



Healthy Waterways

ONE CLEAR VISION

Rocklea Industrial Area Littering and Illegal Dumping Research - Final Report

June 2016



Acknowledgement

The material contained in this publication is produced for general information only. It is not intended as professional advice on specific applications. It is the responsibility of the user to determine the suitability and appropriateness of the material contained in this publication to specific applications. No person should act or fail to act on the basis of any material contained in this publication without first obtaining specific independent professional advice. Healthy Waterways Limited and the participants of the Healthy Waterways Network expressly disclaim any and all liability to any person in respect of anything done by any such person in reliance, whether in whole or in part, on this publication. The information contained in this publication does not necessarily represent the views of Healthy Waterways Limited or the participants of the Healthy Waterways Network.

For further information about Healthy Waterways, please email info@healthywaterways.org or telephone (07) 3177 9100.

Executive Summary

This report outlines the outcomes of the Rocklea – Stable Swamp Creek Industrial Area research into behaviours for littering and illegal dumping. The research was conducted by Healthy Waterways and the Oxley Creek Catchment Association (OCCA) and data was collected from litter audits and surveys, plus observational data and interviews. The research paints a clearer picture of the behaviours of people who visit or work in the Rocklea industrial area in Brisbane.

A key recommendation of this report is to trial a behaviour change campaign using community based social marketing to encourage reduced littering within the industrial estate. This could involve encouraging local businesses to take a leadership role in the waste management of shared public spaces and to improve pride in the cleanliness of the industrial area. In addition, improved bin infrastructure, better security lighting, new surveillance signage and an after-hours presence by authorities could all lead to improvements in litter and illegal dumping in the focus area.

It is hoped that the data and literature review within this report will be of use to organisations seeking to improve the cleanliness of industrial areas, not only for the environmental benefit of the waterways but for the social benefit of the people who work in these urban spaces and the businesses that trade there.

Contents

Acknowledgement	2
Executive Summary	2
Background.....	5
Method	7
Results.....	9
Behaviour change strategies.....	18
Discussion and recommendations	19
Conclusion.....	21
Reference list.....	22

Background

Healthy Waterways' social surveys (2010, 2015) found that the community perceive waterway litter as the primary indicator of poor water quality and health. Litter is known to degrade habitats for wildlife, leach chemicals, and carry pests and weeds. There is also an economic cost to the problem of waterway litter, for example the litter may block drainage and contribute to nuisance flooding, and Councils and community groups bear the cost of manual clean ups (Penhallurick 2014, Tunnell 2008, NSW EPA 2015). The extent of waterway litter across South East Queensland has remained relatively constant over time, and it is recommended that behaviour change campaigns support positive community action to reduce litter at its source (Healthy Waterways Clean Up Annual Report, 2015).

In Queensland, litter is defined as 'unlawful disposal of any type of domestic or commercial waste material of an amount less than 200 litres in volume' (<https://www.ehp.qld.gov.au/waste/littering.html>). Illegal dumping is defined as the 'unlawful deposit of any type of domestic, commercial or industrial waste of 200 litres or more' (https://www.ehp.qld.gov.au/waste/illegal_dumping.html) viewed 7 January 2016). The fine for illegal dumping in Queensland starts at \$1884. (https://www.ehp.qld.gov.au/waste/lid_faq.html#what_are_the_fines).

The industrial area near Stable Swamp Creek has a history of significant littering and illegal dumping. Stable Swamp Creek sits within the northern catchment of Oxley Creek (Figure 1), within the lower Brisbane catchment. The area under study is an industrial business estate, home to more than 40 businesses from a variety of industries such as wholesale suppliers, metal recyclers, auto works, heavy equipment suppliers and more.

In an effort to rectify the problem of littering and illegal dumping, Healthy Waterways, in collaboration with Oxley Creek Catchment Association (OCCA) has been funded by the Queensland State Government Litter and Illegal Dumping Unit to complete Steps 1 and 2 of a community based social marketing (CBSM) program. Step 1 of CBSM focuses on selecting behaviours. Step 2 of CBSM involves barriers and benefits research, including a literature review.

This study seeks to identify the main barriers and benefits to not littering and illegal dumping in an industrial estate and add to the research literature on this topic. Littering and illegal dumping are two quite different behaviours and have different legal definitions, based on the size of items disposed of. However, for the purposes of this study, littering is taken as a behaviour generally done 'on the spur of the moment' and without prior planning, whereas illegal dumping requires some forethought and generally access to a vehicle to transport the goods being dumped. Being 'too lazy' to take large rubbish items to the waste facility is what can prompt illegal dumping (Department Environment and Heritage Protection, Illegal Dumping Beerburrum Report 2014).

The problem of littering in Oxley Creek, Rocklea

Oxley Creek has sites which are recognised 'hotspots' for litter, including Stable Swamp Creek, and these sites are regularly visited by the Healthy Waterways Clean Up Crew. The creek is susceptible to flooding, with flood waters being deep and moving very quickly. In large floods,

the creek may appear more like a river in places, inundating large areas. This means litter has the potential to swiftly flow through this system and deposit into Moreton Bay.

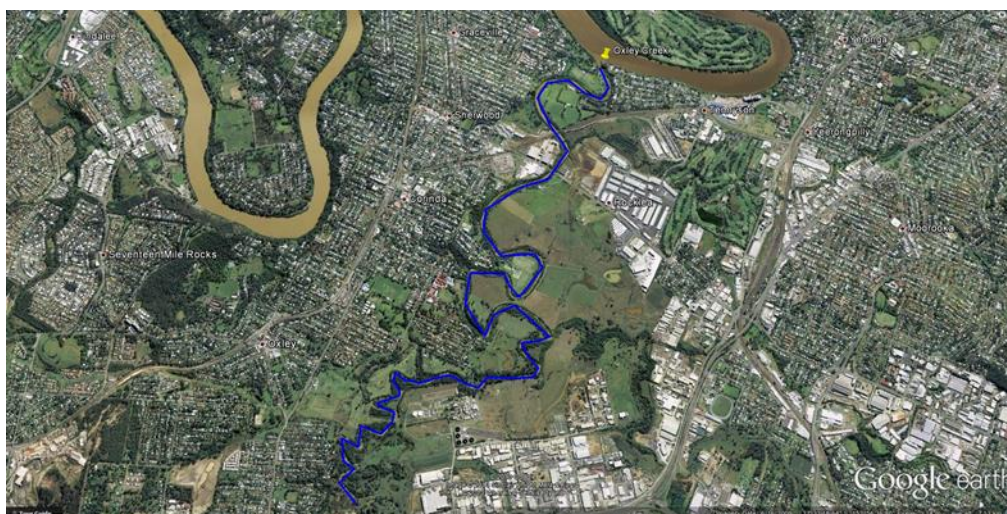


Figure 1 Oxley Creek

The state of waterway litter in the northern catchment zone of Oxley Creek was first evaluated in July 2013. The Healthy Waterways Clean Up crew (the boat tasked with collecting waterway litter) picked up 1793 items of waterway litter from riverbanks and within mangroves in the open waterways of Oxley Creek over a three month period. 5081 pieces of litter were subsequently picked up in 2013/2014, and 2791 pieces in 2014/2015 (Source: Healthy Waterways Clean Up Annual Report 2014 & 2015.)

Collection sites were:

- Oxley Creek 27°31'25.58"S, 152°59'42.00"E
- Oxley Creek 27°32'0.25"S, 152°59'37.52"E
- Oxley Creek to Ipswich Rd 27°32'1.91"S, 152°59'36.75"E

Several other potential waterway health threats were identified during these surveys, including discarded industrial drums, flood debris (from the January 2013 rain event) and trampling of river banks by livestock (Source: Healthy Waterways, *Oxley Creek Waterway Litter Evaluation Report*, October 2013.)

Stable Swamp Creek is acknowledged by Brisbane City Council and OCCA as a problem area for illegal dumping. Council has mapped over 150 dumping hot spots throughout the Brisbane local government area and many of them are in the South West corner of the city in industrialised areas. 40 – 50 of those hot spots are 'high frequency', meaning waste is dumped at least once a week.

According to the Project Officer for Illegal Dumping with Brisbane City Council, most of the dumpers (and the majority of those fined) are individuals coming from residential areas, not from industries in the area. This is important to note for understanding the behaviours of illegal dumping in the Stable Swamp Creek area and potentially other industrial areas.

Brisbane City Council's Project Officer for Illegal Dumping has extensive knowledge of the Rocklea industrial site. He has stated that dumping normally takes place during weekends and after hours because this is when the area is most isolated. He believes industrial areas get

targeted because they are not active outside of business hours and the streets can be dead ends without camera surveillance. The rubbish tends to be general household waste and green waste, and he could not recall there being issues with hazardous waste (Project Officer for Illegal Dumping with Brisbane City Council , pers. comm. 7 January 2016)

Of course, illegal dumping isn't just an issue at Stable Swamp Creek, Rocklea. A Courier-Mail newspaper article highlighted the problem of illegal dumping in Belmont and Chandler. The article reports that illegal dumping costs Brisbane City Council \$800,000 each year and there were 1300 illegal dumping reports in 2014/15, with 104 fines issued (Orr 2016).

According to a Victorian study, industrial sites (and retail sites) have the largest numbers of littered items and the largest volumes are also found at industrial sites (Victorian Litter Action Alliance). A NSW study found that industry thinks illegal dumping is not widespread (NSW EPA).

Method

OCCA and staff from both the Brisbane City Council and the Department of Environment and Heritage Protection's Litter and Illegal Dumping Unit undertook an initial collection and litter count along Dunn Road on 27 February 2015.

This audit highlighted the serious problem of litter in the industrial area and prompted a grant application by Healthy Waterways to fund further research.

Upon successfully receiving funding in March 2016, five sites (refer to Figure 2) were selected for further litter audits and analysis and to inform Steps 1 and 2 of the Community Based Social Marketing method for behaviour change.

Litter was collected, removed from the five sites and documented by OCCA and a team of volunteers on three dates: 22 March 2016, 10 May 2016 and 8 June 2016. The five sites were broken down into 10 zones to allow for easier analysis. The audit methodology was based on the methodology used by Department of Environment and Heritage Protection in recent roadside littering audits. However, OCCA developed an audit that counted items, not weight and included items specific to an industrial estate, e.g. rags, electrical wire and construction materials.

Truck drivers were surveyed for their observations of and opinions about littering on 10 May 2016. Local businesses were interviewed on 7 June 2016 about their current behaviours for litter reduction. Additional observational surveys of the sites were undertaken on 23 May 2016.



Figure 2 Rocklea Industrial Area, Stable Swamp Creek, and five sites selected for litter audits

Rocklea demographics

According to the Australian Bureau of Statistics, there are over 2,000 businesses in the region (Rocklea-Acacia Ridge region SA2) and almost 650 businesses have five or more employees. Manufacturing is the main industry.

As part of this research, OCCA established a database of the businesses operating from the key streets (see map above). This database will be used to assist future communications and engagement between industry and OCCA. Interestingly, a number of businesses work in the waste recycling or natural area management sector and could be key champions in reducing litter in the Rocklea industrial area.

Almost 17% of the region's population work as technicians or trade workers and a further 14% as machinery operators and drivers. 15% are labourers (source: ABS regional statistics).

These statistics outline the employment of residents living in the Rocklea region but it is not known the number or percentage of people working in the Rocklea industrial area who also live locally.

If people feel that a council or local authority is responsible to pick up litter then it may be more socially acceptable to litter. Therefore it could be acceptable to litter in areas where someone else will clean it up and there is a sense of reliance on government cleaning services (Dur & Vollaard, 2015). Areas such as the public spaces of Rocklea Industrial Estate are the responsibility of Brisbane City Council and it is easy to see a difference between the cleanliness of most private properties and the untidiness of public verges and other spaces.

Results

Types of litter

The most common items found in the February visit were plastic beverage bits and containers. Construction tape and cable were also found, along with ties and rubber bands. Vehicle parts were also common and plastic retail containers and packaging such as polystyrene. This type of litter is not unexpected in an area where delivery loads are being unwrapped and sorted. Note: there were no alcoholic containers, spray cans and relatively few cigarette butts found during the February 2015 audit.

At the Dunn Road site, a visit in November 2015 highlighted the dumped rubbish that had been there for some time. Weeds were growing over dumped chairs and tyres (refer to Figure 14). Newer items had been dumped in the same area. Due to safety concerns, an audit was not conducted of the rubbish at the site, except a visual scan. These items had been removed by Brisbane City Council when the site was visited again in May 2016.

During Clean Up Australia Day 2016 dumped items were retrieved by OCCA and these included a heavy door, numerous tyres and a windscreen. Miscellaneous items collected during the litter collections in March and June included asbestos pieces, a mattress, a bag of clothes, crates and tarpaulins.

The results of the audits in March and June 2016 show that beverage and food packaging make up the majority of the litter. Of those there were a surprising number of alcohol containers (17%) which raises questions about the specific behaviours surrounding the littering of multiple bottles of wine.

According to recent interviews with dumping offenders, people are influenced to dump rubbish by the presence of other rubbish at the location. The Illegal Dumping Beerburrum Report also noted that all offenders were male and the average age was 46 years, although only 1–2% of respondents to a recent survey admitted to illegal dumping (Enhance Report, Illegal Dumping Beerburrum).

Litter audits 2016

Gay Street, Coopers Plains is a heavily littered area. The litter collection in Gay Street in March 2016 collected over 30 kilograms of waste with more waste collected from Gay Street in May 2016. A third Gay Street litter audit in early June 2016 collected another 12 bags of rubbish. Despite thoroughly clearing the area six weeks earlier, both litter and dumped items were common and Gay Street was the worst location surveyed.

Audit 1 - Large-Med Littered Items - March 2016

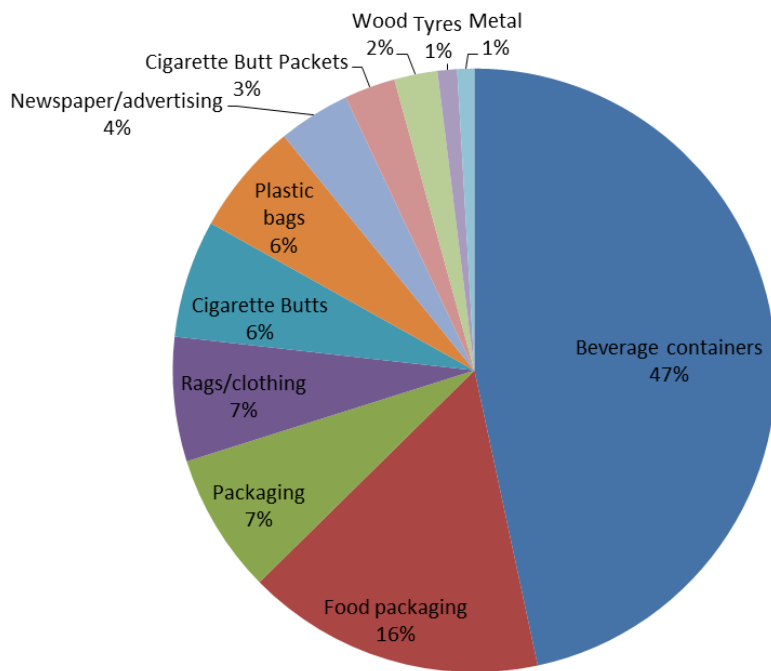


Figure 3 Results from March 2016 audit

Gay St - Litter Audit May 2016

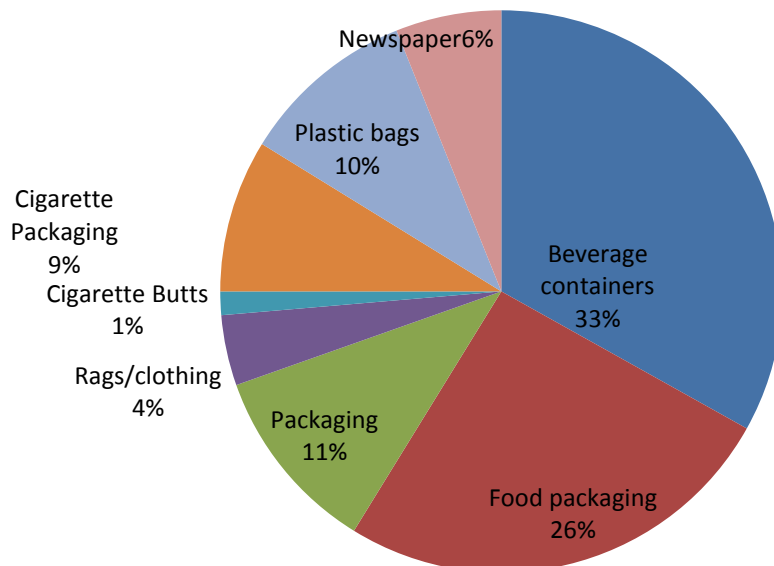


Figure 4 Gay St audit May 2016

Audit 2 - Large to Med Littered Items - June 2016

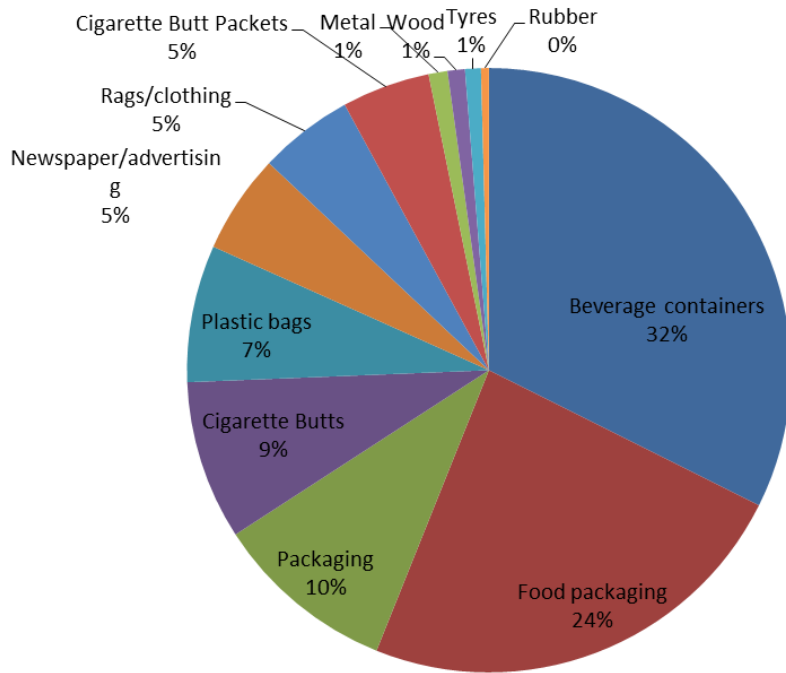


Figure 5 Results from June 2016 audit

Audit 1 - Beverage Container Types

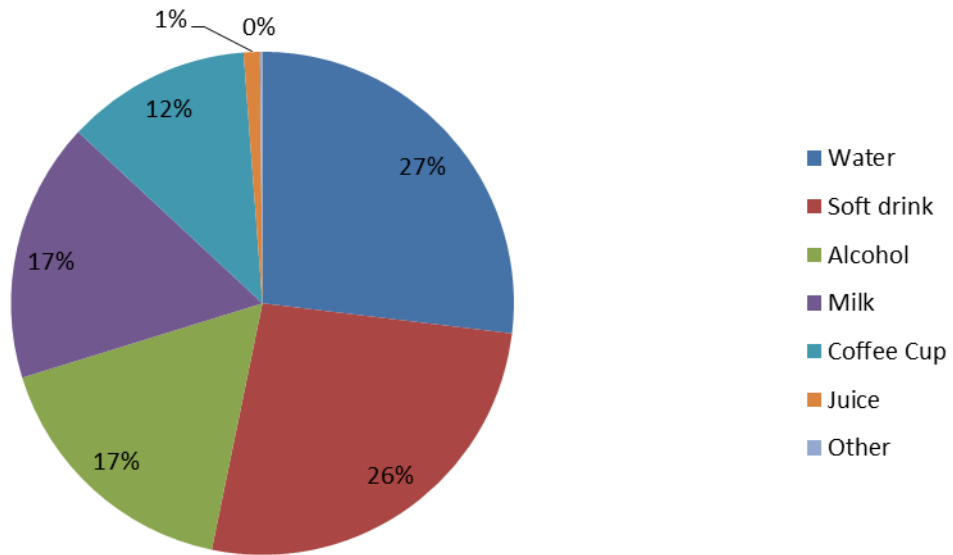


Figure 6 Types of beverage containers collected during litter audits

The majority of the litter is beverage containers (See Figures 5 & 6). The second most common litter items are food packaging. Other littered items fell into the following categories:

- Cigarette butts and packaging

- Rags and cloths have been littered – most rags were oily, indicating they have likely been used to clean engine parts and tyres or to wrap packaged goods for transport.
- Packaging (cardboard, plastic wrap etc.), wood (e.g. planks of wood, pallets) – these appear to be related to packaging
- Metal and electrical pieces (e.g. wiring) – appear to have originated from car parts or related activities.
- Tyres and rubber – may have been dumped by residents or surrounding businesses.
- Small pieces of plastic, paper, foam, metal – there were many small items of unknown origin collected (approximately 800 during the March audit and 1500 during the June audit). The majority of these were plastic and paper and they most commonly appeared in freshly mown areas. The look and colour of most items suggests they were once beverage and food containers, and newspapers/advertising material.

The public spaces bordering the industrial area provide a slightly shaded, open area for workers to sit and eat lunch or take a break from the workplace. It is also the area where numerous trucks pull in before or after making their deliveries (see Figures 7 & 8 below). There is a similar public space along Dunn Road, Rocklea. Occasionally, Dunn Road is also the site for late-night, illegal car races (Personal Communication: Queensland Urban Utilities site manager, June 2016).

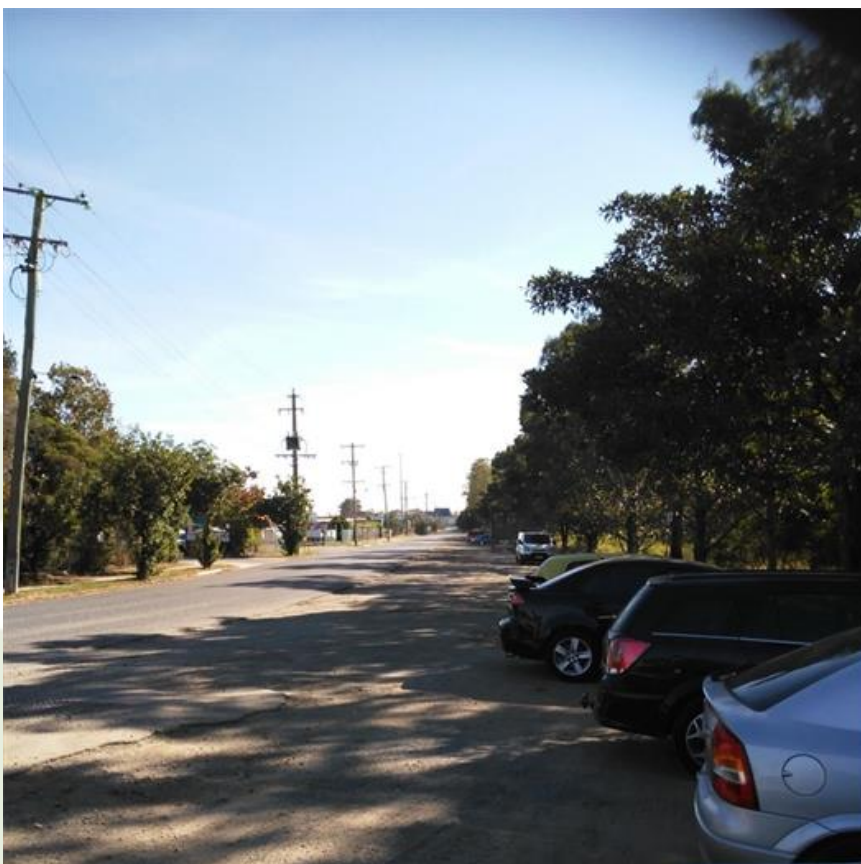


Figure 7 Gay Street parking and break area



Figure 8 Gay Street truckstop

Cars park on the right side of the street where there is some tree cover and shade. A weed infested waterway is partially hidden. Industrial businesses line the left side of the road.

Looking at the litter may provide some clues as to the litterers, but not all is clear. For example, plastic bags with empty glass bottles of wine were found on two occasions and multiple wine bottles were also seen inside bins on Gay Street (see Figure 21). A breakdown of the June audit shows that Gay Street has the most littered alcohol containers, with 33 collected from that one street. Comparatively, Dunn Road had 12 alcohol containers and none were found on Suscatand Street. Gay Street also wins the dubious honour of having the most littered cigarette packets (78) compared with only 8 found on Dunn Road from two collections. The consumption of cigarettes and alcohol at Gay Street are likely to indicate this location is used by groups of people as a late night drinking spot. It is assumed that the littered bottles and cans come from drinkers who choose the quiet and empty location after hours to drink in a group. Observations would need to be conducted during the night and early mornings to get any clarity around this type of litter and who deposited it. Surveillance cameras may help to discretely observe or Queensland Police may have details of groups who gather in that area.

Figures 9 – 18 (below) show a selection of littered and dumped items in the Rocklea Industrial area. They vary from items that have been littered very recently, such as Figure 9 (food packaging items with liquid coming out of a can) and items that would take some effort to illegally dump because they are heavy and bulky (such as the furniture in Figure 13).



Figure 9 Freshly littered lunch



Figure 10 Two dumped tyres



Figure 11 cigarette packet litter



Figure 12 Condom litter



Figure 13 Dumped furniture - dismantled chairs



Figure 14 weathered litter prohibitive sign



Figure 15 Suscatand St. A gathering spot?



Figure 16 e-waste deposited over high fence, Dunn Rd



Figure 17 dumped items Franklin Street



Figure 18 weeds grow over long term dumped items

Where can people get rid of their large rubbish?

The nearest Brisbane City Council waste facility is at Sherbrooke Road, Willawong. It opens at 6:30am and closes at 5:45 pm, and it is approximately 15 minutes drive from the Rocklea Industrial Estate. The fees range from free of charge for homeowners with a waste voucher for general waste and green waste, to up to \$11.20 for up to 100 kilograms (and higher rates for higher weights). It is not mandatory for landlords to provide waste vouchers to renters therefore non-homeowners may need to pay to transfer their waste.

Where can people get rid of their litter?

Numerous waste bins are located on Gay Street, Coopers Plains (see Figure 19). However, as observed on 23 May 2016, one bin was broken and on the ground (see Figure 20). There are no recycling bins. Other bins looked unclean and had cobwebs on them, but were not overflowing. Observations made during the March 2016 audit found that the bins were overflowing but Council emptied them after a report was lodged.

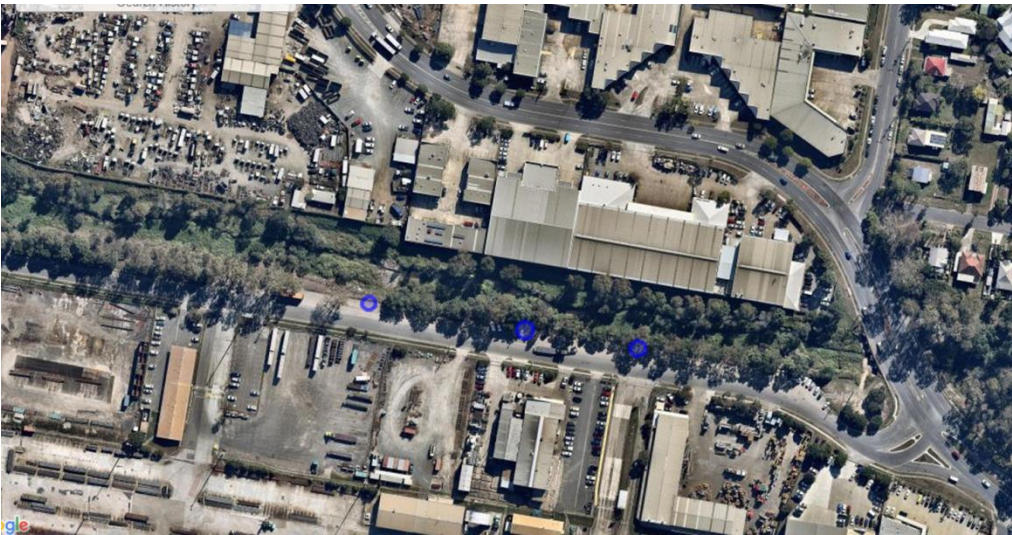


Figure 19 circles indicate bins on Gay Street, Rocklea

Litter was seen in close vicinity (under 1 metre) to the waste bins on Gay Street. This is surprising as bin proximity is generally linked to less littering (Schultz et al, 2013, NSW Litter Prevention Kit 2013, Spehr and Curnow, 2015). There are no public bins on other streets within the identified zone.



Figure 20 Bin on Gay St



Figure 21 Rubbish in bin. Note the wine bottles

Observations of littering behaviour in the industrial area

The act of littering can be difficult to see because often littering is done when the perpetrator thinks no one is watching (Spehr & Curnow, 2015). However, OCCA has reported various observations by users of the Rocklea Industrial Area.

Much of the litter in Rocklea is found beside parking or truck stop areas. According to Shultz et al 2015, their analysis attributes 70% of roadside rubbish to individuals, 21% from unsecured loads, 5% from vehicles and 3% from unsecured containers nearby. The Rocklea audit shows rags and cloths are 5% of the litter stream. Additional observations or surveys of drivers may illuminate what purpose the rags serve before disposal. Assumptions have been made that the rags are used to

clean engine parts or to wrap packaged goods for transport. It was difficult to get specific information from truck drivers as many of those approached declined to be interviewed.

Observations of the Stable Swamp Creek littered area identify that truck drivers waiting to unload deliveries may be a perpetrator of discarded litter. One OCCA representative said that drivers arrive at the industrial area in the early hours of the morning, prior to businesses opening. During this time, they 'clean out' the cab section of the truck and leave bags full of rubbish on the ground. Rubbish collected by OCCA from the site in the past has included human waste, such as soft drink bottles filled with urine (Personal communication, Larissa Mar Fan, OCCA Partnerships Project Manager, 16 November 2015). However, in the observational surveys conducted in 2016 truck drivers were not observed littering items such as food wrappers or bottles from their truck cabs.

Cars park along the littered grassy edge of Dunn Road during business hours. These are likely to be the cars of the employees working in the industrial estate. Customers' cars are more likely to park in the off-street car parks provided by each business. No littering from parked cars was observed.

There is a dearth of literature about littering behaviours in industrial estates. Most helpful is the report looking at littering rates in the United States over 10 states and almost 10,000 observations of littering in public places (Shultz et al 2013). In this report, smokers had a littering rate of 65%.

Littering of cigarette butts was observed on numerous occasions. After a face-to-face littering survey with two truck drivers, the drivers were then observed to litter their cigarette butts. However, there have been no observations of littering of larger items such as food wrappers and some people were observed taking their coffee cups and used rags with them when they left the site.

There was an observation of litter that had been 'wedged'- a coffee cup wedged underneath the slats of an old pallet (that was also litter). Wedging is a negative disposal behaviour and the reasons someone would go to the effort are not known (Spehr and Curnow, 2015, p 24).

There were observations of the yards of nearby businesses and a potential source of litter from baled cardboard (bits were sticking out and could become torn off and blown away) and uncovered skip bins. Some businesses had gone to obvious effort to make their front entrances clean and tidy, some even employed a gardener. However, other businesses did not present a clean entrance, for example rubbish sat in garden beds and there was a sense of disorder with broken fences or junk in the yard. It is assumed that these businesses do not receive public customers and hence do not feel the need to maintain higher standards of presentation. More about the responsibility of local businesses for litter minimisation is discussed in the 'Behaviour Change Strategies' section.

A camera was set up by OCCA to discretely record observations. However, there were issues with placing it in the site and technical problems. Brisbane City Council's Litter Prevention Officer said that a few of the businesses have given approval for a monitoring camera to be set up on their premises (Personal communication: Brisbane City Council's Litter Prevention Officer, December 2015).

Difficulties in collecting observational data included:

- Directly observing littering and dumping behaviours due to the behaviours occurring late at night.
- Knowing who is doing the littering, based on the litter audited.
- Engaging with local businesses on this issue.
- Surveying users of the space.

Industry respondents in a recent New South Wales study acknowledge that illegal dumping is a secretive activity and therefore it is difficult to know how common it is, although a quarter had admitted to dumping waste illegally (NSW EPA 2015, pp. 58 – 62).

During litter audits in March 2016, illegally dumped items were observed in several locations along the length of Gay Street. Most of the items appeared to be household items, such as a mattress, paddling pool, clothes, general household waste, TV etc. There were also tyres (refer to Figure 10) which could have been dumped by residents or businesses. These were reported to Council and collected, however more items were dumped from March to June as noted during the June audit. From the items audited, it is possible the dumpers are residents from nearby suburbs, with access to a vehicle, using the isolated site to 'get rid of' excess household waste and avoid a trip to the transfer station.

Behaviour change strategies

Selecting a behaviour - Step 1 Community Based Social Marketing

Littering and illegal dumping are two distinct categories of actions and therefore have been analysed separately. Any behaviour change campaign would need to focus efforts to reduce either littering or illegal dumping as any strategy will not necessarily influence both. It is likely that the perpetrators are also a distinct audience although it is acknowledged that the presence of littering can promote increased illegal dumping, and vice versa.

Calculating impact, probability and penetration (as required by CBSM methodology) for illegal dumping behaviours does prove challenging. A list of behaviours to prevent littering and illegal dumping in the Rocklea Industrial Estate is included in Appendix One. A range of illegal dumping behaviours are also outlined in the Beerburrum LIDU report (2015, pp.9-10) along with percentages of likelihood. These behaviours and rates of likelihood could be applied to the Rocklea Industrial Area. Both the Beerburrum bushland and Rocklea Industrial Area (outside of business hours) are secluded. The dumping in the Rocklea Industrial Area occurs in bushy areas along the creekline, where plants can cover items or grow over them. Both areas require vehicle access to dump and a waste transfer station is relatively close.

As stated earlier, the behaviours for littering and illegal dumping are distinctly different. Appendix One also lists the behaviours for littering. To calculate 'impact' the behaviour was considered in light of how much difference it would make. For example, if truck drivers kept all litter in their truck cabs, would this greatly reduce litter in the area? Due to limitations on actual observation of truck drivers littering, the impact of this specific behaviour could not be determined or estimated.

Respondents to the survey of businesses on 7 June 2016 were asked the likelihood of them undertaking certain behaviours to curb and prevent littering in the public spaces of Rocklea Industrial estate. All of the small number of respondents said that they would allow and

encourage staff to take measures to keep the frontage clean and tidy, and that they provide waste facilities for staff and visitors, including truck drivers. Therefore, the probability could be high of businesses undertaking behaviours such as:

- prevent rubbish from blowing from workplace e.g. covering skip bins
- put out a workplace bin on the public verge for others to use
- encourage staff to bring waste back from lunch breaks and place waste in workplace bins.

The impact of these behaviours on littering in the area could also be considered high and although there is likely to already be penetration of these workplace behaviours, there is scope to improve the involvement of businesses in the litter issue.

Discussion and recommendations

Potential strategies

Rocklea Industrial Estate is home to a variety of littering and illegal dumping behaviours as evidenced by the surveys and litter audits. Perpetrators could include illegal dumpers from surrounding suburbs, groups of people using the isolation of the area (at night and during weekends) to meet and drink, and the many people who work in and deliver to the area. Therefore, a range of strategies are recommended to tackle the issues and communicate to various audiences.

Firstly, improved bin infrastructure may help reduce littering. The bins on Gay Street are currently small, unclean or broken. Replacement with larger, standardised Brisbane City Council bins (red lid for waste and yellow lid for recycling) may make the bins easier to find and give a perception that waste is collected regularly. It is recommended that Council consider installing bins in other streets, such as Suscatand Street as well as replace old, weathered surveillance signs (refer to Figure 14) to signal an improved sense of care for the site.

Secondly, in order to try and tackle the behaviour of littering from gatherings of people drinking after-hours in the isolated site, police may agree to more regular surveillance of the area. Also, improved lighting of hidden spots may decrease the number of drinkers and deposits of alcohol containers. An increased police presence and lighting may also decrease rates of illegal dumping.

However, it is proposed that the strongest potential strategy would come from engaging with local businesses and asking them to take a role in sharing responsibility for the cleanliness of the area. Much of the waste minimisation research points to increasing the pride in local businesses and then communicating their expectations to users of the space to ensure that the area will be kept clean and uncluttered. Businesses take the lead on the behaviour and the standard they want. Some of the businesses in Rocklea are obviously proud of their entrances, with tended gardens and clean car parking areas. The areas in front of these businesses also appear to be tidy and clear of large litter. One strategy could include ongoing engagement with businesses and fostering supportive businesses to reduce litter in the region. A community based social marketing campaign that engages surrounding businesses to reduce littering could be trialled, potentially using tools such as prompts, social norms and social diffusion.

Local businesses could help with solutions as they employ staff and contract the truck drivers who are possibly the people littering (but not necessarily illegally dumping). The businesses could be the main provider of communications around strong anti-littering messages and also well placed to be the 'eyes and ears' of observation to deter illegal dumping and provide casual surveillance and reporting to authorities. A steep reduction in littering could have flow-on effects to create a place that is less tolerant of illegal dumping.

It could be effective to provide a sense that someone (i.e local businesses) are watching the litterers and are judgemental of this behaviour. It is possible that even a constructed image of 'watching eyes' could have some impact (Bateson et al, 2015). Local businesses are also best placed to be on site to discover illegal dumping and report it immediately. Organisations such as OCCA are not in the vicinity every day and there can be lag times in reporting dumping. Delays could lead to a perception that dumping here is 'OK' and create a downward trend of poor standards. Signs indicating that cameras are observing the site (cameras may or may not be in place at the time) could be trialled.

Businesses in the vicinity could be given tools and bags to pick up litter at the front of their business. Holroyd City Council (NSW) introduced a program in 2015 that gave dustpans and brooms to local business to help them pick up litter outside their businesses (in a retail area rather than an industrial area). Cigarettes were identified as the biggest littered item.

<http://www.holroyd.nsw.gov.au/holroyds-taking-care-of-litter-business/>. If a manager of a public place makes an effort to keep an area clean, then visitors to that area are likely to respond as they have a sense of reciprocity (Spehr & Curnow, pg 95).

'Adopt a road' clean up program could be trialled with local businesses that are able to offer volunteer support and take a leadership role. Businesses in the Keep Australia Beautiful 'Adopt-a-spot' program are encouraged to regularly clean up sections of a road or area, for example, staff from Veolia have done regular roadside clean ups in Brisbane (and were awarded for their efforts). Source: <https://www.brisbane.qld.gov.au/environment-waste/rubbish-tips-bins/reducing-litter/keeping-brisbane-clean/cleaner-communities-brisbane-awards-2015>. Veolia or other businesses may be interested in undertaking a similar program at Rocklea.

Newly dumped rubbish could be highlighted with high-visibility tape and the dumped items immediately reported to Brisbane City Council for removal. Nearby businesses could be supplied with this identifying tape and given easy instructions to report any issues with Council. Business could also be informed about the State Government's online littering reporting tool and encouraged to use this tool if they see someone deposit litter.

From a communications perspective it also makes sense to target businesses and their staff rather than an ever-changing roster of truck drivers who deliver to the area or unknown individuals dumping in secret. Businesses could be approached via face-to-face conversations, regular emails, provision of supporting materials and opportunities at local business events. In addition, focus groups, a pilot campaign and evaluation would be possible with the local businesses. The key strategy is to inspire businesses to take a leadership role in delivering a much cleaner area, and shift expectations of what is acceptable. This, in conjunction with improved bins, new surveillance signs and lighting, and faster reporting of dumping should then impact people entering the area either as a delivery driver, potential illegal dumper or late night drinker.

Conclusion

The litter audits, observations and surveys gathered information about a range of littering and illegal dumping behaviours in an industrial estate in Brisbane, Australia. As expected, there is not one behaviour leading to the problem of litter at the Rocklea Industrial Area, but multiple behaviours.

The main constraint for this research was the difficulty in directly observing some behaviours. Littering can be hard to observe due to the social norm against flagrant littering (Spehr & Curnow 2015) plus the behaviour of illegal dumping most likely happens at night, and on the weekends, when direct observations can be unsafe. However, the litter audits highlight the need to tackle the issue of beverage container and food packaging litter as a priority. Local businesses and transport drivers are generally supportive of reducing litter and illegal dumping in the area.

It is recommended that a community based social marketing campaign be trialled to improve stewardship of the area by local business owners and employees. Further resources are needed to implement this type of campaign. In addition, improved bin infrastructure, better security lighting, new surveillance signage and an after-hours presence by authorities could all lead to improvements in litter and illegal dumping in the focus area.

Reference list

- Australian Bureau of Statistics regional summary Rocklea- Acacia Ridge, <http://bit.ly/1roYZCW>, accessed 11 April 2016.
- Bateson, M., Robinson, R., Abayomi-Cole, T., Greenlees, J., O'Connor, A., Nettle, D. (2015) "Watching eyes on potential litter can reduce littering: evidence from two field experiments." *PeerJ*, 3, e1443.
- Davies, A. (21 April 2016) Illegal dumper caught red-handed, *The Queensland Times*, retrieved from <http://www.qt.com.au/news/dont-illegally-dump-your-waste-here/3003936/>.
- Dur, R & Vollaard, B (2015). "The Power of a Bad Example - A field experiment in Household Garbage Disposal" *Environment and Behavior*, vol 57, no. 9 pp. 970 -1000.
- Enhance Research and Queensland Government (2014). *Illegal Dumping: Beerburrum Hotspot, Research Summary Report*.
- Hardesty, B.D., Wilcox, C., Lawson, T.J., Lansdell, M. & van der Velde, T. 2014. *Understanding the effects of marine debris on wildlife. A final report to Earthwatch Australia*. UNEP. 2005. *Marine litter: an analytic overview – from Ben Penhallurick, 2014 .)*
- Penhallurick, B (2014), *How much is waterway litter worth? Calculating the financial costs of remediating waterway litter in South East Queensland*, Healthy Waterways Report.
- Healthy Waterways (2013). *Oxley Creek Waterway Litter Evaluation Report*.
- Healthy Waterways (2014) *Clean Up Program Annual Report, 2013-14*.
- Healthy Waterways (2015) *Clean Up Program Annual Report, 2014-15*.
- McKenzie-Mohr, D. (2011) *Fostering Sustainable Behaviour, an introduction to Community-Based Social Marketing*, 3rd ed. New Society Publishers.
- New South Wales Environment Protection Authority (2015). *Illegal Dumping Research Report*. Retrieved from <http://www.epa.nsw.gov.au/publications/illegaldumping/150481-illegal-dumping-report.htm>.
- NSW Environmental Protection Authority (2015) *Illegal Dumping Research Summary Report*. Retrieved from <http://www.epa.nsw.gov.au/resources/illegaldumping/150480-illegal-dumping-summary.pdf>
- Orr, S (January 14, 2016) Rubbish abandoned in Belmont and Chandler is disgraceful says Cr Adrian Schrunner, *Quest Newspapers*, retrieved from (<http://www.couriermail.com.au/questnews/>).
- Schultz, W., Bator, R, Brown Large, L., Bruni, C., Tabanico, J. (2013) "Littering in Context – Personal and Environmental Predictors of Littering Behaviour" *Environment and Behavior*, vol. 45, no. 1 pp 35 – 59.
- Spehr, K and Curnow, R (2015) *Litterology – Understanding littering and the secrets to clean public spaces*, Environment Books, Victoria.

Tunnell, K (2008) "Illegal Dumping: Large and Small Scale Littering in Rural Kentucky" *Southern Rural Sociology*, 23(2) pp. 29 – 42.

University of Queensland Institute of Social Science Research for Healthy Waterways, Awareness and attitudes towards waterway health issues in South East Queensland

Victorian Litter Action Alliance (2013), *Litter Prevention Kit Roadside Litter*. Retrieved from <http://www.litter.vic.gov.au/litter-prevention-toolkits/litter-prevention-program-kit/roadside-litter>.

Appendix One

Behaviours specific to illegal dumping in Rocklea industrial estate

Behaviour	Barriers	Benefits
Drive waste to the Council transfer station and use a waste voucher for free drop-off. (NB waste vouchers are only supplied to ratepayers, not necessarily passed onto renters)	<ol style="list-style-type: none"> 1. Need access to a vehicle to carry waste 2. Need to be physically capable of loading waste into and out of a vehicle 3. Need to take waste to transfer station during opening hours (not 24 hours). 4. Need to be a rate payer 5. Need to have stored vouchers (vouchers are only sent once per year and need to be used within specific timeframe). 6. Green waste needs to be loaded separately if a green waste voucher will be used. <p>Note: women regard transport of waste as a bigger barrier than men (Beerburum LIDU Report).</p>	<ul style="list-style-type: none"> o Disposal at your convenience (within opening hours) o Can take large amount of waste at once o Free for ratepayers
Drive waste to the Council transfer station and pay to deposit it.	Barriers 1 – 3 as above	<ul style="list-style-type: none"> o Disposal at your convenience (within opening hours) o Can take large amount of waste at once
Ask to use a friend's waste voucher, collect the voucher and drive waste to Council transfer station and use the voucher	<p>Barriers 1 – 3 as above</p> <p>Need a friend, with a voucher who doesn't need to use it. This requires local contacts</p> <p>Takes time to collect the voucher</p>	<p>As above, plus</p> <ul style="list-style-type: none"> o Could be free
Collect free waste voucher from Council Ward office then drive waste to the Council transfer station and use voucher	<p>Barriers 1 – 3 as above</p> <p>Residents may not know of this option</p> <p>Need to know which Ward you live in and location of Ward office.</p> <p>Need to collect voucher within</p>	<ul style="list-style-type: none"> o Disposal at your convenience (within opening hours) o Can take large amount of waste at once o Free

	opening hours of Ward office.	
Buy waste vouchers online (eg Gumtree) and use them to take your waste to the transfer station	Barriers 1 – 3 as above	
Drive recyclable items to Council transfer station, where it is free to enter and drop off recyclable items only.	Residents may not know of this option to dispose of recyclables Need to separate items and only take recyclables Need to know what is recyclable Need vehicle access and physical ability to move items	Free (for recyclables) One place to deposit a range of items (e.g batteries, old tvs etc)
Put large waste items in the standard household collection service	Large items may need to be cut up May need to deposit waste over a few weeks Large items may not fit in bin (eg a couch/mattress)	Free Convenient to home No vehicle needed
Keep waste at home until there is the annual Council kerbside collection service	This is an annual service only so it will only be an option once per year, e.g. in Rocklea the collection was in February 2016. There are size limits to items that will be collected. Need to be able to store rubbish until collection date. Has to be maximum 70 kilos Can look unsightly in front of residence Residents may not be aware of the kerbside collection date	Free No vehicle needed
Take small items to a charity bin	Only small items accepted (e.g. bags of clothes) fit in charity bin. May need to separate items May need to drive to charity bin therefore need a vehicle Need to locate a charity bin	Free Can happen anytime
Call a charity to come and collect larger, good quality items	Charity will only collect good quality items. Need to be home for collection Need to research which	Free Doesn't require a vehicle Don't need to lift and transfer items

	<p>charity will come and collect</p> <p>Need to live in an urban area</p> <p>Items will be taken away at a timeframe that suits charity (won't necessarily happen quickly)</p>	
<p>Book a waste removal service to bring skip bin to your house and place rubbish in skip bin.</p>	<p>Need to research a waste collection service</p> <p>Takes time to call the service and make a booking</p> <p>Need space for skip bin to be placed (may not be possible in unit blocks)</p> <p>Unightly</p> <p>Costs money</p> <p>Limited time to deposit waste</p>	<p>Convenient (waste only needs to get to skip bin in yard)</p> <p>Could be available quickly</p>
<p>Sell items on online classifieds</p>	<p>Time to take photos and upload onto site</p> <p>Security risk of people coming to the resident's home to collect items</p> <p>Need to answer query calls/emails</p> <p>Items may not sell</p>	<p>Source of income</p>
<p>Give away items to friends or family</p>	<p>May not want friends to see junk. Could be embarrassing</p> <p>Friends may not want items or not all of the items.</p> <p>Requires physical proximity to friends/family</p> <p>Friends may not have room for items</p>	<p>Free</p>
<p>Reuse items in the garden, to make a cubby etc</p>	<p>Items to be disposed of need to be useful and safe to reuse</p> <p>Need skills to reuse items</p> <p>Need tools</p> <p>Need space to make items</p> <p>Takes time and creativity, and may be messy</p>	<p>Free</p> <p>No vehicle needed</p>
<p>If waste is hazardous, book a specialist collection service</p>	<p>Need to know the item is hazardous</p> <p>Need to research which business can collect it</p> <p>Need to book collection service</p>	<p>Safest option</p> <p>No need to handle items</p> <p>No car access needed</p>

	Costs money May not be immediate	
--	-------------------------------------	--

Littering behaviours specific to an industrial area	
Put rubbish from truck cab into street bin	
Place waste from lunch/food eaten at the site into bin	
If eating outside, take waste from lunch break back to workplace	
Take waste from lunch break back to truck for later disposal	
Take recyclables back to workplace to use their recycling bins	
Take recycling home to use home recycling bins	
Place uneaten food into bin	
Pick up litter that has been left behind and put it in bin	
Ask someone to pick up their rubbish if you see them leave it behind	
Remind a colleague not to leave litter	
Put rubbish collected during drive into a waste bag in the truck (for later disposal).	
Use reusable containers and bring lunch from home	
Bring coffee cup from workplace and don't buy take away coffee	
Put cigarette butts into your own butt bin that you are carrying	
Bring a water bottle and don't buy a drink	
Prevent the wind blowing rubbish from workplace e.g. covering skip bins	
Each work morning, put out a workplace bin on the public verge for others to use	
Eat lunch inside (not outside) and use workplace bins	