DESCRIPTIONS OF WASTE TECHNOLOGIES –

C&D RECYCLING FACILITIES

WA Waste Authority - Strategic Waste Infrastructure Planning

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WA WASTE AUTHORITY

STRATEGIC WASTE INFRASTRUCTURE PLANNING

Concise Descriptions of Modern Waste Technologies

Construction & Demolition Recycling Facilities

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APPENDICES

1 SUMMARY

Hyder Consulting has been commissioned by the Western Australia Department of Environment Regulation (DER) on behalf of the Waste Authority to provide a concise description of best practice Construction and Demolition (C&D) waste recycling facility technologies as a means of modern waste treatment and resource recovery.

This report summarises a number of key parameters relating to this suite of technology, as requested by the DER. It is one of a series of reports reviewing various waste treatment and disposal technologies that may be applied in the Perth Metro and Peel Regions. The information is presented in a concise, standardised table format in Section 7 and Section 8 that, when merged with the information on other waste technologies, will allow a comparison of key parameters across the technology types and inform the development of the *Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region*.

The purpose of the project is to provide sufficient information on each technology type to allow a comparison with other waste technologies and help to assess the potential for each option to play a role in the future Perth and Peel waste infrastructure mix. The project is intended to inform Government planning and strategic decisions.

C&D waste recycling facilities are a proven element of many successful waste management systems, and they can potentially make a significant contribution to resource recovery and landfill diversion objectives. They are not a total waste solution in themselves and will not result in zero waste to landfill. C&D waste recycling facilities should be considered as part of a broader integrated waste management system and should complement future and existing waste management systems.

C&D waste recycling facilities separate and reprocess waste generated during construction and demolition activities, and usually generate various secondary construction products to sell to markets. Processing generally involves a mix of manual and automated separation technologies up front, followed by crushing operations. The facilities can be designed for a variety of outcomes and situations, but the viability of operations will often depend heavily on the availability of sustainable markets for the outputs.

There are many different C&D recycling facility technology operations, from simple crushing operations for source-separate materials, through to fully integrated separation systems for mixed C&D loads. For the current project Hyder focussed on multi operation facilities.

The information presented in this report is a combination of detail gained through consultation with the operators of the case study facilities and information arising from a review of relevant and available literature on the topic. Additional general information has been included based on Hyder's industry knowledge and experience.

On the basis of selection criteria agreed with DER, Hyder selected the following C&D recycling facilities to use as case studies.

Type	Location
C&D Recycling Facility – sorting ,crushing and screening	NSW
C&D Recycling Facility – sorting ,crushing and screening	VIC

This report presents key details of each reference facility based on information provided by the operators. In some cases, information was not provided due to commercial concerns. The facility information has been summarised in a table as requested by DER to enable quick comparison with other waste management technologies. Section 8 contains a 'Study Synopsis' table for C&D technologies which summarises the parameters across the technology variations.

2 INTRODUCTION

Following release of the *Western Australian Waste Strategy*, the Western Australian Waste Authority (WAWA) and Department of Environment Regulation (DER) established the Strategic Waste Infrastructure Planning Working Group, with the aim of developing a plan for the future waste disposal and recycling infrastructure needs of the Perth metropolitan and Peel regions. The Working Group will guide the development of a *Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region*.

The WA Waste Strategy sets out challenging recovery targets for each of the major waste streams: municipal solid waste (MSW), commercial and industrial waste (C&I) and construction and demolition waste (C&D), for both the Perth Metro and Peel regions. One of the key objectives of the Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region is to identify the waste technology options and infrastructure mix that will help Western Australia to achieve those targets.

Hyder Consulting was commissioned by the DER on behalf of the Waste Authority to provide a concise description of best practice C&D waste recycling facility technologies, as a means of facilitating modern waste treatment and resource recovery. This report summarises a number of key parameters relating to this suite of technology, as requested by the DER. It is one of a series of reports reviewing various waste treatment and disposal technologies that may be applied in the Perth Metro and Peel Region. The information is presented in a concise, standardised table format in Section 7 and Section 8 that, when merged with the information on other waste technologies will allow a comparison of key parameters across the technology types and inform the development of the Waste and Recycling Infrastructure Plan for the Perth Metropolitan and Peel Region.

There may be numerous different operations making up a C&D waste recovery facility, and for the current project Hyder has focussed on multi operation facilities for detailed analysis.

2.1 PURPOSE

The purpose of the project is to provide sufficient information on each technology type to allow a comparison with other waste technologies and help to assess the potential for each option to play a role in the future Perth and Peel waste infrastructure mix. The project is intended to inform Government planning and strategic decisions.

3 PROJECT METHODOLOGY

The information presented in this report is a combination of

a Details gained through case studies of representative reference facilities identified by Hyder in consultation with the DER; and

b Information arising from a review of relevant and available literature on the topic.

Additional general information has been included based on Hyder's industry knowledge and market experience.

3.1 CASE STUDIES

Information was gathered for the case studies through direct interviews and consultations with the current operators of the selected existing facilities, and Hyder acknowledges their valuable contribution to the project.

To identify appropriate reference sites to use as case studies in the current project, Hyder has focussed on facilities that:

- Use proven, mature and best practice technology;
- Have been operational for at least 12 months;
- Have been operating successfully to a high standard with no known major issues or fundamental failures;
- Are generally large capacity, on a scale that would be appropriate for the Perth Metro and Peel regions;
- Have established sustainable markets for any outputs and products from the process; and
- The operators have agreed to take part in the project and provide information;

As far as possible, Hyder has given preference to Australian facilities, so that the costs, regulatory drivers and environmental standards are likely to be consistent with the Western Australian context.

These generic criteria have been applied consistently across all waste technologies studied by Hyder (not only C&D recycling facilities) in the broader series of waste technology reports.

To facilitate the provision of information by operators, the DER provided an introductory letter to each selected operator to introduce the project, explain Hyder's role, and provide assurance as to the protection of commercially sensitive information.

3.2 LITERATURE REVIEW

To supplement the information obtained through the case studies and provide a broader view of typical facilities, Hyder has conducted a limited review of available literature on C&D recycling technologies and representative reference facilities. Literature in this case includes:

- Technical Publications;
- Published industry reports;
- Journal articles;
- Company websites; and
- Waste and recycling surveys and data reports.

Information obtained from published literature sources has been identified as such and references provided (see section 9).

3.3 KEY PARAMETERS AND INFORMATION

The table below summarises the key parameters and information specified by DER. The same list of parameters will be applied to each waste technology category in order to allow information to be presented in a standardised table format to allow comparison across technologies.

Where relevant and representative information was obtained for the case study facilities, this is presented in the summary table (see Section 7 and 8). Where information was not available or there was a benefit in providing additional background, the table has been supplemented with information obtained through the literature review.

Ref	Information Parameter	Description
1	Process description	A high level description of the process (or technology type) for managing or treating waste including its purpose, conversion processes, stages of treatment and key inputs and outputs (including energy and waste residues)
2	Feedstocks	Types of suitable feedstocks, pre-treatment requirements, broad physical and chemical characteristics, key exclusions
3	Capacity	Processing or disposal capacity (in tonnes per annum) including typical values and ranges
4	Waste Hierarchy	How and where does the technology fit into the established waste hierarchy?
5	Landfill Diversion Potential	Potential to divert waste from landfill (for example, waste recycled/recovered and waste to landfill expressed as a percentage of total waste sent to facility)
6	Products and Residuals	Identify all products, outputs and residuals from the facility / process (including any potentially beneficial outputs and energy)
7	Capital Cost	Expressed as a total cost and $ per tonne of annual capacity
8	Operational Cost	Expressed as $ per tonne of waste processed / disposed
9	Gate fees	Typical gate fees charged to customers. Note gate fees do not necessarily correlate directly with running costs and may include a profit margin and be driven by market forces (i.e., prices of alternatives)
10	Set-up Timeframe	Typical timeframe to establish the technology including planning, approvals, procurement, design, construction and commissioning
11	Lifespan	Typical lifespan of the technology taking into account standard maintenance and replacement practices
12	Footprint	Typical land footprint for a facility including for the core technology and any surrounding ancillary requirements (access roads, waste and product storage, buffers, etc)
13	Buffer zones	Extent of buffers required around the plant, including typical existing facilities and any requirements in regulation
14	Emissions Performance	Typical pollutants arising from the process (solid, liquid and gaseous) – key substances and approximate quantities / concentrations. Also high level estimates of carbon impact including direct carbon emissions and indirect emissions from electricity use.
15	Environmental Performance	Compliance with regulations / permits, key environmental impacts including air, water, groundwater, noise, odour, dust, waste arisings

Ref	Information Parameter	Description
16	Social impacts / costs	Impacts on local community and neighbours, employment, local and economy impacts,
17	Compatibility with existing systems / technologies and supporting systems	To what extent is the technology compatible with the existing waste management system and facilities (sorting, collection, processing, disposal), what broad changes would be required and which other technologies are required to complement the technology
18	Risks	Identification of potential risks including technical, commercial, environmental, operational and market risks
19	Local Application	Most appropriate application of the technology to the local context (metro or non-metro, medium to high density)
20	Maturity of the technology	How long has the technology been in operation, it is considered proven and how many reference facilities exist in Australia and overseas
21	Availability	Typical annual maintenance shutdown requirements, and plant availability as a proportion of the name-plate capacity
22	Penetration	Extent of existing penetration of the technology in the Perth Metro and Peel regions and within Australia (such as number / total capacities of existing facilities)
23	Benefits	Benefits of the technology (financial, environmental, social) compared with alternatives including landfill diversion performance, flexibility, future-proofing, etc
24	Barriers / constraints	Barriers to implementation including markets for outputs, policy and regulatory constraints, availability of technology and support in Australia, etc
25	Other relevant information	Any other relevant information which becomes apparent during investigations

4 BACKGROUND

C&D waste recycling facilities are a proven element of successful waste management systems, and have a long history operating worldwide to recover and reprocess materials from the C&D waste stream. In Australia, C&D waste facilities vary in size and style of operation. A common operation for a basic C&D waste facility involves a mobile crusher being periodically setup on a hard stand area to batch process materials. These C&D recycling facilities essentially recover concrete and masonry by producing a crushed material, which can be re-used as a fill material, a subbase or an aggregate depending on the specification required.

Mobile crushers can also be operated on-site to recover materials from C&D waste, and this style of temporary facility may be operated during the construction or demolition phase of a specific project, where sufficient waste materials are generated to warrant the operation.

C&D recycling facilities will accept different waste feedstock types, dependent on the operations available on a specific site. At the most basic facilities the main operation will be crushing of source-separated materials, with or without metal extraction. These facilities will accept only source separated concrete or masonry, and will use magnets to separate the steel from the concrete. Other facilities will accept mixed C&D waste (i.e. waste from skip bins) and in this case may have a whole suite of operations (not dissimilar to a materials recovery facility (MRF)). These facilities will separate many different materials, and often have a residual component which would require landfill disposal.

C&D waste is defined in the *National Waste Report 2010* as being waste from demolition and building activities, including road and rail construction and maintenance and excavation of land associated with construction activities. Typical components of C&D waste are masonry (brick, concrete, asphalt), organics (timber, garden organics), metals, hazardous waste (contaminated soils, asbestos), plastics, paper and cardboard, glass, leather, textiles, tyres and rubber.[i]

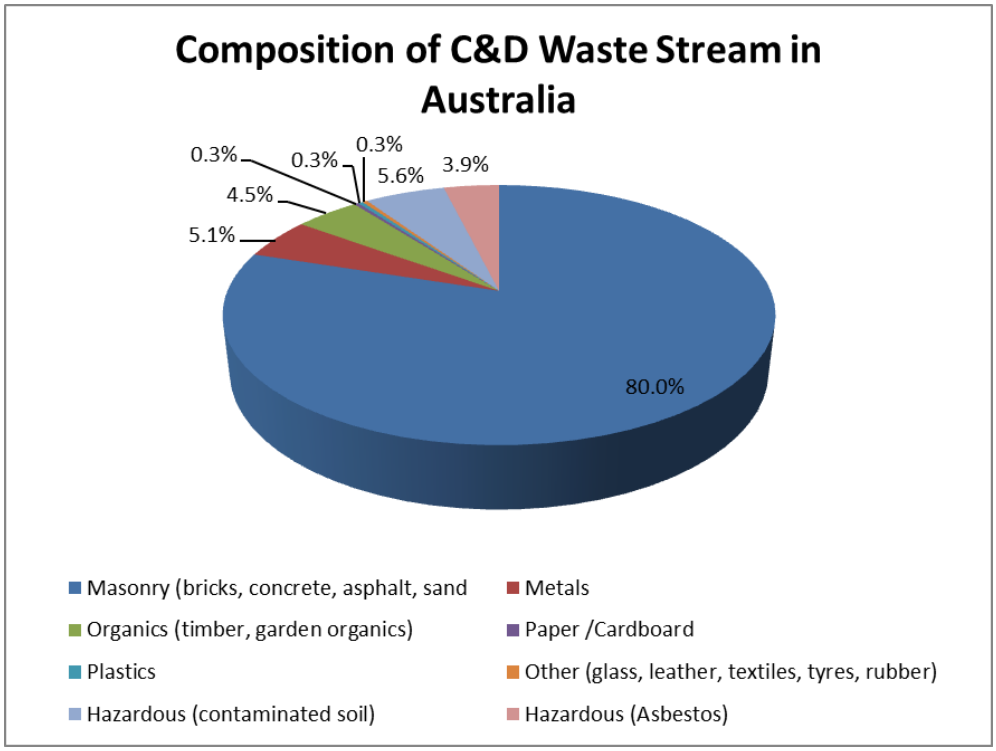

Figure 4-1 Composition of C&D waste in Australia
Adapted using data from the report, *Construction and Demolition Waste Status Report - management of construction and demolition waste in Australia* [ii]

4.1 PURPOSE OF C&D RECYCLING FACILITIES

A waste operator may choose to implement C&D waste recycling technology for a number of reasons, including:

- To divert waste from landfill to meet diversion targets, conserve landfill airspace, reduce environmental and social impacts, and/or avoid landfill levies;
- To recover recyclable materials (such as metals, plastics, glass and inerts) to generate revenue and off-set the use of virgin materials; or
- To reduce the volume and mass of waste requiring landfill disposal to maximise compaction rates in the landfill.

4.2 BRIEF PROCESS OVERVIEW

C&D recycling facilities can differ in their type of set up, based on the types of materials that are targeted for separation and/or reprocessing. They can be broadly categorised into two main classes; facilities which take source separated loads, and those which accept mixed loads.

Facilities that take source separated loads are usually focused on reprocessing, and have crushing operations as the main operation. A range of sustainable aggregate materials may be produced, which can be used as substitutes for virgin quarried material.

Facilities accepting mixed loads of C&D waste generally involve up front separation of materials, either through manual picking, automated separation technologies, or a combination of both.

C&D recycling facilities are designed to perform sorting, screening and processing operations to produce a saleable product. The main waste materials recycled (by weight) from the Australian C&D waste stream are concrete and masonry, with are crushed for use as an aggregate material in civil engineering applications such as road construction.

5 CASE STUDY DETAILS

On the basis of the criteria set out in Section 3.1, Hyder selected the following C&D waste recycling facilities to use as case studies for the current project.

Type	Site / Operator	Location
C&D waste recycling facility - sorting, crushing and screening	Case Study 1	Sydney, NSW
C&D waste recycling facility - sorting, crushing and screening	Case Study 2	Melbourne, VIC

This section provides a brief description of each facility, including key features that make them representative case studies of best practice C&D waste recycling facility technologies and how they satisfy the criteria set out in section 3.1.

Case Study 1 – C&D waste recycling facility (NSW)

This C&D recycling facility is situated in a built up area within a metropolitan area of NSW. The facility is a reprocessing operation, which accepts source separated concrete and masonry as its main feedstock. The materials are crushed to produce a market specification aggregate, roadbase or subbase product. The C&D facility is comprised of a series of conveyor belts with overband magnets, a picking station, jaw crushing and cone crushing operations, and a series of vibratory screening equipment.

The facility has a licence to reprocess 500,000 tonnes per annum. There is not a specific limited operating life at the facility, and its ongoing commercial viability is driven by the market demand for recycled aggregate or subbase products.

The facility commenced operations in 2001, following a three and a half year period of planning, approvals and construction. The buffer zone is small, being the actual fenced boundary of the site .The footprint of the site is relatively small at 8,000m^2.The facility is in close proximity to businesses, with a fast food restaurant and a car wash nearby.

Case Study 2 – C&D waste recycling facility (VIC)

This C&D recycling facility is situated in an industrial zone within a metropolitan area of Victoria. The facility has two operations. The main operation is the reprocessing of concrete and masonry to a crushed aggregate, which accounts for 95% of the works undertaken on site. This operation accepts source segregated concrete, brick and masonry .The materials are crushed to produce a roadbase or sub-base product, meeting the relevant VicRoads specification. The second operation is the sorting of mixed C&D waste. The C&D facility is comprised of a series of conveyor belts with overband magnets, a picking station, jaw crushing and cone crushing operations and a series of vibratory screening equipment.

The facility has a physical capacity to process up to 1 million tonnes of waste per annum. There is not a specific limited operating life at the facility, and its ongoing viability is driven by the market demand for recycled aggregate or subbase products.

The facility commenced operations in 2010 after a five year set up timeframe (three years for planning consent, and 18 months for construction). The buffer zone is 250m and the footprint of the site is 200,000m^2 (20ha).

6 LITERATURE REVIEW

6.1 PROCESS DESCRIPTION

The C&D recycling process varies from facility to facility, however the general set up followed is as outlined below[iii]. Appendix A contains a flow diagram of typical C&D recycling (sorting) operation, and a C&D crushing operation.

6.1.1 INITIAL WASTE INSPECTION AND PREPARATION

The initial steps at a C&D recycling facility consist of an inspection of incoming loads. Mixed wastes will be tipped into an area for subsequent loading into the C&D recycling facility's processing line. At the tipping area, prior to loading, any materials unsuitable for the C&D recycling facility's process are removed for separate management. A key concern for most C&D recycling facilities is identifying and quarantining any asbestos materials in incoming feedstock.

Pre-Sort Screening Process

After the initial inspection, a mechanical grab operator, using loading equipment, will load the waste either directly or via a conveyor belt into an automated screening operation.

The screen recovers soil and other fine material (dust and fine fractions of C&D waste as illustrated in Figure 4-1) which can account for a large proportion of the waste stream – especially if sourced from a demolition operation. During screening operations, two or more fractions are separated on the basis of particle size, shape or weight. Fine waste falls through, while oversized waste continues on the line. Both material streams may be first introduced onto a hopper spreading the material on the conveyor belt, thereby facilitating efficiency in the subsequent sorting processes.

Material recovery from the undersized fraction

The undersized fraction sometimes enters a picking area where manual sorting can take place, but more often undergoes additional automated processes. Magnets remove small pieces of metal, while wind-sifters or density-separators blow or suck to separate small pieces of paper, plastic film and wood from the aggregate materials.

Picking area

The oversized fraction emerging from the pre-sort screen usually passes under an overband magnet to remove small pieces of ferrous metal before it approaches the picking cabin.

Most facilities still employ manual labour for recovering non-inert recyclables. Pickers pull off various types of rigid and film plastic, metals, cables and wires, paper, cardboard and wood. Any oversized objects or non-recyclables missed in the initial inspection are also removed in the picking cabin.

Each recovered material is dropped into separate bays located below the picking shed, for consolidation.

6.1.2 SCREENING EQUIPMENT

At a C&D recycling facility, one of the primary operations is the separation of different sized materials using screening equipment. Common screens include trommels, vibratory and disc screens[iv].

Trommel screens are a large rotating cylinder with holes of various sizes through which materials fall and can be sorted according to size. As materials enter the cylinder, the larger fraction materials pass through the screen first. As the holes become progressively smaller along the length of the cylinder, gradually smaller materials are sorted out.

Vibratory screens consist of a series of tapered levels which are angled down. These levels shake vigorously, resulting in material being sieved to remove fines as it moves down the slope.

Disk screens are suited for input streams with a high proportion of inert material. The disc screen has several inclined rows of steel discs which spin in the direction of the material flow. Larger surface size materials move up the incline of rotating discs while smaller materials are bounced in the air and knocked off the top. Heavier items roll down, while a third fraction of smaller material such as soil and other fines fall through the screen[iii].

Magnets

Powerful over-band magnets can be installed to extract ferrous metals such as steel from C&D waste. Being relatively cheap to install, and targeting a relatively valuable material stream, magnets often generate high revenues and provide a quick return on the investment. Magnets function better on lighter objects. The mechanical grab operator, or manual pickers, can more effectively extract larger metallic objects, and so magnets are more effective if installed over the smaller fractions coming from the automated pre-sort. Despite this, many C&D recycling facility also fit magnets over the oversized material fraction, or at the end of the process. Magnets can be fitted on wood shredders for extracting nails.

Picking area equipment

Minimal sorting technology is generally installed in the picking areas of C&D recycling facilities, with manual labour used to target specific materials for removal from the material stream. The conveyor belt passing through the picking area needs to be of an appropriate width to allow for efficient sorting.

There is potential to employ simple operations to increase the value of the output materials. For example, the value of electrical wiring recovered can be boosted by investing in wire-strippers. The exposed metal, ‘bright wire’, fetches a slightly higher price and the stripped coating itself, typically uPVC, which also has a value[iii].

6.1.3 CRUSHING OPERATIONS

Once separated, concrete and masonry material are crushed to reduce their size and meet other specifications for reuse. There are a number of different types of crushing equipment available, however, mechanical jaws and impact crushers are typically installed at a C&D recycling facilities. A cone crusher may be used as a secondary sort, to achieve a higher specification of output materials.

Impact crushers produce a more consistent and predictable sized aggregate than jaw crushers. They are cheaper to purchase than jaw crushers, but are more costly to operate. Crushers can be small mobile machines, intended for onsite use, or large fixed machines.

6.1.4 OTHER OPERATIONS

Water separation equipment

A flotation tank can be employed for separating wood from heavier aggregates. When waste is placed into the tank, the bricks and rubble sink while timber and plastic floats, and can be skimmed from the surface.[iii]

Air separation equipment

C&D recycling facilities can install air or wind-separation equipment to optimise the quality of aggregate outputs, by removing lighter contaminants (such as paper, plastic and wood) from the heavier rubble. Various systems are available to either suck or blow unwanted material away from the aggregate or soil.

The air-knife, which can be compared to a large hairdryer, works by blowing fine material from heavy objects such as bricks as they fall through a curtain of air. Wind-shifters, by contrast, suck light materials from the waste stream.

Density separators combine a vibratory screen with an air-knife. Material on the conveyor belt is fluidised by vibration so that light material rises to the top. The heavier waste drops through a gap while the lighter material is blown over it[iii].

Shredders

C&D recycling facilities can employ powerful wood-shredding machines to reduce the space taken up by recovered wood, and thus increase transport efficiency. Shredders are also used to prepare wood material for a range of end markets, such as animal bedding or mulches.

In Europe, “Flocking machines” are used to produce higher value products such as animal bedding, mulches and refuse-derived fuel. These reduce material to between 20 and 50mm by cutting it with blades and pressing it through a screen. The technology is expensive and requires substantial maintenance: Material requires pre-treatment prior to its introduction into the process; this may involve primary shredding and the removal of all metals, wood, and other heavy particles that can damage or affect the accuracy of the blades[iii].

Advanced equipment

Ballistic separators can be installed after a trommel. These perform a sophisticated separation process whereby heavy material is transported up a slope, while lighter material travels down the incline. A screen can also be used to recover a third fraction of heavy fines. The heavy fines fraction may then pass on for handpicking, while the lighter fractions then pass through an optical separator.

6.1.5 ENVIRONMENTAL CONSIDERATIONS

There are a number of potential environmental impacts associated with C&D waste facilities. [iiiv]. The main issues are identified below.

Noise issues

C&D waste recycling facilities are reliant on the use of heavy vehicles and specialised site plant and equipment. The type of equipment which would generate a significant level of noise includes grinders, crushers, and screens used to grade and standardise aggregate size. Activities such as loading and unloading of trucks, mechanical grabs, forklift trucks, bulldozers as well as general vehicle movements can also create noise.

Dust

Dust can be generated as a result of many of the activities undertaken at C&D recycling facilities. Dust requires control measures and management to prevent local nuisance or impact to air quality. Dust generated by vehicle movements is a key problem for C&D recycling facilities, particularly in dry weather. Misting or other wet-down systems can be used to reduce dust issues during the processing of materials.

Asbestos

Asbestos can be found in a variety of products including formwork, exterior wall cladding and roofing. Asbestos poses a potential risk to human health if asbestos fibres become airborne during transporting, unloading and processing of C&D waste[v]. The ubiquitous historical use of asbestos as a building material in Australia means there is significant potential for it to be present within the C&D waste stream, and ensuring measures are in place to identify and quarantine the material in order to avoid negative health impacts is a major concern for all C&D recycling facilities.

Surface water

Stormwater run-off can carry sediment and contaminants from the facility into drainage systems and nearby watercourses. Uncontrolled site run-off can also block or restrict drainage systems and cause local flooding and/or soil erosion. Sediment can be transported from the site through entering drainage systems, which may pollute local watercourses.

Litter

Littering could occur during the transportation of C&D waste to the site, as well as from the facility. All vehicles should be covered to prevent waste being blown onto the road, or sand escaping through rear loading doors. Larger items need to be well stacked and strapped to ensure they do not fall from the transport vehicle.

6.2 SITING FACILITIES

The selection of potential C&D waste recycling facilities sites need to consider constraints such as buffer distances for dust and noise control, traffic management, planning requirements and costs. Generally, sites would be in industrial or special industrial zoning areas, or collocated with an existing or future landfill site or quarry. Likely objections to a C&D recycling facilities would be in relation to visual amenity, noise and dust emanating from the facility.

Processing in regional areas is often undertaken by mobile equipment, as the feedstock available may not be sufficient to support permanent infrastructure.

6.3 COSTS

The major capital expenditure for a C&D waste recycling facility is often associated with acquiring the site and meeting associated design and construction costs. Operational costs will also involve responsible site management practices, risk management measures, and making adequate provision for on-going environmental protection.

6.4 OUTPUTS

It is important that the reprocessed output material is of sufficient quality to meet the specification required for the target market.

The commercial model for C&D recycling facilities is to minimise the tonnage of output material sent for disposal landfill. Sorting the input stream into high quality material outputs is vital to achieve this aim.

6.5 RISKS

Statutory controls are one of the main constraints on C&D recycling facilities. Achieving planning and licensing requirements can be costly, difficult and time consuming. Operators who operate in accordance with such requirements may therefore have increased costs compared with operators who do not, and a lack of regulatory oversight to ensure a “level playing field” would be considered a major risk for legitimate C&D recyclers.

The main commercial risks associated with a C&D recycling facility relate to the availability of feedstock material, and the market price and acceptability of the end products (recycled aggregate, roadbase) compared to virgin products. Unlike the municipal waste market, where local governments act as aggregators of significant tonnage and can enter a long-term contract with a facility owner, the nature of the C&D market makes it more difficult to guarantee feedstock inputs. Relatively low barriers to market entry also increase the risk of increased competition for operators, which may impact feedstock availability.

Meeting standards and specifications for recycled aggregates and end-products is important to achieve a sellable product. The presence of some sub-standard products within the marketplace may undermine confidence in the wider recycled aggregate market, and therefore operators are commonly as concerned about the quality of their competitor’s products as they are with their own products.

A very large risk to C&D recycling facilities is associated with the potential for asbestos materials to be present in the C&D waste stream. If feedstock containing asbestos is received, processed and sold to market, the liability implications may be enormous. This includes liability associated with the potential exposure of workers to asbestos, as was as potential exposure of end clients.

There are also a suite of other health and safety risks at C&D recycling facilities. The noise, dust, hazardous materials, vehicle movements and heavy machinery mean C&D recycling facilities can be dangerous places to work. A risk management regime is necessary to reduce the likelihood of accidents.

There are environmental risks associated with dust, noise and traffic which need to be managed during the development and operation of a C&D recycling facility.

Maintenance and regular care of equipment is crucial for effective operation. On-site engineers should be available to clean and maintain equipment during down-times, and to respond immediately to mechanical failure that can otherwise cost the operator significant time and money, as well as potentially impact product quality and safety standards.

7 SUMMARY OF WASTE TECHNOLOGY FEATURES

In the project brief, the DER identified a number of key features and parameters to be identified for each technology type and case study. This information has been collated in the following summary table. By collating information in this standardised and summary format, a comparison of different waste technologies should be simplified.

Table 7-1 Summary Features – C&D Recycling Technology

Technology	1	2	3	4	5	6
	Process Description	Feedstock (type and tonnes)	Annual processing capacity (tpa)	Place in waste hierarchy	Landfill diversion potential (%)	Products and residuals
C&D Facility 1	Vehicles enter the weighbridge and deposit waste concrete and masonry on the site. Excavators break up larger pieces of concrete. A loader lifts the waste materials onto the conveyor belt which leads to the picking station. Four overband magnets separate ferrous metals. Manual picking is undertaken to remove any non-recyclable items and other metals that were missed. The waste materials are then conveyed to the crushers. The crushed material subsequently passes to vibratory screening equipment where it is sorted into specific sizes, (ranging from 10mm-70mm aggregate specifications or other roadbase or subbase specifications). These are stockpiled and stored for sale. Recovered ferrous metals from the process are stockpiled and sent to a metal reprocessor for recycling.	Used concrete and used bricks and masonry from the construction and demolition of buildings.	The licenced capacity is 500,000 tonnes per annum. The facility reprocesses approximately 250,000 tonnes per annum. The facility has a holding capacity of 20,000 tonnes of feedstock and 18,000 tonnes of products.	Recycling. A reprocessor of concrete and masonry.	99.5%.	Crushed aggregate, Roadbase, Scrap metals, 850 tonnes per annum of residue of residue waste (<0.5% of total processed). (Waste materials that are accepted at the facility are clean and recoverable.)

Technology	1 Process Description	2 Feedstock (type and tonnes)	3 Annual processing capacity (tpa)	4 Place in waste hierarchy	5 Landfill diversion potential (%)	6 Products and residuals
C&D facility 2	The C&D recycling facility is primarily a stockpiling, crushing and screening facility. Waste C&D materials are received and loaded into a hopper then crushed using a primary jaw crusher, a secondary cone crusher and sorted to size using a series of vibrating screens to produce different sized roadbase and subbase products. Ferrous metal from the concrete is recovered and sent for reprocessing. The facility also has a pug mill mixer that can prepare special blended stabilising products. This primary operation accounts for 95% of the C&D facility. The site also has a secondary mixed waste sorting operation which processes the remaining 5% of the throughput. This operation involves hand- sorting the waste on a tipping floor using manual labour to separate timber, plastics, soils and other recoverable products from the mixed waste with any concrete/brick going to the main plant for processing.	Waste feedstock for the primary operation is: waste concrete, asphalt, bricks, foundry sand and masonry. The secondary operation feedstock is mixed C&D skip bin waste.	The facility typically processes in total 600,000 -700,000 tonnes per annum. The physical limit on the crushing operations is 1M tonnes per annum. There is no restriction on the processing capacity.	Recycling.	This facility a landfill diversion of over 99%.	Products from the main C&D operation include: roadbase and subbase that are in line with VicRoads specification, ferrous metals and residual waste. The products from the mixed waste operation (in addition to concrete/bricks which are the further processed) are: ferrous metals, timber, plastics and residual waste. In total the residual waste is less than 0.5% of the total waste sorted, recovered and reprocessed.

Technology	1 Process Description	2 Feedstock (type and tonnes)	3 Annual processing capacity (tpa)	4 Place in waste hierarchy	5 Landfill diversion potential (%)	6 Products and residuals
Literature Review	C&D recycling facilities are designed to perform sorting, screening and processing operations to produce a sellable product. The main waste materials recycled are concrete and masonry, where they are crushed for use in civil engineering applications such as road construction. Some facilities have their main operation as crushing with metal extraction. These facilities will accept only source separated concrete or masonry, and will use magnets to separate the steel from the concrete. Other C&D facilities will accept mixed C&D waste (i.e. waste from skip bins) and have a whole suite of operations not dissimilar to a materials recovery facility (MRF). These facilities will separate many different materials, and often have a residual component which would require landfill disposal.	Materials commonly recovered at C&D facilities are: Concrete, Masonry, Metals, Soils, Timber and Asphalt. More advanced operations can be installed to recover cardboard, plastics and other waste streams.	Annual processing capacity at C&D recycling facilities is dependent on the feedstock received and the limits of the development approval.	Recycling.	The landfill diversion potential depends on feedstock accepted, however, facilities receiving C&D waste as masonry and concrete consistently achieve over 95% landfill diversion.	The products and residuals at a C&D recycling facility depend on the feedstock accepted at the facility. Common products include: crushed materials (aggregate / subbase) of different specifications , metals, and timber Other materials can also be sorted if required, (examples include cardboard, plastics etc.). Residual materials include those materials that cannot be recovered as a product

Technology	7	8	9	10	11	12	13
	Capital cost	Operational cost	Gate fees	Set-up timeframe	Lifespan	Technology/ facility footprint	Buffer
C&D Facility 1	$6M for machinery and equipment. (Not including land purchase and approvals.) Much of the equipment was recovered from demolition projects. So the true capital costs will be more than $6M. The equipment on site includes: Four excavators (with pulverising and hammer attachment) and two loaders. The C&D waste reprocessing equipment includes: A jaw crusher a cone crusher, overband magnets and a series of conveyors.	Between $4M-$5M per annum.	Varies between $4 and $8 per tonne. The gate fee is dependent upon the demand for products. If there is shortage of materials in the market, the facility would be prepared take materials at no cost. Income from sales of products is $11-$14 per tonne. Metal prices are dependent on the commodities price. Current prices are $250 per tonne for ferrous metals, and $6000 per tonne for copper	Total set-up time is three and a half years. Two and a half years for approvals and licencing, and twelve months for construction.	No limited lifespan. The facility can operate indefinitely whilst a market for aggregate and resources are available.	Total site footprint is 8,000m^2. A very small footprint for a facility of this type.	The buffer is as far as the actual facility boundary fence. The height of the buffer is 13 metres.

Technology	7	8	9	10	11	12	13
	Capital cost	Operational cost	Gate fees	Set-up timeframe	Lifespan	Technology/ facility footprint	Buffer
C&D facility 2	The capital cost was $15M. This includes the purchase of the land, the development approval costs and the construction cost.	The operational cost is approximately $11.50 per tonne of waste processed.	There are no gate fees for concrete and asphalt. Bricks and masonry attract a fee of $40 per tonne.	The total set up timeframe for the facility was five years. Gaining planning consent took three years. The design stage took six months and the construction eighteen months.	The facility has a 15 year permit (subject to renewal. Physically the facility can operate for between 30 and 50 years providing maintenance is undertaken regularly.	20 ha.	The buffer is 250m, which is similar to the buffer required for a quarrying operation.

Technology	7	8	9	10	11	12	13
	Capital cost	Operational cost	Gate fees	Set-up timeframe	Lifespan	Technology/ facility footprint	Buffer
Literature Review	The capital cost at a C&D recycling facility is defined by the equipment installed, the costs for acquiring the land, development approvals and construction.	The operational cost is defined by the equipment installed at the facility, and the extent of manual sorting at the facility.	The gate fees at a C&D recycling facility vary, ResourceCo advertise that they take concrete and brick waste free of charge. They charge $50-121 per tonne is charged for mixed C&D waste at their different facilities.[vi]. [vii].The Port Augusta Resource Recovery Centre in SA advertises charges of $0-$99 per tonne of inert mixed C&D waste.[viii].	The setup timeframe at a C&D recycling facility is dependent on the approvals process.	A C&D facility does not have a specific lifespan.	Site footprint is expected to be similar to a Materials recovery site (1-4Ha).	There is no clear buffer restriction. Restrictions would be in relation to keeping dust and noise to a minimum, and similar to buffers for a material recovery facility operation.

Technology	14	15	16	17	18
	Emissions	Environmental impacts	Social impacts	Supporting technology required	Risks
C&D Facility 1	Emissions are from: Loaders and excavators as exhaust fumes; Dust from site operations, which are controlled using dust suppressing controls.	Dust has an impact on the air quality at the C&D facility. Fogging machines generate a fog to suppress the dust. Fine mists of water are used during the crushing and screening operations. The ground is kept wet to minimise dust generation. Stormwater impacts are reduced by using settling tanks and collecting the sediment. Noise could be an impact, however, noise from the facility is normally not detected due to the existing background traffic noise. Visual impacts are not an issue. The facility is sited behind buildings and cannot be seen from the highway.	The facility provides employment opportunities. The facility has not received any direct complaints.	If there was space available on site, further sorting technology could be implemented to accept mixed C&D waste from skip bins. However, the operator advises that there would be increased risk as a result of asbestos and other hazardous materials which may be introduced. Skip bins contain materials from unknown sources, and have the potential to contain contaminants such as lead paint, asbestos and treated wood. Handling concrete and masonry has less risk. There is more confidence that the materials are reasonably clean.	The operator advises there is significant risk from asbestos being in any incoming and outgoing material. If asbestos appears on site, it has the potential to be processed with the other waste and remain in the end product. If this is applied on land, there may be significant repercussions. The facility would be liable for clean-up, and disposal of any materials potentially contaminated with asbestos at a very high cost. The cost of disposing asbestos to landfill in NSW is $360 per tonne.

Technology	14	15	16	17	18
	Emissions	Environmental impacts	Social impacts	Supporting technology required	Risks
C&D facility 2	Dust from site operations.	Impacts expected are related to: dust, noise and odour. The permit has control measures for litter control, odour, and dust visibility beyond the boundary. The site has 24/7 dust monitoring equipment installed.	The facility has created local employment opportunities. There is regular community engagement undertaken with the local school.	The C&D recycling facility technology is highly compatible. Current mixed waste operations provide feedstock to the main C&D operations. C&D recycling facilities provide other facilities with an option to recycle, rather than dispose C&D waste.	The perceived risks include: the availability of guaranteed markets (i.e. road making market) which are subject to the construction sector cycles. Incoming demolition material feedstock can be reduced in economic downturn periods. Market forces and competition from other facilities are a risk.
Literature Review	Direct emissions are generated by diesel using equipment used on site. These emissions do not require monitoring. Dust emissions may also originate+ from the site operations (sorting, crushing).	There are a number of potential environmental impacts associated with C&D waste facilities including; noise, dust, surface water, litter and asbestos contamination of the products.	Social impacts include; resource recovery, ability to supply construction material products to the local area, mitigating transport costs, and job creation.	If space is available, C&D facilities have the option to expand to meet the needs of the market Operations can be installed to perform more complex sorting for other materials if required.	The risks include; statutory constraints in gaining approval, feedstock guarantees, end market availability, environmental risks, health and safety risks and risk of asbestos

Technology	19	20	21	22	23	24	25
	Applicability to local context	Technology maturity	Availability rate	Regional penetration	Benefits	Barriers	Other
C&D Facility 1	This facility is sited in a built-up area, and has a small footprint for the technology operations installed on site. The preference for siting a C&D recycling facility is to be away from built up areas, and be well positioned to serve waste generation sites and buyers of recycled C&D materials.	C&D recycling operations are well proven worldwide, and are similar in nature to technologies used in the quarrying industry. The facility has been operating for twelve years.	The operations are dictated by the flow of feedstock and products at the site. The facility is available between 7am and 4pm, 6 days per week. The equipment is routinely switched on and off for breaks and lunches. This has no impacts to the operation. Shutdowns for replacement of parts are minimal (one day per year).	There are a number of similar C&D facilities in the metropolitan area. (Boral recycling, Concrete Recyclers) There are many mobile crusher facility setups that outweigh the number of advanced facilities.	The benefits of C&D recycling facilities are; resource recovery and the carbon savings from use of recycled products vs. virgin products.	The barriers to C&D recycling facilities are primarily in the development approvals process and competition from other facilities. The risks associated with asbestos may also present a barrier.	

Technology	19	20	21	22	23	24	25
	Applicability to local context	Technology maturity	Availability rate	Regional penetration	Benefits	Barriers	Other
C&D facility 2	A facility in a metropolitan area processes a higher volume of feedstock material, to a specification, and requires a high level of investment. Facilities operating in non-metropolitan areas generally have a lower throughput, they process less and the output is a commercial grade product rather than a specified product. The scale of investment would therefore be lower (i.e. mobile crushing equipment).	C&D facilities have operated for approximately 15years in Australia. The facility is equipped with leading technology in terms of the equipment installed.	The facility has no fixed demand for shutdown or maintenance. The maintenance operations are undertaken during evenings, weekends and public holiday periods.	There are other C&D recycling facilities operating in the metropolitan area. One facility has similar operations, the other two facilities have less advanced operations.	The benefits of C&D recycling facilities are; recovery of material which would otherwise be sent to landfill and the production of recycled products which are 10% lighter than virgin materials (reduced carbon footprint).	The barriers of C&D recycling facilities are: competition, market forces, and lack of support from state of local government in material uptake.	In Victoria, the state government and VicRoads support the use of recycled products through using specified recycled products in road construction projects. This has given added confidence to other users that the quality and application of the product is as good as virgin material.

Technology	19	20	21	22	23	24	25
	Applicability to local context	Technology maturity	Availability rate	Regional penetration	Benefits	Barriers	Other
Literature Review	The ideal location for a C&D recycling facility would be; somewhere with adequate buffers to minimise environmental impacts, and be close enough to serve the delivery of feedstock and the buyers of crushed aggregate.	C&D recycling technology is proven. It uses the same operating equipment as used in quarrying operations to crush materials. The conveyor and magnets are simple operations that are also proven in material recycling facilities operating worldwide.	The restrictions on availability are limited by the development approval. C&D facilities can be available as required. The operations are dependent on the feedstock. Extra shifts can be operated if required.	C&D recycling facilities should be sited near to the waste generating area (metropolitan) where developments are likely to be built. Virgin materials can have a large hauling distance, and, recycled products will have an increased take up by the market as transporting costs are reduced	C&D recycling facilities recover materials for re-use and therefore conserve virgin material. This in turn has a greenhouse gas benefit.	The barriers to C&D recycling facilities are; community resistance such as 'Not in my backyard (NIMBY)', and the development approvals process The competition with virgin aggregate prices may also prevent new facilities to set up.	

8 STUDY SYNOPSIS

Technology	1	2	3
	Process	Feedstock (type and tonnes)	Annual processing capacity (t/yr.)
C&D Recycling Facility Study Synopsis	C&D recycling facilities are designed to perform sorting, crushing, screening and processing operations to produce a sellable product. The main waste materials recycled are concrete and masonry, where they are crushed for use as an aggregate or subbase material in civil engineering applications such as road construction. Some C&D facilities have their main operation as a process of crushing with metal extraction. These facilities will accept only source separated concrete or masonry, and will use magnets to separate the steel from the concrete. Other facilities will accept mixed C&D waste (i.e. waste from skip bins) and have a whole suite of operations not dissimilar to a materials recovery facility (MRF). These facilities will separate many different materials, and often have a residual component which would require landfill disposal.	The feedstock for a C&D recycling process can include; used concrete, used bricks and masonry from the demolition of buildings, asphalt, foundry sand and mixed C&D skip bin waste.	The capacity of a C&D recycling facility is defined by the development approval and /or licence depending on the jurisdiction. Between the two facilities consulted, the physical limit or licenced capacity was 500,000 and 1M tonnes per annum. The actual processing capacity achieved at these facilities was between 250,000 and 700,000 tonnes per annum respectively.

Technology	4	5	6
	Place in waste hierarchy	Landfill diversion potential (%)	Products and residuals
C&D Recycling Facility Study Synopsis	C&D recycling facilities fit within the 'recycling' category of the waste hierarchy.	The landfill diversion potential for a C&D recycling facility depends on the feedstock of waste material received. Facilities that process only masonry and concrete consistently achieve over 95% and sometimes over 99%.	The main products generated at a C&D recycling facility are; crushed aggregate, roadbase, subbase and scrap metals. Other materials can also be sorted if required, such as timber, cardboard, plastics etc. The residual waste is a mixed C&D waste residue that is unsuitable for processing at the facility.
Technology	7	8	9
	Capital cost	Operational cost	Gate fees
C&D Recycling Facility Study Synopsis	The capital cost of a C&D recycling facility depends on a number of factors; the capacity of the facility, the acquisition of the land, and the equipment to be installed. Of the two facilities consulted, one had a capital cost of $6M for just machinery and equipment. Some of the equipment was recovered from demolition projects. The actual capital cost was likely to be a lot more than $6M. The other facility had a capital cost of $15M, which included land acquisition.	The operational costs for the C&D recycling facilities consulted were $11.50 and $20 per tonne of waste processed or $4M and $8M per annum.	The gate fee charged by C&D recycling facilities is dependent upon the supply and demand for feedstock and products, as well as market conditions. If there is shortage of materials in the market, the facility would be prepared take materials at no cost. The gate fee varied between the facilities consulted and ranged from; $0-8 per tonne for concrete, $8-$40 per tonne for masonry and brick, and $36-121 per tonne for mixed C&D waste.

Technology	10	11	12
	Set-up timeframe	Lifespan	Technology Footprint
C&D Recycling Facility Study Synopsis	The total set-up time for C&D recycling facilities can vary. From the two facilities consulted, one had a timeframe of three and a half years and one five years. Gaining development approval took two and a half years and three years, and between twelve months and eighteen months respectively for construction.	A C&D recycling facility does not have a specific lifespan. Practically, however, the facility can operate for between 30 and 50 years providing the equipment is maintained.	The site footprint for a C&D recycling facility is expected to be similar to a materials recovery facility site (1-4 ha). One of the facilities consulted had a very small total site footprint of 8,000m^2, whereas the other facility was 20 ha (20,000m^2).
Technology	13	14	15
	Buffer	Emissions	Environmental impacts
C&D Recycling Facility Study Synopsis	The buffer at a C&D recycling facility can vary depending on the approval and licence within the jurisdiction. The restrictions would be based on dust and noise. One of the facilities consulted has a buffer height of 13 metres and distance was as far as the actual facility boundary fence. The other facility had a 250m buffer.	The emissions generated at C&D facilities are from diesel *fumes*, dust from site operations. (Dust can be controlled using dust suppression techniques.)	There are a number of potential environmental impacts from C&D facilities including; dust, stormwater, nose, litter, visual impacts and odour. Asbestos can also cause an impact to the air quality.
Technology	16	17	18
	Social impacts	Supporting technology required	Risks
C&D Recycling Facility Study Synopsis	C&D recycling facilities can provide local employment opportunities, however has the potential to generate dust and impact on air quality in the local area.	The C&D recycling facility technology is highly compatible with other waste technologies. They have the option to expand if space is available. Operations can be installed to perform more complex sorting for if required.	The risks to C&D recycling facilities involve the supply and demand of materials. The availability of guaranteed markets (i.e. road making market) and incoming demolition material can fluctuate. Other risks include competition from other facilities, statutory constraints, feedstock guarantees, environmental risks and health and safety risks.

Technology	19	20	21
	Applicability to local context	Technology maturity	Availability rate
C&D Recycling Facility Study Synopsis	The ideal location for a C&D recycling facility would be somewhere with adequate buffers to minimise environmental impacts, and be close enough to serve the delivery of feedstock and the buyers of crushed aggregate. Being closely located than a quarry (supplier of virgin materials) is beneficial, and therefore, costs of hauling to site are reduced.	C&D recycling technology is proven. It uses the same operating equipment as the quarrying sector to crush materials. The conveyor and magnets are simple operations that are also proven in material recycling facilities operating worldwide.	The operations at C&D recycling facilities are dictated by the flow of materials at the facility. They have no fixed demand for shutdown or maintenance. The maintenance operations are undertaken during evenings, weekends and public holiday periods.
Technology	22	23	24
	Regional penetration	Benefits	Barriers
C&D Recycling Facility Study Synopsis	C&D facilities with advanced sorting operations are usually located in the metropolitan area. Sydney, Melbourne, Adelaide Brisbane and Perth all have at least one or two advanced C&D waste recycling facilities. Other smaller mobile crusher facility setups are more common and are found in metropolitan and rural areas.	C&D recycling facilities recover materials which would otherwise be sent to landfill. Recycling conserves virgin material.	The barriers of C&D recycling facilities include; the complexities of the approvals process and the commercial risks (competition from other facilities and virgin aggregate prices).

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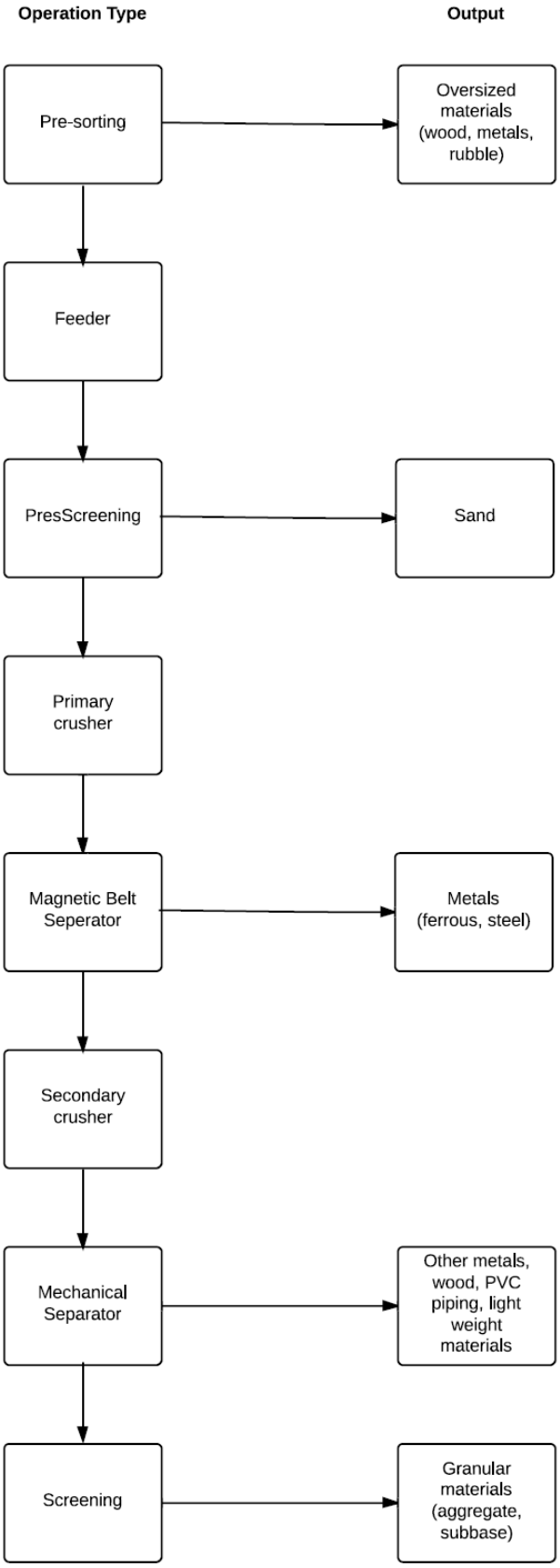
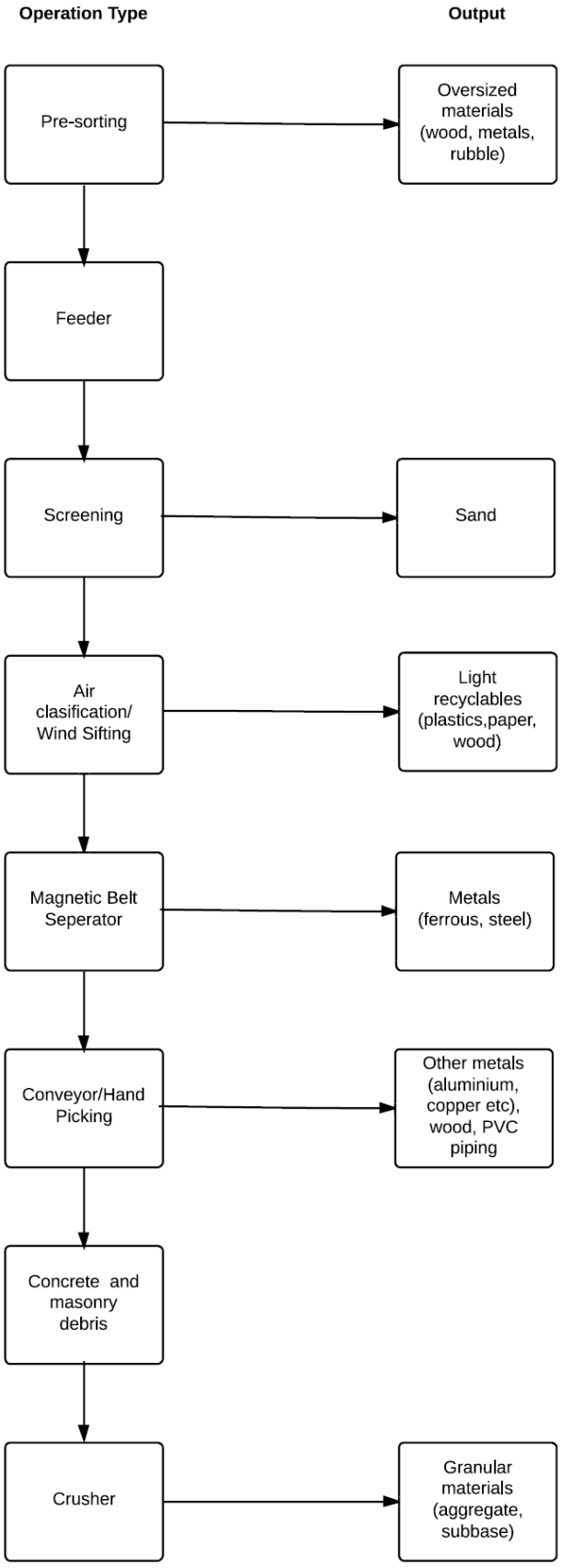
APPENDIX A

C&D FACILITY OPERATION PROCESS FLOWS



Process Flow of a C&D Waste Crushing Operation

This process is 'typical' of a C&D waste crushing operation. An actual operation may be different in detail.



Process Flow of a C&D Waste Separation Operation

This process is 'typical' of a C&D waste separation operation. An actual operation may be different in detail