemicals
- the removal of client identification labels on the trays, allowing all trays to be used for any client
- the cessation of the generation of a waste that was difficult to contain
- improved working conditions
- increased environmental compliance by removing a potential contaminate source.

### 3.4.2 Waste diversion

Waste diversion can take many forms, but generally refers to the redirection or diversion of waste materials from a waste stream to create a waste product that can be used or processed for the same or other purpose. Diverting waste can help to reduce waste management costs in one of two ways. Firstly, diverting waste from the general waste stream can reduce the quantity requiring disposal, in turn reducing the number of bins needed or the frequency of waste collection. Secondly, separating specific waste items from the general waste stream can increase the value of those items, making them more attractive for collection, reuse or recycling. If the items are of high value, it is possible to have that waste product collected for free or create an income from the sale.

#### *Reuse*

Reuse is using an item in its original form for the same purpose more than once. This does not exclude reconditioning or rejuvenating an item by washing or painting to prolong the life of the product. Some definitions question whether this is an actual disposal method, as the items are capable of and are being used for their original purpose and therefore are not actually a waste, but a reusable resource. No matter the definition, reusing an item will help to reduce purchasing costs and increase resource use efficiency.

Depending on the purpose of the resource and any biosecurity issues, it may be necessary to implement new processes or install equipment to address pathogen control. The use of detergents, disinfectants or other technological processes may be required. However, the costs incurred to clean items for reuse can be less expensive in the long-term compared to the combined purchase and disposal cost for single use items. The greater the volume or quantity of a resource that can be reused, the greater the potential savings and the wider the variety of cleaning systems available.

One example of the savings achievable by reuse is the implementation of a growing container sterilisation and reuse program by one large production nursery. A second-hand diesel steam generator and small insulated cargo container was installed with a new temperature control unit at a cost of $39,400. A variety of growing containers are emptied of rejected plants and growing media, and then stacked in large plastic crates. Approximately 3000 containers in two crates are steamed. A disinfectant is injected into the steam lines and the system is run overnight for 12 hours to ensure sterilisation. Sterilising and reusing the growing containers are expected to save purchase costs of approximately $70,000 per year, provide a continuous supply of clean production equipment, therefore paying for itself in the first year of use.

*Figure 3: Containers being prepared for steaming and reuse.*

### *Recycling*

Recycling involves the collecting and processing of discarded items to recover the raw material to remake the original item or to make a new item. It can also refer to the diversion of a material or item from a waste stream for an alternative purpose. The term 'recycling' is an umbrella term that refers to various waste diversion practices. Broadly, it refers to any process that converts a waste product into a new product to reduce the use of raw materials and energy consumed during processing, reduce waste to landfill and greenhouse gas emissions, and reduce the potential for air or water pollution (DSEWPaC 2012a, EPA 2009). Some common terms associated with recycling are listed below.

1. Down-cycling: the recycling of a product or waste material for remanufacturing into a product of lesser quality and functionality in order to reduce the use of virgin materials. For example, plastic drink bottles and packaging are remanufactured into park benches, bollards or buckets.
2. Up-cycling: the recycling of waste materials for an alternative purpose of equal or greater value or functionality other than the original purpose. An example of this would be diverting organic waste from landfill to a composting facility that processes the greenwaste into a marketable top soil or mulch of greater value for landscaping, or returned to farms to enhance soil health and fertility.
3. Repurposing: changing the purpose of an item from its original intended use. The item may be used in its original form or altered to suit the new purpose. For example, using old irrigation polypipe as structural hoops for a small polytunnel, using worn machinery parts for an art sculpture, or using old greenhouse films or obsolete billboard vinyl as transport tarpaulins and shade sails.

Recycling opportunities in production nurseries will vary, but most nurseries engage in some form of recycling. The main material being recycled are paper and cardboard, plastic containers, and metals, including aluminium. These materials have an existing collection network and known trading value, but other by-products of production also have the potential to be recycled or diverted. Examples include soft plastics such as pallet wrap, produce bags and

greenhouse films. The larger the quantity of these materials that can be collected, the higher the value and the greater the opportunity to divert the materials.

*Recovery*

Recovery is a form of recycling, except the purpose is not to recover the raw materials but to convert waste to energy. It uses non-recyclable materials to fully or partially recover the energy embedded in the items from the raw material or during production. There are several processes used to convert the waste, including incineration, gasification, pyrolysis and digestion. The energy content of the source material, the cost and the conversion efficiency of the different methods is a limiting factor for small-scale use in production nurseries. However, some nurseries are using non-recyclables and rubbish to fuel a cogeneration system to produce electricity and heat for protected cropping.

On a larger scale, some organisations are using greenwaste, general waste or medical waste in a biomass boiler to produce electricity and will accept deliveries of combustible materials from nurseries. The $CO_2$ gas produced from this process is also captured for sale to greenhouse vegetable production facilities. A few companies are starting to use non-recyclable wastes to produce biochar for various uses and will accept deliveries of clean and uniform greenwaste. Unfortunately, these facilities are location-specific and are only available to a limited number of nurseries.

### 3.4.3 Disposal

Disposal usually refers to the burying of waste in a landfill and is the loss of all raw materials and energy embedded in the items during manufacture or use. It should be considered the last resort, as it has the highest environmental impact with the potential to produce polluting leachates and greenhouse gasses. Material recovery facilities are now extracting various materials prior to landfill, but high levels of contamination reduces separation processes, increasing the cost of disposal.

Contamination can refer to both hazardous and controlled substances or unwanted material being mixed in with wanted materials. It can be the presence of dirt, chemicals or other waste materials. For example, a greenhouse film recycling company considers certain types of heat- or light-reducing paints as chemical contamination, as well as high levels of dirt picked up during the bailing process. Most recycling companies consider soft plastic packaging and pallet wrap as contaminants in hard plastics.

Modern landfill sites are addressing these issues by installing highly sophisticated sorting equipment and processing systems, leachate containment and treatment systems, and gas capture technologies to extract the methane and carbon dioxide gas for commercial use. However, the cost of installing these technologies, the introduction of new waste management regulations, and a decrease in land availability are increasing the cost of traditional waste disposal.

### 3.4.4 Alternative waste disposal options

There are several methods that can be used to reduce waste disposal costs. These range in complexity and the level of investment required. Not all options will be appropriate for all nurseries and will need to be determined by each nursery, depending on current waste

management practices and the level of benefits achievable. The best option nursery managers have to increase waste diversion and reduce waste disposal costs is to increase the collection value of the waste materials.

### 3.4.5 Increasing the collection value of waste

The collection value of a waste material is determined by market pressures, transport costs, the trading price, and the level of demand for the material. Waste materials with low demand or limited collection infrastructure will have a low collection value, which may remain low until a new use or processing method is developed. Low-value materials will be more difficult to divert, due to limited demand, and may still incur some form of transport costs. Waste materials that are in demand for recycling or as a trading commodity will have a medium to high collection value that can justify the implementation of new recycling practices. One of the most common methods of increasing the collection value of recyclable materials is to use a baler or compaction system.

#### *Baler or compaction equipment*

Baling and compaction systems have been used for many years to compact large quantities of various wet or dry waste destined for landfill. Today, balers of varying sizes are being used to compress recyclable materials into a 'bale' to increase material handling efficiency, reduce transport costs, and increase the quantity of material that can be stored onsite prior to collection. Primarily, baling machines are used to compact cardboard and paper packaging, but these machines can also be used for materials such as plastic packaging, produce bags, pallet wrap, plastic bottles, silage wrap and other compactable materials.

*Figure 4: Large bales of cardboard packaging*

*Figure 5: A bale of 25 litre liquid containers*

Baler units come in a variety of sizes, from small, single, hand-operated units, to large, automated, multi-bay units for managing several materials at once. The size of the baler required will depend on the type and volume of material needing compaction and the disposal method. Large bales have a greater value due to the volume of material they contain, but can require heavy lifting equipment for moving and loading. Smaller bales are easily moved and transported, but have less commercial value due to the extra handling required. This can reduce the collection value of some recyclable materials. However, providing a source of clean, separated recyclable material will increase the opportunities to divert the materials from the general waste stream. The greater the quantity of material that can be supplied the greater the chance of having the material collected for free or to receive payment.

Using a baling machine has the potential to reduce waste disposal costs in four ways:

1) reducing the volume and/or collection frequency of general waste by removing recyclable materials from the general waste steam
2) reducing the collection frequency of recyclable materials by increasing the quantity of material that can be collected in a limited space
3) increasing the collection value of recyclable materials by providing a large quantity of separated clean material
4) providing a cleaner facility, especially around the waste collection area, and reducing fire hazards from loose waste material.

*Figure 6: A bale of 1.25 litre soft drink bottles*

*Figure 7: A bale of silage wrap*

Currently, several industries use baler or compaction machines to compress paper, cardboard, plastic containers, pallet and silage wrap, and aluminium cans. Material compaction can be between two and ten times that of loose material in a bin (Table 2).

Some garden centres in the UK are currently using baler machines to compact plastic and cardboard packaging. This has reduced onsite waste issues and provided a small income from selling the clean and sorted materials (http://www.miltek.com.au/VIDEOS.aspx?ID=9919). Similar systems can also be used to compress expanded polystyrene (EPS) boxes by 80 per cent of the original size, which significantly reduces collection costs. Production nursery managers interested in implementing a baler system should contact a product supplier or service provider to discuss the best machine for their nursery.

*Table 2: The difference in quantity between loose, non-compacted materials and baled materials*

| Material type | Loose (kg per $m^3$) | Bales (kg per $m^3$) |
|---|---|---|
| Cardboard | 30 – 60 | 356 – 652 |
| Paper | 269 – 356 | 593 – 712 |
| PET plastic (code 1- bottles & packaging) | 18 – 24 | 120 – 297 |
| HDPE (code 2 - food & other containers) | 13 – 15 | 120 – 297 |
| Aluminium cans | 30 – 45 | 89 - 297 |
| Steel cans | 89 – 104 | 97 - 593 |

### *Pallet strap cutters*

Pallet strapping is not considered to be a large issue for most production nurseries, but for some that receive deliveries of palletised goods such as bulk coir, it can be a considerable quantity over the production year. Most pallet strapping used in this case is a polypropylene (code 5), the same plastic as many growing containers and other recyclable plastic items. Loose pallet strapping is difficult to compress in a standard industrial bin due, to the rigidity of the material, and can take up a sizable volume. However, a strap cutting machine allows the strap to be cut directly into a separate drum, increasing the collection value of the material and reducing the space used in the general waste bin. It may take a year to fill the drum and collect

a reasonable quantity for recycling, but the small footprint of the machine, the increased collection value of the material and the volume of bin space saved by diverting the strapping may be beneficial depending on the volume of strapping. However, the cost of a commercial strap cutting machine can be high, and this option may only be appropriate for large production nurseries or garden centres.

#### *Bin share arrangements*

The quantity of recyclable materials generated by small businesses can be insufficient or too irregular to warrant a separate collection service by waste collection companies. The collaboration of several small businesses that generate a common recyclable material can help to gather a greater quantity of recyclables and justify collection. Bin share arrangements have been successful in industrial estates for co-mingled recyclables, paper and cardboard. There can be issues relating to identifying an appropriate area for materials collection and a fair sharing of costs in proportion to recyclables generated by each participant.

#### *Redirect recyclables to local businesses (industry symbiosis)*

Some materials may not be generated in sufficient quantity or have a high enough value to justify collection by a waste collection company, but they may still be desired by other businesses in the local area. Partnering with local businesses to redirect surplus materials for reuse or processing into another product is slowly gathering momentum, but is limited in Australia. Currently developing partnerships to redirect waste materials is up to the nursery manager and requires an understanding of the resource requirements of local businesses. Checking with the local council, trade registers or local waste services can help to identify potential partners. Some nurseries have already entered into such agreements; for example, supplying greenwaste and used growing media to local landscape companies for composting and garden rejuvenation, or supplying combustible waste as a fuel source in bio-boilers.

## 3.5 Online survey results

Overall, 34 nursery representatives responded to the online survey, providing a wide range of waste management information. This information has been collated and is presented below.

### 3.5.1 Nursery size and crops produced

Survey respondents varied in both yearly turnover and number of full-time equivalent employees, with several nurseries producing more than one crop. Figure 8 provides a breakdown of the yearly turnover and the number of nurseries per turnover range. The largest nursery that provided data had a yearly turnover greater than ten million dollars; however the majority of nurseries that responded had a yearly turnover of less than $500,000 (8 nurseries). Seven nurseries reported as having a yearly turnover of between $500,000 and $1,000,000; four nurseries between $1,000,000 and $1,500,000; another twelve nurseries having a yearly turnover between $2,000,000 and $5,000,000 and two nurseries in the $6,000,000 to $7,000,000 turnover range.

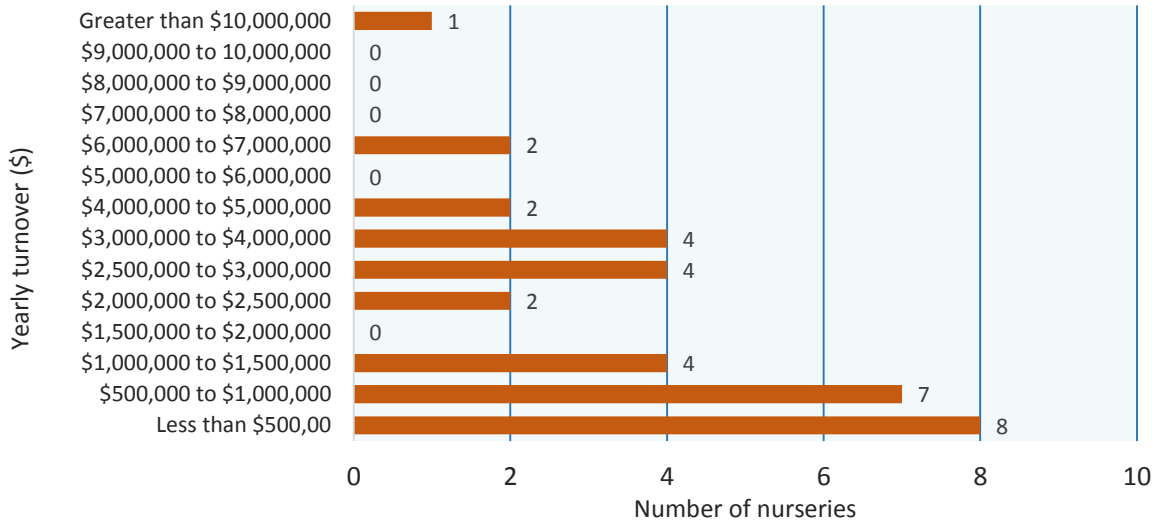


*Figure 8: Breakdown of survey respondents by yearly turnover*

The types and number of crops each of these nurseries produced varied across to whole range of yearly turnover. Thirteen nurseries (37%) stated they specialised in only one crop type, eleven nurseries (31%) produced two crops types, eight nurseries (23%) produce three different crop types and three nurseries (9%) produced more than four crop types.

The most popular crop type was Trees and Shrubs, with four nurseries specialising in these alone and another 15 nurseries either producing these as their primary or secondary crop type. The second most popular crop type, Tubestock, also had four nurseries specialising in this crop type, with another 11 nurseries producing at least one other crop type as well. There was also two nurseries specialising in both Seedling and Plugs and Potted colour (26%), with one nursery specialising in Fruit trees. All other crop types were grown in parallel with a combination of House plants, Grasses, Herbs, Fruit trees or Palms. Table 3 shows the breakdown of crops grown by survey respondents.

*Table 3: Breakdown of crops grown by nursery respondents*

| Crop | Percent by crop type * | Nurseries growing crop* | Nurseries that specialise in only one crop type |
|---|---|---|---|
| Trees & shrubs | 56% | 19 | 4 |
| Tubestock | 44% | 15 | 4 |
| Seedlings/plugs | 29% | 10 | 2 |
| Potted colour (annual or perennial) | 27% | 9 | 2 |
| House plants (indoor) | 27% | 9 | |
| Grasses | 18% | 6 | |
| Herbs | 15% | 5 | |
| Other | 9% | 3 | |
| Fruit trees | 6% | 2 | 1 |
| Palms | 6% | 2 | |

* Response percentage and counts indicate the number of nurseries growing each crop type separately and does not take into account that 22 nurseries grow multiple crops in parallel.

More than half of nurseries (57%) employed less than ten full-time equivalent (FTE) employees, with 23 per cent employing between 20 and 30 employees (FTE), 9 per cent employing 30 to 40 FTEs, and 6 per cent employing 40 to 50 FTEs. Only one nursery reported employing 10 to 20 FTEs and one employing greater than 100 FTEs. Table 4 shows the breakdown of FTEs by nursery turnover.

*Table 4: Breakdown of nurseries by yearly turnover and staff (FTE)*

| Yearly turnover ($) | Nurseries per $ | Number of employees (FTE) | | | | | |
|---|---|---|---|---|---|---|---|
| Less than $500,00 | 8 | 7 | | 1 | | | |
| $500,000 to $1,000,000 | 7 | 7 | | | | | |
| $1,000,000 to $1,500,000 | 4 | 4 | | | | | |
| $2,000,000 to $2,500,000 | 3 | 1 | | | | 2 | |
| $2,500,000 to $3,000,000 | 4 | 1 | 1 | 1 | 1 | | |
| $3,000,000 to $4,000,000 | 4 | | | 3 | 1 | | |
| $4,000,000 to $5,000,000 | 2 | | | 2 | | | |
| $6,000,000 to $7,000,000 | 2 | | | 1 | 1 | | |
| Greater than $10,000,000 | 1 | | | | | | 1 |
| Nurseries per FTE = | | 20 | 1 | 8 | 3 | 2 | 1 |
| | | 1 to 10 FTE | 10 to 20 FTE | 20 to 30 FTE | 30 to 40 FTE | 40 to 50 FTE | Greater than 100 FTE |

### 3.5.2 Waste generation awareness

Approximately 33 per cent of the survey respondents (11 nurseries) stated they are aware of how much waste their nursery generates over a year, but only 27 per cent (9 nurseries) have actually conducted a waste audit. Twelve nurseries (36%) stated they do conduct specific waste reduction training with their staff and a further 27 per cent provide basic waste management training as part of an employee's induction.

Of those nurseries that had conducted a waste audit, seven of the nine nurseries reported a positive outcome and two nurseries reported that no benefit was achieved. The positive outcomes varied from financial savings due to a reduction in general waste disposal costs, to an increase in efficiency due to a raised awareness of wasted resources.

Comments from the survey respondents about the benefits of conducting a waste audit included:

- "We used to get the general waste bin emptied weekly, but now fortnightly, reduced our bill by half"
- "Reduced collection of industrial bin to once per fortnight"
- "Green waste bins replaced landfill bins"
- "Streamlined processes and reduced waste"
- "Assessed yearly as part of a P & L monitoring plan, helps to identify alternative solutions"
- "Increased awareness but hasn't helped reduce costs yet"

- "Has increased costs as we consciously recycle as much as possible".

From the survey responses and the discussions with nursery managers, waste management and disposal was once only seen as a secondary issue to plant production, but now is being seen has having a greater impact on business due to a noticeable increase in packaging associated with production inputs. This increasing waste awareness has triggered many nursery managers to introduce some form of waste reduction training and seek out alternative disposal or recycling method. Unfortunately a manager's desire to responsibly dispose of or recycle their waste materials may not match the level of waste services in their area. Furthermore, the increased cost of recycling in some areas discourages some managers from separating their recyclable materials from general waste.

### 3.5.3 Waste management and disposal costs

Waste management and disposal costs varied between survey respondents, with eight nurseries either not knowing what waste disposal was costing them or refraining from providing a value. Of the remaining 27 nurseries, waste management costs ranged from $250 per year to $31,200 per year, with staff hours allocated to waste management ranging from one hour to 40 hours per week. For all respondents waste disposal costs were below 1 per cent of yearly turnover, with 88 per cent of respondents reporting waste management and disposal costs below half a per cent of yearly turnover. Figure 9 shows an overlay of the number of staff hours spent on waste management and waste costs by yearly turnover.

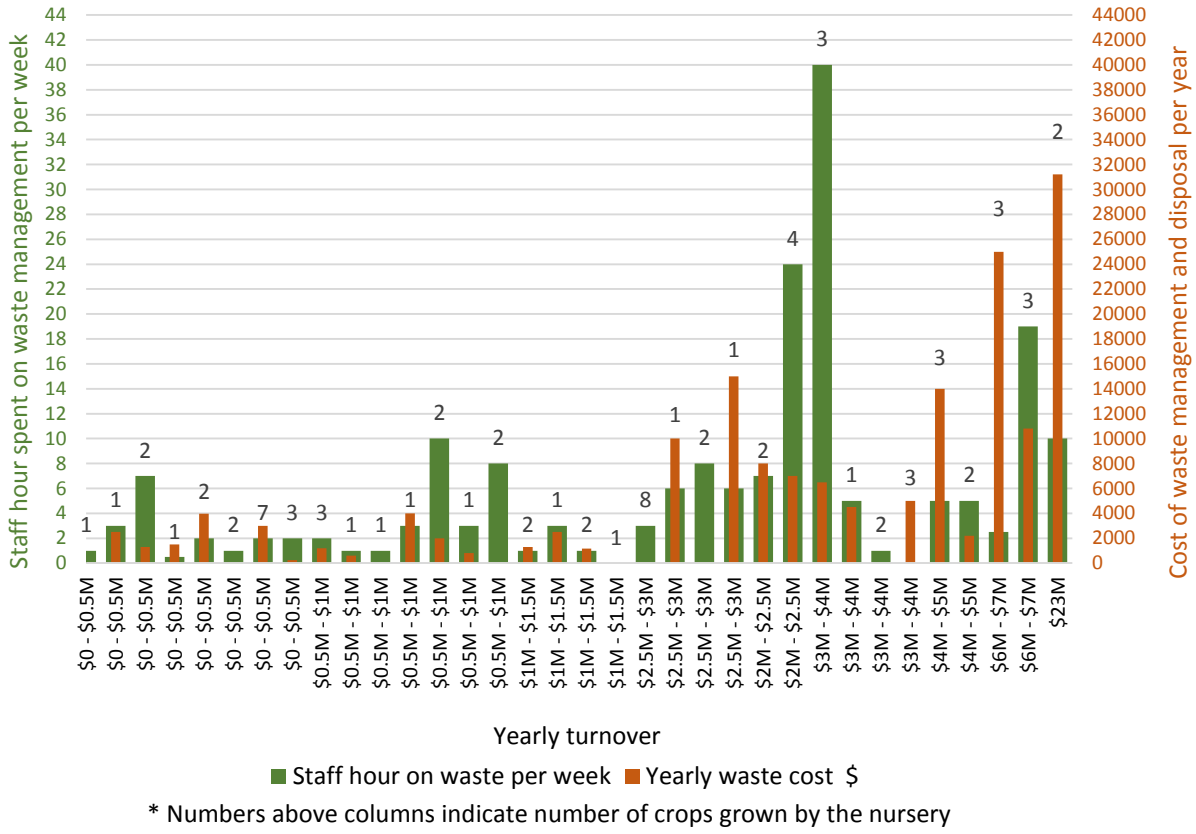


*Figure 9: Comparison of yearly turnover, staff hours spent on waste management and waste management costs for survey respondents*

The survey results indicate the number of hours each nursery spent on waste management varied across all crop types, FTEs and yearly turnover. No relationship between the costs of waste management, the number of employees, or crop type was identified from the survey results. However a basic increasing trend in waste management costs was related to an increase in the size of the business (i.e. yearly turnover). When considering the percentage of turnover attributed to waste management cost, the three highest percentages belonged to nurseries with a turnover of less than one million dollars producing one or two crops. The nursery with the lowest percentage had a yearly turnover of between three and four million dollars producing two crops. Of the seven nurseries with the lowest waste management costs (<0.1%), only one nursery reported having conducted a waste audit. A full list of nurseries by crop type, turnover, number of employees, disposal costs and training is presented in Table 5

.

*Table 5: List of survey respondents showing crop type and waste management details*

| # of crops produced | Crop type | Turnover | # of employees | Waste audit done (Y/N) | Yearly waste cost $ | Yearly waste cost % | Trained in waste reduction | Staff hour on waste per week |
|---|---|---|---|---|---|---|---|---|
| 1 | Fruit trees | < 0.5 | 0-10 | No | DK | DK | Basic | 1 |
| 1 | Indoor house plants | < 0.5 | 0-10 | No | $2,500.00 | 0.50 | No | 3 |
| 1 | Indoor house plants | 3 - 4 Mil | 20-30 | No | $6,500.00 | 0.16 | Basic | 5 |
| 1 | Seedlings/plugs | 0.5 - 1 Mil | 0-10 | No | $600.00 | 0.06 | Basic | 1 |
| 1 | Seedling/plugs | 1 - 1.5 Mil | 0-10 | No | $2,500.00 | 0.17 | Yes | 3 |
| 1 | Trees & Shrubs | 0.5 - 1 Mil | 0-10 | No | $4,000.00 | 0.04 | No | 3 |
| 1 | Trees & Shrubs | 0.5 - 1 Mil | 0-10 | No | NA | NA | Yes | 1 |
| 1 | Trees & Shrubs | 2 - 2.5 Mil | 40-50 | No | $10,000.00 | 0.40 | Basic | 6 |
| 1 | Trees & Shrubs | 2.5 - 3 Mil | 0-10 | Yes | $11,094.00 | 0.37 | Yes | 6 |
| 1 | Tubestock | < 0.5 | 0-10 | Yes | $1,500.00 | 0.30 | No | 0.5 |
| 1 | Tubestock | 0.5 - 1 Mil | 0-10 | Yes | $800.00 | 0.08 | No | 3 |
| 1 | Tubestock | 1 - 1.5 Mil | 0-10 | No | DK | DK | No | 0 |
| 2 | Indoor house plants; Ferns | < 0.5 | 20-30 | Yes | $1,300.00 | 0.26 | Yes | 7 |
| 2 | Indoor house plants; Trees & Shrubs | 3 - 4 Mil | 30-40 | No | $4,500.00 | 0.01 | Yes | 1 |
| 2 | Potted colour; Indoor house plants | 1 - 1.5 Mil | 0-10 | Yes | $1,300.00 | 0.15 | Basic | 1 |
| 2 | Potted colour; Herbs | 2.5 - 3 Mil | 30-40 | No | DK | DK | No | 8 |
| 2 | Trees & Shrubs; Grasses | 0.5 - 1 Mil | 0-10 | No | $2,000.00 | 0.75 | Yes | 10 |
| 2 | Trees & Shrubs; Herbs | 1 - 1.5 Mil | 0-10 | Yes | $1,179.00 | 0.19 | No | 1 |
| 2 | Tubestock; Native trees & shrubs (140mm) | < 0.5 | 0-10 | No | $3,960.00 | 0.79 | Basic | 2 |
| 2 | Tubestock; Seedlings/plugs | < 0.5 | 0-10 | No | NA | NA | Yes | 1 |
| 2 | Tubestock; Tress & Shrubs | 0.5 - 1 Mil | 0-10 | No | DK | DK | Basic | 8 |
| 2 | Tubestock; Seedlings/Plugs | 2.5 - 3 Mil | 0-10 | Yes | $8,000.00 | 0.23 | Yes | 7 |
| 2 | Tubestock; Trees & Shrubs | 4 - 5 Mil | 20-30 | No | $14,000.00 | 0.28 | Yes | 5 |
| 2 | Tubestock; Seedlings/plugs | 6 - 7 Mil | 20-30 | No | $10,800.00 | 0.17 | No | 10 |
| 3 | Potted colour; Indoor house plants; Trees & Shrubs | 0.5 - 1 Mil | 0-10 | No | $1,200.00 | 0.02 | No | 2 |
| 3 | Potted colour; Trees & Shrubs; Grasses | 6 - 7 Mil | 30-40 | Yes | $25,000.00 | 0.36 | Yes | 19 |
| 3 | Tubestock; Seedlings/plugs; Trees & Shrubs | < 0.5 | 0-10 | No | $250.00 | 0.05 | No | 2 |
| 3 | Tubestock; Potted colour; Trees & Shrubs | 3 - 4 Mil | 20-30 | NA | NA | NA | NA | NA |
| 3 | Tubestock; Potted colour; Trees & Shrubs | 3 - 4 Mil | 20-30 | No | $5,000.00 | 0.13 | No | 5 |
| 3 | Tubestock; Trees & Shrubs; Grasses | 4 - 5 Mil | 20-30 | No | $2,200.00 | 0.05 | No | 2.5 |
| 3 | Tubestock; Potted colour; Trees & Shrubs | 23 Mill | 100- 120 | No | $31,200.00 | 0.14 | Basic | 40 |
| 4 | Tubestock; Trees & Shrubs; Palms; Grasses | 2.5 - 3 Mil | 20-30 | No | $7,000.00 | 0.2 | Yes | 24 |
| 7 | Tubestock; Seedlings/plugs; Potted colour; Indoor house plants; Trees & Shrubs; Grasses; Herbs | < 0.5 | 0-10 | Yes | $3,000.00 | 0.37 | Yes | 2 |
| 8 | Seedlings/Plugs; Potted colour; Indoor house plants; Trees & Shrubs; Fruit trees; Palms; Grasses; Herbs | 2 - 2.5 Mil | 0-10 | No | DK | DK | Basic | 3 |

DK = don't know; NA = did not answer

### 3.5.4 Waste quantities by nursery size

The total combined quantity of all waste generated by the 34 nurseries over a year is approximately 1362 tonnes. The largest single quantity of waste (25%) was contributed by the biggest nursery, with 344.9 tonnes. Table 6 presents a breakdown of the number of nurseries per tonnes of waste generated over a year. The majority (76%) of nurseries generate less than 50 tonnes of waste per year. Nineteen nurseries (47%) generated less than 20 tonnes of waste with 16 of the 19 nurseries having a yearly turnover of less than $1.5M. Of those 16 nurseries, 10 generated less than 10 tonnes per year but the small quantity of waste generated did not correlate with the yearly turnover. Figure 10 shows the distribution of waste generation in relation to yearly turnover. Ten nurseries generated between 20 and 50 tonnes of waste per year and ranged in yearly turnover from $0.5M to $4M. The 3 nurseries that generated between 50 and 100 tonnes of waste had a yearly turnover from $2.5M to $5M. The 4 nurseries that generated more than 100 tonnes of waste per year had a yearly turnover of between $2.5M and $23M.

*Table 6: the number of survey respondents per tonnes of waste generated*

| Tonnes of waste generated | Number of nurseries per tonnage | Percentage of survey respondents per tonnage |
|---|---|---|
| 0 – 20 | 16 | 47% |
| 20 – 50 | 10 | 29% |
| 50 – 100 | 3 | 9% |
| 100 – 200 | 4 | 12% |
| 200 – 400 | 1 | 3% |

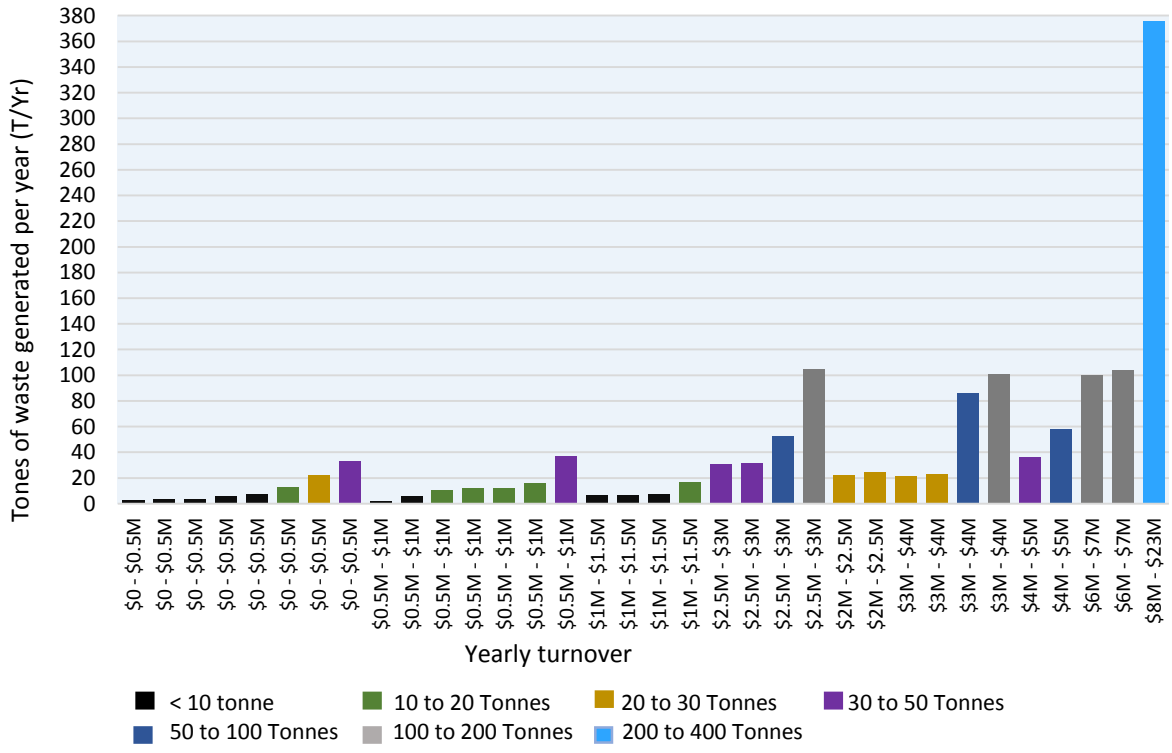


*Figure 10: A distribution for tonnes of waste generated compared to yearly turnover.*

Figure 11 shows the average tonnes of waste generated by yearly turnover (not including the largest nursery). The tread line suggests there is a potential relationship between the average tonnes of waste generated and the nursery's yearly turnover; however this could not be confirmed without a greater number of survey respondents. Further comparisons between tonnes of waste generated, number of crops produced and yearly cost of waste disposal did not provide any defined relationships.

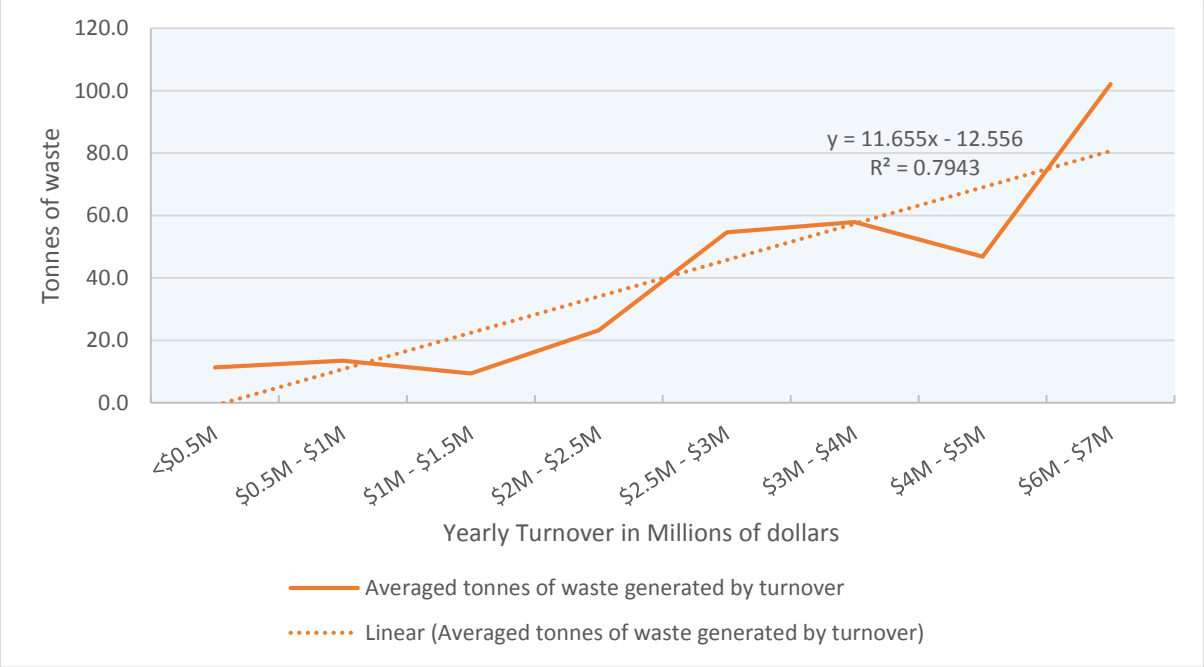


*Figure 11: Average tonnes of waste generated by yearly turnover.*

Figure 12 shows an overlay of yearly turnover, tonnes of waste generated, number of crops produced and cost of waste management. The orange columns indicate the cost of waste disposal for each survey respondent; this highlights that the cost of waste disposal is not related to the tonnes of waste generated or the number of crops produced. It is suspected that the quantity of waste generated by a nursery is more related to the type of crop produced and management practices. The types of waste generated by each nursery varied in both composition and quantity and although no defined relationship between waste quantities and nursery turnover or number of crops produced could be identified, the composition of waste types is relatively consistent.

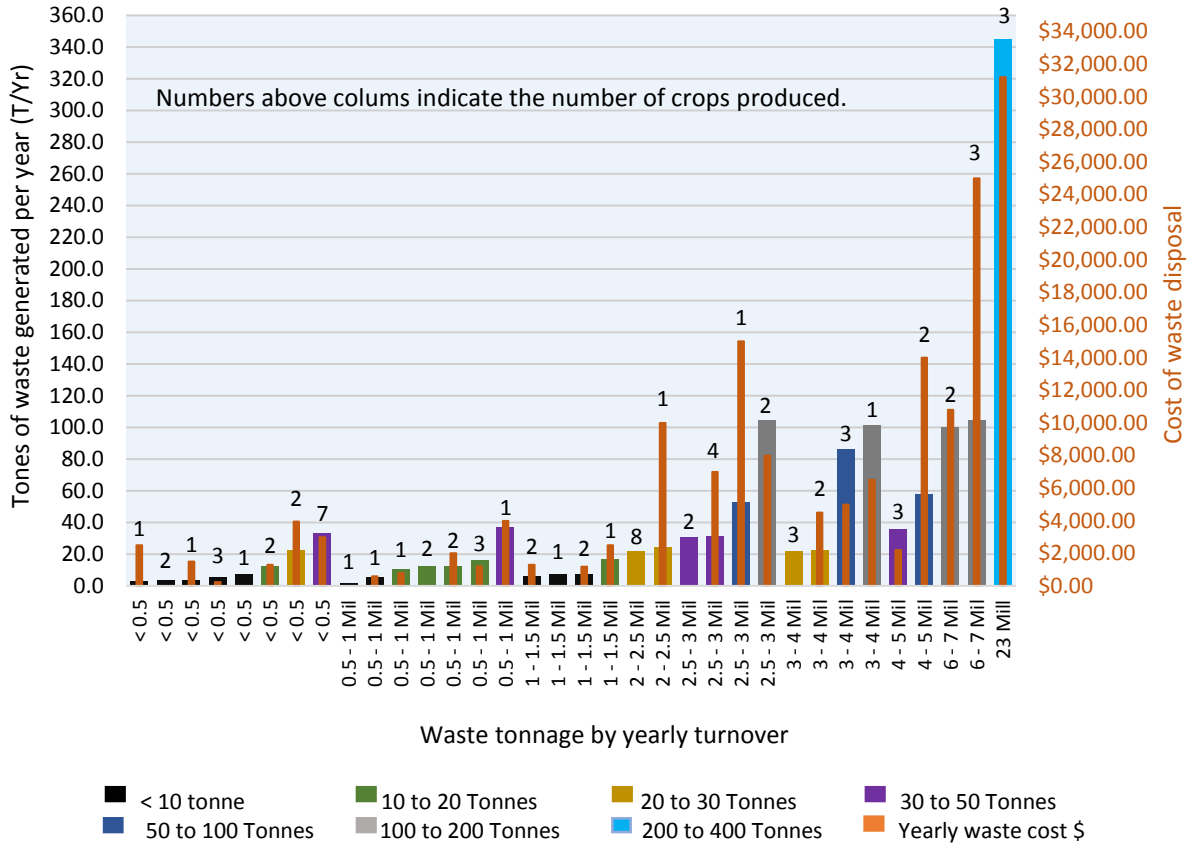


*Figure 12: Ranking of nurseries by the tonnage of waste generated and yearly turnover with an overlay of waste management costs and number of crops produced. (Yearly cost overlay is not proportional to tonnes of waste indicated on the graph)*

### 3.5.5 Waste types and quantity

Survey respondents were asked to estimate the quantity of waste generated for specific waste types, such as office paper, production cardboard and paper packaging, greenwaste (plant cuttings, rejected and dead plants), and used or rejected growing media. However from survey comments and discussions with nursery managers, similar waste types are combined and treated as one for disposal efficiency. As not all survey respondents provided separate estimations of these similar waste types, those waste types that are similar were combined for the purposes of analysis. For example, greenwaste (plant cuttings, rejected and dead plants) and used or rejected growing media is collectively grouped as greenwaste. The other grouping combines production cardboard and paper packaging, and office paper which is referred to as cardboard and paper.

Also several nurseries listed growing bed gravel as a waste item but this was removed from the final waste calculation after further discussions with industry representatives. In general, gravel is not actually wasted but reused onsite to repair roadways, or is cleaned and decontaminated for reuse as bedding gravel. In this case the gravel is considered to be a resource that is recycled or reused onsite and not a waste needing disposal. However if the gravel is decontaminated onsite by a professional cleaning service, the associated costs should be recorded as part of the waste management.

Table 7 presents the unadjusted quantities of waste and Table 8 presents the combined or adjusted waste quantities with the tonnage and percentage of each waste type generated. There are five main waste categories: general waste (40%), greenwaste (30%), cardboard and paper recycling (14%), plastics, including growing containers, packaging and pallet wrap (7%), and pallets (5%). The remaining four per cent is comprised of a variety of other production wastes and general recycling. This ranking was relatively consistent across all surveyed businesses, with each nursery generating slightly different waste types and quantities due to differences in production methods, input resources used and crop type.

*Table 7: Unadjusted breakdown of all waste type including growing bed gravel.*

| Waste material | Tonnes per year | % of waste total |
|---|---|---|
| General waste | 535.93 | 32.226 |
| Gravel | 300.90 | 18.093 |
| Greenwaste | 297.94 | 17.915 |
| Packaging card & paper | 189.31 | 11.383 |
| Used media | 110.70 | 6.656 |
| Plastic pots | 73.08 | 4.394 |
| Pallets | 66.04 | 3.971 |
| Metals | 25.04 | 1.506 |
| Plastics wrap & packaging | 22.50 | 1.353 |
| Greenhouse film | 10.83 | 0.651 |
| Miscellaneous | 7.90 | 0.475 |
| Builders plastic & weed mat | 7.31 | 0.440 |
| General recycling | 4.50 | 0.271 |
| Office paper | 3.85 | 0.232 |
| Batteries | 1.77 | 0.107 |
| Rubber/tyres | 1.66 | 0.100 |
| eWaste (office & production) | 1.34 | 0.080 |
| Oil | 0.72 | 0.043 |
| Chemicals & fertiliser | 0.47 | 0.028 |
| Timber | 0.42 | 0.025 |
| Faulty equipment | 0.25 | 0.015 |
| Glass | 0.22 | 0.013 |
| Irrigation pipe | 0.14 | 0.008 |
| Irrigation fittings | 0.11 | 0.007 |
| Shadecloth | 0.11 | 0.006 |
| Total waste generated = | 1663.0 | |

*Table 8: Adjusted breakdown of waste types and quantities generated excluding growing bed gravel but combining greenwaste and used media, and all cardboard and paper.*

| Waste material | Tonnes per year | % of total Waste |
|---|---|---|
| General waste | 535.93 | 39.345 |
| Greenwaste | 408.64 | 29.999 |
| Cardboard & paper | 193.16 | 14.181 |
| Plastic pots | 73.08 | 5.365 |
| Pallets | 66.04 | 4.848 |
| Metals | 25.04 | 1.838 |
| Plastics wrap & packaging | 22.50 | 1.652 |
| Greenhouse film | 10.83 | 0.795 |
| Miscellaneous | 7.90 | 0.580 |
| Builders plastic & weed mat | 7.31 | 0.537 |
| General recycling | 4.50 | 0.330 |
| Batteries | 1.77 | 0.130 |
| Rubber/tyres | 1.66 | 0.122 |
| eWaste (office & production) | 1.34 | 0.098 |
| Oil | 0.72 | 0.053 |
| Chemicals & fertiliser | 0.47 | 0.035 |
| Timber | 0.42 | 0.031 |
| Faulty equipment | 0.25 | 0.019 |
| Glass | 0.22 | 0.016 |
| Irrigation pipe | 0.14 | 0.010 |
| Irrigation fittings | 0.11 | 0.008 |
| Shadecloth | 0.11 | 0.008 |
| Total waste generated = | 1362.1 | |

### 3.5.6 Waste type categories

When the waste types were grouped as regularly generated waste and infrequent waste, there were six waste categories identified. For simplicity the infrequent wastes are a group of different waste types that may be disposed of or recycled differently due to the frequency and small quantities generated. In some circumstances, these small quantities are considered to be uneconomical to recycle by many and tend to be added to general waste.

These categories are fairly consistent across all nurseries but slight changes in quantities generated will change the ranking. Figure 13 is a colour-coded ranking of waste categories for different waste tonnage. This shows that on average, general waste and greenwaste are constantly the most common waste types generated. Cardboard and paper waste is the third most generated waste type, followed by plastic (growing containers and packaging). All other wastes generated fell into either other wastes or general recycling. This highlights the waste categories that are contributing the most to waste management costs and which waste categories to focus on for reducing waste management costs.

| Up to 10T | % | 10T to 20T | % | 20T to 30T | % | 30T to 50T | % | 50T to 100T | % | 100T to 200T | % | 200T to 400T | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| General waste | 45.0 | Greenwaste & used Media | 39.6 | General waste | 59.4 | General waste | 50.8 | Greenwaste & used Media | 37.9 | Greenwaste & used Media | 39.8 | General waste | 37.6 |
| Greenwaste & used Media | 42.6 | General waste | 34.0 | Greenwaste & used Media | 23.3 | Greenwaste & used Media | 31.5 | General waste | 35.6 | General waste | 32.7 | Other wastes | 23.4 |
| Cardboard & Paper | 5.7 | Plastic pots & packaging | 12.0 | Cardboard & Paper | 8.4 | Cardboard & Paper | 9.7 | Cardboard & Paper | 18.3 | Cardboard & Paper | 14.5 | Cardboard & Paper | 18.8 |
| Other wastes | 3.6 | Other wastes | 8.4 | Plastic pots & packaging | 5.8 | Plastic pots & packaging | 4.7 | Plastic pots & packaging | 5.4 | Plastic pots & packaging | 6.8 | Greenwaste & used Media | 11.1 |
| Plastic pots & packaging | 2.7 | Cardboard & Paper | 5.5 | Other wastes | 3.0 | Other wastes | 2.5 | Other wastes | 2.7 | Other wastes | 5.7 | Plastic pots & packaging | 9.1 |
| General Recycling | 0.5 | General Recycling | 0.4 | General Recycling | 0.1 | General Recycling | 0.9 | General Recycling | 0.1 | General Recycling | 0.5 | General Recycling | 0.0 |
| 10 Nurseries | | 6 Nurseries | | 5 Nurseries | | 5 Nurseries | | 3 Nurseries | | 4 Nurseries | | 1 Nursery | |

*Figure 13: A colour ranking of the top six waste types by tonnes of waste generated.*

### 3.5.7 Current recycling, reuse or diversion practices

Thirty-three of the survey respondents stated that they recycle some form of waste materials. Packaging cardboard is the most common resource recycled (82%) with office and production paper being the second most recycled resource (76%). A few nurseries recycle office documents and paper via a specialty document recycling company, but in many cases both the production and office cardboard and paper are combined and recycled via a single industrial recycling bin for cost efficiency.

Almost 64 per cent of survey respondents stated they recycle plastic growing containers and approximately 52 per cent recycle other plastics (chemical and fertiliser drums), but pallet wrap and pallet strapping is only recycled by approximately 40 per cent. Other items recycled include greenhouse glass and cladding material. One survey respondent recycles greenhouse framing metals, and another captures and reuses carbon dioxide gas from the heating system in the greenhouses. Only one nursery reported recycling waste water by diverting nursery runoff for irrigation within the onsite orchard. Figure 14 show a breakdown of waste materials recycled and the percentage of survey respondents that recycle each material.

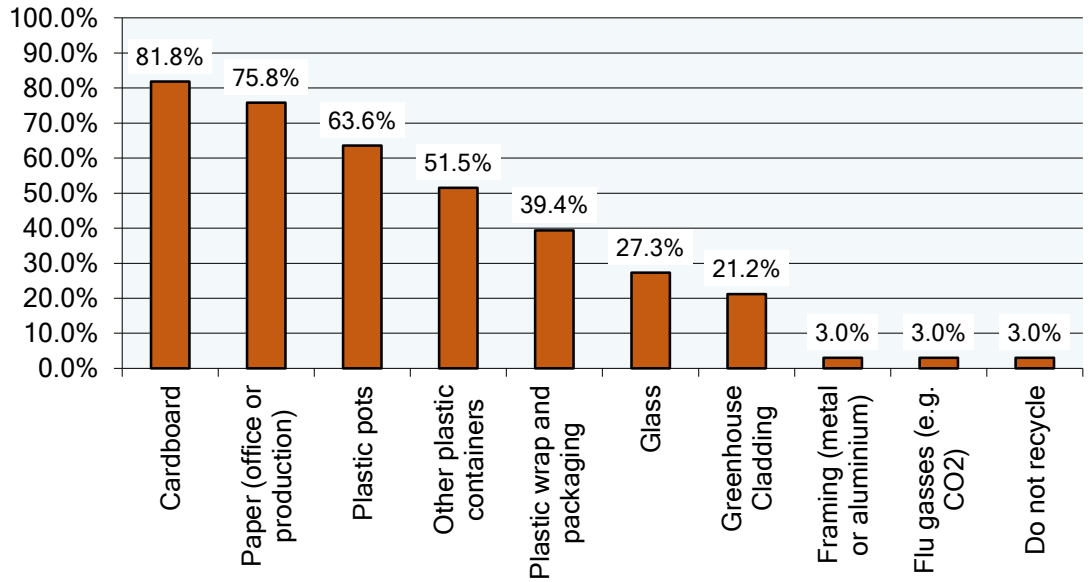


*Figure 14: A breakdown of waste items recycled with percentages.*

Several survey respondents stated that they recycle as many materials as possible and would like to recycle more materials but are limited by the recycling services in their local area. A few nursery managers recycle materials even though they incur a higher disposal cost due to collection service fees or equipment and staff costs for dropping off materials at a recycling centre. Several survey respondents were prepared to deliver infrequent recyclable material to collection centres, but found it difficult to locate businesses that recycled specific materials, such as large quantities of used greenhouse films or plastic pallet wrapping.

Some nurseries are reusing or disposing of wastes onsite because of the cost of a commercial disposal service; for example, using bedding sand or gravel to repair and resurface roadways or dumping greenwaste onsite. Several survey respondents commented that they wanted to divert these wastes for recycling or reuse but have not being able to identify an economical alternative to onsite dumping or general waste disposal.

### *Greenwaste*

The disposal of greenwaste was a regular issue raised by most survey respondents. An estimated 298 tonnes of greenwaste and a further 110 tonnes of used, rejected or contaminated growing media is generated each year. This is an estimated 409 tonnes of combined greenwaste and growing media being generated by 34 nurseries. Several survey respondents stated that greenwaste disposal costs have increased due to changes in fees at local waste processing facilities and in some local council areas greenwaste could not be recycled due to biosecurity controls.

A large proportion of survey respondents (82%) stated that greenwaste is separated from general waste (Figure15), with 64 per cent of these dumping or composting the greenwaste onsite. Only twenty-one percent (21%) or approximately 86 tonnes of greenwaste is sent to a commercial processing facility to be mulched or composted. Fifteen per cent (15%) or 61 tonnes of greenwaste is reported to be still sent to landfill via a general waste service (Figure 16).

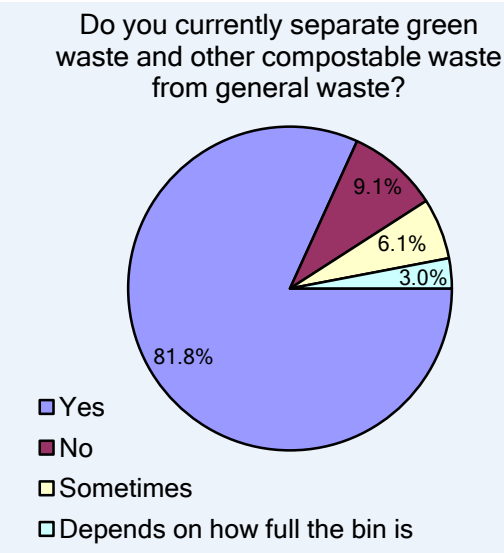


*Figure 15: Nurseries that currently separate greenwaste from general waste.*

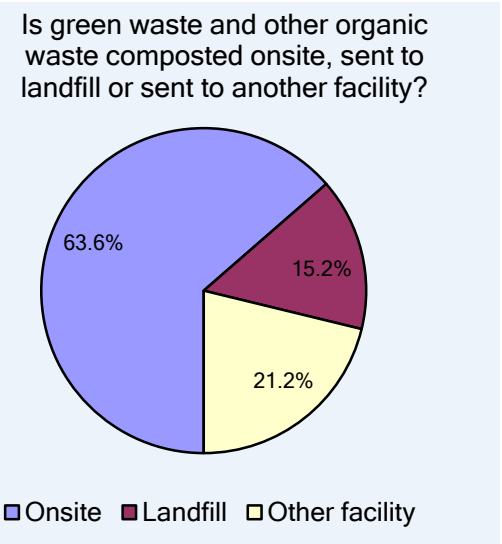


*Figure 16: How nurseries dispose of greenwaste.*

Of those nurseries that process their greenwaste onsite, most composted it and incorporated it into onsite gardens, used it as a mulch or as a soil amendment in other production areas on farm. Other disposal methods included disposing of small quantities via the local council greenwaste bins or using larger woody waste for wood burning heaters. One nursery reported sending the greenwaste to be incinerated. Two production nurseries stated that they have an agreement with a local landscaping service that collects greenwaste for composting and use on local parks and gardens.

### *Plastics*

There is an estimated 95.6 tonnes per year of plastic waste being generated by the 34 nurseries. Only 9 production nurseries reported to be recycling plastic via a commercial recycling service, with another three nurseries reporting to be participating in an official pot recycling program, and three other nurseries are washing and reusing pots onsite. This suggests that 20.3 tonnes per year generated by the 34 production nurseries is being recycled by specific plastic recycling services and another 2.2 tonnes per year is being recycled by other means or reused. The remaining 73.1 tonnes of plastic waste generated per year is being disposed of via general waste services.

On average, plastics make up approximately six per cent of the total waste generated, with several survey respondents commenting that plastic packaging has increased considerably in recent years to the point that it has increased the general waste disposal costs. The majority of this packaging being pallet wrap, pallet strapping and produce packaging. The main reason suggested for not recycling more plastics was that no plastic separation policy was in place or there wasn't a specific plastic recycling service available in the local area. Several survey respondents did comment that some plastics are recycled via other co-mingled recycling services, e.g. council recycling bins, but none could provide an estimate of the quantity being recycled via these other recycling services.

### *Other recyclables*

Comments from survey respondents suggest there is a wide variety of waste materials that could be recycled are not being recycled, such as greenhouse films and cladding, weed mat, builder's plastic, damaged or disused benches, trolleys and framing metals. Also, an increase in the use of technology has increased the need for eWaste disposal, but these materials are simply added to general waste because they are not aware of any recycling services or the cost of recycling is too great. A few survey respondents also stated the disposal of unwanted fertiliser or chemicals was an issue, as not all unwanted chemicals or containers are accepted by the drumMUSTER program.

There is an increase in waste recycling services for materials such as greenhouse film, but these services are location specific. For example, a soft plastic recycling service that accepts greenhouse film and pallet wrap operating in certain areas of South Australia and Victoria will not accept materials from other areas of these states or any other state. This is primarily due to small private companies operating within particular locations to address a local issue but unable to accommodate a wider portion of the population due to transport costs.

# 4.0 Conclusion and recommendation

This project was developed to investigate waste management and disposal practices within the Australian nursery industry, provide baseline data on waste generation, and identify any alternative waste disposal options that can be adopted by the industry to reduce waste disposal costs. The information gathered through discussions with nursery managers, waste collection companies, and the online survey has highlighted some issues with nursery waste disposal and how waste is valued. This information has been condensed and presented in separate sections covering the changing value of waste, current industry waste management practices, and the development of a Nursery waste self-assessment pack.

The Nursery waste self-assessment pack will help nursery manager to quantify waste generation and develop a waste management plan. However the best way to reduce waste management and disposal costs is to adopt waste minimisation practices, and increasing the value of the waste materials. Some of the waste generated in a production nursery will need to be disposed of via general waste due to the hazardous or dangerous nature of the materials but other recyclable materials should be reclassified as a resource. Adding value to these discarded resources is the key to not only diverting waste from landfill but is an opportunity to reclaiming some of the costs associated with waste management.

Currently the limitations to recycling and resource reclamation is due to a general miss-understanding of what materials can be recycled, a fragmented recycling network, and a low demand for products made from reclaimed materials. Although this is slowly changing and new manufacturing process are being developed, without an increase in the demand for products made from reclaimed materials, the value of these materials will remain low. As a demand for remanufactured products is increased so will the demand for these waste resources and the creation of more closed-loop recycling systems. Adding value to the waste materials is the key to increasing the demand for waste products and reclaiming some of the costs associated with waste management and disposal.

Increasing the value of waste can be approached from both an industry and an individual business level.

Some potential options from an industry level approach are -

1. Encourage nurseries to conduct waste audits using the self-assessment pack and develop a website portal for listing waste materials. This would provide ongoing waste generation data for the industry and provide a geographical reference for surplus resources that other industries can use to locate materials. It would add value to waste materials and help to connect waste generators with waste users within specific geographical areas. NGIA could partner with organisations such as PlanetArk who currently have a business recycling search function and an environmentally responsible image.

2. Implement an industry specific waste awareness campaign to clarify the recycling or diversion potential for production nursery waste materials. Develop signage or

partner with recycling organisations to distribute signage that can be displayed at waste generation points to highlight disposal options.

3. Promote collaboration between nurseries or other adjacent businesses to combine similar waste types under a bin share arrangement to increase the collection value and provide a source of material that warrants free collection. This could also be developed in conjunction with local community or environmental groups to increase the image of the program.

4. Currently the infrastructure of plastic recycling is expanding and several companies are manufacturing quality products from recycled plastic. One example is RePlas Pty Ltd (http://www.replas.com.au/) who have partnered with the RED Group to process plastic shopping bags and other soft plastic into bollard, fencing material, park benches and a variety of other products. One of the limiting factor for this technology to develop further is the small customer base and the contamination of the waste plastic collected. These businesses provide an opportunity for the Nursery and Garden Industry to develop a recycled plastic supply chain that could provide a regular source of clean material. However nursery industry members would be expected to purchase product to maintain the closed loop recycling system. However, a partnership with these businesses would also provides an opportunity for the nursery industry to help develop products more suited for nursery use. This would increase the customer base and provide an avenue to recycle the plastic waste currently going to landfill.

5. There may be opportunity to partner with Envirobank reverse vending machine to expand the types of plastic that can be accepted in these machines. Currently these machine are used to collect plastic bottles and aluminium soft drink cans but may provide an opportunity for larger garden centres to encourage customers to recycle other plastics. This may provide other opportunity to expand the plastic items able to be collected to include nursery related plastics such as growing containers, fertiliser or pesticide containers. Further discussions with the development company is required to determine the potential of using the Envirobank.

   (https://www.youtube.com/watch?feature=player_embedded&v=ZwEtbPC3fxo)

For individual businesses the opportunities will vary and is limited by the level of investment required or the recycling services available. The first step is to conduct a waste assessment to identify the types and quantity of waste being generated and identify recycling services locally available. Then minimise waste generation by assessing the efficiencies of production processes and purchase practices. More specifically nurseries can -

1. Develop strategic and progressive investment options that will help to transition the business to more sustainable practices such as reuse, recycling, remanufacturing, and encourage product stewardship.

2. Upgrade equipment and processes to use resources more efficiently, improve recycling options, and increase the collection value of waste materials.

3. Implement recyclate separation strategies and install a baler or compaction system to reduce contamination and increase collection value.

4. Partner with adjacent businesses to develop a bin share arrangement to increase the collection value and reduce disposal cost for both businesses.

5. Partner with local businesses to redirect surplus materials for use in another industries.

6. Engage staff in the waste management process to facilitate involvement and foster personal investment in waste management.

7. Implement waste identification training to encourage sustainable waste management practices. Several waste collection companies provide support services to assist businesses in training staff.

8. Contact local community or environmental groups to initiate and partner in recycling programs. This can provide waste redirection opportunities while supporting a good cause and creating a 'green' marketing opportunity.

9. Start or join a growing container recycling program to encourage the return of containers by customers. This can provide the opportunities to increase community involvement, develop a clean green marketing image and increase the collection value of the containers.

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# 6.0 Waste Management and Information Websites

## 6.1 Australian Government reference websites:

Department of Environment, National waste policy landing page
http://www.environment.gov.au/topics/environment-protection/national-waste-policy

Department of Environment, Policies and governance for waste – National Waste Reporting 2013
http://www.environment.gov.au/topics/environment-protection/nwp/reporting/policies-and-governance

Department of Environment, Product Stewardship legislation
https://www.environment.gov.au/protection/national-waste-policy/product-stewardship/legislation

Department of Environment, Hazardous waste act 1989
http://www.environment.gov.au/topics/environment-protection/hazardous-waste/about-hazardous-waste-act

Australian Government, pollution and waste management of hazardous waste
http://australia.gov.au/topics/environment-and-natural-resources/pollution-and-waste-management

Common Law database:
http://www.comlaw.gov.au/comlaw/management.nsf/lookupindexpagesbyid/IP200401419?OpenDocument

Australian Government, National waste policy, Product Stewardship:
https://www.environment.gov.au/protection/national-waste-policy/product-stewardship

Australian Government, National waste policy, Product Stewardship Act 2011:
https://www.environment.gov.au/system/files/resources/3947fa3a-8404-472c-92c9-1745e6954558/files/fs-product-stewardship-act.pdf

Living Greener – Reduce, Reuse, Recycle:
http://www.livinggreener.gov.au/waste/reducing-and-recycling/reducing-waste/reduce-reuse-recycle#recycle

## 6.2 State and local council waste reference websites

ACT Government, business recycling program and waste management service
http://www.actsmart.act.gov.au/yourbusiness/waste/ACTSmart_business -

ACT Government, Recycling program case studies
http://www.actsmart.act.gov.au/more_information/case_studies

NSW Government, Waste disposal grant options
http://www.epa.nsw.gov.au/waste/wasteinfragrants.htm

Queensland Government, waste management
https://www.ehp.qld.gov.au/waste/

South Australia Government, Zerowaste, E-waste recycling
http://www.zerowaste.sa.gov.au/e-waste/what-can-be-recycled-from-e-waste

Sunshine Coast Council waste transfer facility
http://www.sunshinecoast.qld.gov.au/sitePage.cfm?code=waste-facilities-menu

Tasmanian Government, Waste management information centre
http://www.gcc.tas.gov.au/content/Waste_Management_Centre.GCC?ActiveID=1337

Victorian Government, EPA, Lower your impact
http://www.epa.vic.gov.au/business-and-industry/lower-your-impact/

Western Australia Government, Waste Authority
http://www.wasteauthority.wa.gov.au/

## 6.3 Resource recovery and waste management services:

### *Scrap Metal recycling price guide*

http://www.scrapmetal-prices.com.au/

### *Timber and pallet recycling*

http://www.timberstewardship.org.au/reduce-reuse-recycle/timber-recycling-directory

http://www.directpallets.com.au/pallets-sydney/waste-pallet-recycling/

http://wasteconverters.com.au/PalletsandCrates.php

http://businessrecycling.com.au/recycle/pallets-wood

http://brisbane-pallets.com/

http://www.marshallfamilygroup.com.au/pallet-recyclers/akasha-pallet-recyclers/

http://www.designrulz.com/product-design/2012/09/35-creative-ways-to-recycle-wooden-pallets/

### *E-waste recycling:*

http://recyclingnearyou.com.au/ewastescheme/

http://www.ecyclerecovery.com.au/index.htm

### *Plastic recycling:*

RePlas - soft plastic recycling and manufacturing company
http://www.replas.com.au/news-media/online-videos?wid=66

PACIA plastics identification code guide listing recycling uses.
http://www.pacia.org.au/Library/PageContentVersionAttachment/c5dd1bc7-0a5a-4ef0-b81b-e703664b3c9c/pic.pdf

Plastic Recyclers Australia, commercial plastic recycling
http://www.plasticrecyclers.com.au/waste-plastic-recovery.htm

### *Retail recycling centres:*

Reverse Garbage an industrial waste retail store

http://www.reversegarbage.com.au/ -

Glenorchy Recovery shop
http://www.recoveryshop.com.au/contact.html

### *General recycling information services:*

Planet Ark waste material factsheets
http://recyclingweek.planetark.org/recycling-info/downloads.cfm -

Greenwaste disposal search service
http://compostforsoils.com.au/ -

Waste conversion factors
http://www.epa.vic.gov.au/business-and-industry/lower-your-impact/~/media/Files/bus/EREP/docs/wastematerials-densities-data.pdf

Guides and information on setting up a workplace recycling program
http://recyclingweek.planetark.org/business/new-systems.cfm

Drum muster 'finding a collection site' search service
http://www.drummuster.com.au/find-a-collecion-site/

Recycling search service for South Australia
http://www.recyclesa.com.au/

Construction material trading bite search service
http://www.recyclebuild.com.au/index.html

Recyclate trading site
http://www.grn.com/cgi-bin/exview.cgi?w=60&sc=1005&st=LA

Recycling Exchange and recyclate market price provider
http://www.recycle.net/price/

## 6.4 International waste and recycling websites:

### *Waste auditing:*

http://www.zerowaste.co.nz/assets/BusinessSolutions/wasteaudit.pdf

http://www.solidwastedistrict.com/projects/waste_audit.htm

http://urbanimpact.com/

### *General recycling and waste reduction reference websites*

Recycling in New Jersey
http://www.recyclingnj.com/index.html

Organic Coop recycling information
http://communitygreennj.org/index.html

New York waste recycling alternative waste disposal case studies
http://www.nyc.gov/html/nycwasteless/html/home/home.shtml

San Francisco recycling options and reduction programs
http://www.sfenvironment.org/zero-waste/recycling-and-composting?ti=6

Recology Zerowaste service auditing and recycling options.
http://www.recology.com/index.php/for-businesses#audits-consultation -

# Appendix A: Production nursery waste survey

https://www.surveymonkey.com/s/NurseryWasteSurvey

Purpose of survey

This survey has been developed by EHR Consultants and NGIA to capture industry specific information on the types and quantity of waste generated by a containerised production nursery (Levy project NY13003).

'Waste' refers to all site wastes generated by your nursery including green waste, office waste, e-waste, waste from maintenance activities and general production waste.

All information provided will be kept confidential and will only be used to estimate -
1) the average amount of waste generated over a year,
2) to identify the true cost of waste management to the industry and
3) help determine what options there are to re-directed or re-purpose the waste to reduce disposal costs.

Your input is appreciated and valued. By completing the survey, you go in the draw to win a set of 10 Pocket Diagnostic Test Kits, valued over $100. For more information on these kits please visit http://www.pocketdiagnostickits.com.au

The survey should only take approximately 15 minutes and will require you to answer a range of questions. There are no right or wrong answers, we are only interested in getting an overview of the type and quantity of waste generated by the industry. Some questions only need a Yes or No answer, or choosing from a dropdown list, other questions will require you to type in a response or a value. Any questions marked with an asterisk (*) requires an answer to progress. Please answer all other questions relevant to your business and take your time to estimate waste quantities accurately. Your answers could help the whole industry to reduce waste costs.

Units of measure:

When entering a value please indicate the unit of measure used e.g. kg, m3, litres, etc.
Note: If a wheelie bin or wheelbarrow is used to gather green waste please state the size –
Large wheelie bin = 240L, Small wheelie bin = 120L,
Standard wheelbarrow = 100L, 44 gallon drum = approximately 200 litres.
Industrial bins are measured in cubic metres (m3) and come in sizes from 1m3 to 10m3. Most industrial bins will have the size marked on the side of the bin but if not it will be stated on your waste collection agreement.

Survey questions

1. Have you ever conducted a waste audit at your nursery? Y N
2. Do you know how much waste your business generates in a year? Y N
3. Are your employees trained in waste reduction methods? Y N
4. Do you currently separate and recycle -
    a. Cardboard, plastic and glass Y N
    b. Green waste and other compostable items Y N
5. Do you re-direct any waste items to other industries? Y N
6. Do you re-use waste onsite for another purpose? Y N
7. Is organic waste composted on site or transported to landfill? Onsite Landfill

8. What is the size of your primary waste bins for
    a. General waste - Industrial bins Size: _____ How many: _____ Emptied: _____ per month
    b. General waste - Domestic bins Size: _____ How many: _____ Emptied: _____ per month
    c. Recycling – Industrial service Size: _____ How many: _____ Emptied: _____ per month
    d. Recycling – Domestic service Size: _____ How many: _____ Emptied: _____ per month
9. In a typical year, how much does waste management and disposal cost your business?

$_____ OR _____ % (Please provide either a yearly dollar value or percentage of operating costs attributed to waste management.)

10. How much of the following regular waste types do you dispose of –

| Type of waste | Volume ($m^3$) or weight (Kg) | How often (per week, month or year) |
|---|---|---|
| Production | | |
| Green waste – cuttings and support stakes | | |
| Depleted or contaminated growing media | | |
| Chemicals – liquid or granular | | |
| Fertiliser – liquid or granular | | |
| Plastic plant containers – pots, tubes & trays | | |
| Other plastics - packaging & storage drums | | |
| Packaging – paper & cardboard | | |
| Office | | |
| Paper | | |
| E-waste (printers, computers, controllers, etc.) | | |
| Other waste not identified above | | |
| | | |
| | | |

11. How often and how much of the following items do you need to dispose of -

| Type of waste | How much (m, kg, litres, or quantity) | How often (e.g. 2 years) |
|---|---|---|
| Greenhouse covering material – cladding, films, netting | | |
| Weed matting and builders plastic | | |
| Structure material - metal & wire support frames etc. | | |
| Sediment traps sludge or depleted filtration material | | |
| Growing bed gravel | | |
| Irrigation pipe and irrigation fittings | | |
| Workshop & maintenance | | |
| Steel, aluminium | | |
| Timber | | |
| Faulty equipment - mechanical | | |
| Faulty equipment - electronic, light bulbs, thermostats, | | |
| Batteries - car, truck or standard | | |
| Oils - mechanical and other lubricants | | |
| Rubber items – truck or trolley tyres or bumper strips | | |

12. Do you have a specific waste item that is a problem to dispose?

    _____

13. What waste issues would you would like more information on?

    _____

14. Can we contact you to discuss waste disposal options? Y N

    Name: _____ Phone: _____ Email: _____

# Appendix B: Waste conversion factors

| Type of waste | Kg/$m^3$ | | |
|---|---|---|---|
| | Uncompacted | Light compaction | Compacted |
| General waste – mixed garbage | 150 | 270 | 400 |
| General recycling | 13 | 23 | |
| Green waste – general (foliage, grass, seedlings) | 91 | 200 | 445 |
| Green waste - woody cuttings (trees & shrubs) | 150 | 450 | 900 |
| Growing media – Old/Rejected (double weights if wet) | 50 | 200 | 400 |
| Compost – mixed wet | 237 | 474 | 949 |
| Plastic - plant pots & trays | | 72 | 139 |
| Plastic - other storage containers | 10 | 72 | 139 |
| Plastic - soft (plastic wraps & packaging) | 39 | 78 | 156 |
| Plastic - polystyrene | 14 | 21 | 28 |
| Plastics – Builders & weed mat (~ 114g/$m^2$) | 70 | 170 | 348 |
| Cardboard & paper - packaging | 100 | 130 | 296 |
| Paper only – Office | 76 | 150 | 237 |
| Combined production and office card & paper | 100 | 133 | 600 |
| Glass – containers | 250 | 347 | 411 |
| Glass – sheets or panes | 411 | 411 | 411 |
| Greenhouse films –(0.2kg/$m^2$ – 0.5kg/$m^2$) | 43 | 320 | 910 |
| Greenhouse cladding (polycarbonate) | | | 1190 |
| Shade cloth – (50% shade; 0.12kg/$m^2$) | 21 | 160 | 455 |
| Sediment traps sludge (wet) | 720 | 949 | 1186 |
| Depleted filtration material (material dependent) | 560 | 720 | 1000 |
| Gravel - growing bed | 1500 | 1800 | 2000 |
| Irrigation pipe and irrigation fittings | 80 | 120 | |
| Metal | | 140 | |
| Aluminium | 139 | 140 | 154 |
| E-waste – general office & production | 105 | 113 | 120 |
| Rubber – loose & bumper strips | 140 | 200 | 400 |
| Pallets – wooden (~20 kg each) | 156 | 156 | 156 |
| Wood/Timber – soft | 150 | 200 | 300 |
| Wood/Timber - hard | 900 | 1000 | 1100 |
| | Other units | | |
| | Light-duty | Med-duty | Heavy-duty |
| Plastic – 25L drums (~ weight of 1 drum empty) | | 1kg | 1.6kg |
| Batteries – commercial (size dependent) | ~ 5kg | Car 12.5kg (75/$m^3$) | Truck 18kg (55/$m^3$) |
| Tyres – Car; Light Truck/forklift; Heavy Truck | 9 kg | 14 kg | 45 kg |
| Faulty equipment – (whitegoods average) | | ~ 68kg/ | |
| Oils – (mechanical and other lubricants) | 0.8 kg/L | 0.9 kg/L | 0.96 kg/L |
| Chemicals – (liquid or granular average) | | 0.9 kg/L | |
| Fertiliser – (liquid or granular average) | 0.98 kg/L | 1.1 kg/L | 1.3kg/L (wet) |

Sustainability Victoria 2013; DCCEE 2012; DSEWPaC 2012; Paulin & O'Malley 2008; Handreck & Black 2005; Nanan 1998; ASM n.d.; Machinist-Materials; Tanzi; Fluid Fertilizer Foundation 2014; SANGIO Pipe 2014; PYR Ltd 2014.

# Appendix C: Waste self-assessment pack