SELECTING LITTER TRAPS

Selecting a litter trap for stormwater installations can be a confusing task with many claims by vendors and numerous issues to consider. This guide is intended to provide assistance to Melbourne Water staff for the selection of litter traps for stormwater.

Concern for the impacts of stormwater gross pollutants (litter and organic material), particularly for litter has increased in recent times. There has been some research carried out in Melbourne on its characteristics and transport mechanisms, some relevant findings are:

- Approximately 100,000 m^3 (including 1 billion litter items) of gross pollutants reach Melbourne's waterways annually;
- Stormwater gross pollutants are composed of approximately 20% litter (plastic, paper and metal) and 80% organic material (such as leaves and twigs);
- The most amount of gross pollutants are carried during times of the highest flows;
- Less than 20% of litter is transported as floating material, the remainder is either entrained in the flow or sinks;
- Commercial areas contribute the most amount of litter to the stormwater system; and
- There are a range of techniques available for removing litter. The most effective strategies involve a combination of non-structural measures (eg. education and waste management programs, and source controls) and structural treatments.

This document focuses on structural treatments to reduce litter loads in stormwater (litter traps). The location for a litter trap is also a complex issue and readers are referred to the Urban Stormwater Best Practice Environmental Management Guidelines (Stormwater Committee, 1999) for guidance. In addition, to investigate litter loads from different areas for the purpose of selecting a location for a trap, readers are referred to the decision-support-system for determining effective trapping strategies for gross pollutants developed by the Cooperative Research Centre for Catchment Hydrology (CRCCH, 1998).

Selecting a litter trap

The decision of which type (and brand) of trap to select is a trade-off between the life cycle costs of the trap, the expected pollutant removal performance in regard to the values of the downstream waterbody and any social or political considerations.

Life cycle costs vs. Pollutant removal performance

This guide provides a method to estimate the life costs and pollutant removal rates.

The final decision on which particular device should be selected should be made by committee with open debate. It should include one person from Operations, a project manager and one other person (e.g., from Waterways and Environment or Asset Management). The discussion should include the issues covered in this document.

LIFE CYCLE COSTS

Life cycle costs are a combination of the installation and maintenance costs. To determine the life cycle costs the estimated duration of the project needs to be determined (eg. 20 or 25 years) or if the trap is to control pollutants during the development phase only it may be 3-10 years.

This is used to extrapolate the annual operating costs to project life costs. Below are more details on estimating the costs.

Life cycle costs

To estimate the life cycle costs for a litter trap the installation costs and the annual operating costs (for the project duration) are combined.

This can be simply performed for all traps and then, with consideration to the other influences (social, political etc.), the most appropriate trap can be selected.

To estimate life cycle costs:

1. Determine the project life (*n*: years)
2. Estimate the installation cost (including supply, installation and ancillary works)
3. Estimate the annual operating cost (including collection and disposal)
4. Estimate the Equivalent Annual Cost by estimating the Net Present Cost of the project and dividing by the project duration

NPC (\$) = **Installation** (\$) + [**n x annual maintenance** (\$)]

EAC (\$/year) = **NPC** (\$)/ **duration** (years)

Installation Costs

To estimate the installation costs there a number of local issues that will need to be considered. These include the:

- design flow rate,
- size and configuration of the trap (with regard to site constraints),
- hydraulic impedance and the requirements for operation and maintenance, and
- safety and other construction issues.

If any of the below factors can not be adequately satisfied by a particular trap it should be deemed as potentially inappropriate for that location.

Design flows

Every litter trap should be designed with provision for a high flow by-pass system. The purpose of the by-pass is to protect the operational integrity of the trap during floods, ensure no flooding is caused by the trap and to prevent excessive scour of collected pollutants from within a trap.

The trap should be designed for between Q 3-months and Q 1-year, with the operation of the by-pass once these flows are exceeded (refer to Best Practice Guidelines for more details). A rule-of-thumb method for approximating more frequent flows from Q-5 values (which should be available for most minor drainage systems) has been developed for Melbourne, these are:

- Q –3 months = 0.20 x Q –5 years,
- Q –6 months = 0.33 x Q –5 years, and
- Q –1 year = 0.50 x Q –5 years.

* note that these relationships are only valid for Melbourne rainfall conditions

Size of the unit (footprint, depth)

The size of litter traps varies considerably and this will need to be accommodated by the potential location for the trap. Things to consider when assessing the size of traps include:

- the required footprint,
- the depth of excavation (to the bottom of the sump in some cases) – rock can substantially increase the installation costs,
- the sump volume required, and
- the location of any services.

Hydraulic impedance/ requirements

Some litter traps require particular hydraulic conditions in order to operate effectively, for example some traps require a drop in the channel bed for operation. Requirements such as these can affect which traps may or may not be suitable in a particular area.

Other considerations are possible upstream impacts on flow and the hydraulic gradeline due to the installation of the trap. This can increase the flooding risks and all traps should be designed to not increase the flooding risk during high flows. Therefore if a trap increases the flooding risk above acceptable limits it may not be considered further.

Other construction issues

For each specific location there will be a number of other considerations and points of clarification that may sway the decision on which trap may be the most suitable, these include:

- Does the cost of the trap include supply and installation or just supply - if so how much is installation likely to cost?
- Does the cost include any diversion structures that will be required?
- Is specialist equipment required for installation (eg. special formwork, cranes or excavators) and what cost implications do this have?
- Is particular below ground access required, will ventilation and other safety equipment be needed – at what cost?
- Will the trap impact on the aesthetics of an area – will landscape costs be incurred after the trap installation - if so how much?
- Are there conflicts with other services at the site (eg. sewer, water, power or phone lines) and what are the cost implications of these?
- Will the trap be safe from interloper or misadventure access?
- Do the lids/covers have sufficient loading capability (particularly when located within roads) – what is the cost of any increase in load capacity and will it increase maintenance costs?
- Will the trap be decommissioned (eg. after the development phase) and what will this cost – what will remain in the drainage system?
- Are there tidal influences on the structure and how will they potentially affect performance or construction techniques?
- Will protection from erosion be required at the outlet of the device (particularly in soft bed channels), and what cost implications are there?

Maintenance Costs

Maintenance costs can be more difficult (but are sometimes the most critical variable) to estimate than the installation costs. Variances of the techniques used, the amount of material removed and the unknown nature of the pollutants exported from a catchment. In many cases maintenance costs are the most significant cost of a treatment measure. It is therefore imperative to carefully consider the maintenance requirements and estimated costs when selecting litter traps.

One important step is to check with previous installations by contacting the owners and asking their frequency of cleaning and annual operation costs (vendors can usually supply contact information).

All maintenance activities should be developed that require no manual handling of collected pollutants because of safety concerns with hazardous material.

Below is a list of maintenance considerations that should be applied to all litter traps. They are divided into the maintenance equipment, ancillary works, disposal of collected pollutants and safety issues.

Maintenance equipment requirements

- Is special maintenance equipment required? eg. large cranes, vacuum trucks or truck-mounted cranes. Does this equipment need to be bought or hired - at what cost?
- Is special inspection equipment needed (eg. access pits)?
- Are any services required (eg. wash-down water, sewer access)?
- Are there overhead restrictions such as power lines or trees?
- Does the water need to be emptied before the pollutants - if so how will it be done, where will it be put and what will it cost?
- Can the device be isolated for cleaning (especially relevant in tidal areas)?

Construction additions for maintenance

- Are road closures required and how much disturbance will this cause?
- Are special access routes required for maintenance (eg., access roads or concrete pads to lift from) – and what are these likely to cost?
- Is there a need for dewatering ares (eg. for draining sump baskets)?

Disposal costs

Disposal costs will vary depending on whether the collected material is retained in wet or dry conditions (ie. either under water or left so it can drain). Handling of wet material is more expensive and will require sealed handling vehicles.

- Is the material in a wet or dry condition and what cost implications are there?
- Are there particular hazardous materials that may be collected and will they require special disposal requirements (eg. contaminated waste –what cost implications are there?
- What is the expected load of material and what are the likely disposal costs?

Loads can be estimated using the decision support system developed by the CRCCH (see references) which requires rainfall and land-use information. In the event there are no other data, the values in following table should be adopted for Melbourne conditions. Note that litter and gross pollutants (litter and vegetation) are listed, this is because the disposal costs are dependent on the gross pollutant load rather than just the litter component. No litter traps can distinguish between litter and organic material therefore, in order to remove litter they must also collect debris in the same way.

Gross pollutant loads should be used to estimate disposal costs.

APPROXIMATE LITTER & GROSS POLLUTANT LOADING RATES FOR MELBOURNE

LANDUSE TYPE	LITTER[1] Volume (Litre/ha/year)	LITTER[1] Mass[2] (kg/ha/year)	GROSS POLLUTANTS[3] Volume (Litre/ha/year)	GROSS POLLUTANTS[3] Mass[2] (kg/ha/year)
Commercial	210	56	530	135
Residential	50	13	280	71
Light-industrial	100	25	150	39

[1] litter is defined as anthropogenic materials larger then 5 mm
[2] mass is a wet mass, ie. the mass expected when removed from a litter trap
[3] gross pollutants contain vegetation as well as anthropogenic litter (not sediments)

- Do existing installations of a particular trap have comparable maintenance costs to the estimate above? – if not should an adjustment be made?

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- Is there any manual handling of pollutants and what will safety and equipment cost?
- Is entering the device required for maintenance and operating purposes – will this require confined space entry? What cost implications does this have on the maintenance cycle (for example, minimum of three people on site, safety equipment such as gas detectors, harnesses, ventila0tion fans and emergency oxygen)
- Are adequate safety features built into the design (eg. adequate step irons and inspection ports) or will these be an additional cost?

POLLUTANT REMOVAL EFFICIENCIES

The removal rate of litter is the primary function of a litter trap and should be estimated from previous independent testing and compared between different types of traps.

Target litter removal rate

To objectively assess various pollutant traps criteria need to be develop that outline the aims of the litter trap. These can range from reducing:

- just floating visible litter,
- a proportion (eg. 70%) of all litter,
- a proportion (eg. 70%) of all litter and organic material, or
- just one component of the litter (eg. sharps).

Melbourne Water generally has the objective of either reducing 70% of the litter load in a catchment, or capturing litter greater than 20 mm with treatment of all flows up to at least Q-3 months. These objectives may vary depending on the beneficial uses and threats to a receiving water body.

Litter trap removal rates

There are many claims by vendors on their respective removal rates for litter and other constituents. It is recommended to check any claims, ensure testing is independent and refer to the Best Practice Guidelines for removal rates estimates when no data are available.

Additional pollutant removal

A litter trap will be one component of a strategy to improve stormwater quality. A Stormwater Management Plan (SWMP, developed for each Local Government area) should identify the threats to waterways, the pollutants and remedial works to reduce the threats. The selection and location of a litter trap should always be consistent with and compliment the objectives set out in the SWMP.

With the SWMP in mind, it is important to recognise that some litter traps have the additional benefit of reducing other non-litter pollutants such as organic material, and some sediment. Should the SWMP identify these as causing a threat to waterways then preference may be given to those traps.

Contrary to the above point is the possibility of a litter trap releasing pollutants during dry weather flows (ie., it collects pollutants during storms and then trickle flows flush some pollutants from the trap – potentially in a changed form). This can be of particular concern with devices that retain pollutants in a wet sump for extended periods. Careful consideration of any performance studies and consultation with owners of existing traps is the most efficient way to explore this issue.

ADDITIONAL CONSIDERATIONS

The selection of a litter trap can also depend on social and political considerations. These should be taken into account on a case by case basis. Influences may include:

- Potential odour concerns at a location,
- Likelihood of pests and vermin such as mosquitoes or rats,
- Impact on the aesthetics of an area,
- Education and awareness opportunities,
- Potential trapping of fauna (eg. turtles, eels and fish), and
- Political boundaries for funding.

COSTING SHEET – SELECTING LITTER TRAPS

Costs estimates for the life cycle of all litter traps considered should be performed. The next page is a check-list to help identify all costs that may be involved during the life span of the trap. This total life cost can then be compared between different traps and the most suitable trap selected, also with consideration to the pollutant removal performance.

REFERENCES

1. Urban Stormwater – Best Practice Environmental Management Guidelines, Victorian Stormwater Committee, 1999, CSIRO Publishing

2. A decision support system for determining appropriate trapping strategies for gross pollutants, 1998, Cooperative Research Centre for Catchment Hydrology, Research Report 98/3

LIFE CYCLE COSTS CHECKLIST

INSTALLATION

Does the trap satisfy:

	YES	NO
- the design flow rate	☐	☐
- the available space constraints	☐	☐
- hydraulic and flooding issues	☐	☐
- other concerns (safety, aesthetics, etc.)	☐	☐

if any of the above questions were NO then go no further with that trap.

Trap cost $ ____________

Installation costs (if not include in supply) $ ____________

Other costs (rock excavation, lid loading, access road for maintenance etc.) $ ____________

TOTAL INSTALLATION COSTS $ ____________

MAINTENANCE

	YES	NO
Is a maintenance contract included in the proposal?	☐	☐

If YES…

What is the annual maintenance cost? $ ____________

What are the expected costs of disposal? $ ____________

TOTAL MAINTENANCE COSTS $ ____________

IF NO…

Cost of special maintenance equipment (cranes, trucks, pumps etc.) $ ____________

Cost of maintenance (including frequency, time, crew etc.) $ ____________

Estimated disposal costs (regard to expected loads and material type) $ ____________

Safety requirements (safety equipment hire, additional site equipment) $ ____________

TOTAL MAINTENANCE COSTS $ ____________

EQUIVALENT ANNUAL COST

$$\text{Life cycle costs} = \frac{\text{Installation costs} + (n \times \text{Maintenance costs})}{n}$$

where n = project duration (years)

Extract from "*Urban Stormwater – Best Practice Environmental Management Guidelines*"

Device	Catchment area (ha)	Trapping efficiency						Cleaning frequencies	Head	Installation costs	Maintenance costs
		gross pollutants	coarse sediment	medium sediment	fine sediment	attached pollutants	dissolved pollutants				
Grate and entrance screens	0.1-1	L	N	N	N	N	N	weekly	L	L	L/M
Side entry pit traps	0.1-1	M/H	L	N	N	N	N	monthly	L	L/M	M/H
Baffled pits	0.1-2	L	M	L/M	L	N	N	monthly	L	L/M	L/M
Litter collection baskets	2-150	M/H	L/M	N	N	N	N	weekly/ monthly	M/H	M/H	M/H
Boom diversion systems	10-40	M	L/M	N/L	N	N	N	monthly	L	M/H	M/H
Release nets	1-50	M/H	N/L	N	N	N	N	weekly/ monthly	L	L	L/M
Trash racks	20-500	L	N/L	N/L	N	N	N	monthly	L/M	M/H	L/M
Gross pollution traps	20-5000	L/M	M/H	M	L	N	N	monthly/ quarterly	H	H	M/H
Return flow litter baskets	20-100	M/H	M	L	N	N	N	monthly	L	M/H	L/M
Hydraulic ally operated trash racks	>10	H/VH	L/M	N	N	N	N	weekly	L	L/M	M/H
Circular screens	5-150	VH	H	M	L/M	L	N	quarterly	L	H	M
Down-wardly inclined screens	5-500	H/VH	N	N	N	N	N	monthly/ quarterly	H	M/H	L/M
Flexible floating boom	>100	N/L	N	N	N	N	N	weekly/ monthly	L	L	M
Floating debris traps	>100	L	N	N	N	N	N	weekly/ monthly	L	L	M
Sediment settling basins	10-500	N	M/H	M	L	N/L	N	half-yearly	L	L/M	L/M
Circular settling tanks	1-20	L/M	H	M/H	M	L/M	N	monthly	L	H	M
Hydro dynamic separatio n	5-100	L/M	M/H	M	M	L/M	N	monthly	L	H	L/M
N = negligible, L = low, M = moderate, H = High, VH = very high											

Table 7.1 Summary of primary treatments