

## 2.2 Maintenance practices

### 2.2.1 Street sweeping/cleansing

#### Description

Street sweeping is widely used in urban areas to reduce the accumulation of litter, leaves and coarse sediment from roads, carparks and footpaths. It is undertaken to improve aesthetics, public safety and stormwater quality. It is also the most studied non-structural best management practice for the improvement of urban stormwater quality.

Street sweeping as a stormwater quality BMP is an attractive option for many local authorities, as it is already in use (albeit primarily for aesthetic reasons), and roads, carparks and footpaths account for approximately 70% of impervious urban areas (VSC, 1999).

This guideline will focus on street *sweeping* rather than flushing, as the flushing of pollutants through the stormwater system is not recommended. There are many types of sweeping equipment (see NVPDC, 1996), with new technologies recently emerging that have the potential to collect a high proportion of fine sediments (with absorbed nutrients and heavy metals), unlike their predecessors.

Improvements in stormwater quality using street sweeping is best achieved by focusing on pollution ‘hot spots’ rather than routinely sweeping all streets (VSC, 1999). In addition, it is recommended that street sweeping be coordinated with other maintenance activities and events. For example, targeted street sweeping may be undertaken after:

- resurfacing works on a roadway;
- unloading of materials in an industrial or commercial area; or
- a public rally or major sporting event.

#### Applicability

Street sweeping may be undertaken by owners of commercial and industrial premises, developers during construction activity, the local government authority as part of a well-planned sweeping schedule, or by State government authorities after construction activities.

Although Taylor and Wong (2002c) concluded that while street sweeping appears to have limited benefits as a stormwater quality BMP when applied on a citywide scale using traditional equipment, it has significant benefits when applied in high risk areas and in specific circumstances. For example:

- Street sweeping is applicable for large industrial or commercial sites or residential construction sites, where access to pollutants on impervious surfaces can be easily controlled and resources are available for more frequent sweeping and sweeping at particular times.
- Street sweeping in areas with deciduous trees during autumn. Large volumes of leaf litter can be collected, which would minimise the loading of organic matter on sensitive water bodies.
- To collect large volumes of gross pollutants deposited as a result of a specific event in a clearly defined and easily accessible area (e.g. after a ticker tape parade or major sporting event).
- Programs that sweep streets, carparks and pavement before ‘first-flush’ runoff events, to collect accumulated sediment.
- To target high pollutant generator areas (e.g. commercial precincts, shopping centre precincts).

- The collection of absorbent material commonly used by incident response crews to contain liquids after traffic accidents.

Street sweeping in Perth has several advantages compared to many other parts of Australia. Firstly, there is evidence to suggest that the particle size distribution of sediment in Perth's urban areas generally has a higher percentage of coarser particles, making it more likely to be collected by street sweepers. Secondly, the city's long dry periods over summer provide a good opportunity for material that has accumulated on impervious surfaces (e.g. wind-blown litter and sediment) to be collected before it is washed into receiving waters. Areas like the lower Canning River catchment upstream of the Kent Street Weir occasionally experience harmful blue green algal blooms shortly after late summer/early autumn rainfall events. These blooms often occur after long, dry periods. Targeted street sweeping in such catchments is beneficial (i.e. targeting areas where nutrients may be associated with sediment and/or organic material that can be collected by a sweeper).

## Recommended Practices

Recommended practices for street sweeping are summarised below from VSC (1999) and NVPDC (1996):

### Planning and monitoring

- ✓ Ensure that street sweeping resources enable targeting of 'hot spots' to occur.
- ✓ Identify priority pollutants that could be collected by street sweeping (e.g. leaves from deciduous trees upstream of a lake) and priority locations where these pollutants may accumulate.
- ✓ Identify the best timing for street sweeping, to maximise capture efficiency while reducing costs.
  - Street sweeping should be strongly considered after a long dry period (e.g. mid summer), when large loads of material have accumulated on impervious surfaces and there is the potential for this material to be flushed into water bodies following the next major storm event (e.g. those in late summer/early autumn). Such storm events can be associated with harmful algal blooms in receiving water bodies.
  - Areas with a high percentage of deciduous trees should be swept during/after the autumn leaf fall.
  - Sweeping frequency should be increased during the wet season, as rainfall is a significant pollutant vector.
- ✓ Ensure street sweeping occurs at a time when vehicles do not block access to the kerb because significantly more particulates accumulate along the gutter line/kerb.
- ✓ Inspect the swept area before sweeping to determine the need and likely effectiveness, and after sweeping to *broadly* determine its value.
- ✓ Ensure that records are kept of the quantity and composition of collected material, as well as the cost, so that the cost-effectiveness of the sweeping program can be improved over time.
- ✓ Keep up to date with new street sweeping technology and ensure new equipment maximises the capture efficiency for pollutants of concern (e.g. phosphorus adsorbed to fine particles of sediment). Local research to understand the pollutants on impervious surfaces is highly recommended (e.g. understanding the typical particle size distribution of sediments and the association of nutrients and toxicants with sediment particles of varying size).

### Coordination with other activities

- ✓ Undertake a risk assessment to identify those activities whose impacts on stormwater quality could be minimised through street sweeping. For example, street sweeping would be beneficial prior to the scouring of new water mains or at the end of the day around a construction site where sediment has tracked on to the road.
- ✓ Ensure routine maintenance programs that have a need for street sweeping (such as road repair works) include street sweeping as part of their procedures.
- ✓ Identify infrequent activities that may require street sweeping after the event (e.g. a street market or ticker tape parade).

### Community coordination

- ✓ Advise the community of street sweeping schedules and encourage people to remove vehicles from the street so that the sweeper can access the kerb.
- ✓ Install temporary parking restrictions to gain access to the kerb in areas that are heavily trafficked.

### Operational restrictions

- ✓ Ensure street sweepers do not discharge any solid or liquid waste to the drainage system. Such wastes should be assessed to determine the correct form of disposal in consultation with operators of liquid and soil waste disposal facilities. For information about waste acceptance criteria and determination of the appropriate type of landfill for disposal of the collected material, refer to the *Guidelines for Acceptance of Solid Waste to Landfill* (DEP, 2002).
- ✓ Discourage the washing of footpaths and flushing of kerbs unless necessary for safety reasons. Where flushing is necessary, investigate opportunities to trap the stormwater for subsequent disposal (e.g. to a grassed area) or filter it prior to discharge to stormwater.
- ✓ Where mechanical sweeping equipment has limited access to an area, hand sweeping is recommended.

## Benefits and Effectiveness

Street sweeping has significant benefits when applied in high risk areas and in specific circumstances, particularly when new technology sweepers are used.

In 1999, Walker and Wong reviewed the street sweeping literature and data from Australian field studies (including Western Australian studies) to evaluate the effectiveness of this BMP for stormwater quality improvement. However, new street sweeping technologies have emerged in recent years, making much of the research that was undertaken in the 1980s and 1990s obsolete. Therefore, the following conclusions should not be applied to new street sweeping technology. Taylor and Wong (2002c) summarised their principal findings and conclusions as:

- Literature from overseas studies indicates traditional street sweeping is relatively ineffective in reducing the load of particles smaller than 125  $\mu\text{m}$  (in diameter) on the street surface.

- The typical range of suspended solid particle size in Australian urban stormwater is 1 - 400  $\mu\text{m}$  (in diameter), with approximately 70% of the particles being smaller than 125  $\mu\text{m}$  (in diameter). As mentioned in the Applicability section, however, areas like Perth may not be ‘typical’ with respect to particle size distribution, due to the higher proportion of coarser particles.
- For typical Australian conditions, street sweeping as it was practised in the late 1990s was unlikely to effectively reduce pollutants of concern (i.e. fine suspended particles <125  $\mu\text{m}$  with adsorbed heavy metals and nutrients).
- Australian field studies found significant loads of gross pollutants in stormwater draining from urban areas that had been subject to a daily street sweeping regime. Drawing on the findings of studies on the generation of gross pollutants in Melbourne, Walker and Wong (1999) suggest that loads of gross pollutants in stormwater draining from urban areas depend more on the type of rainfall (i.e. the available *energy* to mobilise and transport gross pollutants) than reductions to the load of gross pollutants on the street surface (i.e. through street sweeping).
- While newer street sweeping technology<sup>8</sup> more effectively removes the finer fraction of suspended particles under experimental conditions (see Sutherland and Jelen, 1996), ‘the effectiveness of street sweeping programs depends more on factors such as land-use activities, the inter-event dry period, street sweeping frequency and timing, access to source areas and sweep operation than the actual street sweeping mechanism’ (Walker and Wong, 1999, p. 4).

While street sweeping frequency is a variable that can influence pollutant removal efficiency, Taylor and Wong (2002c) caution that slightly increasing the frequency will not *necessarily* increase the efficiency of the BMP, due to other factors such as the type of rainfall (e.g. its timing). For example, the influence of sweeping frequency on the load of litter entering stormwater from Californian highways was investigated in a US\$2.8M Litter Management Pilot Study (Caltrans, 2000). The study found that increasing the frequency of mechanical sweeping from monthly to weekly did not statistically reduce ( $\alpha = 0.05$ ) the count or weight of litter in stormwater (as measured at stormwater drain outlets) or the total load of litter in the stormwater system (Caltrans, 2000). In addition, statistical analysis between treatment and control areas failed to show a reduced concentration of chemical constituents in stormwater that could be attributed to the increased sweeping frequency.

As discussed in the Recommended Practices section, planning the sweeping program will significantly increase its effectiveness.

Highman (2004) found that the vacuum mounted rotary brush street sweeper was relatively ineffective at collecting smaller particles (i.e. <150  $\mu\text{m}$ ), but it was effective at removing >150  $\mu\text{m}$  particles. Highman (2004) concluded that without street sweeping, more pollutants would have reached downstream stormwater treatment systems (e.g. inlet pits) or receiving water bodies. The material collected by street sweepers can also block some stormwater treatment systems, resulting in stormwater bypassing the treatment systems.

For *quantitative* information on ‘sweeper removal efficiencies’ and ‘reductions in the surface contaminant load’ that have been associated with various street sweeping studies, see Taylor and Wong (2002c) and/or Walker and Wong (1999).

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<sup>8</sup> For example the ‘small-micron surface sweeper technology’ can reportedly remove particles as small as 4  $\mu\text{m}$  (in diameter), and produce a total removal efficiency of approximately 70% for particles smaller than 63  $\mu\text{m}$  (Sutherland and Jelen, 1997). Another technology is the ‘regenerative air sweeper’ that can reportedly produce a removal efficiency of approximately 32% for particles smaller than 63  $\mu\text{m}$  (Sutherland and Jelen, 1997). For more details, see Taylor and Wong (2002c).

## Challenges

The following challenges may need to be addressed to improve implementation, as reported by Schueler (2000), US EPA (2001) and Taylor and Wong (2002c):

- Determining the optimal sweeping frequency, which is region specific, and needs to draw upon local research (this is the primary limitation). Such frequencies have not yet been determined for Western Australia.
- Determining reliable pollutant removal efficiencies for modern ('high efficiency') street sweepers in a local context (again, additional local research is required in this area).
- Overcoming operational problems that diminish street sweeping performance such as speed, parked cars, and the ability to get access to the kerb<sup>9</sup>.
- Budgeting for the cost of new technology sweepers.
- Budgeting for the cost of appropriately disposing of highly contaminated waste that may be classed as hazardous and require special disposal arrangements.
- The capability of street sweepers (i.e. their ability to capture a high percentage of fine sediments and associated pollutants), although this limitation is reducing with time.
- Training sweeper operators.
- The inability of sweepers to collect some forms of pollutants (e.g. oils and greases, as well as nutrients in a dissolved form).

## Cost

An approximate cost of monthly street sweeping in Western Australia is \$55 per kerb km in 1998 dollars (Davies and Pierce, 1998). Adjusted for inflation (at a rate of approximately 3% per annum) this rate is approximately \$66 per kerb km in 2004 dollars. However, this cost is at the high end of the scale because most streets do not require a monthly street sweeping program.

Indicative costs have been provided by the Town of Victoria Park, Perth (Dawson, 2004, pers. comm., 29 October). This Town is home to approximately 27,500 people and covers an area of approximately 17.6 km<sup>2</sup>. Current estimates are that it costs approximately \$130,000 using one street sweeper to collect approximately 720-1080 tonnes of waste in one year. The level of service is:

- Main roads: swept fortnightly.
- Albany Highway (a main arterial road that has a high concentration of commercial/shopping premises): swept three times a week.
- Residential streets: swept monthly, for 8 months in a year.
- Large carparks (managed by the Town): swept fortnightly.
- Shopping centre carparks (managed by the centre owners): swept daily.
- Industrial areas: swept fortnightly.

<sup>9</sup> US studies have demonstrated almost 90% of contaminants on streets typically accumulate within 30 cm of the kerb (VSWCB, 1979).

- Stormwater gullies are cleaned and educted once a year, before winter, but usually after the ‘first-flush’ rains. A few problem areas are educted more often, particularly in winter, and the stormwater drains with gross pollutant traps are educted every three weeks during winter.

## Additional Information

A wide range of guidelines and research reports are available on this subject (see references below). High quality performance data is also available on the US BMP Database (<[www.bmpdatabase.org](http://www.bmpdatabase.org)>). However, new street sweeping technologies have emerged in recent years, making much of the research that was undertaken in the 1980s and 1990s obsolete.

## Examples / Case Studies

### Calculation of optimal sweeping frequency - Northern Virginia, USA

As noted previously, determining the optimum sweeping frequency based on local research is important. In guidelines for local stormwater managers, the Northern Virginia Planning District Commission (NVPDC, 1996) undertook this work, and recommended street sweeping frequencies of at least one sweep per week for residential areas and one to three sweeps per week for commercial and industrial areas, to maximise its effectiveness.

These recommendations represent a significant change to *typical* street sweeping frequencies in the region, which were based primarily on meeting aesthetic and safety needs (i.e. one sweep every six months for residential areas and one sweep every three months for industrial areas).

### Control of parked cars to optimise sweeping effectiveness - Wisconsin, USA

Gaining access to the kerb is another limitation of street sweeping, particularly in areas where cars are parked during the day and overnight. Like most limitations to street sweeping, this constraint can be managed if resources are available. A successful example reported by Taylor and Wong (2002c) comes from the City of Madison, Wisconsin. The City of Madison undertook a pilot study that aimed to test whether the surface pollutant removal efficiency of street sweeping could be improved by applying parking restrictions to areas where gaining access to the kerb was often difficult.

The study included a public education, parking enforcement and a street sweeping component. As a result, the total quantity of pollutants collected by street sweeping increased in volume by 118% (from 5.25 to 11.46 cubic metres per kerb kilometre swept). In addition, a public survey found 97% of respondents were aware of the new parking restrictions and the revenue gained from parking enforcement activities enabled the education and enforcement aspects of the program to be self-funding in the long term (Lehner *et al.*, 1999). No data was gathered on the effect on stormwater quality.

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