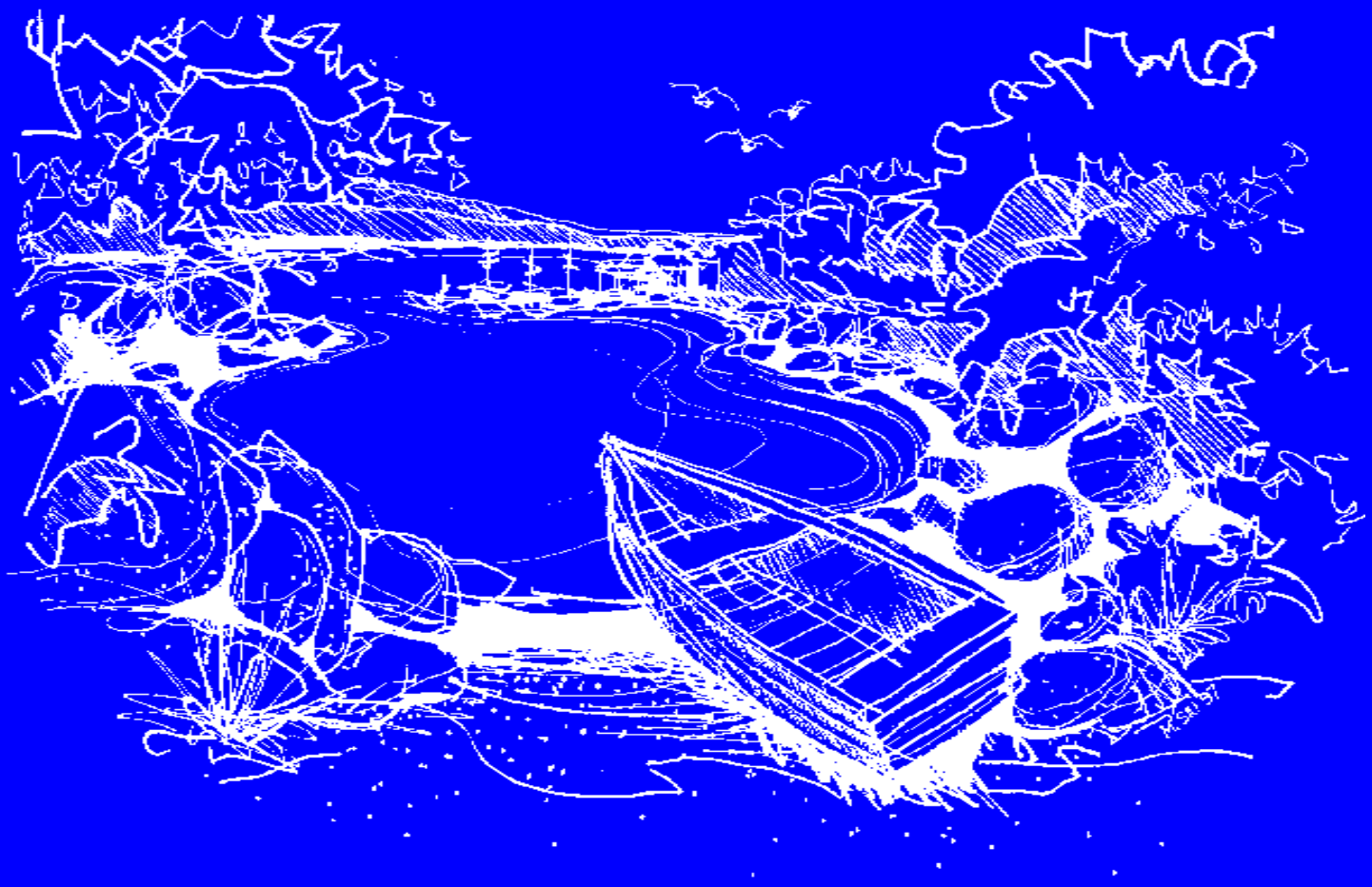
SUSTAINABLE WATER

Best Practices

To be used in conjunction with the Sustainable Water Development Control Plan



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FOREWORD

Hornsby Shire Council has joined forces with Sydney Water, the Environmental Protection Authority, the Department of Planning and Urban Affairs and the Hawkesbury Nepean River Catchment Trust to promote the careful management, usage and disposal of water.

All five organisations signed a “Statement of Joint Intent” which set out identified goals and commitments for each organisation. As part of the statement, Hornsby Shire Council made an undertaking to “utilise the principle of water sensitive urban design in its consideration of future development”. To achieve this goal two documents have been prepared; **Sustainable Water Best Practices** and the **Sustainable Water Development Control Plan, 1997 (Draft)**.

This **Sustainable Water: Best Practices** document has been prepared to accompany the Sustainable Water Development Control Plan, 1997 (Draft) which applies to all development on all lands under the Hornsby Shire Council Local Environment Plan, 1994. The primary purpose of the Development Control Plan (DCP) is to provide development controls to ensure that all activities adopt a water sensitive approach in the pursuit of Ecologically Sustainable Development. The DCP defines what tasks and/or devices must be implemented whilst this document defines what the practices, devices and activities are.

Due to the constantly evolving nature of this field, it is intended that the Best Practices document be regularly updated to describe current knowledge and acceptable practices. The devices, activities and practices are therefore the “Best Practices” known at the time of writing.

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INTRODUCTION

Hornsby Shire Council, the Bushland Shire, is characterised by rugged sandstone ridges, deeply incised gullies and bounded by National Parks, recreation areas and scenic waterways. As the northern gateway to metropolitan Sydney, Hornsby is home to 135,000 people with a mix of urban, commercial, industrial and rural landuses.
The challenge for Hornsby is to maintain the careful balance between the pressure of development and in servicing the needs of metropolitan Sydney whilst conserving the natural features of the "Bushland Shire". The Shire has four major catchments including Berowra Creek, Lane Cove River, Cowan Creek and the Hawkesbury River.

Ecologically Sustainable Development

Council is responsible for the protection and enhancement of the natural environment through the preservation of water quality and the promotion of water conservation and re-use. Water should be recognised as a valuable resource and the planning and management of a site be undertaken with regard to water being an asset. This is often referred to by the phrase "water sensitive design" and has been defined by the Environmental Protection Authority (1996) as "minimising the impacts of development on the total water cycle and maximising the multiple use benefits of a stormwater system."

By minimising adverse effects on the natural environment such as the loss of water as a resource, loss of amenity and aesthetics, loss of habitat and reduced recreation potential, resources are conserved and sustainable outcomes achieved.

Three main objectives have been defined to achieve Council's aims. These are:

Water Sensitive Design

For the community and other stakeholders to adopt practices of water sensitive design and management.

Traditionally, Council's approach to the management of water has been to prioritise health and safety, to prevent damage and danger to person/s and property. Regrettably, this has often resulted in an emphasis on the conveyance of stormwater as quickly as possible from its point source to a watercourse with little regard given to other ramifications, such as the usage of quality treated water for all domestic functions where a lesser quality would suffice.

Council's new approach is to achieve a water quality in the Shire's waterways capable of sustaining aquatic ecosystems, to ensure the maintenance of indigenous vegetation, and to provide for recreational usage whilst ensuring aesthetic appeal. Water consumption is also to be reduced through the use of water conservation devices and through the reuse of greywater or effluent wherever possible.

A water sensitive urban design has the following characteristics:

- Emphasis on the maintenance of natural water courses, native vegetation and conservation of existing ecosystems/habitat;
- Adoption of appropriate development forms and standards through the use of current best management practices to reduce the quantity and improve the quality of runoff;
- Integration of public open space with trunk stormwater drainage corridors to enhance aesthetic appeal and opportunities for passive recreation;
- Minimised use of reticulated water through conservation practices and reuse of stormwater.

INTRODUCTION

Water Quality

For the community and other stakeholders to adopt practices to improve and ensure water quality.

Urbanisation can significantly increase pollutant concentrations and loadings as a result of increased runoff volumes caused by the associated impervious surfaces. The quality of water is reduced as a result of urbanisation with potential impacts on human health due to pathogens, the health of aquatic ecosystems, quality of riparian and estuarine vegetation and the visual amenity of the receiving waters.

All new and re-development in the Shire should ensure a minimum practical net increase in such materials as sediments, nutrients, bacteria and trash to local watercourses and receiving waters, both during construction and post-development.

Water Balance

For the community and other stakeholders to adopt practices which will sustain a water balance appropriate for present and projected development in the Shire.

Urbanisation of a catchment can also significantly alter the natural hydrological cycle, through the creation of large areas of impervious surfaces such as roofs, driveways and roads. These hard surface areas decrease the amount of rainfall which can infiltrate the soil surface, which in turn increases runoff volumes and accelerates the overland flow of stormwater. Traditional urban stormwater conveyance systems such as pipes, kerbs and gutters relay water away from the urban areas as quickly as possible to minimise flooding potential. As a result, there are decreased baseflows and groundwater recharge and the water cycle is imbalanced. The increased frequency and magnitude of flood events caused by urbanisation can also impact the ephemeral nature of smaller watercourses and floodplain ecosystems as well as the quality of the receiving waters.

Council's new requirements are to ensure a sustainable water balance with the retention of natural watercourses and water bodies as well as the reinstatement to those previously piped or channelled. Consideration is to be given to the environmental flow requirements of watercourses, the implementation of integrated stormwater plans such that flood damage is prevented, all drainage systems are maintainable and water related ecological and social functions enhanced.

Education

For Council to communicate the benefits of water sensitive design and management to all.

Council will take an active role in education campaigns to promote community awareness of the benefits of incorporating water sensitive and sustainable practices into both development design and personal activities. Council will inform the public of the appropriate current best management practices for all construction and water-use activities in both existing and new urban areas.

INTRODUCTION

How to use this document

This document accompanies the Sustainable Water DCP, 1997 (Draft). Reference is made in the DCP to prescriptive Best Practices to enable the meeting of conditions of approval. (Note that compliance with the prescriptive measures does not guarantee approval of an application as it must also achieve the element objectives and performance criteria).

Best Practices are defined as being the best current practical approach for achieving an objective.

In this document, there are *Best Planning Practices (BPPs)* which utilise the best practical planning approach at a strategic level and *Best Management Practices (BMPs)* which define the best practicable method of achieving a water management objectives through the implementation of activities or devices.

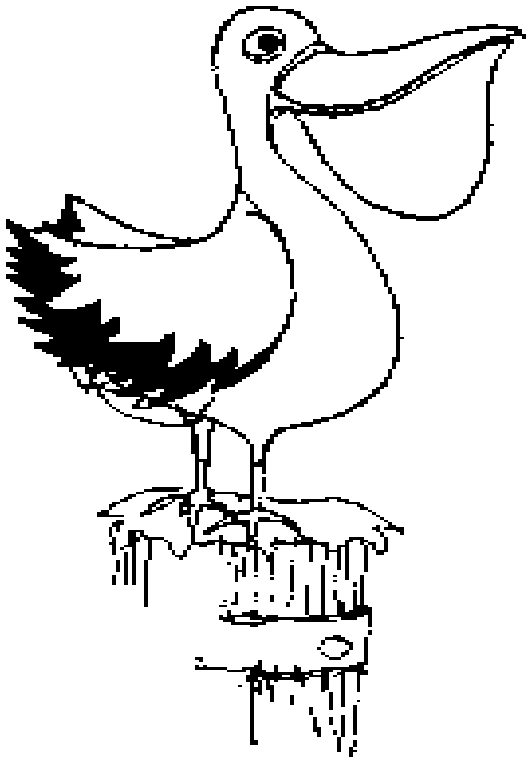
For example, the location of open space areas and the incorporation of overland flow paths is described under a planning practice whilst the detail design phase such as the design of a wetland within the open space area is a management practice.

The more best practices incorporated into a system, the greater the potential effectiveness in controlling or improving the water as it is conveyed from point to point. Likewise, the more best practises incorporated upstream at the point source, the greater the potential for achieving water sensitive urban design.

These are not the only options, but are the best current known practices appropriate for Hornsby Shire. Note that this document will be regularly reviewed and users should check they have the most recent version.

For the community and other stakeholders to adopt water sensitive planning practices to improve water quality and sustain an appropriate water balance.

SD 1.0 PLANNING



SUSTAINING NATURAL DRAINAGE SYSTEMS

Description

Water sensitive urban design requires the retention of natural watercourses and water bodies as well as the reinstatement of those previously piped or channelled. Through the implementation of an integrated stormwater plan, flood damage is to be prevented, all drainage systems should be maintainable, water related ecological and social functions should be enhanced and water quality improved.

Application Where BMP May Apply

* General application.

Conditions When BMP May Apply

* Applies to all watercourses and water bodies including those which have been piped or channelled.

Purpose

* The retention of open watercourses and bodies allows for the assimilation and elimination of various contaminates
* The conservation of bio-diversity, and habitat, particularly wildlife corridors
* Increased aesthetic value
* Increased recreational value
* The maintenance of an appropriate water balance through infiltration, groundwater recharge and reduced flooding.
* Retention and improvement of energy and nutrient cycling in the catchment

Limitations

* Soil types and topography will influence the specific design solutions required. There may be a loss of profits from reducing the number of lots available in a subdivision in areas where traditionally piping could have occurred. Safety and health are to be considered, particularly for open bodies of water.

Integration Opportunities and Constraints

* The retention of open drainage lines and water bodies allows for the integration with the open space network.
* Allows for the potential of a series of water quality and water balance devices to maximise treatment, infiltration, groundwater recharge and minimisation of flooding.

Cost Effectiveness

* By retaining existing water bodies there will be reduced maintenance of any pipe work, pits, kerbing and guttering.

Maintenance

* Maintenance requirements are low in comparison to the maintenance of pipework, pits, kerbing and guttering.

* Maintenance costs may be offset against open space costs if the areas are dual usage.

Construction Technique/Expertise

* Design professionals are recommended such, as engineers for drainage design and landscape architects and planners for site design. The Department of Land and Water Conservation provide information regarding construction techniques and expertise.

Compliance

Clean Water Act (1970)
Local Government Act (1993)
River and Foreshores Improvement Act (1948)

References

Whelans and Halpern Glick Maunsell (1994), Planning & Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Water Authority of Western Australia and the EPA, Whelans, WA.

Environmental Protection Authority (1996), Managing Urban Stormwater Guidelines (draft), EPA,

Natural creek systems

ENVIRONMENTAL FLOW REQUIREMENTS

Description

In order to maintain water balance and sustain aquatic ecosystems, the environmental flow requirements of watercourses are to be considered.

Flows that support the different parts of the environment such as habitats for fish and other aquatic fauna and flora are to be maintained with consideration given to the pre-develpment flow regime. (Flows vary in magnitude on both long and short term scales, fluctuating with seasons and over the years.)

In rural areas, flows in streams are often reduced because of the construction of dams and the retention of water. This may directly influence the watercourses downstream of the dam by stopping or markedly reducing flows during dry weather and thus detrimentally affecting aquatic ecosystem health.

In urban areas, environmental flows increase due to the presence of impervious surfaces and as such these flows need to be dissipated before being discharged into natural watercourses. Urban stream peak flow rates can be expected to average 2-5 times the pre-development rates.

Refer also BMPs - Swales, Wet Detention Basins, Dry Detention Basins, Porous Pavements, On-site Systems Infiltration, Swales, Parking Lot Storage, Rural Dams.

Application Where BMP May Apply

* New development
* Existing development
* Commercial activities
* Industrial activities
* Council activities including maintenance and construction of water quality control structures.

Conditions When BMP May Apply

* In urban and rural areas where a watercourse is present which is defined as any blue line on a 1:25 000 topographic map produced by the Central Mapping Authority and/or any drainage line displaying aquatic or semi-aquatic habitat. This will include the presence of any species of ephemeral vegetation.
* When any new development or changes to existing development will alter or increase the flow of stormwater into a watercourse.

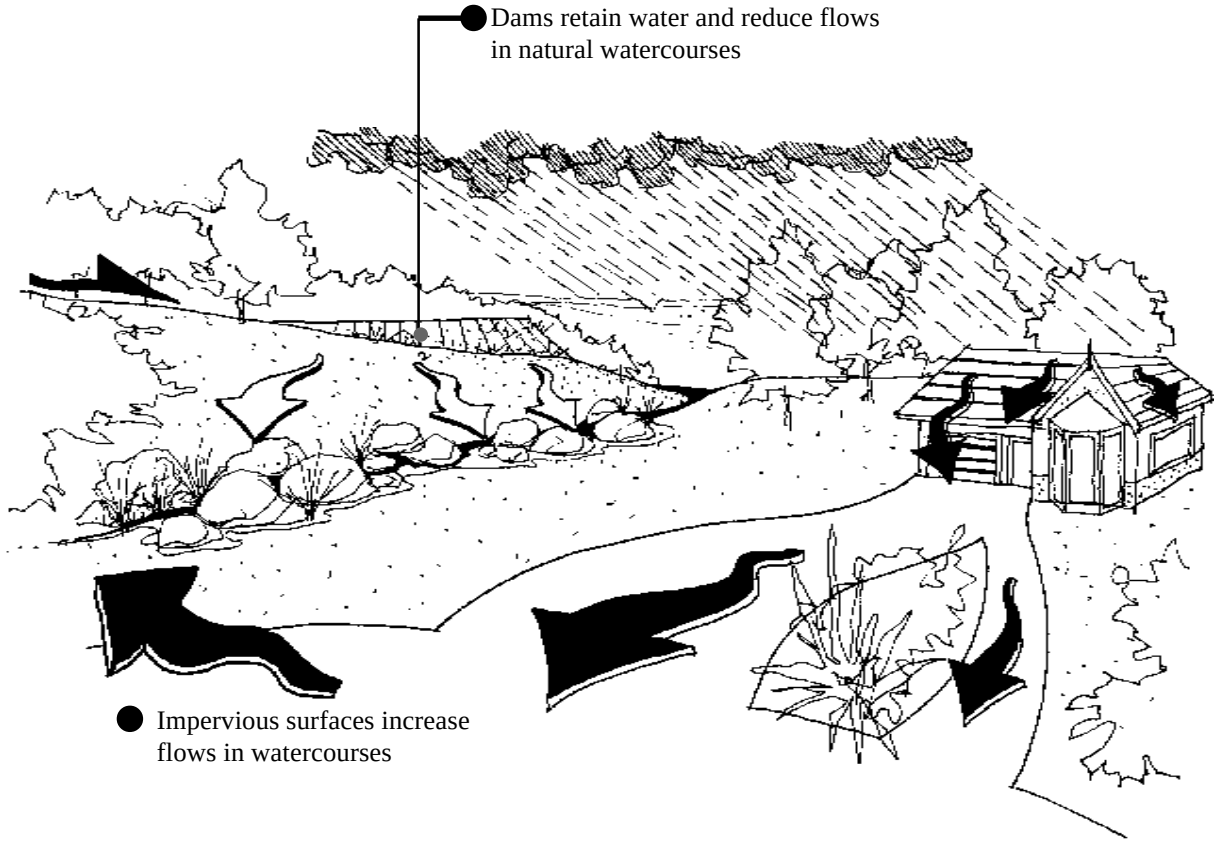
Purpose

* The purpose of this BMP is to maintain water balance and which will in turn improve water quality through the maintenance of instream habitats and ecology.

Limitations

* The maintenance of environmental flows in urban areas is limited through the lack of baseline data at this stage. Studies are currently underway to determine baseline flows in the Berowra Creek catchment and the results from this study will enable more specific details on the maintenance of flows to be recommended.
* In rural areas, the number of existing dam structures is not fully known as yet and the positioning of these structures is also not known.

ENVIRONMENTAL FLOW REQUIREMENTS



Integration Opportunities and Constraints

* A well maintained water balance will ensure the well being of instream habitats and aquatic ecology.

Cost Effectiveness

* The cost effectiveness of maintaining environmental flows is related to the water quality and quantity control devices that are necessary to control flows from urban areas. These devices may include wet or dry detention ponds, on-site detention systems, swales, porous pavements or wetlands.

* In maintaining the correct environmental flows, flow monitoring of an affected watercourse is required to determine pre and post-development impacts. Prior to the proposal of farm dams, applicants are required to engage the services of a qualified practising consultant to determine what environmental flows need to be maintained.

Maintenance

* Maintenance of the water quality and quantity control structures will ensure environmental flow requirements for watercourses.

Construction Technique/Expertise

* Refer to BMPs on detention basins, swales, wetlands, porous pavements etc.

* Assessment of environmental flows may require the expertise of a hydrologic/hydraulic professional.

ENVIRONMENTAL FLOW REQUIREMENTS

Compliance

HSC (1995) Rural Lands Development Control Plan
Rivers and Foreshores Improvement Act, (1948)
Clean Waters Act, (1970)

References

Hornsby Shire Council, Rural Lands Development Control Plan, Hornsby Shire Council, Hornsby

Department of Land and Water Conservation - Algal Management Program, Department of Land and Water Conservation

THE DRAINAGE NETWORK

Description

The Drainage Network consists of street gutters, pits, pipelines, channels, overland flow paths and natural watercourses.
The design of the Drainage Network uses the philosophy of major/minor conveyance systems. The minor system uses street gutters, pits and pipelines and is designed to carry runoff from minor storms. The major system consists of street pavements, drainage easements, and open space areas and carries the additional overland runoff that exceeds the design capacity of the minor system. Both the major and minor flow networks are also defined in terms of their capacity to convey a stormwater flow of specific magnitude, represented by Average Recurrence Interval (ARI).

Application Where BMP May Apply

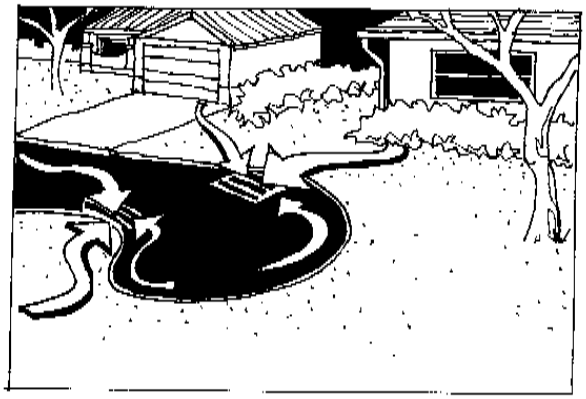
* New developments.
* Existing developments.
* Council activities.

Conditions When BMP May Apply

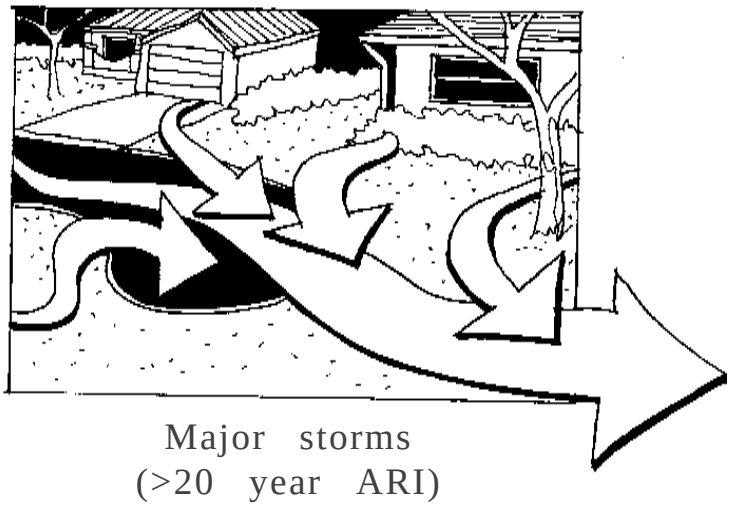
* For new and redeveloping areas, Council has established design ARIs to be applied for stormwater drainage systems.
* For existing urban areas, many old drainage systems do not meet these updated standards and it would be financially prohibitive to upgrade them all.
* Reconstruction of existing drainage systems emphasises the provision of overland flow paths and maximising the efficiency of the existing system.

Purpose

* This BMP will improve water quality and water balance by controlling stormwater runoff from developed areas.

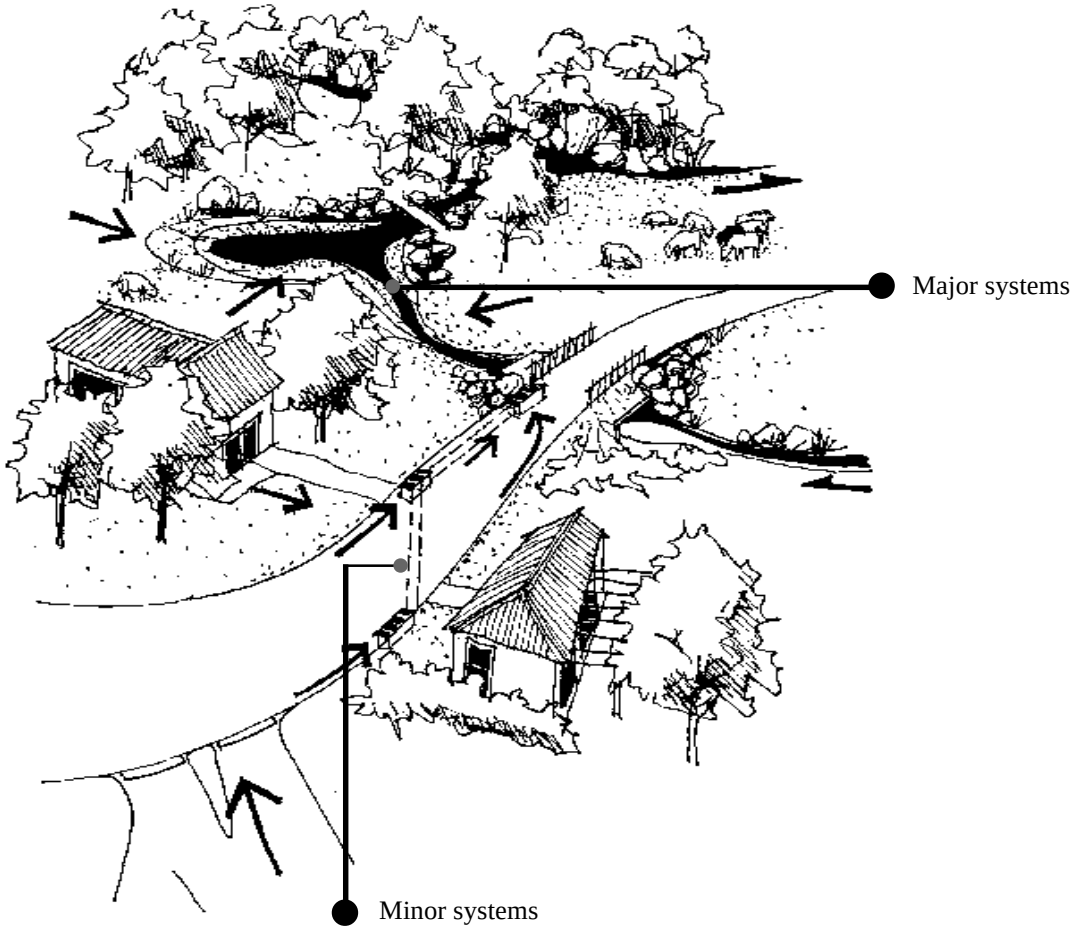


Minor storms
(1 - 5 year ARI)



Major storms
(>20 year ARI)

THE DRAINAGE NETWORK



Limitations

* Minor system operation can be affected by debris blockage.

* Major system overland flow paths can be blocked or interfered with by residents carrying out landscaping and other improvements to properties.

Integration Opportunities and Constraints

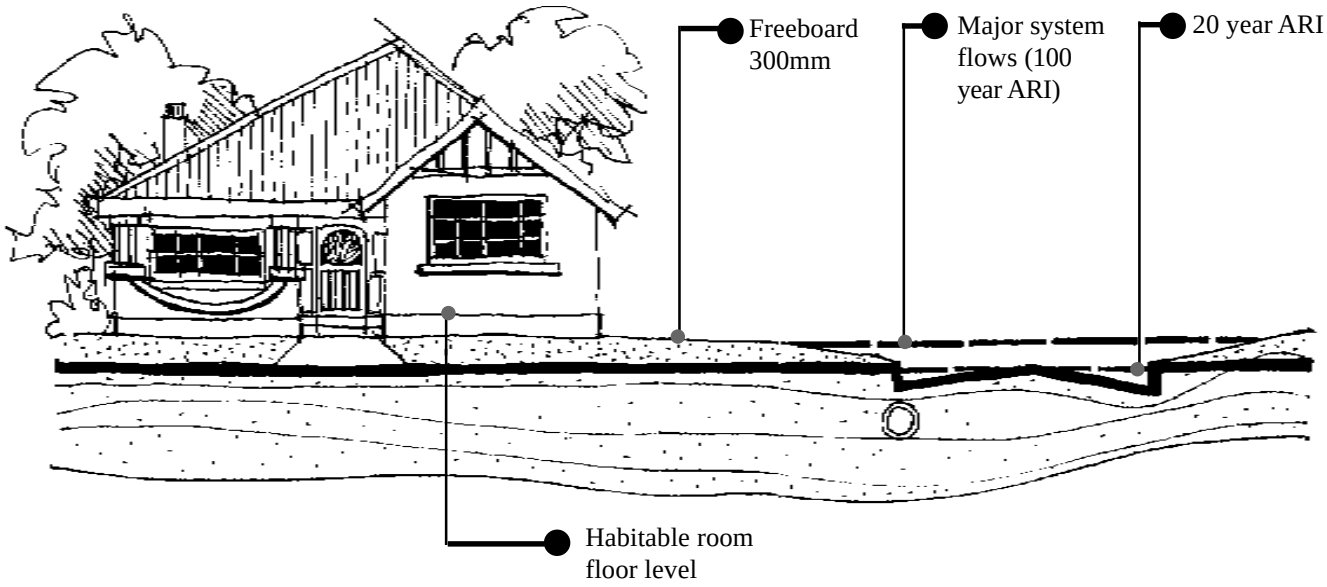
* Enhanced landscape and recreation opportunities exist for parts of the major system in open space areas. Runoff entering bushland must be integrated carefully.

Cost Effectiveness

* The Drainage Network is cost effective in preventing or reducing the impact of stormwater in developed areas.

Maintenance

* No special ongoing maintenance is required. Regular inspections after major storms is required to clear debris from systems and check for localised damage such as scour or erosion.



Construction Technique/Expertise

* Requires suitably trained personnel, familiar with design and installation techniques such as hydraulic and civil engineers.

Compliance

All major systems are to convey 1 in 20 year ARI stormflows.
The major systems are to convey the 1 in 100 year ARI stormflows.
Clean Waters Act (1970).
Local Government Act (1993).
Hornsby Shire Council - Urban Runoff Management Code (Draft), September 1994

References

Hornsby Shire Council (1994), Urban Drainage Design Manual, Hornsby Shire council, Hornsby

Institute of Engineers Australia (1987), Australian Rainfall and Runoff, Institute of Engineers, Australia

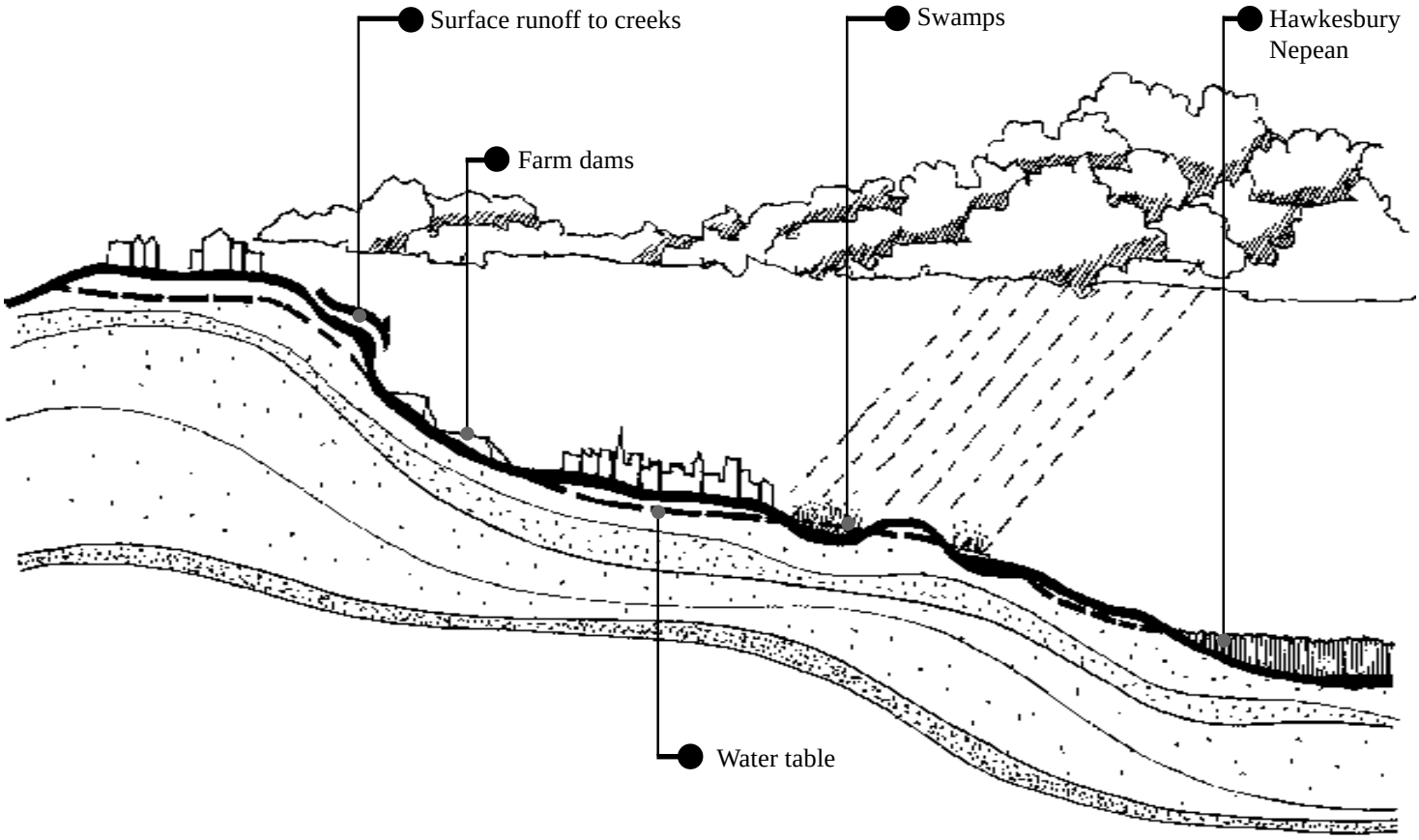
Institute of Engineers Australia, (1995), Making Muddy Waters Cleaner, from the Second Symposium on Urban Stormwater Management, Institute of Engineers, Australia

MAINTAINING GROUNDWATER LEVELS

Description

It is essential that groundwater levels are adequately maintained and recharged. Groundwater is utilised in rural areas as a water supply. The groundwater table can be recharged in urban areas through the greater utilisation of porous pavements, swales and infiltration basins.

Refer BMPs - Swales, Infiltration Systems, Porous Pavements.



Application Where BMP May Apply

* New developments
* Existing developments
* Rural developments
* Council activities

MAINTAINING GROUNDWATER LEVELS

Conditions When BMP May Apply

* Will apply in rural areas where water is extracted from the groundwater supply and for the location of dams.

* Will apply in urban areas where the recharge of groundwater should occur but may be limited through the traditional usage of impervious surfaces and the quick removal of run-off.

Purpose

* Maintenance of water balance.

* Conservation of water resources.

Limitations

* Drought combined with extraction will reduce this resource.

* Unauthorised water extraction from the groundwater table reduces its levels.

* Dam/mining excavations below the shallow water table influences ground water levels.

* Contamination will prevent use for potable water.

Integration Opportunities and Constraints

* Landscaping and re-vegetation will help maintain the groundwater resource by allowing infiltration to occur as well as having aesthetic, habitat and recreational benefits.

Cost Effectiveness

* Keeping groundwater in the soils will reduce the need for irrigation and therefore reduce the use of potable water supplies.

Maintenance

* Maintenance of pervious surfaces.

* Recharge of groundwater supplies.

* Ensuring that all water extraction is licensed by Department of Land and Water.

Construction Technique/Expertise

* For the construction of dams, a suitably qualified consultant needs to be engaged to determine the impact that a proposed dam will have on the groundwater table.

* Groundwater is not to be compromised during the construction of dams as the excavating dams below the groundwater table provides a path for contaminants to directly contaminate this resource.

MAINTAINING GROUNDWATER LEVELS

Compliance

Department of Land and Water Conservation - Water Act, (1912) for water extraction.
Department of Land and Water Conservation - Rivers and Foreshores Improvement Act, (1948) for any development within 40 metres of a watercourse including the construction of dams.
Hornsby Shire Council (1995) - Rural Lands DCP
Clean Waters Act (1970).

References

Hornsby Shire Council (1995), Rural Lands Development Control Plan.

Rivers and Foreshores Improvement Act (1948), Department of Land and Water Conservation

Department of Land and Water Conservation, Maroota Groundwater Study, (1996), Department of Land and Water Conservation, Sydney.

SUBDIVISION DESIGN

Description

The water sensitive urban design of a subdivision requires the maintenance of the pre-development flows to receiving waters and minimised disturbance of existing natural vegetation, watercourses, wetlands and overland flow paths. It should also consider the urban form of the subdivision, its social requirements, the spaces created and their usability and aesthetics.

Application Where BMP May Apply

* Applies to all new subdivisions
* New development
* Existing residential
* Commercial activities
* Industrial activities
* Council activities
* Maintenance
* Construction

Conditions When BMP May Apply

* Opportunities exist in the development of new subdivisions to design the spatial layout of roads, lots, open space areas etc. using the principles of water sensitive urban design. This allows for the maintenance of water related ecological processes and the maximising of an integrated public open space network with high aesthetic values. This may be achieved on all green field developments and may also be retrofitted with the redevelopment or upgrading of large sites.

Purpose

* To achieve an appropriate water balance with the protection, renewal and maintenance of urban streams.
* Water quality improvement
* Conservation of water

Limitations

* There may be loss of profits through reduced numbers of developable lots in areas which would traditionally have been available through the piping of watercourses.
* There is a perception that the retention of existing watercourses and bushland areas will increase maintenance costs.
* Increased open space areas may require additional maintenance, however this is dependent on the design.
* Consideration should be given to the topography with the elements of the subdivision responding to the contours.

Integration Opportunities and Constraints

* Open space areas can be multi-functional, incorporating drainage requirements, providing a recreational zone and linking the functional elements of the subdivision.
* The maintenance of natural features such as creeklines increases the visual amenity of the subdivision and reduces the requirements for piping, channelling etc.

SUBDIVISION DESIGN

Cost Effectiveness

* There is a reduction in capital and maintenance costs by reducing the extent of pipework. Through retaining existing watercourses there is the potential to reduce the costs of water quality improvement/control structures.

Maintenance

* Maintenance costs will be generally reduced compared with the installation of pipework.

* Design requirements for ease of maintenance.

* Where existing watercourses and the remnant vegetation has been kept, maintenance requirements will include bush regeneration.

Construction Technique/Expertise

* Site planning professionals should be engaged to undertake this work such as planners and landscape architects.

* Detail design of various devices should be undertaken by engineers and landscape architects.

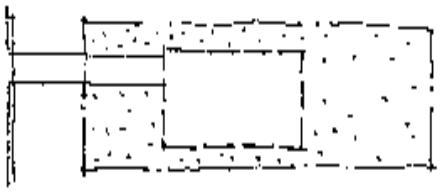
Compliance

Clean Waters Act (1970)
Local Government Act (1993)
Rivers and Foreshores Improvement Act (1948)

References

Whelans and Halpern Glick Maunsell (1994), Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, Department of Planning and Urban Development, Water Authority of Western Australia and the Environmental Protection Authority, published by Wheelans, WA.

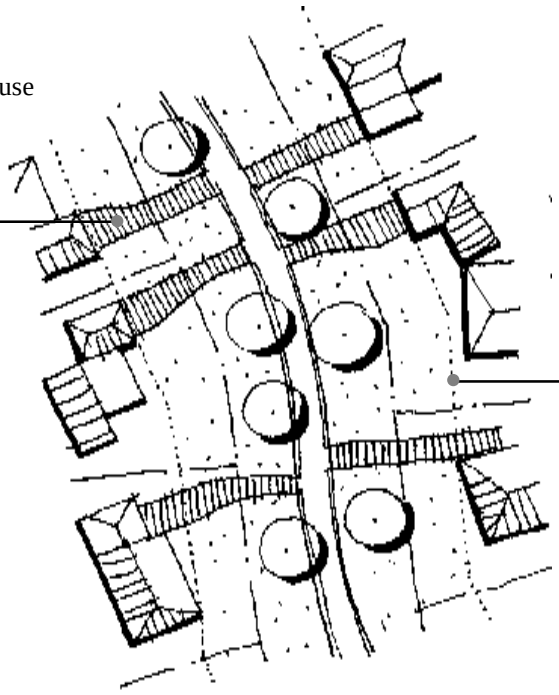
Building set-back



● Traditional building envelope does not maximise usage of lot, resulting in increased irrigation for low-functional areas at building frontage

SUBDIVISION DESIGN

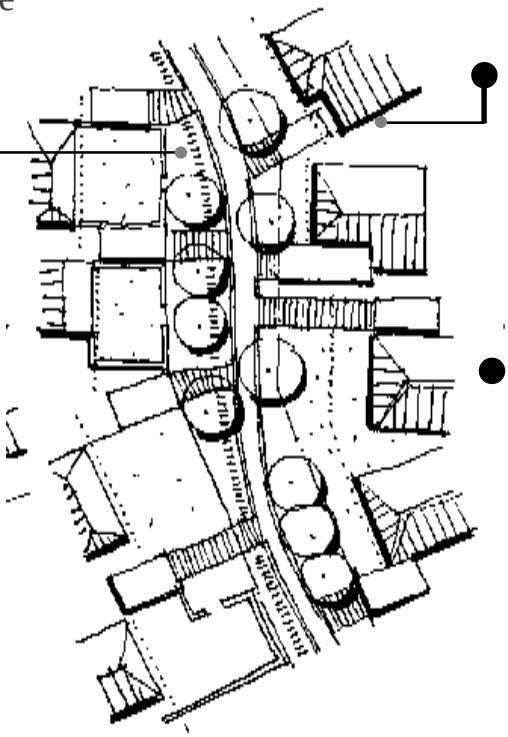
Conventional



Long driveways & paths use impervious materials

Traditional building setback creates residual space with low function and potentially monotonous streetscape

Water sensitive



Zero lot line - where the building is placed on the boundary to maximise use of the lot

Reduced setbacks on frontages reduces residual space, maximising usage of lots

Buildings sited for solar efficiency and open space relationship

OPEN SPACE PLANNING

Description

The effective site planning and design of recreation areas, to maintain an appropriate water balance, achieve Council's water quality objectives:

* to minimise water consumption, including irrigation and to conserve water wherever possible.

Refer also - BMPs Hydrozones and Minimizing Irrigation.

Application Where BMP May Apply

* General application.

Conditions When BMP May Apply

* All public open space areas including sports fields, district and local parks, except for bushland areas.
* Applies similarly to large open space areas around residences, industrial, commercial and educational complexes.

Purpose

* To maintain an appropriate water balance through:
  * water re-use
  * enhanced water related ecological and social functions.
* To maintain acceptable water quality in receiving waters.
* To encourage water conservation

Limitations

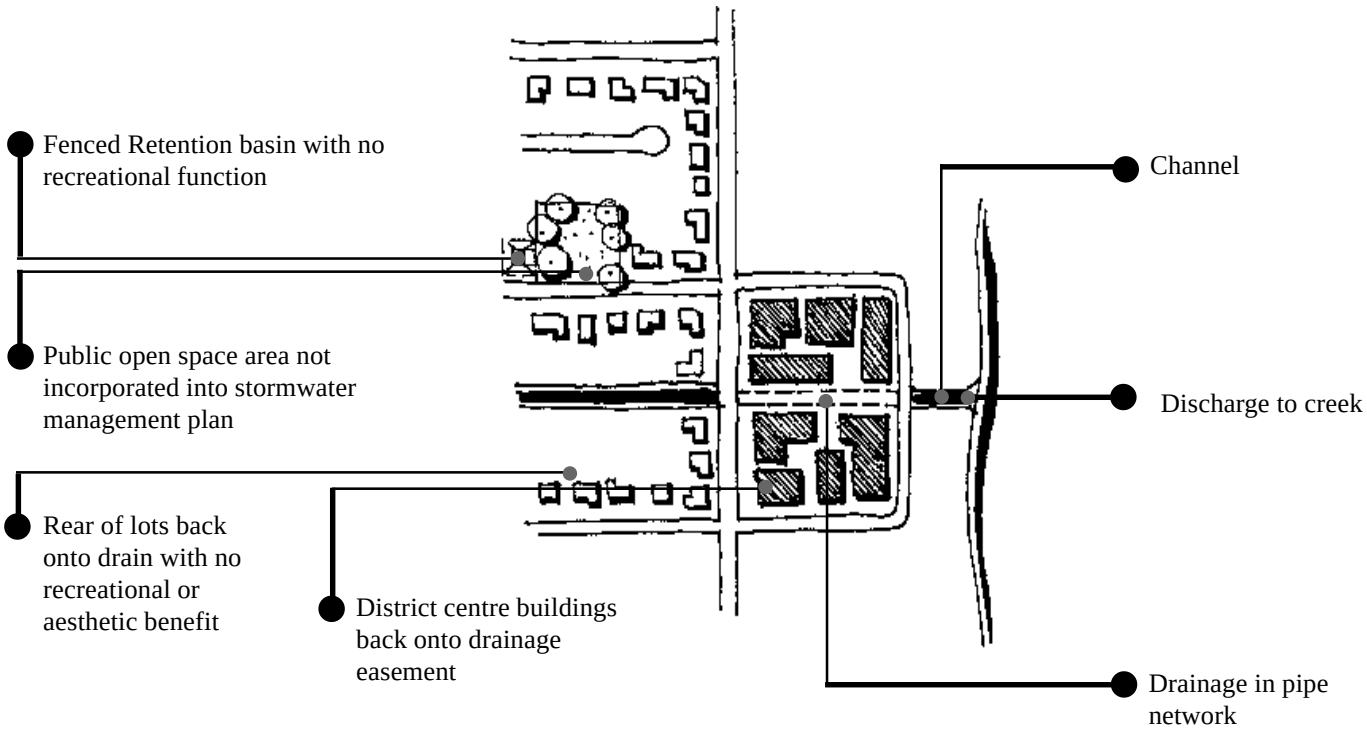
* Soil permeability
* Catchment size
* Landform
* Ability of existing vegetation to adapt to change in drainage and/or landform
* Extent of incorporation of BMPs
* Concerns for public safety around lakes and ponds in terms of public health risk and drownings.

Integration Opportunities and Constraints

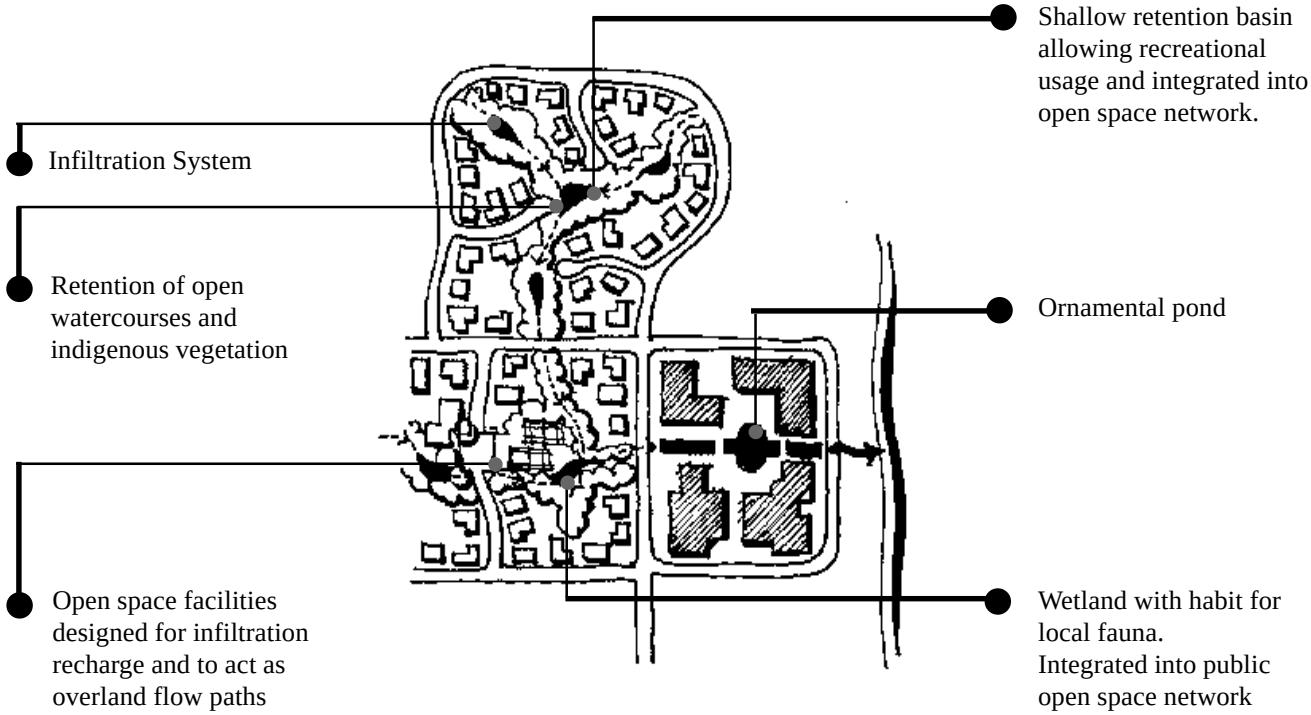
* Provides opportunity for groundwater recharge, re-use of stormwater, improving water quality of run-off, increased habitat value for fauna and flora, re-use of grey water for irrigation.

OPEN SPACE PLANNING

Conventional



Water sensitive



Integration Opportunities and Constraints

* Provides opportunity for groundwater recharge, re-use of stormwater, improving water quality of run-off, increased habitat value for fauna and flora, re-use of grey water for irrigation.

Cost Effectiveness

* Minimizes capital and maintenance costs of pipes, pits and kerbing. Minimises need for irrigation of turfed and landscaped areas. Initial capital cost for water tanks, and/or infra-structure for re-use of grey water may be expensive

Maintenance

* Subject to REF for lakes, sediment ponds and wetlands.

* Pipe and pit maintenance minimised through use of open systems.

Construction Technique/Expertise

* Design is more complex and may require skills of a drainage engineer and landscape architect.

* Construction technique and design is site specific.

Compliance

Clean Waters Act (1970)

References

Environmental Protection Authority for Stormwater Co-ordinating Committee (1996), Managing Urban Stormwater, Strategy (Draft), EPA, Sydney.

Whelans and Halpern Glick Maunsell (1994), Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, Department of Planning and Urban Development, Water Authority of Western Australia and the Environmental Protection Authority, Published by Wheelans, WA.

ROAD LAYOUT AND STREETSCAPE DESIGN

Description

The water sensitive design of roads should result in an appropriate water balance, improved water quality and a highly aesthetic streetscape. It implements the practices of temporary storage, infiltration at or close to the source point and the use of plant material to improve water quality. The emphasis on the conveyance of water as quickly as possible away from the site using kerbs, gutters and pipework is minimised by implementing new design philosophies.

* An integrated approach to streetscape in terms of drainage, footpaths and the nature strip is to be achieved. (Refer also BMP Swales).

* The design of road layouts in new subdivisions should incorporate the existing drainage network in its natural form (Refer BMP Subdivision Design).

Application Where BMP May Apply

* Applies to all new subdivisions, retrofitting to existing streets by the removal of kerb and gutter and to locations where no kerb, gutter or pipework currently exists.

* New development

* Industrial activities

* Existing residential

* Council activities

* Commercial activities

* Maintenance

* Construction

Conditions When BMP May Apply

* The best results are achieved when the road layout and streetscape is designed as part of an integrated approach for a whole subdivision or for a development with a long street frontage. Existing roads which currently have no kerb and gutter may be upgraded by incorporating as necessary, infiltration systems, detention areas and vegetative zones for reducing the peak flows and to improve water quality.

Purpose

* To reduce the volume of runoff from road pavements by minimising road widths.

* To promote the infiltration of runoff from road and footpath surfaces by collection and ponding in order to reduce the volume and velocity of runoff.

* To improve water quality through the reduction of erosion from high velocity flows and through the use of plant material or other filtration systems to remove pollutants.

ROAD LAYOUT AND STREETSCAPE DESIGN

Limitations

* Requires a suitable area within the carriageway or nature strip to locate infiltration systems.
* The design must ensure that overflows are controlled to prevent flooding and erosion.
* Infiltration may be limited by soils of low permeability and by steep road gradients.
* Low recreational benefits unless incorporated adjacent to and complementing the landscaped areas within private properties.
* Cross overs to properties may require specific design resolution to allow for easy access.
* Road safety should not be compromised.

Integration Opportunities and Constraints

* A water sensitive streetscape will integrate vehicular and pedestrian requirements with drainage needs.
* For new subdivisions, the drainage systems for the road system can be incorporated within the open space network or adjacent to private landscape areas.

Cost Effectiveness

* Cheaper to install than kerb and gutter in most situations.
* Maintenance may be reduced depending on the landscape treatment and the number and type of devices installed.

Maintenance

* Maintenance of any devices such as infiltration cells will be necessary.
* Landscape treatments will require maintenance. Maintenance costs will be high if mowing is to occur regularly.

Construction Technique/Expertise

* Should be designed by an engineer to ensure water volumes and velocities will be adequately contained.
* Landscape planners and landscape architects can assist with the streetscape planning and design.

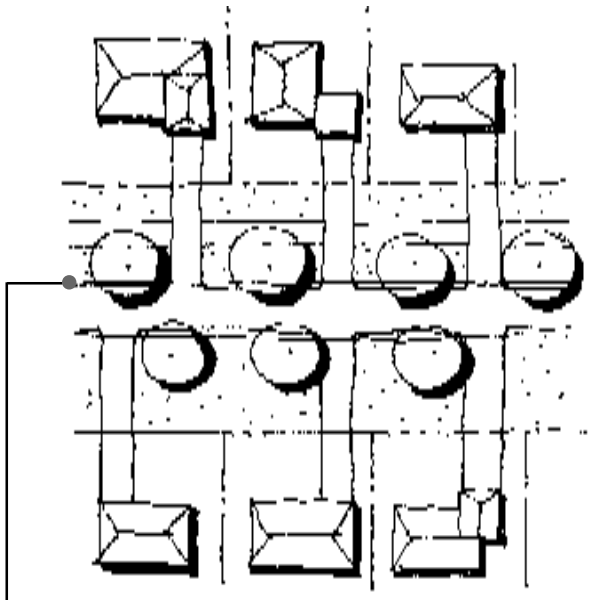
Compliance

Clean Waters Act (1970)
Local Government Act (1993)

References

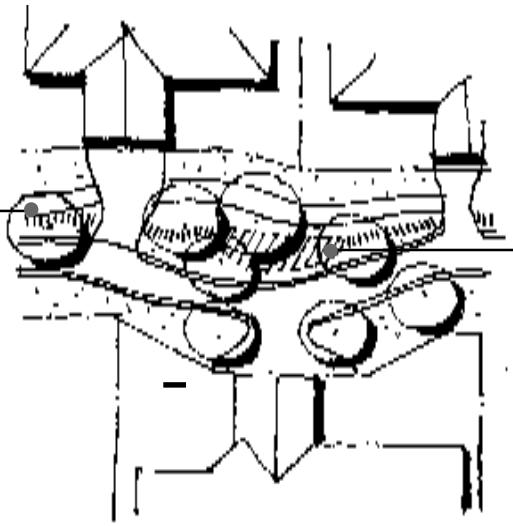
Whelans and Halpern Glick Maunsell (1994), Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, Department of Planning and Urban Development, the Water Authority of Western Australia and the Environmental Protection Authority, Wheelans, WA.

Conventional



Traditional setback creates mostly unusable space which contributes little to the function and aesthetics of the street

Water sensitive

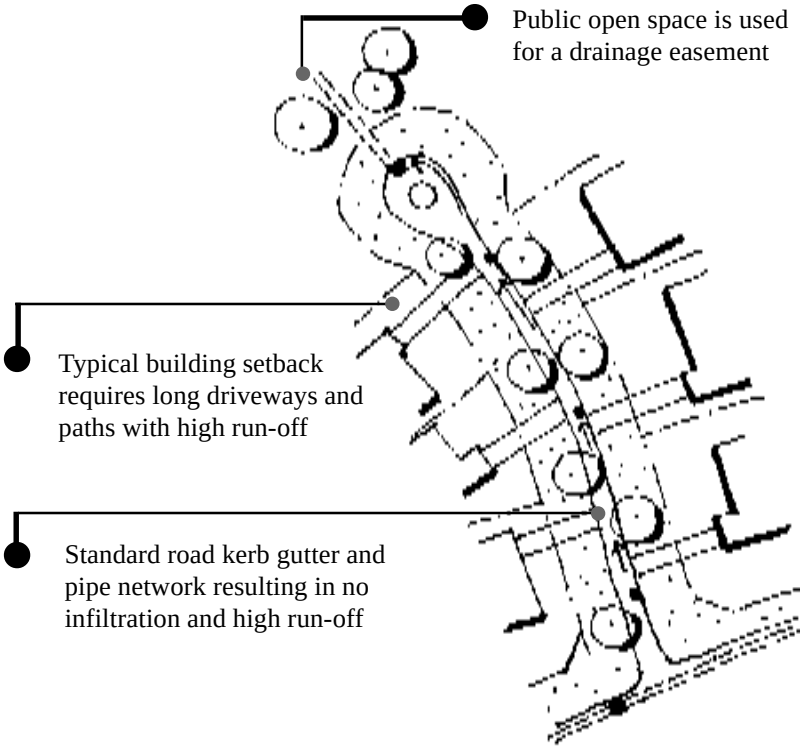


New footpath alignment allows for integrated stormwater management and responds to natural features

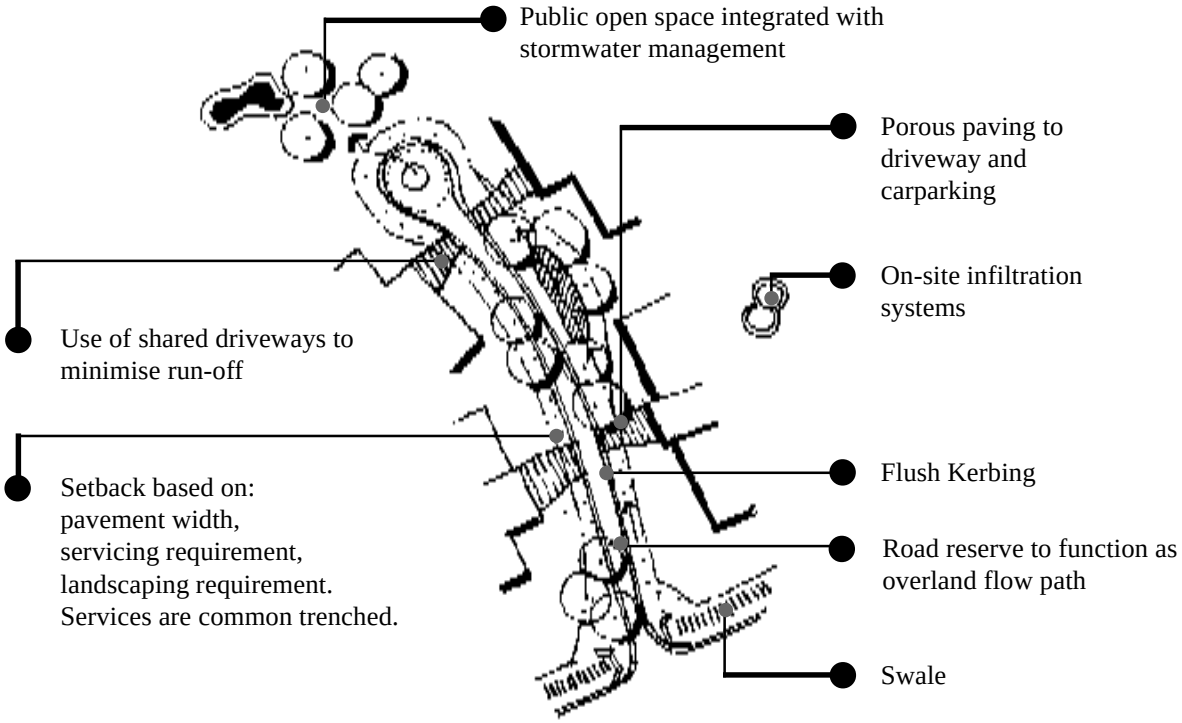
Variation in width of the reserve facilitates integrated design of stormwater management

ROAD LAYOUT AND STREETSCAPE DESIGN

Conventional



Water sensitive



HYDROZONES

Description

The site planning of recreation and landscape areas in terms of intensity of usage, visual importance and irrigation requirements, for the purpose of reducing maintenance costs, including water usage. Refer also: BMP Water Harvesting, Minimising Irrigation - Recreation and Minimising Irrigation - Gardens.

Application Where BMP May Apply

* New recreational facilities and landscaped areas.

* Retrofitted to existing recreational facilities or landscaped areas.

Conditions When BMP May Apply

* Any recreational area or landscape area where water is used for irrigation and where runoff can be collected, treated and potentially re-used.

Purpose

* To reduce water consumption and ultimately overall maintenance costs relating to plant growth, especially mowing.

Limitations

* May be limited on sites where existing usage requires the usage of exotic plant species and hence significant irrigation e.g. horticultural type parks.

* Retrofitting and re-planning of a site to result in the necessary changes in watering on a zone by zone basis may not be sufficiently flexible and result in justifiable savings.

Integration Opportunities and Constraints

* Significant reduction in water consumption can be achieved over the long term with no loss to the aesthetic or functional nature of a recreational area.

Cost Effectiveness

* Initial costs may be higher if more complex irrigation systems are required for differing watering requirements. Good planning and design will reduce other maintenance requirements such as mowing.

Maintenance

* Overall maintenance may be reduced by minimising irrigation requirements.

* Irrigation systems require regular maintenance.

Construction Technique/Expertise

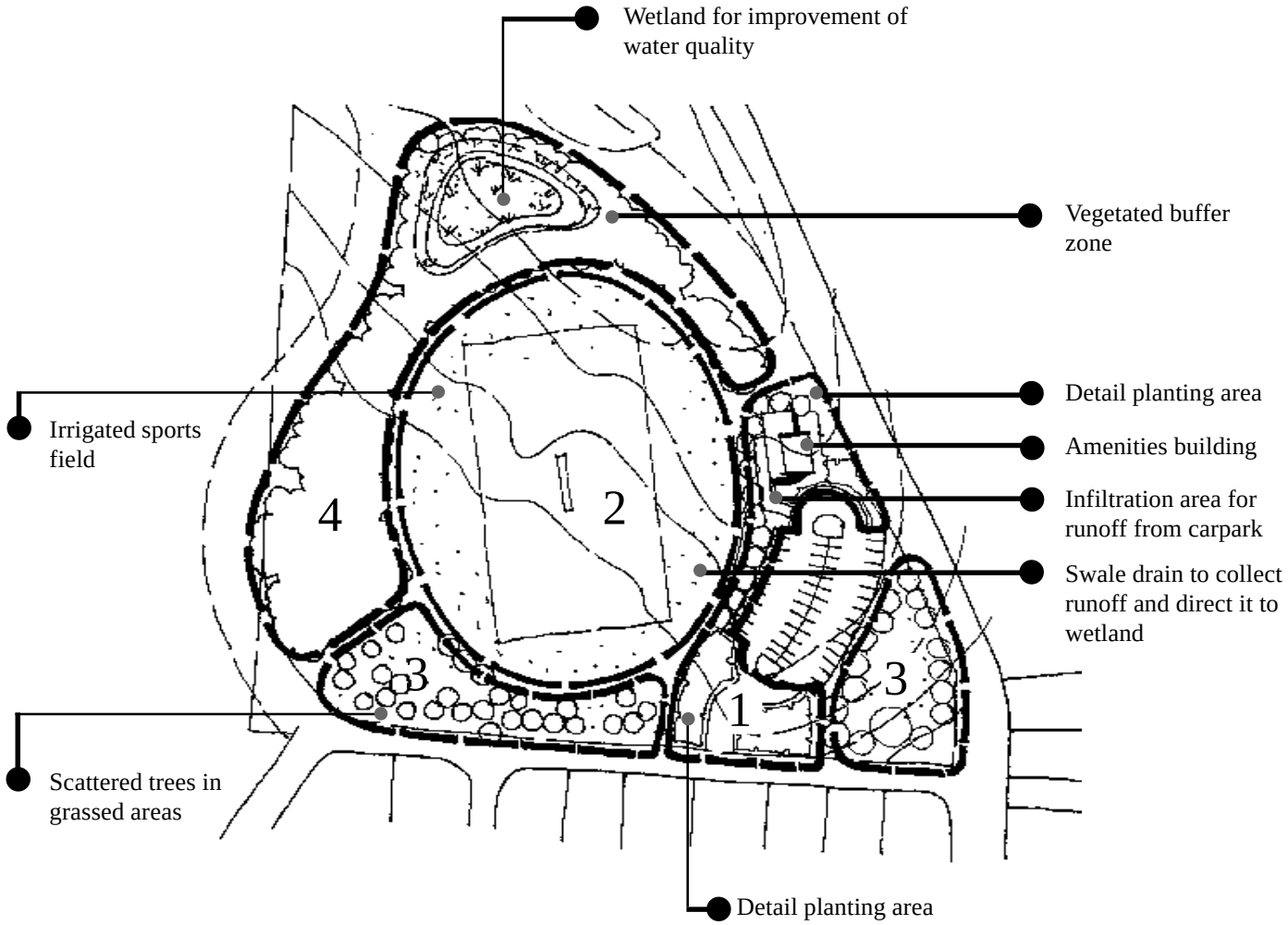
* Site planning and recreational design should be undertaken by a landscape architect.

* Landscape design can be undertaken by a garden designer or landscape architect.

* Irrigation specialists should be involved for irrigation design.

HYDROZONES

Hydrozones - recreational



1. **Detail landscape areas**

   High maintenance areas often requiring watering.

2. **Sports facilities**

   High maintenance and irrigated during sporting season.

3. **Parkland**

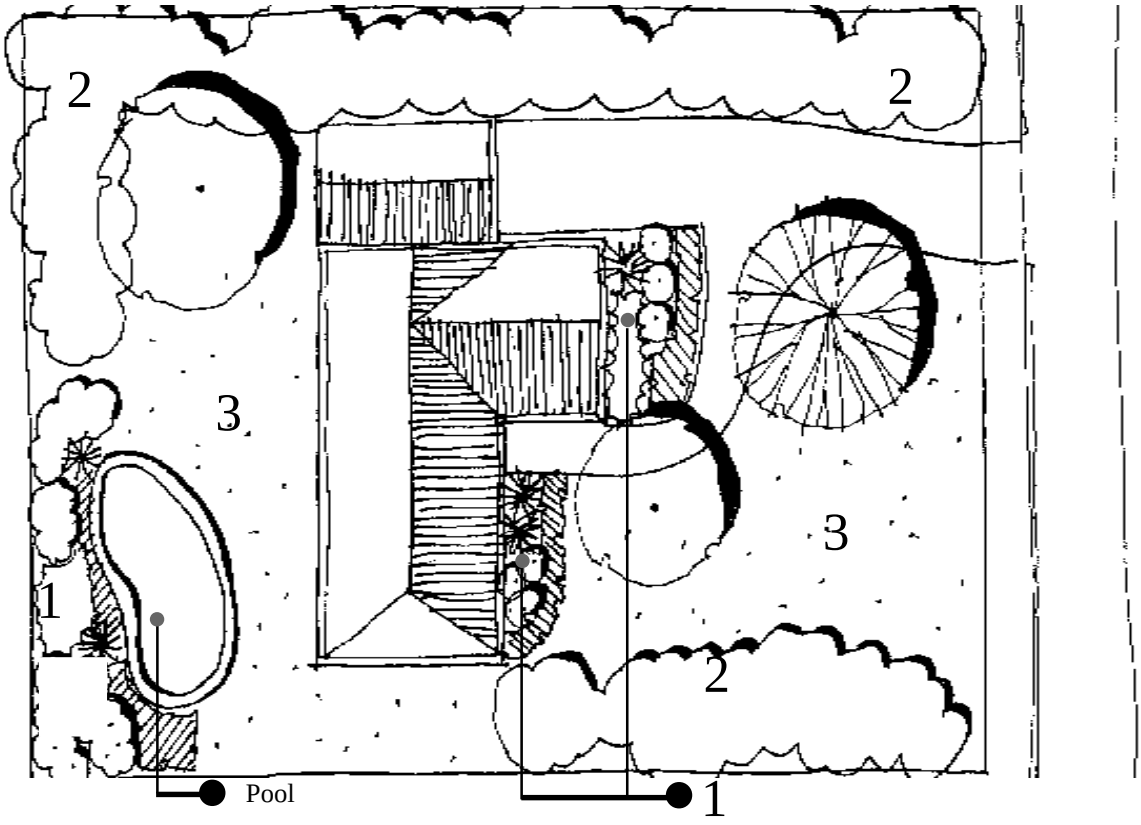
   Scattered trees in grassed areas which receive no irrigation.

4. **Bush regeneration area**

   No water requirements and minimal to no maintenance.

HYDROZONES

Hydrozones residential



1. Extreme maintenance areas and areas of high visual importance, eg. Annuals, Irrigation.

2. Mass planting areas, general planting such as natives - little or no irrigation.

3. Grass and trees - no irrigation

Compliance

Clean Waters Act (1970)

References

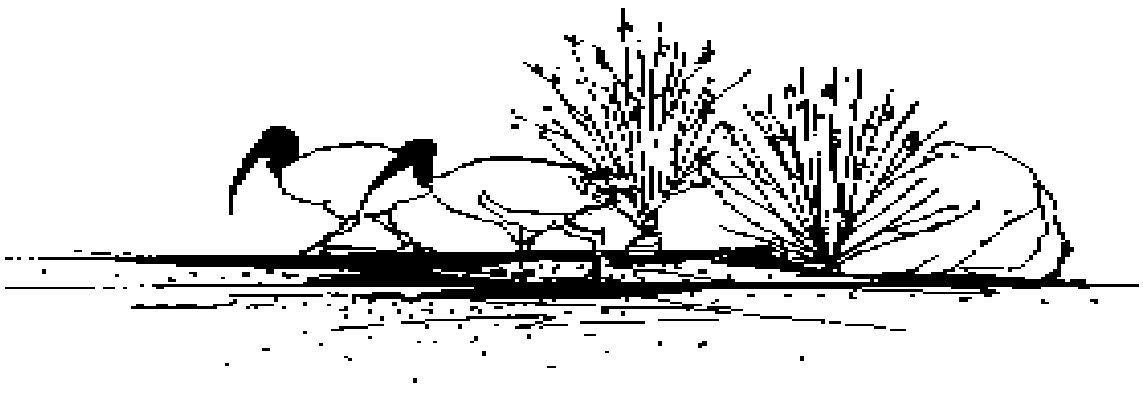
Robinette G.O. (1984), Water Conservation in Landscape Design and Management, Van Nostrand Reinholdt Co.

For the community and other stakeholders to adopt practices to improve water quality.

Q1.0 STABILISATION

Q2.0 POLLUTION CONTROL

Q3.0 MAINTENANCE PROCEDURES



RIPARIAN VEGETATION

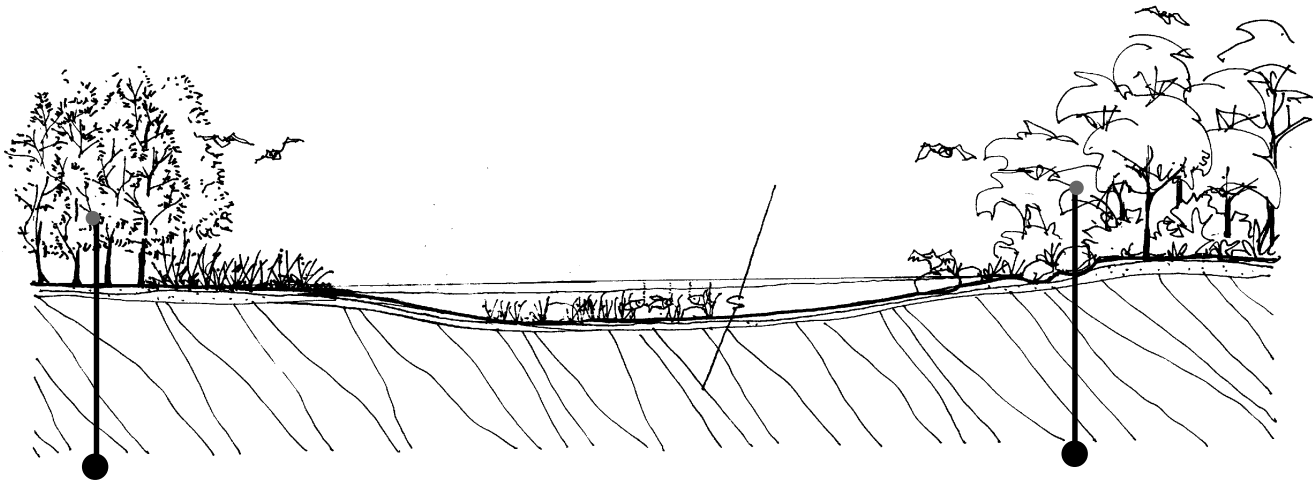
Description

Reconstruction projects involve the rehabilitation of areas where a native vegetation community capable of naturally regenerating no longer exists. Rehabilitation generally takes the form of soil stabilisation through strategic weed removal and planting.

Reconstruction projects in areas surrounded by or in proximity to native bushland, require the replacement of a native vegetation community. Where reconstruction occurs in areas where little or no native vegetation remains, reconstruction should include locally native species where appropriate, however, the existing landscape should be taken into consideration when selecting species.

The native vegetation communities found along watercourses within Hornsby Shire are varied and should be identified for each specific area in question. For a description of all vegetation communities found in the Hornsby Shire, Smith and Smith (1990) should be consulted. The major vegetation community likely to be found is as Smith and Smith (1990) described as Community O - Warm Temperate Rainforest.

Vegetation Community O - Warm Temperate Rainforest found in sheltered gullies on Hawkesbury sandstone. Major species are *Ceratopetalum apetalum* (Coachwood), *Tristaniopsis laurina* (Water Gum), *Acmena smithii* (Lilly Pilly), *Callicoma serratifolia* (Blackwattle), *Pittosporum undulatum* (Sweet Pittosporum). For a complete species list and community description see Smith & Smith (1990).



Casuarina Glauca
closed forest

Warm temperate
rainforest

Application Where BMP May Apply

* Applicable to the activities and situations listed below where they impact on vegetation along watercourses.
* New development
* Degraded areas adjacent to existing developments

Conditions When BMP May Apply

* Applicable to any watercourse that does not retain a native vegetation community capable of naturally regenerating including areas:
    * devoid of vegetation,
    * that are weed infested,
    * where a landscaped exotic community exists.
* Generally in areas where soils are stable.

Purpose

* Improvement in water quality along watercourses through the reconstruction of native vegetation communities or the use of exotic species where appropriate.
* Reconstruction of the vegetation cover will reduce pollutant and nutrient levels in overland waterflow, and limit soil loss from stream banks.
* Provision of habitat.

Limitations

Weed growth

* In the short term, weed establishment can be beneficial in stabilising soil, however in the medium to long term, weed infestation can lead to changes in stream temperature, shading and clogging of waterways. Weed removal must therefore, be regulated to limit soil loss whilst reconstruction occurs.

Soil loss

* Soil loss may occur during the early phases of reconstruction in areas where soil is unstable.

Weed control

* In the long term, the scrape and paint or herbicide injection methods of weed control may lead to the build up of dead stems.
* Weed refuse buildup in proximity to waterways has the potential to clog waterways in periods of high water flow, therefore all weed refuse must be removed from the riparian zone.

Poor plant establishment

* This may result from unfavourable weather conditions.

RIPARIAN VEGETATION

Integration Opportunities and Constraints

* Improvement in wildlife habitat and fauna corridors.
* Recreational opportunities for bushwalking and bird watching.
* Significant improvements in the aesthetic value of an area .

Cost Effectiveness

* Reconstruction projects are very variable and therefore it is difficult to determine cost effectiveness.
* Supplementary planting to enhance an already existing vegetation community is a relatively low cost measure to reduce stream bank erosion and sedimentation.
* Replacement of an exotic community with a native community is generally a long term project entailing moderate to high costs.

Maintenance

* Reconstruction projects vary dramatically depending on local conditions and level of weed infestation.
* Limited on-going maintenance is generally required where a stable state is achieved.
* Maintenance costs are approximately $1000 - $3000 per hectare/per year based on 1996 figures.

Construction Technique/Expertise

* Expertise required will range from bush regeneration to landscaping depending on the nature of the project. Managers will also require knowledge of the role of vegetation in stream stabilisation.
* Only standard bush regeneration techniques and fully qualified bush regenerators should be employed to undertake projects where the original native vegetation community is to be reconstructed.
* In areas of dense weed infestation, weed removal must be limited to a mosaic of relatively small areas at any one time to limit soil loss and stream bank de-stabilisation. Temporary erosion and sediment control measures may be required.
* Re-vegetation by planting and seeding should, where appropriate, make use of locally native species collected from local seed stock.
* As far as possible (depending on weed species dispersal method) all roots should remain in the ground for soil stabilisation.
* No spraying of herbicides should occur within 20 metres of waterways.

Compliance

Environmental Planning and Assessment Act (1979)
Threatened Species Conservation Act (1995)
Rivers and Foreshores Improvement Act (1948)
Soil Conservation Act (1938)
Clean Waters Act (1970)
Pesticides Act (1978)

References

Buchanan, R.A. (1989), Bush Regeneration - Recovering Australian Landscapes. TAFE Student Learning Publications.

Martyn, J. (1994), A Field Guide to the Bushland of the Upper Lane Cove Valley. STEP Inc.

Smith, P. & Smith, J. (1990), Hornsby Shire Bushland Survey. Unpublished report to Hornsby Shire Council

Smith, P. & Smith, J. (1990), Vegetation and Fauna of Berowra Valley Bushland Park. Unpublished report to Hornsby Shire Council.

Smith, J. & Smith, P. (1993), Vegetation and Fauna of Pennant Hills Park. Unpublished report to Hornsby Shire Council.

Raine, A.W. and Gardiner, J.N. (1995), Guidelines for Ecologically Sustainable Management of Rivers and Riparian Vegetation, LWRRDC, Canberra.

RESTORATION OF ESTUARINE VEGETATION

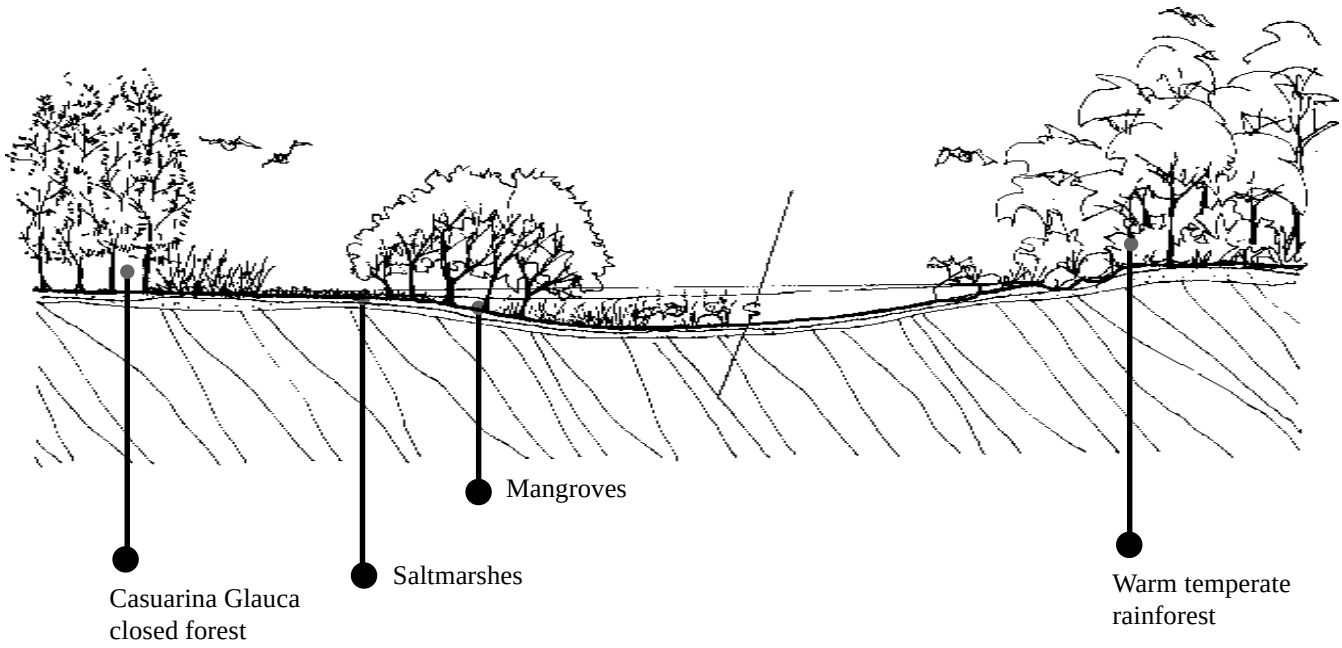
Description

Restoration of aquatic estuarine vegetation involves creating conditions whereby natural regeneration can occur or by replanting.

Two major estuarine vegetation communities are Mangroves and Saltmarshes. These communities are described below. For a complete species list and community description see Smith & Smith (1990). Refer references below.

* **Mangroves** - Vary from a closed forest of *Avicennia marina* (Grey Mangrove) with or without an understory of *Aegiceras corniculatum* (River Mangrove), to a closed scrub of *A. Corniculatum* found on intertidal mud flats along the Hawkesbury River, Marramarra Creek and Berowra Creek.

* **Salt Marsh** - Varies from bushland dominated by *Juncus krausii* (Sea Rush) to Samphire vegetation dominated by *Sarcocornia quinqueflora* (Samphire). Found on intertidal mud flats along the Hawkesbury River, Marramarra Creek and Berowra Creek. Occurs on slightly higher ground than mangrove communities and is subject to less frequent tidal inundation.



Application Where BMP May Apply:

Applicable to the activities and situations listed below where they impact on estuarine vegetation along water-courses

* New development

* Degraded areas adjacent to existing development

Conditions When BMP May Apply

* Applicable to any watercourse that retains a native estuarine vegetation community capable of naturally regenerating or conditions suitable for re-vegetation.

RESTORATION OF ESTUARINE VEGETATION

Purpose

* Improvement in water quality through the regeneration of native estuarine vegetation communities.

* Restoration of estuarine vegetation will reduce pollutant and nutrient levels in waterways, and limit siltation and soil loss from intertidal areas.

Limitations

* This is a relatively new and hence experimental field with little information available for reconstruction of saltmarshes.

* A major cause of mangrove planting failure is damage caused by high wave action. Structures may need to be constructed to deflect the force of wave action.

Integration Opportunities and Constraints

* Recreational opportunities for bushwalking on board walks.

* Significant improvements in the aesthetic value of an area.

* Improvements to the habitat of estuarine fisheries, wading and sea birds.

Maintenance

* After works have been completed, the area may require further protection from damage.

Construction Technique/Expertise

* Only fully qualified regenerators should be employed to undertake restoration projects.

* Standard regeneration and restoration techniques should be employed in all restoration projects. Erosion and sediment control measures may be necessary.

* Re-vegetation by seeds, seedlings and cuttings should make use of locally native species collected from local seed stock. Saltmarsh species may require watering after planting. The viparious seedlings of mangroves can also be transplanted.

* Restoration projects vary dramatically depending on local conditions. Generally optimum growth and establishment success for mangroves occurs just above the mid-tide level. Further information can be obtained from NSW Fisheries and the Department of Agriculture.

Compliance

NSW Fisheries has published Estuarine Habitat Management Guidelines (1993) to guide estuarine development. These guidelines include activities liable to affect estuarine habitats and the legal requirements involved for each activity, as well as a list of relevant Acts and their administering bodies. Any activity that may affect mangroves must be referred to NSW Fisheries.
Environmental Planning and Assessment Act (1979).
State Environmental Planning Policy No. 14 (Coastal Wetlands) (SEPP 14) aims to ensure that all remaining coastal wetlands listed are preserved and protected. SEPP 14 requires that a person shall not clear, construct a levee on, drain or fill that land without an Environmental Impact Statement (EIS).
Rivers and Foreshores Improvement Act (1948).
Fisheries and Oyster Farms Act (1935).
Clean Waters Act (1970)

References

Buchanan, R.A. (1989), Bush Regeneration - Recovering Australian Landscapes. TAFE Student Learning Publications.

NSW Fisheries. (Oct. 1992), Fishnote DF/30, Fishcare - Our Mangrove Forests.

NSW Fisheries (1993), Estuarine Habitat Management Guidelines.

Smith, P. & Smith, J. (1990a), Hornsby Shire Bushland Survey. Unpublished report to Hornsby Shire Council

Smith, P. & Smith, J. (1990b), Vegetation and Fauna of Berowra Valley Bushland Park. Unpublished report to Hornsby Shire Council.

State Pollution Control Commission and the Department of Agriculture, A Guide to Mangrove Transplanting.

REGENERATION OF TERRESTRIAL VEGETATION

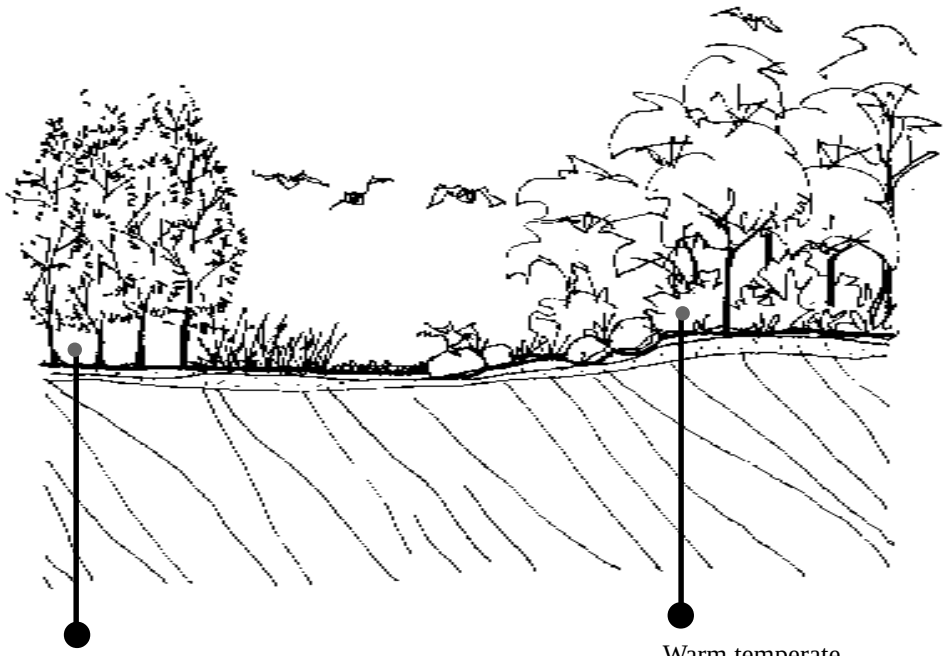
Description

Regeneration of terrestrial vegetation communities involves the rehabilitation of the bush from a weed infested or degraded plant community through natural regrowth to a healthy native plant community. It differs from reconstruction which refers to the process used when there is no seed source remaining from the original plant community.

The native vegetation communities found along watercourses within Hornsby Shire are varied and should be identified for each specific area in question. For a description of all vegetation communities found in the Hornsby Shire, Smith & Smith (1990) should be consulted. The major vegetation community likely to be found in this area is as Smith and Smith (1990) describe as Community O - Warm Temperate Rainforest which is described below.

Vegetation Community O - Warm Temperate Rainforest found in sheltered gullies on Hawkesbury sandstone. Major species are *Ceratopetalum apetalum* (Coachwood), *Tristaniopsis laurina* (Water Gum), *Acmena smithii* (Lilly Pilly), *Callicoma serratifolia* (Blackwattle), *Pittosporum undulatum* (Sweet Pittosporum). For a complete species list and community description see Smith & Smith (1990).

Other common riparian vegetation communities include Community U - *Eucalyptus robusta* Open - forest, Community V - *Casuarina glauca* Closed forest and Community X - *Melaleuca ericifolia* Closed scrub. These communities often occur beside mangrove and saltmarsh communities on slightly higher ground.



REGENERATION OF TERRESTRIAL VEGETATION

Application Where BMP May Apply

* Applicable to the activities and situations listed below where they impact on vegetation along watercourses.
* New development .
* Degraded areas adjacent to existing development.

Conditions When BMP May Apply

* Applicable to any site that retains a native vegetation community capable of naturally regenerating.
* Generally in areas where soils are stable.

Purpose

* Improvement in water quality through the regeneration of native vegetation communities along natural watercourses.
* Regeneration of the vegetation cover will reduce pollutant and nutrient levels in overland waterflow, and limit soil loss from stream banks.

Limitations

* In the short term, weed establishment can be beneficial in stabilising soil, however in the medium to long term, weed infestation can lead to changes in stream temperature, shading and clogging of waterways. Weed removal must therefore, be regulated to limit soil loss whilst regeneration occurs.
* Soil loss may occur in areas where soil is unstable.
* In the long term, the scrape and paint or herbicide injection methods of weed control may lead to clogged waterways by dead stems, during high flow periods.
* Weed refuse buildup in proximity to waterways has the potential to clog waterways in periods of high water flow, therefore all weed refuse must be removed from the riparian zone.

Integration Opportunities and Constraints

* Improvement in wildlife habitat.
* Significant improvements in the aesthetic value of an area.
* Recreational opportunities for bushwalking and bird watching.

Cost Effectiveness

* Approximate figures for labour cost/ha of primary (P) and secondary (S) bush regeneration work (Note that sites are highly variable. These figures are only an indication and do not include tools, herbicide etc.).
* Minimal weed infestation $5 000 (P) $3 000 (S)/ha (1996)
* Moderate weed infestation $32 000 (P) $11 500 (S)/ha (1996)
* High level of weed infestation $50 000 (P) $25 000 (S)/ha (1996)

REGENERATION OF TERRESTRIAL VEGETATION

Maintenance

* Regeneration projects vary dramatically depending on local conditions and level of weed infestation.

* Limited on-going maintenance is generally required after several years of primary and secondary bush regeneration works.

* Maintenance costs tend to be in the range of $1000 - $3000/hectare per year based on 1996 figures.

Construction Technique/Expertise

* Only fully qualified bush regenerators should be employed to undertake regeneration projects.

* Standard bush regeneration techniques should be employed in all regeneration projects.

* Re-vegetation by planting and seeding should make use of locally native species collected from local seed stock.

* As far as possible (depending on weed species dispersal method), all roots should remain in the ground for soil stabilisation.

* No spraying of herbicides should occur within 20 metres to waterways.

Compliance

Environmental Planning and Assessment Act (1979)
Threatened Species Conservation Act (1995)
Rivers and Foreshores Improvement Act (1948)
Soil Conservation Act (1938)
Clean Waters Act (1970)
Pesticides Act (1978)
State Environmental Planning Policy

References

Buchanan, R.A. (1989), Bush Regeneration - Recovering Australian Landscapes. TAFE Student Learning Publications.

Martyn, J. (1994), A Field Guide to the Bushland of the Upper Lane Cove Valley. STEP Inc.

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Smith, J. & Smith, P. (1993), Vegetation and Fauna of Pennant Hills Park. Unpublished report to Hornsby Shire Council.

STREAM REHABILITATION

Description

Stream Rehabilitation involves the reinstatement of natural characteristics such as meandering, pool-riffle sequencing and the preservation of riparian vegetation. These may achieved through a variety of techniques;

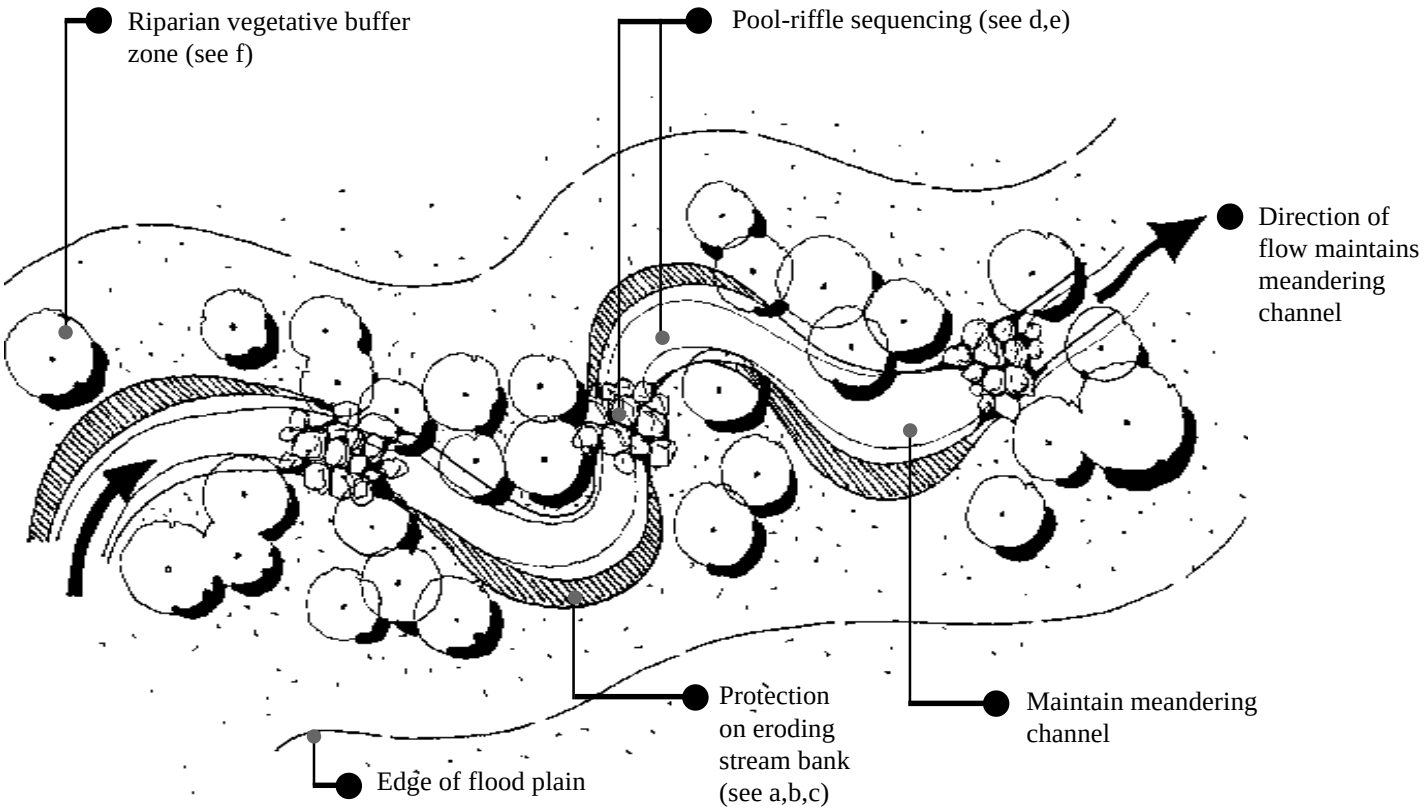
* Meandering - cribbing, boulders, gabions (basket, mattress), concrete, fitted blankets
* Pool-riffle sequencing - boulders/rip rap drop structures
* Preservation and reinstatement of riparian vegetation

Refer also BMP - Preservation of Natural Flow Characteristics

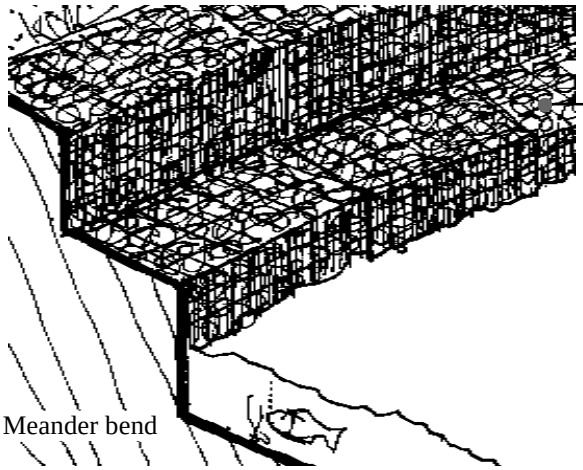
Application Where BMP May Apply

* In all streams where the stream bed and/or banks are in a degraded state as a result of natural or human processes.
* Can be applied as an alternative to conventional strengthening, deepening, concreting or culveting.

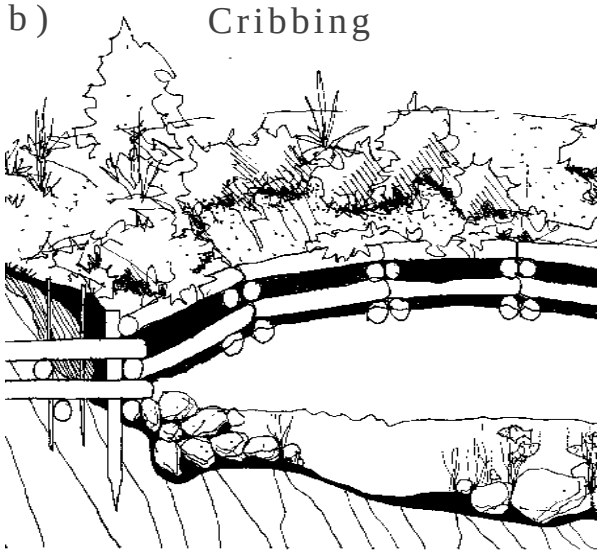
Plan



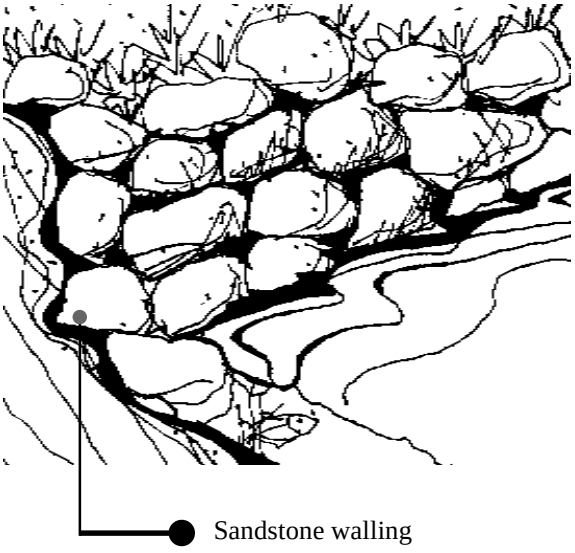
a) Gabion



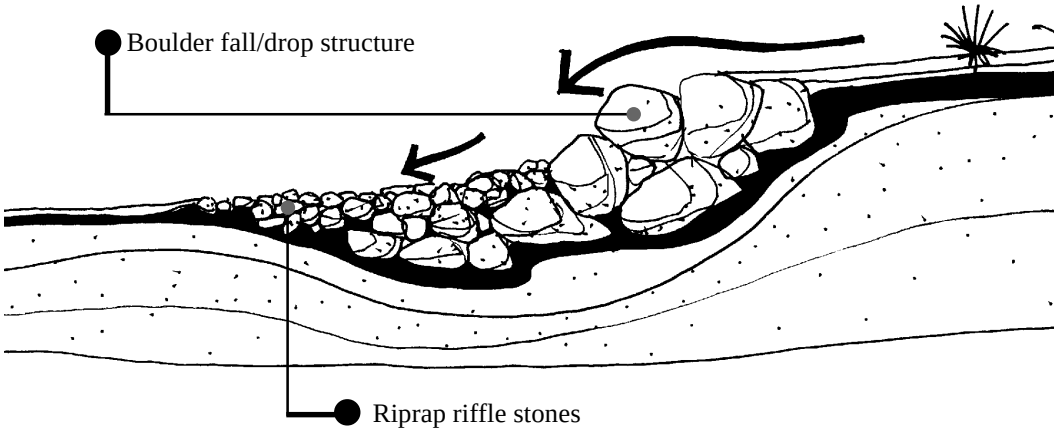
b) Cribbing



c) Boulder line



d) Fall structure



STREAM REHABILITATION

Conditions When BMP May Apply

* After major storm events where stream degradation has occurred through increased velocities and/or flooding.
* As part of development approval.
* As part of Council's catchment remediation works or other activities.
* In cases where water quality monitoring indicates that stream rehabilitation would have a beneficial effect.

Purpose

* To rehabilitate or restore a stream system to a condition of equilibrium by preserving natural characteristics and stream bank stability through a combination of BMPs.

Limitations

* Length and degree of rehabilitation works required.
* Access for machinery.
* Requires the inclusion of other BMPs upstream which can reduce peak runoff flows.
* Gabions, cribbing, revetment mattresses may have undesirable aesthetic appeal and are more expensive than sandstone boulders and labour intensive
  Cost: $5,000 - $50,000 (1996) per sq.m.
  Boulders/riprap: $500 - $10,000 (1996) per sq.m.

Integration Opportunities and Constraints

* Restoration of natural functioning of stream, water quality and habitat potential.
* Enhancement of riparian buffer zones, aesthetic appeal, screening and passive recreation.

Cost Effectiveness

* Stream rehabilitation is less expensive than channelisation and mimics the natural functioning of a watercourse.

Maintenance

* Routine inspection after large storm events is required
* Existing BMPs repaired or modified, or additional BMPs incorporated.

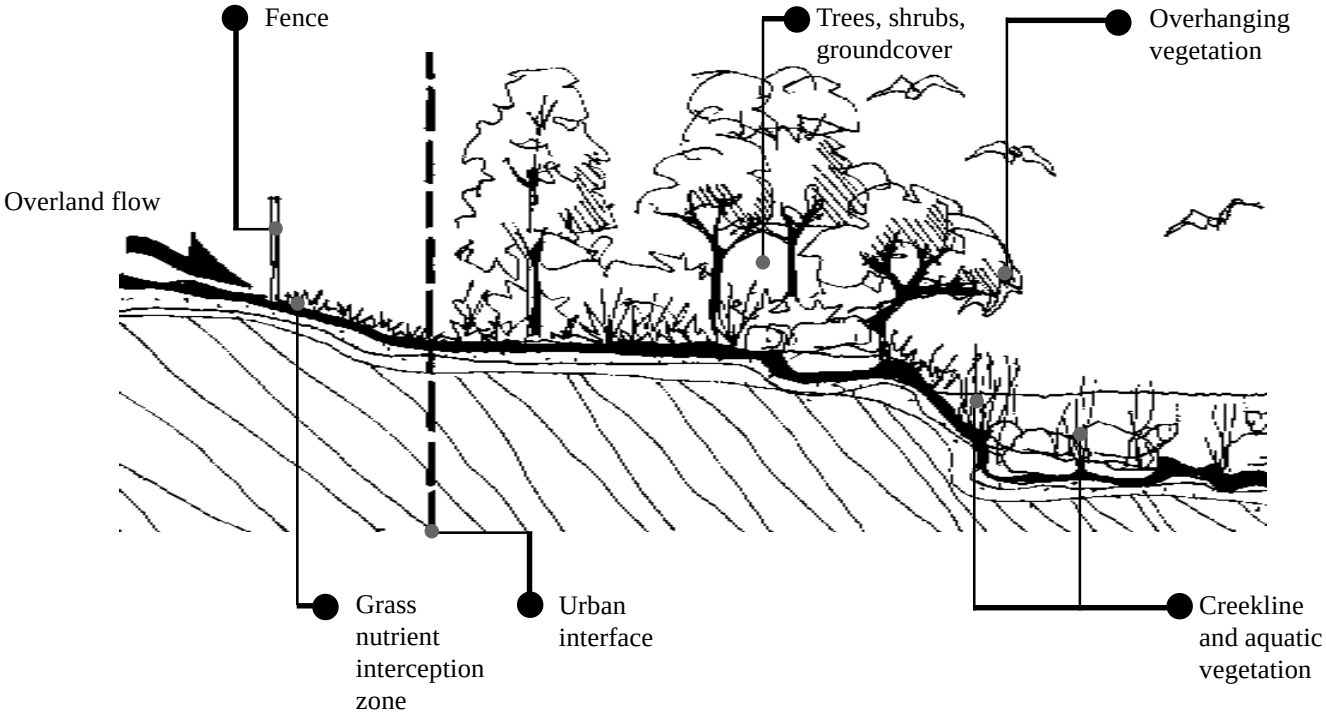
Construction Technique/Expertise

* Use of natural and locally sourced materials.
* Minimum disturbance during staged works through restricted access, preparation of a sediment and erosion control plan and Review of Environmental Effects (REF).
* Experienced machine operators.

e) Riprap

- Riffle zones - sandstone spalls or river cobbles

f) Riparian vegetation



Compliance

Clean Water Act (1971)
Rivers & Foreshores Protection Act (1948) - Section 3(a) permit
Fisheries and Oyster Farms Act (1935)
Soil Conservation Act (1938)

References

Whelans and Halpern, Glick, Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Water Authority of Western Australia and the Environmental Protection Authority, Whelans, W.A.

Sydney Coastal Group (1995), Interim Stormwater Management Model - Policies and Guidelines.

Department of Urban Affairs and Planning (1996), Resource Guide for BMPs to Control Diffuse Source Water Pollution in the Hawkesbury Nepean Catchment, DUAP, Sydney.

Hornsby Shire Council (1996), Policy on the Protection, Renewal and Maintenance of Urban Streams in the Hornsby Shire, HSC, Hornsby.

Environmental Protection Authority (1996), Managing Urban Stormwater, Draft Strategic Framework, EPA, Sydney.

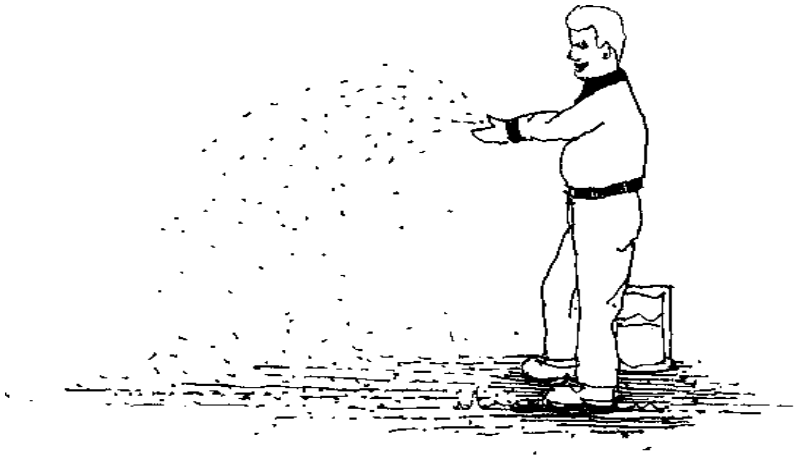
SOIL SURFACE STABILISATION/TREATMENT

Description

Good site practice on a disturbed area involves the minimization of exposed soil and immediate stabilisation.

Soil surface stabilisation/treatment can include the techniques of:

* seeding
* hydromulching
* erosion control matting
* turfing
* planting



Application Where BMP May Apply

* Any site which is susceptible to erosion and requires stabilisation or establishment of a vegetative cover.

Conditions When BMP May Apply

* Both during and after any works where the soil surface has been disturbed or exposed to erosive forces.

Purpose

* To protect soil against erosion and reduce water use by protecting and improving soil structure during the land development process.

Limitations

* Only suitable for treatment of sheet flow surface runoff and low to medium flow events.
* Some treatments are not easily applied to slopes greater than 1 vertical: 2 horizontal.
  Refer BMP - Berm and Slope Configuration.
* Limited periods during the year suitable for seeding.
* Turf/hydromulch requires regular watering until a strong cover is established.
* Mulches may require anchoring with netting or chemical binders in windblown sites or on steep slopes.

SOIL SURFACE STABILISATION/TREATMENT

Hydromulching an embankment

Integration Opportunities and Constraints

* Can reduce surface runoff water and velocity.
* Can reduce water use by protecting and improving soil structure/moisture regime.
* Low to moderate habitat creation and aesthetic value, however prevention of degradation of these areas has a positive impact.

Cost Effectiveness

* Seeding, hydromulching and mulching have a small initial establishment costs, whereas, turfing and biodegradable fabrics are more expensive but have less chance of failure than with seeding.

Maintenance

* Any repairs, reseeding, initial watering and replacement costs should be made, pending regular inspection.

Construction Technique/Expertise

* Need to prepare site for application.
* Application of seeding and hydromulch should be done by suitably experienced operators.
* Biodegradable fabric should be applied according to product instructions.
* Application of hydroseed/mulch should be under optimum weather conditions.
* Temporary sediment and erosion control measures should be implemented, and run-off directed away from the disturbed areas.

Compliance

Clean Waters Act (1970)
Environmental Offences & Penalties Act (1984)
Conditions of Development/Building Consent
Local Government Act (1993)
Soil Conservation Act (1938)

References

Department Urban Affairs & Planning (1996), Resource Guide for BMPs to Control Diffuse Source Water Pollution in the Hawkesbury-Nepean Catchment

CaLM (1992), Urban Erosion & Sediment Control Manual

Department of Housing (1993), Soil & Water Management for Urban Development

EPA for State Stormwater Co-ordinating Committee (1996), Managing Urban Stormwater, Construction Activities (Draft).

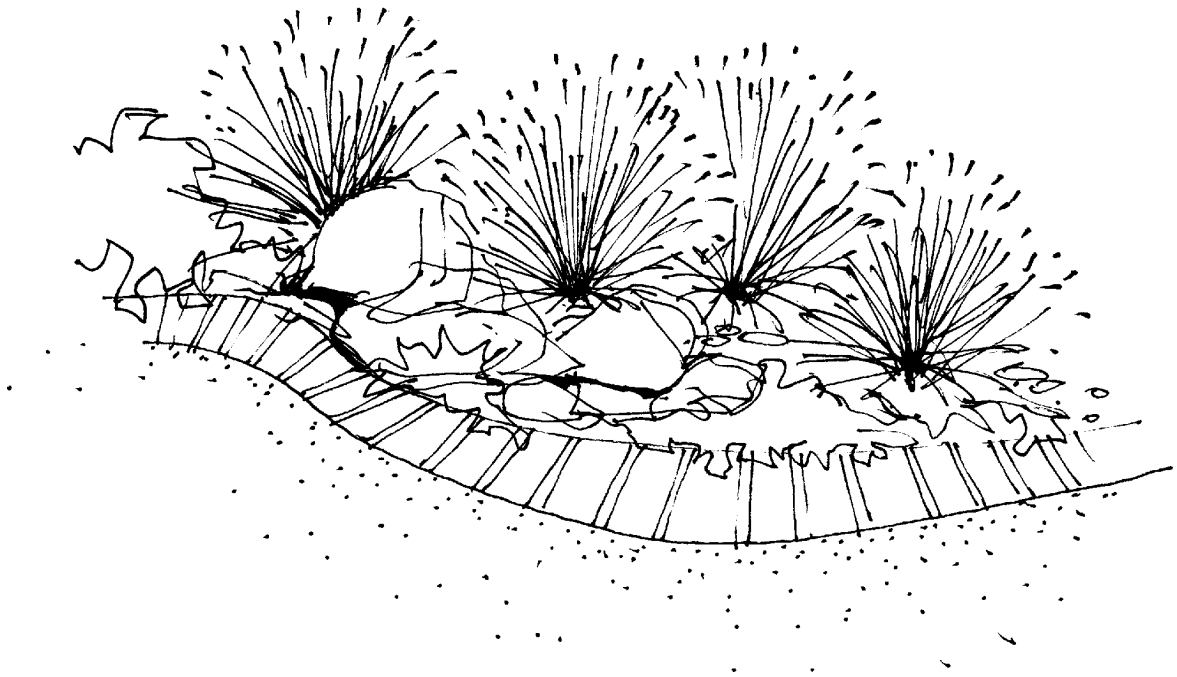
Whelans and Halpern, Glick, Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Develpment, the Water Authority of Western Australia and the Environmental Protection Authority, Whelans, W.A.

NATIVE GRASSES

Description

Native grass species may be sown, planted as spriggs or plugs (viro-cells) and for some species, as a turf. Native grasses are particularly useful to reduce maintenance costs and water consumption.

Landscaping using native grasses



Application Where BMP May Apply

* New and existing development
* Recreation areas
* Construction sites for sediment control

Conditions When BMP May Apply

* May be grown wherever there is adequate sunlight, moisture and soil.
* May be used for covering large surface areas or planted in strips for sediment control.
* Particularly useful where low or no maintenance is to be applied.

Purpose

* Minimises erosion and hence maintains water quality.
* Reduces moisture loss from the soil.
* High aesthetic potential.
* Is appropriate on sites adjacent to bushland, native gardens and passive recreational areas.

NATIVE GRASSES

Species Characteristics/Usage

Botanical Name	Common Name	Characteristics	Usage
Chloris ventricosa	Tall Chloris	Tufted perennial 400mm ht. Seed head 1m. Flowers spring, summer, autumn. Claysoils May be mown to 50mm ht. Plant at 3-15 per sq m	Erosion control Revegetation Road Sides Rough Landscape Areas
Danthonia setacea	Wallaby Grass	400mm ht. Seed head 800mm ht. Flowers spring and autumn. Sandy or sandstone soils Drought and frost tolerant. Plant 20-30 per sq m Attractive for mass planting for continuous cover.	Used as garden plants, and revegation areas and rough landscape areas.
Eragrostis elongata	Lavender Grass	Tufted perennial 300mm ht. Warm season grass. Lavender seed head in spring to late autumn. Drought tolerant. Clay, sand or rocky soils.	Garden ornamental. Mass planted ground cover Roadside planting
Paspalum distichum Dryarna	Salt-water Couch Stoloniferous	Perennial 50mmht Most soils. Drought tolerant and will accept some inundation. Wear tolerance similar to couch. Can be purchased as turf.	Lawn for low maintenance Embankment stabilization
Pennisetum alopecuroides	Swamp Foxtail	Tufted ornamental grass 750mm ht. Seed head 1m ht Purplish seed head. Flowers in summer	Garden ornamental. Mass planted ground cover
Poa labillardieri Cv Eskdale	Large Tussock Grass	Tufted Ornamental Grass 800mm ht Drought tolerant. Retains fine blue foliage.	Garden ornamental. Mass planted ground cover.
Poa poiformis	Coastal Tussock	Tussock Grass 700mm ht. Seed head 1m. Flowers summer. Blue-green leaves. Drought, frost and salt tolerant. Plant all year. Clay, sandy or rocky soils.	Ornamental garden plant. Underplanting in rough landscape areas. Revegetation projects.
Poa sieberiana		Tufted perennial 600mm ht Grey green leaves, purplish seed head. Flowers in summer.	Garden ornamental Mass planted ground cover.
Themda australis	Kangaroo Grass	Tufted perennial 500mm ht. Seed head 1m ht. Brown-purple colouring. Heavy texture soils Good shade tolerance Flowers spring-summer. Autumn and winter plantings often fail.	Mass planted ornamental roadside, revegetation or understorey planting. Good for rough landscape area.

NATIVE GRASSES

Limitations

* Species selection to be appropriate in terms of soil, drainage, extent of usage, ongoing maintenance and aesthetics.

* Initial cost may be greater than exotic turf, however, significant maintenance savings will be found.

* Many species have low germination rates and are very seasonal, and hence may not be practical if an instant cover is required.

Integration Opportunities and Constraints

* Native grasses are an excellent plant for landscape features (eg. *Poa labillardieri*, Large Tussock Grass) or as a continuous swarth (eg. *Paspalum distichum*, Dryarna)

Cost Effectiveness

* Where maintenance will be minimal, native grasses are a practical alternative.

* Capital cost for supply and installation may be high.

Maintenance

* Consideration should be given to allowing grass to grow unmaintained and an attractive species selected for this purpose.

Construction Technique/Expertise

* The installation of native grasses is dependent on the desired quality of the surface required and its ultimate usage. Some native grasses are stolonising and create a turf whilst others are tufted and require close planting to achieve continuous cover.

* Timing with seasons is of importance for germination and growth for some species.

Compliance

Landscape Code for Development and Building Approval

References

Aabulk advertising material.

Bendle NCW, Carolin R.C., Evans O.D (1989), Flora of the Sydney Region, Reed Books Pty Ltd.

TURF SELECTION AND USAGE

Description

A square or roll of grass species with soil and roots laid to provide an instant vegetative cover which has been selected for a particular function such as a football field or general open space area.

Turf laying

Application Where BMP May Apply

* New and existing development
* Recreation areas
* Construction sites - strip turf for sediment control

Conditions When BMP May Apply

* Turf may be applicable where an instant vegetative cover is required to provide protection against the erosion from water and wind and to provide a usable aesthetic surface.
* May be grown wherever there is adequate sunlight, moisture and soil .
* May be used for covering large surface areas or laid as a strip for sediment control.

Purpose

* Minimizes erosion and hence maintains water quality
* Reduces moisture loss from the soil
* High aesthetic and recreational potential

TURF SELECTION AND USAGE

Limitations

* Turf species must be suitable to climate and likely future maintenance resources.
* Only applicable on stable slopes and gradients less than 1 vertical: 4 horizontal if to be mowed.
* Initial capital cost is more expensive than seeding or sprigging and involves significant maintenance costs during establishment period.
* Maintenance costs of turf are high, particularly if irrigation, fertilizing and mowing is required.
* Irrigation is likely to offset any water balance gains.
* Some species brown off in winter and become dormant during cold and/or drought periods.
* May become a weed in areas adjacent to bushland, particularly Kikuyu grass.
* Highly trafficked areas may result in turf grass wear, soil compaction, soil displacement, soil removal or divots.
* The presence of certain insects, nematodes or fungi can seriously impair water absorption through damage to the root zone.
* The selection of an appropriate sand-soil-organic matter ratio will aid in developing quality drought resistant turf.

Integration Opportunities and Constraints

* Strip turfing has high potential for usage as a water quality device on construction sites .
* Excellent as a landscape element and for recreation setting.
* Native grasses should also be considered, however only a few species are available as turf, but are often available as spriggs or cells.

Cost Effectiveness

* Capital cost for supply, lay and establishment is high. For the purpose of stabilisation this is an expensive solution and is typically used in critical areas only. Where aesthetics and/or recreational usage is anticipated, it is an unavoidable cost .
* Ongoing maintenance costs are high, particularly if irrigation, fertilizing and mowing is required.
* More expensive than seeding and sprigging, however provides an instant result .
* Consideration should be given to the use of drought tolerant species.

Maintenance

* Irrigation, fertilizing and mowing costs are high .
* Ongoing maintenance costs are high, particularly if irrigation, fertilizing, mowing and edging is required.
* Consideration should be given to allowing grass to grow unmaintained and an attractive species selected for this purpose.

Construction Technique/Expertise

* The installation of turf is dependent on the quality of the turf surface required and the ultimate usage. e.g. sports fields require exceptional drainage and level surface whilst swale drains may be more functional with a degree of roughness.

* Turf is typically laid on a prepared soil surface and butt jointed with the length of the roll following parallel to the contours.

Compliance

Landscape Code for Development and Building Approval
Clean Waters Act (1970)

References

EPA for State Stormwater Co-ordinating Committee (1996), Managing Urban Stormwater, Construction Activities (Draft), EPA.

Australian Turf Grass Research Institute (1992), Turf Grass Variety Manual, ATGRI, Sydney.

MULCHES

Description

A layer of non-living plant material such as chipped bark, seed cases or inorganic products such as gravels, used to reduce moisture loss from soil, reduce erosive impacts of water and wind as well as aesthetic purposes.

Gravels

Bark chip

Leaf litter

Application Where BMP May Apply

* New development
* Landscape works
* Maintenance works
* Construction works

Conditions When BMP May Apply

* Used on landscaped sites and re-vegetation areas where moisture loss is to be minimised and to provide some protection against soil loss from the erosive capabilities of water and wind.
* May be applied on flat to moderate slopes. An adhesive is required on steep slopes.
* Often used in conjunction with re-vegetation projects.
* May be used to aesthetically improve an unvegetated area as well as around planting in mass landscape beds.

Purpose

* Reduces the erosive impact of water and wind.
* Reduces loss of moisture from the soil through evaporation.
* Potential aesthetic benefits.
* Assists with reducing weed growth.
* Organic mulches such as leaves provide nutrients to the soil.
* May be mixed with desirable seed material, adhesive and fertilizers and sprayed onto steep or sites which are difficult to access.

MULCHES

Limitations

* Use of mulch on steep slopes may be limited to those with an adhesive additive or with binding component such as straw mulch.

* May be combined with netting or matting to increase its stabilizing and moisture retention capabilities.

* Not suitable on sites with high volumes and velocity of water flow as mulch is quite easily transported.

* Organic mulches decompose and may need replacement.

* Decorative gravel mulches can be expensive.

* Avoid placing mulch against trunks of plants as fungal problems may result in collar rot.

Integration Opportunities and Constraints

* High potential for combined usage for water retention, erosion control as well as improved aesthetics in landscape areas.

* Decorative gravels and horticultural grade mulches have high ornamental value.

* Mulches may be used in highly trafficked, damp or shaded areas as a substitute for turf grasses.

Cost Effectiveness

* If existing vegetation can be chipped on-site for re-use as mulch, it is very cost effective.

* Costs for imported mulch vary on type. Horticultural grade bark chip mulch and decorativegravels are expensive ($40.00 /cu.m, 1996) whilst leaf litter is inexpensive although it decomposes rapidly.

* Gravels will last indefinitely, however, pale and polished gravels may reflect light and cause water stress in plants. Dark gravels absorb heat and may also cause stress to plantings.

* Hydromulching is a cost effective means of mulching large areas, particularly in difficult terrain.

Maintenance

* Decorative mulches may require raking or topping up to maintain adequate depth. Any deposited material on the surface may require removal to maintain aesthetics.

* Organic mulches decompose and may require replacement.

Construction Technique/Expertise

* Most mulches are spread in an even layer 50 - 150 mm thick depending on type and location.

* Hydromulch uses a different technique.

* Mulch can be created on-site if undesirable existing vegetation can be chipped. (Avoid weed species).

MULCHES

Compliance

Landscape Code for Development and Building Approval.
Clean Waters Act (1970)

References

EPA for State Stormwater Co-ordinating Committee (1996), Managing Urban Stormwater, Construction Activities (Draft).

BERMS AND SLOPE CONFIGURATION

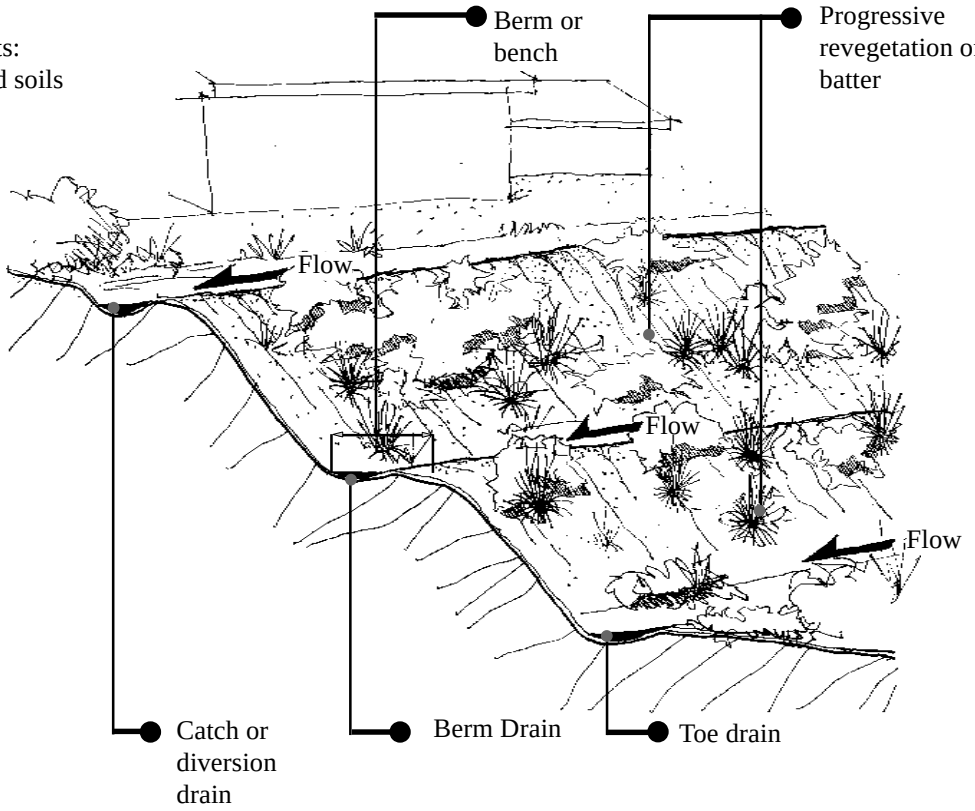
Description

The erosion potential of berms can be reduced by shortening continuous runs and reducing slope angles. Slopes should be restricted to 1v:2h, with runs no more than 5 metres.

(Refer also to BMP - Swales, Soil Surface Stabilisation Treatments and Stabilisation of Disturbed Areas.)

Batter stabilisation

- Maximum batter gradients: 1:2 on low erosion hazard soils



- All drains channelled to sediment traps or filters

Application Where BMP May Apply

* New development.
* Council activities - maintenance or construction.
* Especially applicable to steep or long slopes on erodible soils.

Conditions When BMP May Apply

Any development or activity, where disturbance of existing slopes will occur.

Purpose

This BMP will improve water quality by reducing erosion and siltation potential.

BERMS AND SLOPE CONFIGURATION

Limitations

* Requires suitable equipment and experienced operators to construct.

* Increased infiltration of water may cause failure and sloughing of steep fill slopes.

Integration Opportunities and Constraints

* Landscape/re-vegetation opportunities exist due to better stabilisation of the slopes.

Cost Effectiveness

* Can significantly increase the cost of site earthworks but is considered an inexpensive BMP.

Maintenance

* Requires regular inspection and minor repairs during the initial stabilisation period.

Construction Technique/Expertise

* Requires suitably trained personnel, familiar with the design and installation techniques.

Compliance

Clean Waters Act (1970)
Soil Conservation Act (1938)

References

Department Urban Affairs & Planning (1996), Resource Guide

CaLM (1992), Urban Erosion & Sediment Control Manual

Department of Housing (1993), Soil & Water Management for Urban Development

Lane Cove River CMC (1996), Keep it Clean a guide to sediment control on building sites

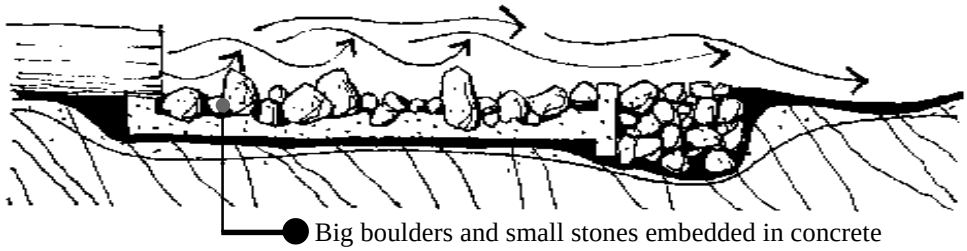
EPA for State Stormwater Co-ordinating Committee (1996), Managing Urban Stormwater, Construction Activities (Draft).

ENERGY DISSIPATORS AT PIPE OUTLETS

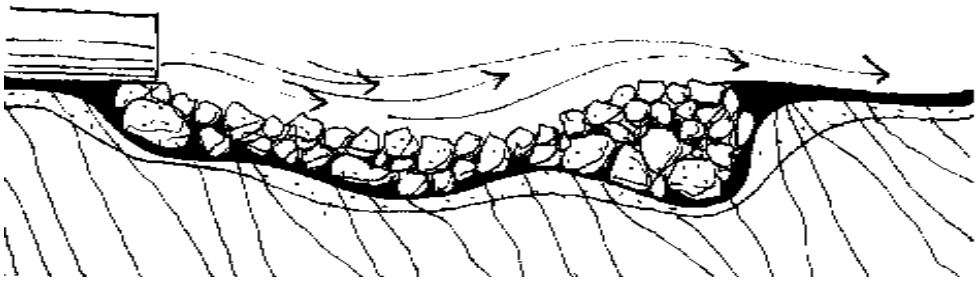
Description

Erosion potential and scour at pipe outlets can be reduced by dissipating energy through turbulence resulting in a reduced velocity of flow.

Horizontal roughness element dissipator



Riprap energy dissipator



Application Where BMP May Apply

* New development
* Existing systems

Conditions When BMP May Apply

* Any outlet to pipes or channels where the flow from the outlet will exceed the non-erosive velocity of the soil.

Purpose

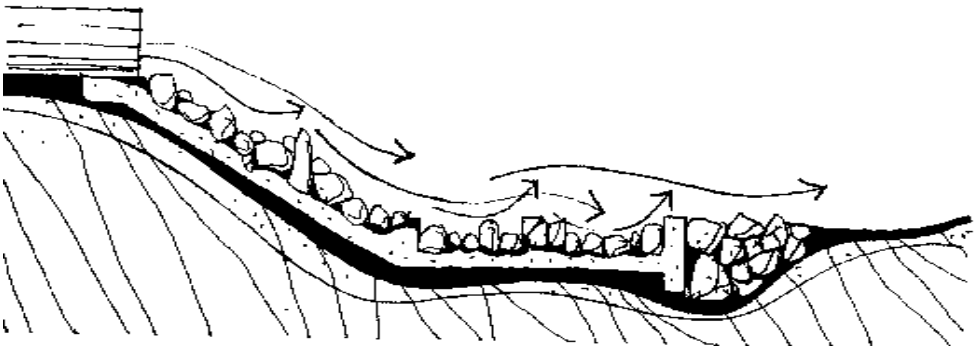
* This BMP will improve water quality by reducing erosion potential.

Limitations

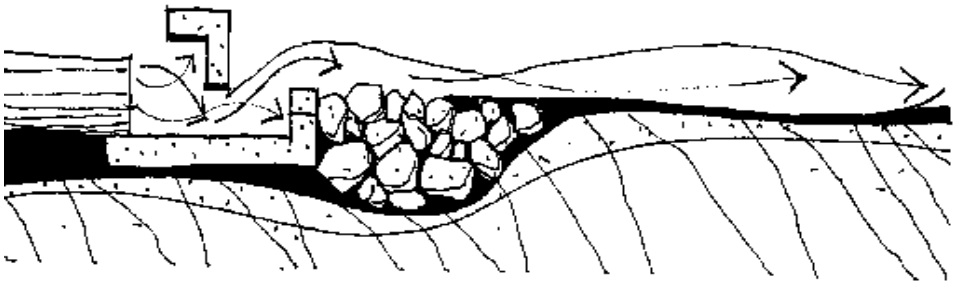
* Will result in reduced flow capacity and greater flow depths which may affect flood levels.
* Can cause sediment load to be deposited at the outlet.

ENERGY DISSIPATORS AT PIPE OUTLETS

Forced jump energy dissipator



Impact energy dissipator



Integration Opportunities and Constraints

* Landscape opportunities exist where careful design, location, construction and maintenance is carried out.

Cost Effectiveness

* Can be expensive (range from $1000 to $10,000+). (1996).

Maintenance

* Generally little or no maintenance is required.

* Regular inspection after high flows to check for any disturbance or undermining.

Construction Technique/Expertise

Requires suitably trained personnel, familiar with design and installation techniques.

Compliance

Clean Waters Act (1970)
Soil Conservation Act (1938)

References

Department Urban Affairs & Planning (1996), Resource Guide

CaLM (1992), Urban Erosion & Sediment Control Manual

Department of Housing (1993), Soil & Water Management for Urban Development

Lane Cove River CMC (1996), Keep it Clean, a guide to sediment control on building sites

STABILISATION OF DISTURBED AREAS

Description

Successful erosion and sediment control relies on the effective and progressive stabilization of disturbed areas as well as the treatment of runoff and physical barriers. This includes stabilization of drainage lines and batters during construction as well as re-vegetation of areas as earthworks are completed.

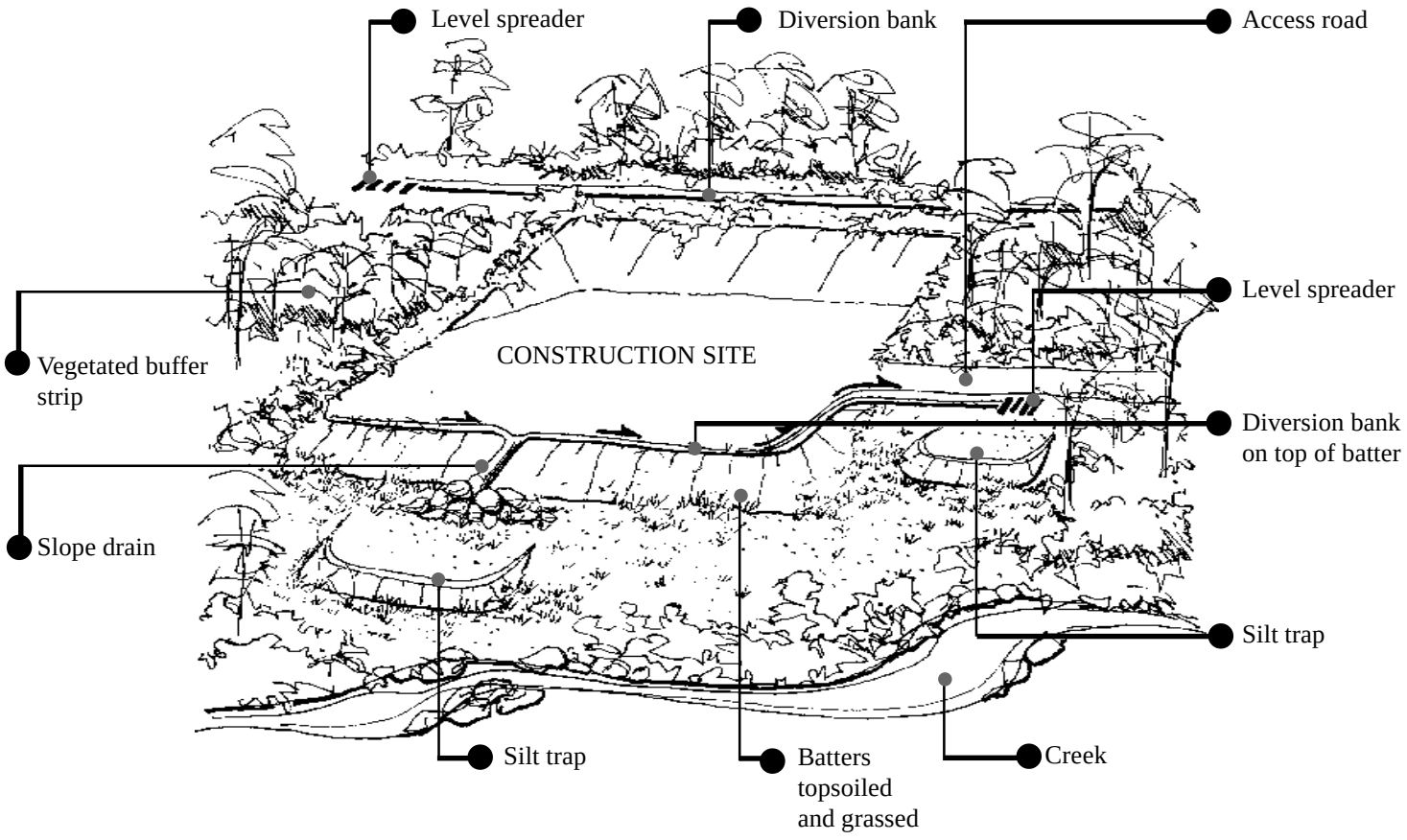
Good site practice involves minimizing the area of site disturbed at any time, installing protective measures prior to commencement of construction and immediately stabilising the site after completion of the works. These practices include the use of:

* diversion banks,
* level spreaders,
* silt traps/sediment ponds,
* vegetated buffer strips.

Refer also BMP - Soil Surface Stabilization Treatment, Berms and Slope Configuration.,

Application Where BMP May Apply

* New development
* Council activities - maintenance or construction



STABILISATION OF DISTURBED AREAS

Conditions When BMP May Apply

* Any development or activity, where disturbance of existing surface cover will occur.

Purpose

* This BMP will improve water quality by reducing erosion potential and the amount of silt and sediment generated during construction activities.

Limitations

* Requires diligence and good site management

* Type of technique used may be influenced by storm events, slope of the land, soil type and its erosion potential and extent of vegetation loss.

Integration Opportunities and Constraints

* Designing an erosion and sediment control plan at the early planning stage of development aids in integrating the natural constraints of the land into the development. Landscape/re-vegetation opportunities exist for sites which are already disturbed for improved habitat value, aesthetics and recreational value.

Cost Effectiveness

* A good site management practice which has the potential to reduce costs.

Maintenance

* Requires regular and frequent inspection which will add a small cost to project. Suitable materials and design will minimize this cost.

Construction Technique/Expertise

* Requires suitably trained personnel, familiar with the design and installation techniques.

Compliance

Clean Waters Act (1970)
Soil Conservation Act (1938)

References

Department Urban Affairs & Planning (1996), Resource Guide

CaLM (1992), Urban Erosion & Sediment Control Manual

Department of Housing (1993), Soil & Water Management for Urban Development

Lane Cove River CMC (1996), 'Keep it Clean' a guide to sediment control on building sites

Environmantal Protection Authority (1996), Managing Urban Stormwater, Construction Activities (Draft), EPA for State Stormwater, Sydney.

SEDIMENT AND EROSION CONTROLS

Description

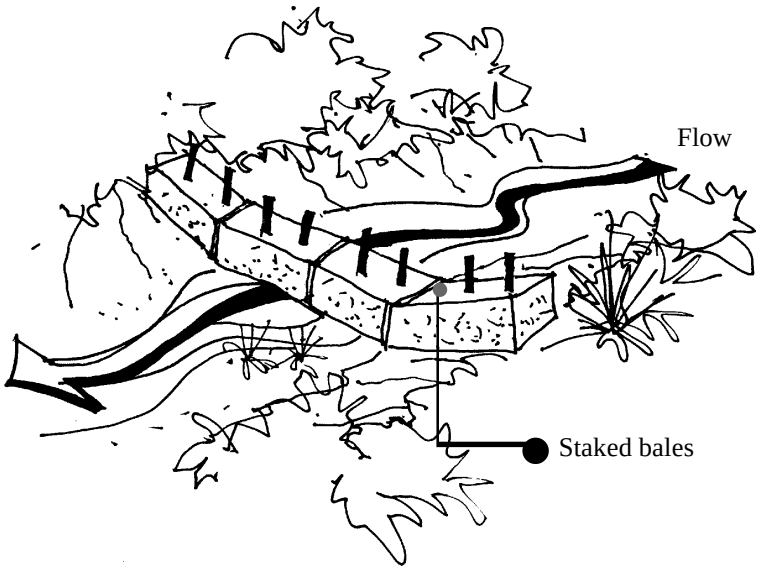
Sediment and Erosion Controls are used as a temporary solution for disturbed sites for use until stabilization has occurred.

Soil stabilisation practices include:

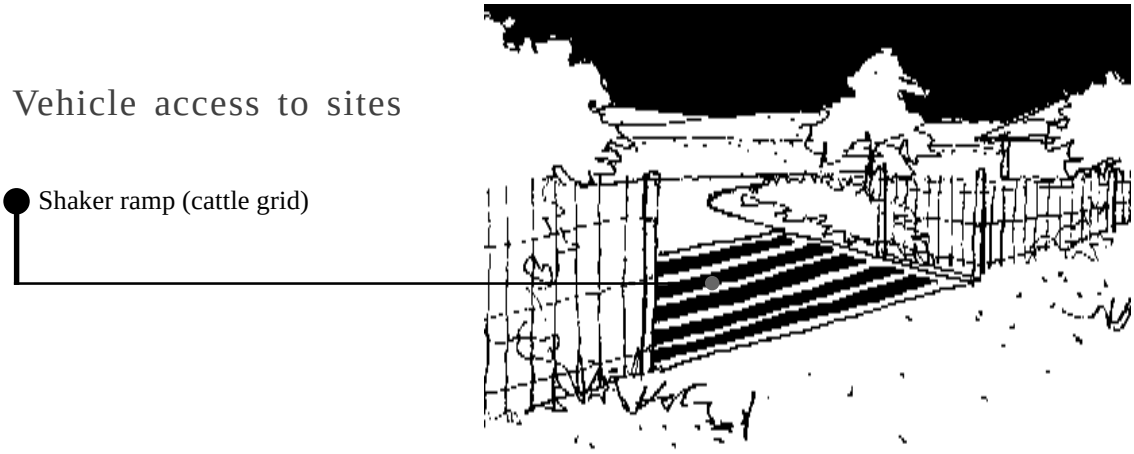
* Sediment control fencing
* Straw bales
* Check dams
* Kerbline turf strips
* Stabilised site access points
* Shaker vehicle access points
* Correct practices for stock piles.

Refer also BMP - Stabilisation of Disturbed Sites.

Straw bale traps or check dams

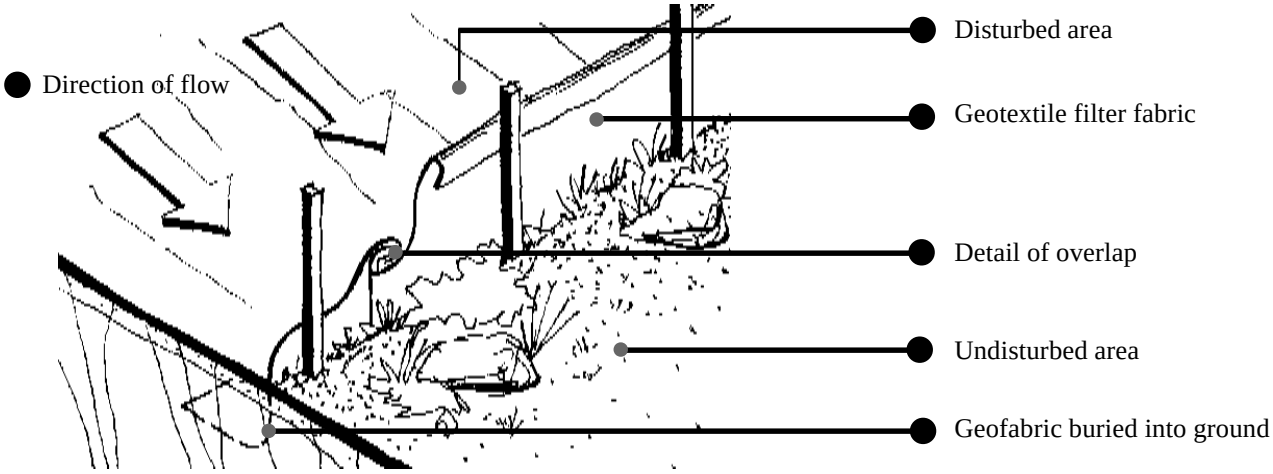


Vehicle access to sites

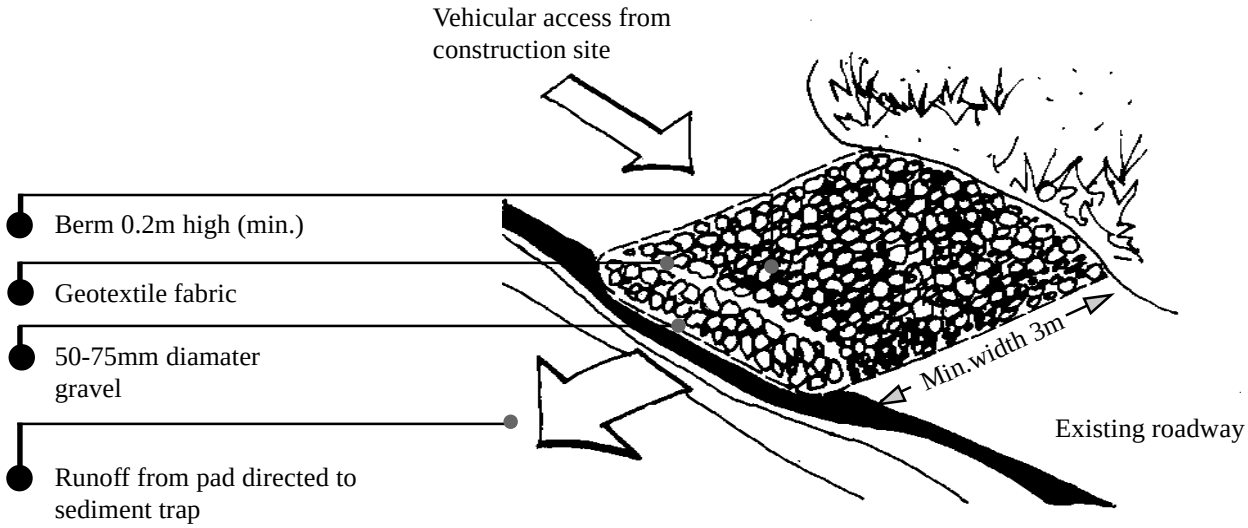


Vehicle access to sites

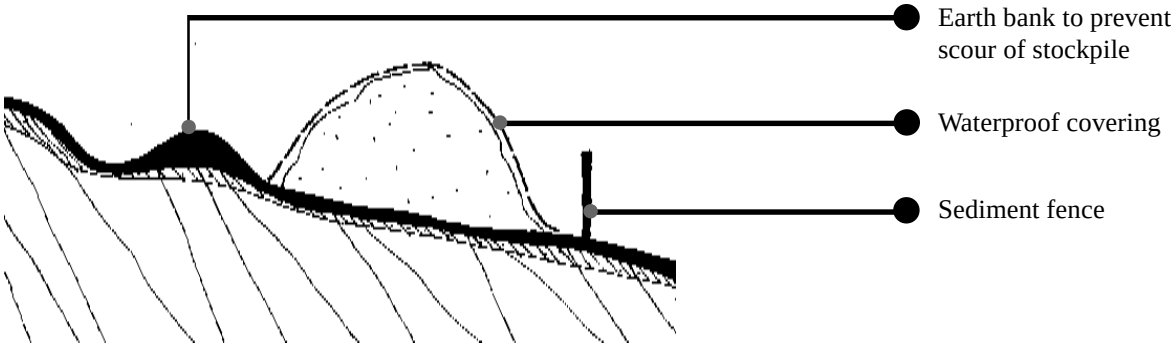
Sediment fence



Vehicle access to site



Building material stockpiles



SEDIMENT AND EROSION CONTROLS

Application Where BMP May Apply

* All building or development sites where the soil surface is disturbed temporarily.

Conditions When BMP May Apply

* Installation of sediment and erosion controls are essential on building sites before the commencement of works to ensure adequate trapping of soil during periods of wet weather.

Purpose

* To filter runoff from small areas and trap sediments, preventing them from entering watercourses.

Limitations

* Many devices are only suitable for small catchments. Effective planning of larger sites ahould divide them into manageable catchments.

* Devices can deteriorate over time and require regular checking.

* Devices need to be replaced if choked by sediment, however effective maintenace should prevent this from occuring.

Integration Opportunities and Constraints

* Correct installation and maintenance of these devices can prevent problems associated with blockages and flooding, sediment and weed plumes in bushland areas and smothering of aquatic habitats

Cost Effectiveness

* These devices are relatively inexpensive to install initially. They are very cost-effective if properly installed and regularly maintained.

Maintenance

* Inspect frequently and repair or replace as appropriate, particularly after rain or high wind.

Construction Technique/Expertise

* Installation should occur as per manufacturer's specifications and/or CaLM manual.

Compliance

Conditions of development or building consent including the approved Sediment and Erosion Control Plan
Clean Waters Act (1970)
Environmental Offences & Penalties Act (1989)
Local Government Act (1993)
Soil Conservation Act (1938)

References

Department Urban Affairs & Planning (1996), Resource Guide

CaLM (1992), Urban Erosion & Sediment Control Field Guide, CaLM

CaLM (1992), Urban Erosion & Sediment Control Manual

Department of Housing (1993), Soil & Water Management for Urban Development

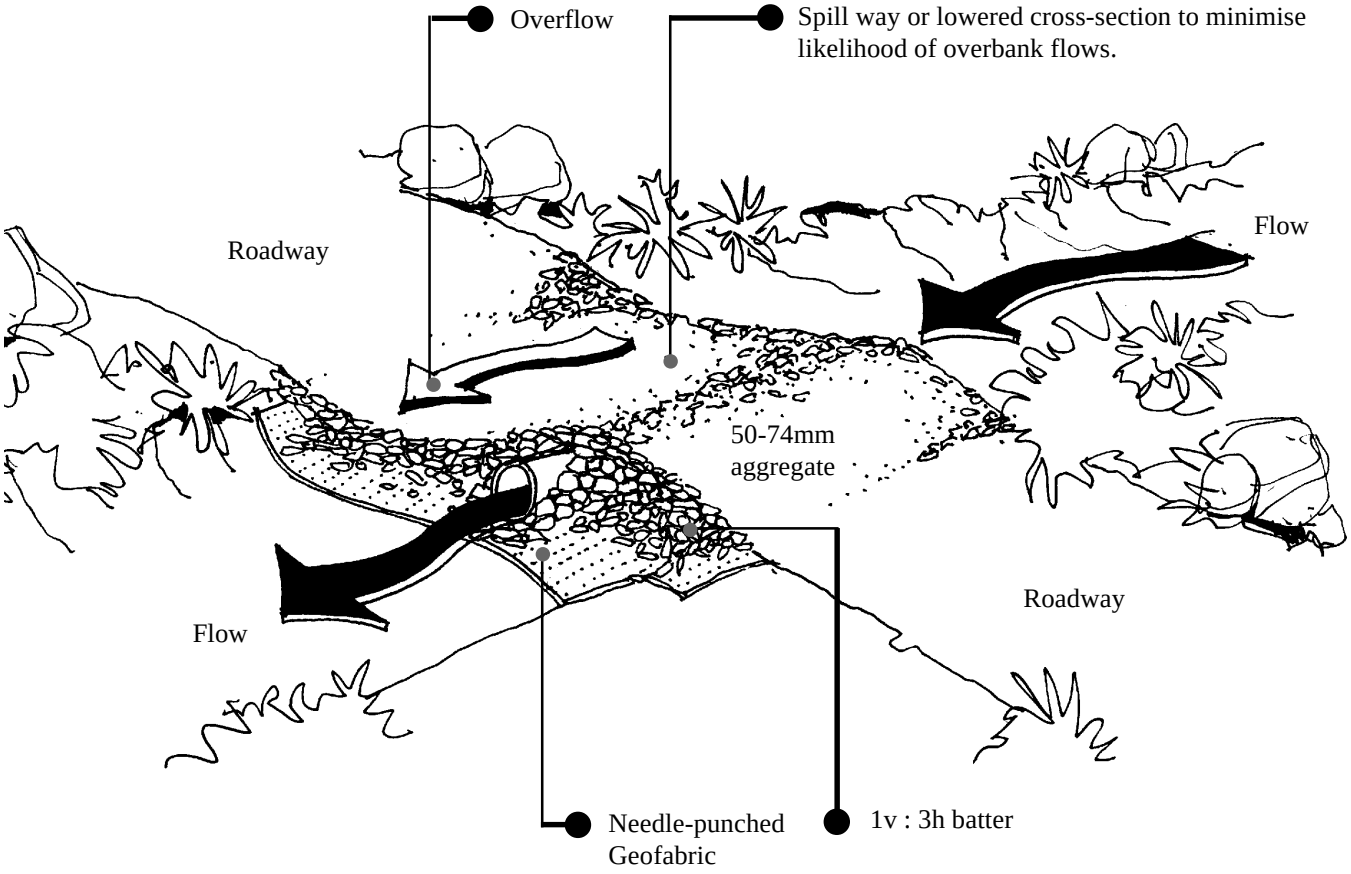
Lane Cove River CMC (1996), 'Keep it Clean' a guide to sediment control on building sites

EPA for State Stormwater Co-ordinating Committee (1996), Managing Urban Stormwater, Construction Activities (Draft).

TEMPORARY WATERWAY CROSSINGS

Description

This construction technique allows vehicles to easily and safely cross a watercourse without causing damage and erosion to the creek bed and banks. It is usually achieved by using pipes or culverts to carry low flow under the raised carriage-way without impediment.



Temporary Waterway Crossing

Application Where BMP May Apply

* New development

* Retrofitted into existing drainage lines/watercourses for maintenance or access purposes.

Conditions When BMP May Apply

* Hornsby Council may require developers to install these temporary measures as a condition of development approval, where drainage lines/watercourses are associated with works.

* Note: A watercourse is defined as any blue line on a 1:25,000 topographical map, as produced by the Central Mapping Authority, and/or a drainage line displaying aquatic or semi-aquatic habitat. This includes the presence of any species of ephemeral aquatic vegetation.

TEMPORARY WATERWAY CROSSINGS

Purpose

* To provide adequate temporary access across drainage lines/watercourses with minimum disturbance and cost.

Limitations

* Can only effectively conduct flow for which the culvert or pipe diameter is designed.
* Extent of native vegetation in and adjoining the waterway (riparian zone).
* Grade of side batters (less than a 1v: 3h slope).

Cost Effectiveness

* Dependent on the size of the crossing and shaping works involved on the side batters. Because the structure is temporary all materials including the pipe can be reused for further projects. With this in mind, the crossing works are very cost-effective ($1,000 - $5,000).

Construction Techniques/Expertise

As per Diagram to include:

* Needle punched geo-fabric over base of waterway.
* Minimum 200mm depth of clean gravel (50-75mm diameter) or aggregate over the top.
* Provision for emergency spillway/depression over the top of the crossing for overtopping in larger storm events.
* Ensure the pipe outlets extend past the toe of the aggregate (to prevent undercut and scour).

Maintenance

* Regular inspections of the structure after each storm event is essential for operating efficiency, including blockages of the pipe/culvert.
* Recover any gravel/aggregate that may have been dislodged.
* Remove structure and restore waterway at the conclusion of works (including stabilisation of the channel bed and banks with rock and/or vegetation).

Compliance

Hornsby Shire Council - Conditions of Development Consent
Hornsby Shire Local Environment Plan, (1994)
Local Government Act, (1993)
Rivers and Foreshores Improvement Act, (1948)
Clean Waters Act, (1970)
Soil Conservation Act, (1938)

References

CaLM (1992), Site Work Practice 25 in Soil and Erosion Controls, CaLM.

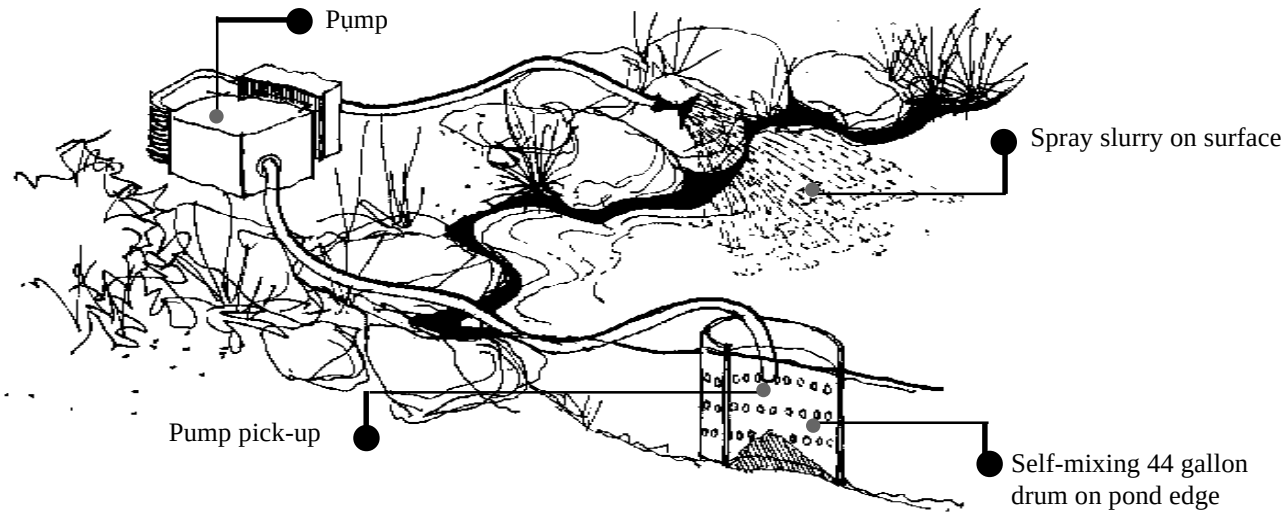
Environmental Protection Authority (1996), Site work Practice 25 in Managing Urban Stormwater, Construction Activities, Draft, EPA for Stormwater Co-ordinating Committee.

FLOCCULATION

Description

Flocculation refers to the application of chemicals (usually gypsum - CaSO4) to water bodies to cause suspended solids to form large “flocs’ which precipitate. These flocs can then be mechanically removed.

Flocculation system (example)



Application Where BMP May Apply

* Enclosed wet retention or sediment basins, particularly during construction stage when soil is disturbed.

Conditions When BMP May Apply

* Sediment basins which contain suspended solids eg. sites which contain clay soils in which soil particles are highly dispersible and water remains ‘murky’ for days.

Purpose

* To improve water quality by removing fine particulate matter which is held in suspension and any inactive phosphorous.

Limitations

* Requires appropriate dosing rates and to be spread evenly across the pond. This can be done by pre-mix and a pump or spreading by hand (depending on pond surface area).

* Alum (Aluminium Sulphate) is not recommended for use in the Hornsby Shire due to the nature of low pH soils and the potential for aluminium toxicity to effect aquatic life. Organic polyelectolytes can also serve as flocculants but are not recommended for use in Hornsby Shire.

* Removal of precipitates may be difficult and cause temporary disturbance to the water quality.

FLOCCULATION

Integration Opportunities and Constraints

* Improved water quality and clarity may increase recreational and aesthetic potential of a water body.

* Flocculation is not successful in large ponds or basins which have a significant wind fetch, as the wind generates turbulance which inhibits the settling of flocs.

Cost Effectiveness

* Approx. cost per dose is $9 (plus labour) (1996). Large areas require pre-mixing and numerous doses. Operation and maintenance costs will vary with the degree of mechanisation and amount of sludge remaining for disposal. The amount of dosage and hence cost will depend on the soil type in the disturbed area and the size of the pond.

Maintenance

* Regular inspection to determine if sufficient disposed material has flocculated (within 36-48hrs).

* Disposal of sediment and floc to secure landfill as required.

* Catchments draining industrial and/or agricultural lands will require sediment testing to determine if the sediemts are contaminated and thus require authorised disposal.

Construction Technique/Expertise

* Accurate dosing rates to be utilised.

* Adequate access for machinery when removing sediment and floc to be considered when designing artificial ponds, and basins.

Compliance

Clean Waters Act (1970)
Environmental Offences & Penalties Act (1989)
Local Government Act (1993) - Conditions of Development Consent
Review of Environmental Factors to be undertaken prior to commencement of work

References

Department of Housing (1993), Soil & Water Management for Urban Development

Department Urban Affairs and Planning (1996), Resource Guide for BMPs to Control Diffuse Source Water Pollution in the Hawkesbury-Nepean Catchment

Whelans and Halpern Glick Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

Freeman, G and Howell, L (1995), Saline Flocculation in Stormwater Quality Management in Soil & Water Management for Urban Development - Conference Proceedings

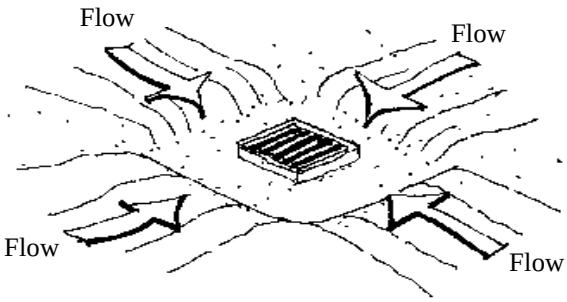
Environmental Protection Authority (1996), Managing Urban Stormwater, Construction Activities (Draft), EPA for the State Stormwater Co-ordinating Committee, Sydney.

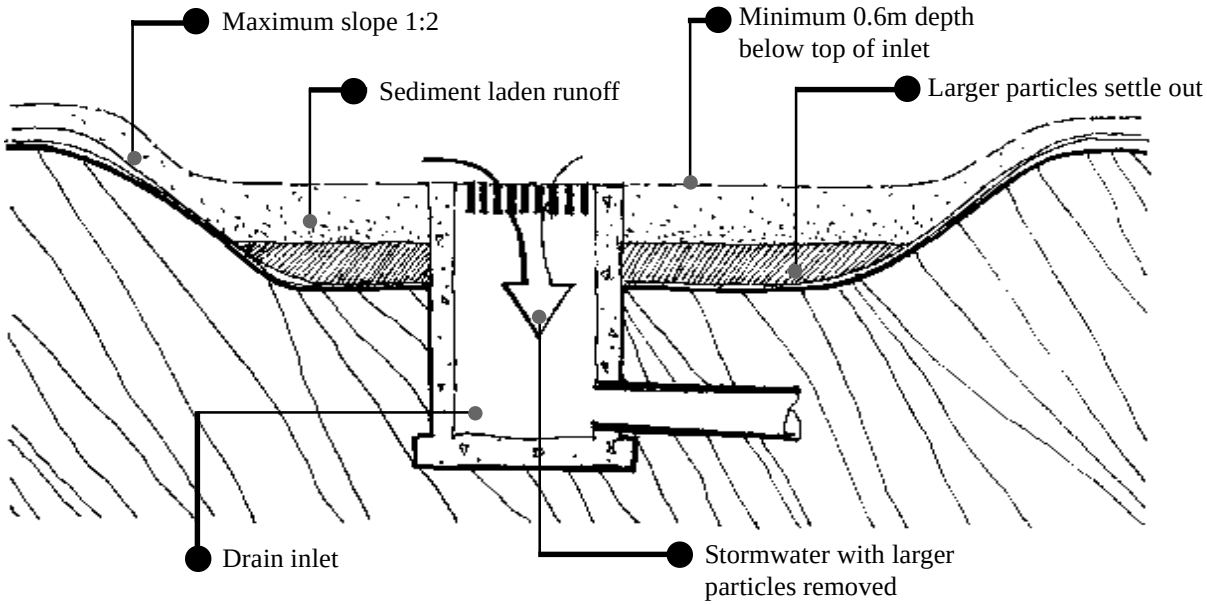
SMALL SEDIMENT TRAPS

Description

Small sediment traps are temporary sediment control structures, formed by excavation and embankment construction to intercept sediment laden runoff and to retain the sediment. They can also include silt fencing comprised of geotextile filter fabric.

Excavated sediment trap





Application Where BMP May Apply

* New development.
* Council activities - maintenance or construction.

Conditions When BMP May Apply

* Any development or activity where disturbance of the surface will occur.

SMALL SEDIMENT TRAPS

Purpose

* This BMP will reduce the risk of water quality decline by minimising siltation of downstream waterways.

Limitations

* Only suitable for catchments less than 0.4 hectares in size.
* Requires regular cleaning and disposal of sediments.
* Subject to soil type.

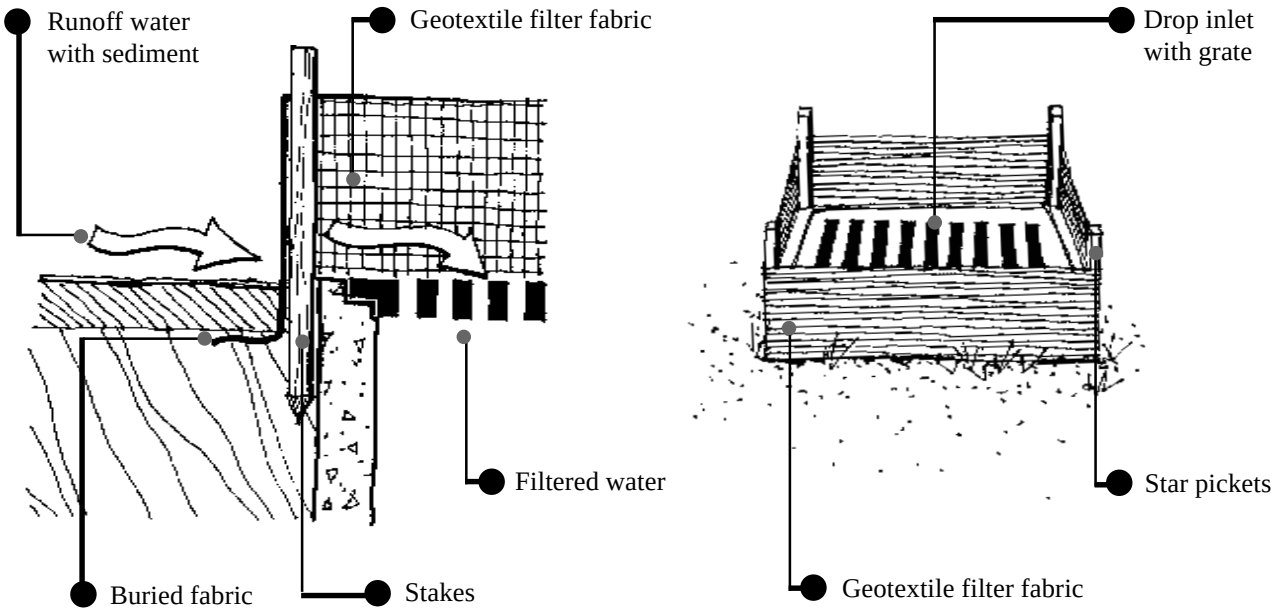
Integration Opportunities and Constraints

* No opportunities or constraints as these are generally temporary structures.

Cost Effectiveness

* Inexpensive and effective control measure ($20 - $200) (1996)
* Dumping fees of sediment $40/tonne (1996)

Geotextile filter fabric drop inlet sediment trap



SMALL SEDIMENT TRAPS

Maintenance

* Requires regular and frequent inspection with repairs as necessary after damage resulting from construction plant movement as well as after rain.

Construction Technique/Expertise

* Requires suitably trained personnel, familiar with the design and installation techniques.

Compliance

Required for disturbed sites with an area less than 0.4 ha.
Clean Waters Act (1970)
Soil Conservation Act (1938)

References

Dept. Land and Water Conservation, Urban Erosion and Sediment Control, 1992 edition

Department Urban Affairs & Planning (1996), Resource Guide

CaLM (1992), Urban Erosion & Sediment Control Manual

Department of Housing (1993), Soil & Water Management for Urban Development

Lane Cove River CMC (1996), `Keep it Clean' a guide to sediment control on building sites

Environmental Protection Authority (1996), Managing Urban Stormwater, Construction Activities (Draft), EPA for the State Stormwater Co-ordinating Committee, Sydney.

LARGE SEDIMENT BASINS

Description

Large sediment basins are constructed to trap and remove sediment contained in runoff on medium to large construction sites. The basin should have sufficient capacity to store volumes from 2 to 5 year ARI storms. The basin layout should be configured to give a length to width ratio of at least 2:1 to prevent short circuiting. It is fitted with a de-watering system and usually remains empty between rainfall events. Runoff from outside the site or from stabilised areas of the site should be diverted away from the basin.

Application Where BMP May Apply

* New development
* Council activities

Conditions When BMP May Apply

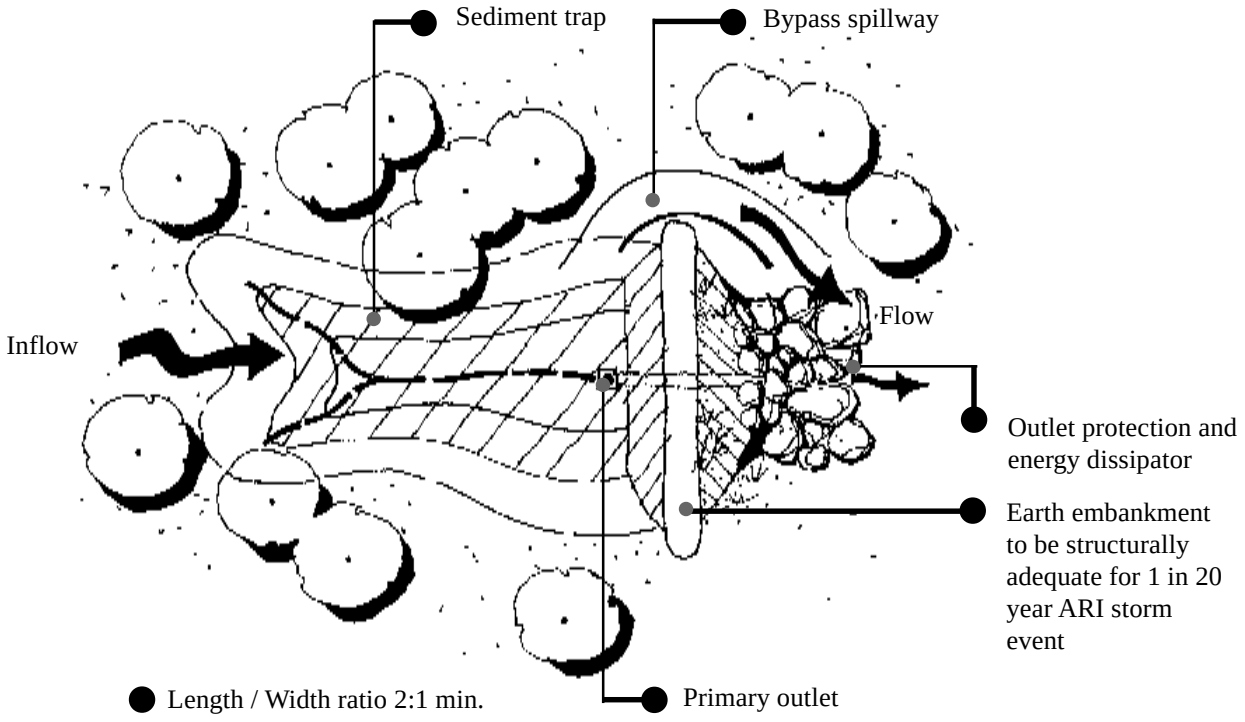
* Any large development or activity, where disturbance of existing surface cover will occur such as subdivisions.

Purpose

* This BMP will reduce the risk of water quality decline by reducing siltation of downstream waterways.

Limitations

* Requires regular cleaning after rain periods and disposal of sediments.
* Access for heavy equipment will be necessary for maintenance.



LARGE SEDIMENT BASINS

Integration Opportunities and Constraints

* There may be opportunities for reuse as part of a permanent stormwater retention and quality system on completion of the site works. Early design consideration should therefore be given to this potential and its siting relative to other site features. Sizing of basins should take into account the particle sizes of sediment entering the basin to allow adequate settling and residence time.

Cost Effectiveness

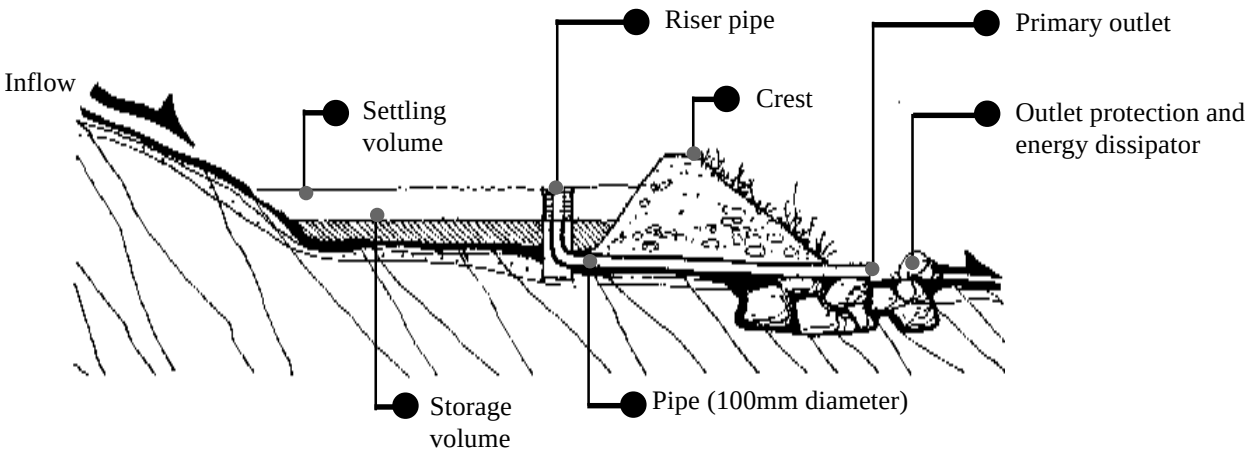
* Expensive but effective control measure (up to $200,000 in the Hornsby Shire (1996))

Maintenance

* Requires frequent inspection and sediment removal after each major storm event.

* Access for maintenance requires careful consideration as heavy equipment may be necessary.

* Sediment removed from basins should be re-used on site where possible, or disposed at a secure landfill site. Contaminated sediments are to be disposed of at approved sites.



Construction Technique/Expertise

Requires suitably trained personnel, familiar with the design and installation techniques.

Compliance

Required for all disturbed sites greater than 0.4ha.

Basin volume (m^3/ha of disturbed catchment)

Slope gradient (%)		
	<10%	250m^3/ha
	10-15%	400m^3/ha
	>15%	detailed design required

Minimum basin surface area (m^2/ha of disturbed catchment)

	<10%	180m^2/ha
	10-15%	200m^2/ha
	>15%	Detailed design required

Length to width ratio of basin to be 2:1 to prevent short circuiting

Clean Waters Act (1970)

Soil Conservation Act (1938)

References

Department of Land and Water Conservation (1992 ed.), Urban Erosion and Sediment Control.

Department Urban Affairs & Planning (1996), Resource Guide

CaLM (1992), Urban Erosion & Sediment Control Manual

Department of Housing (1993), Soil & Water Management for Urban Development

Lane Cove River CMC (1996), `Keep it Clean' a guide to sediment control on building sites

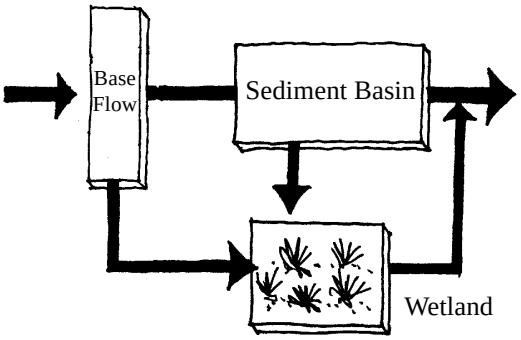
EPA for State stormwater Co-ordinating Committee (1996), Site Work Practice 34, Managing Urban Stormwater, Construction Activities, (Draft), EPA for the State Stormwater Co-ordinating Committee, Sydney.

CONSTRUCTED WETLANDS

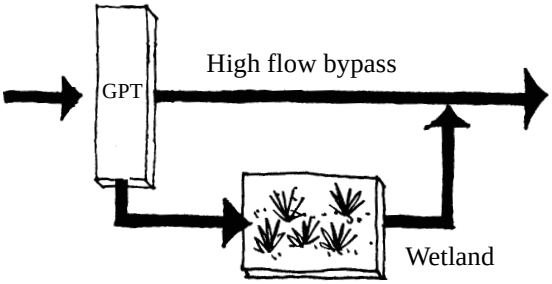
Description

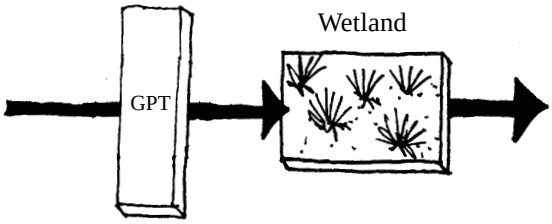
Constructed wetlands are areas of shallow ponded water either on-line or preferably adjacent to drainage lines, where a large proportion of their water surface is covered by macrophytes.

Refer also to BMP Ponds and Urban Lakes

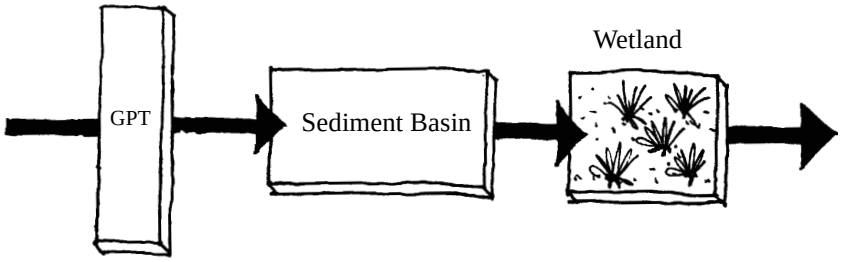


Free surface - offline





Free surface - Online



Application Where BMP May Apply

* May be incorporated into a planned system of open space, as part of a new development or alternatively retrofitted into existing urban polluted watercourses where practical.

Conditions When BMP May Apply

* For treatment of diffuse polluted runoff as a result of localised development/industrial activity.
* Can be a locally or regionally sized structure which has a surface area of at least 0.5% of the catchment area served.
* Constructed wetlands can also be multi-functional.

Purpose

* To improve water quality of stormwater by reducing concentration of pollutants through physical processes and assimilation by aquatic plant life.

Limitations

* May be limited where suitable space (sizing), access and land costs are at a premium
* A minimum of 18Ha. of site catchment is required to maintain a permanent trickle flow.
* Site constraints may influence whether the wetland is placed on-line or off-line, and is subsurface or a free-surface in design.

Integration Opportunities and Constraints

Positive impacts include:

* Creation of wildlife habitat, increased recreation and landscape amenities,
* Higher property values and greater educational/scientific potential.
* Reduction of peak flow rates and flooding potential.

Negative impacts include:

* Safety and liability,
* Sedimentation of the permanent pool and pests (eg mosquitos) and odour potential.
* Can be integrated with other devices for improved water quality treatment and water balance.
  Refer BMPs Trash Racks, Energy Dissipators.

Cost Effectiveness

* Potentially very cost-effective at removing pollutants/contaminants from stormwater.
* Construction cost: $10,000 - $250,000 (size dependant) (1996).

Maintenance

* Ongoing maintenance for repair/replacement of structures and macrophytes, periodic sediment and trash removal/ treatment of potential pests, weeds and odours is required.

CONSTRUCTED WETLANDS

Maintenance (cont.)

* Ongoing monitoring of water quality is essential to measure performance and to ensure achievement of objectives at each inlet to pond.

* Ongoing monitoring of water quality parameters is essential to indicate performance and to measure the achievement of objectives.

* "Weeding" and removing aggressive species will ensure efficency.

* A GPT/Sediment Basin upstream or at each inlet to wetland is required.

* Wetland design should consider hydraulic flows/residence time, length to width ratios, optimum depth < 1 metre, plant selection species mix and timing, substrate, public health and safety, baffling, water level control, access and ongoing operation and maintenance.

Construction Technique/Expertise

* Skilled and experienced machine/plant operators and experienced supervision is essential.

Compliance

Preparation of a Sediment & Erosion Control Plan and Review of Environmental Effects (REF) prior to construction.
Clean Waters Act (1970)
Local Government Act (1993)
Rivers and Foreshore Improvement Act (1948)
With condition of Development consent/DCPs/LEPs
Design to treat the 2 year ARI event (total run-off from a critical storm duration)
Volume of permanent pool estimate

WV = RmD / 365 (EPA 1996)

Where: Wv = Wetland Volume
Rm = estimate of mean annual runoff calculated form the average rainfall
D = theoretical hydraulic residence time (in days)

Minimum length to width ratio 3:1
Maximum length to width ratio 10:1
Maximum depth for macrophyte zones = 0.5m
Maximum depth for open water zones - 2.5m

References

Environmental Protection Authority (1996), Managing Urban Stormwater, TreatmentTechniques (Draft), EPA for the State Stormwater Co-ordinating Committee, Sydney.

NSW Department of Planning (1993), Better Drainage Guidelines for the Multiple Use of Drainage Systems, Department of Planning, Sydney.

Whelans and Halpern Glick Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

Bourne, P. and Sheathe-Reid, M. (1990), Integration of Wetland and Riparian Buffer Systems within the Urban Environment, in Proceedings of National Greening Australia Conference, 1994.

White, G. (1995), Constructed Wetlands for Urban Stormwater, proceedings for Soil and Water Management for Urban Development Conference, 1995, Sydney.

References (cont.)

White, G. (1995), The Design of Constructed Wetlands in NSW in Proceedings of Wetlands for Water Quality Control, National Conference, Townsville, 1995.

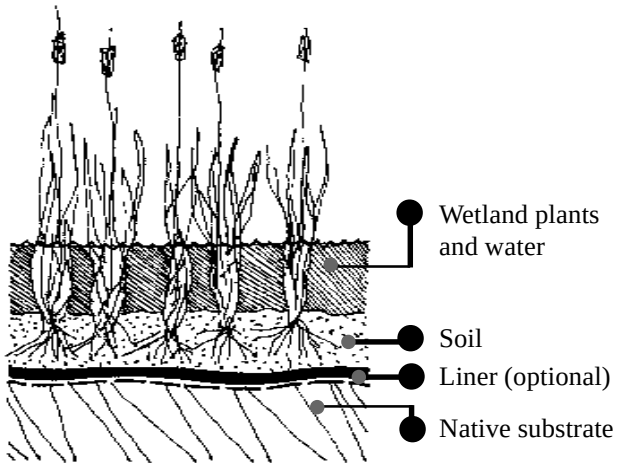
Reed, S.C. Crites, R.W. and Middlebrooks, E.J. (1995), Natural Systems for Waste Management and Treatment, Second Edition, McGraw-Hill Inc.

Reed, S.C. Mitchell, C. and Maslin, P. (1995), Artificial Wetlands Principles, Design and Management, in Course Notes from International Winter Environment School, Gold Coast, 1995.

Department of Urban Affairs and Planning (1996), Constructed Wetlands in the Hawkesbury-Nepean in Background Information Sheet Resource Guide HNCM Trust, DUAP, Sydney.

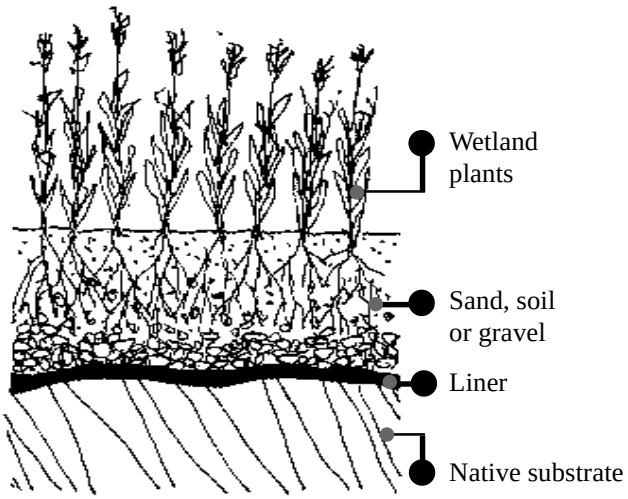
Russell, R. et. al. (1995), Constructed Wetlands and Mosquitos - Some Problems and Some Solutions, in Proceedings of Wetlands for Water Quality Control, National Conference, Townsville, 1995.

Environmental Protection Authority (1996), Site Practice 4 and 13, in Managing Urban Stormwater, Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Commitee, Sydney.



Free water surface

Water level is above the ground surface; vegetation is rooted and emergent above the water surface; water flow is primarily above ground; vegetation may be planted or allowed to colonize voluntarily.



Subsurface flow system

Water level is below ground; water flow is through soil or gravel bed; root penetration is to bottom of bed.

WATER QUALITY CONTROL PONDS & URBAN LAKES

Description

Water quality control ponds (including urban lakes) are similar to constructed wetlands, however, they usually have a large open water zone and fringing macrophytes. They are usually incorporated into a planned system of open space lines adjacent to natural drainage.

Refer also BMP Constructed Wetlands

Application Where BMP May Apply

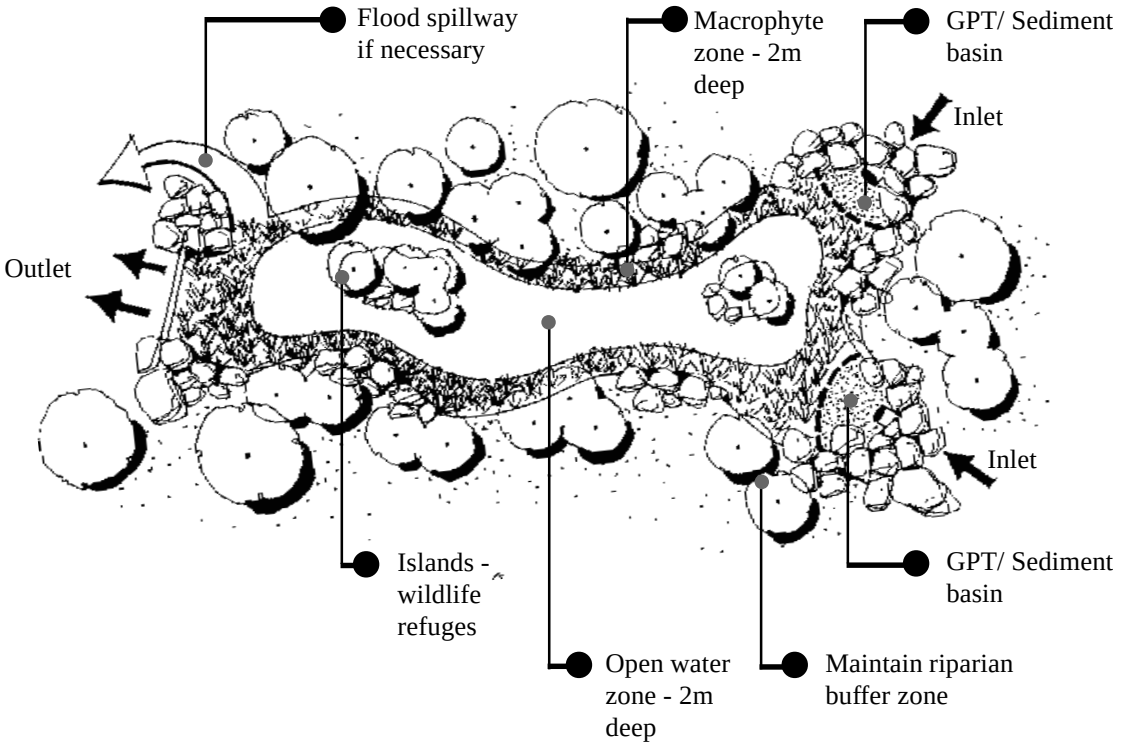
* Typically applied in open space systems.

Conditions When BMP May Apply

* Practical in high groundwater sites.
* Desirable when the constructed pond is multi-purpose.
* For enhancement of aesthetic and/or passive recreational values into a planned open space system.

Purpose

* To improve water quality of stormwater by reducing concentrations of pollutants through the process of filtration, sedimentation, ultra-violet radiation and bio-assimilations.



Limitations

* Capacity to adequately reduce pollutants (particularly nutrients) is limited due to growth of macrophytes on fringe areas only.

* If flows are too small to maintain a permanent pool in drier months, aesthetic values may deteriorate and odours may be generated.

* Probably not feasible where space/access or land costs are at a premium.

* Low flows may have an impact fringing macrophytes.

Integration Opportunities and Constraints

Positive impacts include:

* Creation of wildlife habitat,

* Increased recreation and landscape amenities,

* Higher property values and greater educational/scientific potential.

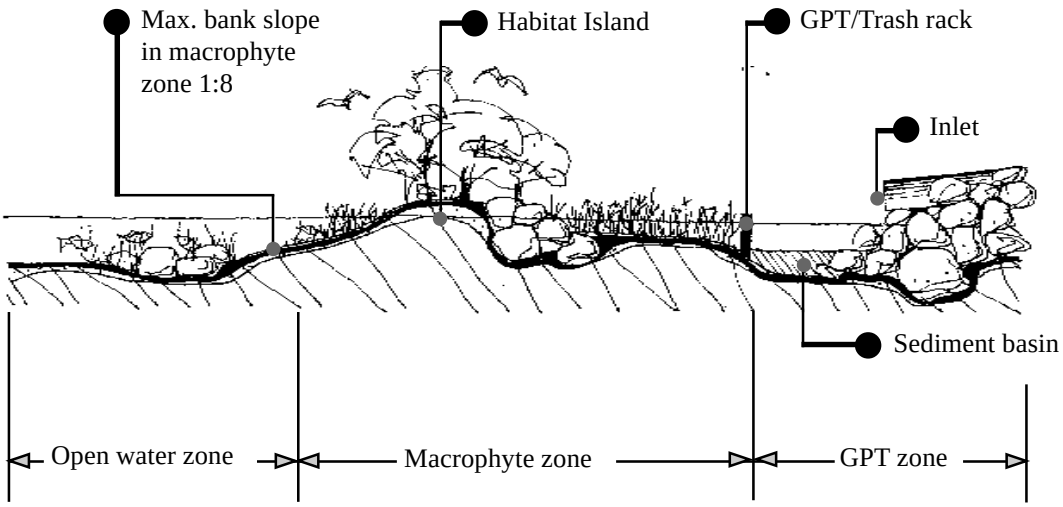
Negative impacts include:

* Safety and habitability,

* Sedimentation of the permanent pool which can also reduce peak flow rates in a trunk drainage system.

* Pest (eg. mosquitos) and odour problems.

* Can be integrated with other devices. Refer BMPs Trash Racks, Energy Dissipators.



WATER QUALITY CONTROL PONDS & URBAN LAKES

Cost Effectiveness

* More cost effective on large development sites or where runoff from several smaller sites is treated in one central pond.

* Construction costs: $20,000 - $100,000 (size dependent) (1996)

* Cost may be offset in residential developments by increased amenity and hence increased property values.

Maintenance

* Ongoing maintenance for repair/replacement of structions and macrophytes, periodic sediment and trash removal/ treatment of potential pests, weeds and odours is required.

* Costs: $500 - $5,000/yr (size dependent) (1996)

* Ongoing monitoring of water quality is desirable to measure performance and to ensure achievement of objectives.

Construction Technique/Expertise

* Installation of a GPT/Sediment Basin upstream of pond or at each inlet to pond is necessary.

* Open water zone to be a maximum of 10 metres deep.

* Macrophyte zone to be a maximum of 2.0m (average depth 0.5m) and planted with both emergent and submerged plants (6 plants/m2).

* Provision for habitat islands and retention of a terrestrial vegetation buffer zone around the pond.

* Avoid short circuiting and hydraulically ‘dead-spots’.

* A moat around the edge of deep ponds will provide greater safety.

Compliance

Clean Water Act (1970)
Local Government Act (1993)
Rivers & Foreshore Improvement Act (1948)
Conditions of Development Consent/DCPs/LEPs
Design to treat the 2 year ARI event (total run-off from a critical storm duration)
Volume of permanent pool estimate

WV = RmD / 365 (EPA 1996)
Where: Wv = Wetland Volume
Rm = estimate of mean annual runoff calculated form the average rainfall
D = theoretical hydraulic residence time (in days)

Minimum length to width ratio 3:1
Maximum length to width ratio 10:1
Maximum depth for macrophyte zones = 1.0m
Maximum depth for open water zones - 2.5m

References

Environmental Protection Authority (1996), Managing Urban Stormwater, TreatmentTechniques (Draft), EPA for the State Stormwater Co-ordinating Committee, Sydney.

NSW Department of Planning (1993), Better Drainage Guidelines for the Multiple Use of Drainage Systems, Department of Planning, Sydney.

Whelans and Halpern Glick Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

Bourne, P. and Sheathe-Reid, M. (1990), Integration of Wetland and Riparian Buffer Systems within the Urban Environment, in Proceedings of National Greening Australia Conference, 1994.

White, G. (1995), Constructed Wetlands for Urban Stormwater, proceedings for Soil and Water Management for Urban Development Conference, 1995, Sydney.

White, G. (1995), The Design of Constructed Wetlands in NSW in Proceedings of Wetlands for Water Quality control, National Conference, Townsville, 1995.

Reed, S.C. Crites, R.W. and Middlebrooks, E.J. (1995), Natural Systems for Waste Management and Treatment, Second Edition, McGraw-Hill Inc.

Reed, S.C. Mitchell, C. and Maslin, P. (1995), Artificial Wetlands Principles, Design and Management, in Course Notes from International Winter Environment School, Gold Coast, 1995.

Depatment of Urban Affairs and Planning (1996), Constructed Wetlands in the Hawkesbury-Nepean in Background Information Sheet Resource Guide HNCM Trust, DUAP, Sydney.

Russell, R. et. al. (1995), Constructed Wetlands and Mosquitos - Some Problems and Some Solutions, in Proceedings of Wetlands for Water Quality Control, National Conference, Townsville, 1995.

Environmental Protection Authority (1996), Site Practice 4 and 13, in Managing Urban Stormwater, Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Commitee, Sydney.

GPTs SMALL LITTER GRATES

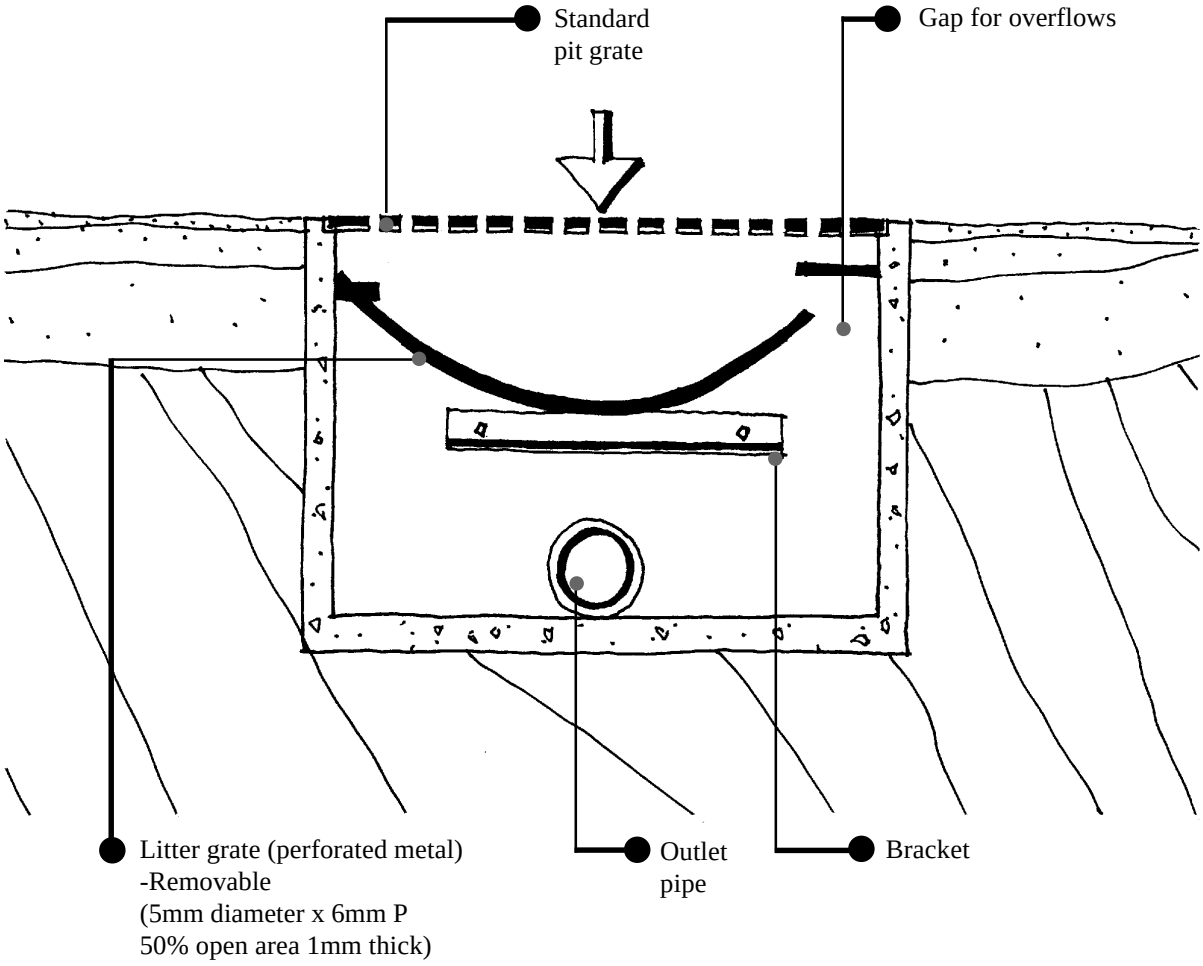
Description

A metal or plastic grate installed in stormwater pit/s in a high use outdoor commercial Mall or Plaza, to capture litter (particularly small items such as polystyrene and cigarette butts).

Application Where BMP May Apply

* New development

* Retrofitted into existing drainage systems.



GPTs SMALL LITTER GRATES

Conditions Where BMP May Apply

Hornsby Council may require developers to install permanent litter grate devices as a condition of development approval in commercial areas.

* Appropriate for retrofitting into existing development with a high litter source.
* Suitable where the outdoor area receives regular hosing down with water.
* Feasible in the treatment of 'first flush' in stormwater, designed to treat 3 month - 1 year ARI events.

Purpose

* To improve water quality downstream of a pollution source through the interception of litter/organic from high use outdoor commercial venues.

Limitations

* Does not collect sediments and soluable pollutants.
* Potential odours and health risk when handling trash.
* Must be maintained regularly to ensure optiminal functioning.
* Potential to block and cause overtopping remobilising previously caught material.

Integration Opportunities and Constraints

* Collects litter at a single, discrete location (compact) which can be installed below ground and therefore is less aesthetically obtrusive.
* Provision for overflow gap in inlet pits.

Cost Effectiveness

* Low capital cost with moderate to high maintenance costs. Less than $300 per device.

Maintenance

* Regular inspections of the structure after each hose down or storm event is essential for operating efficiency.
* Records of volume and breakdown of material removed is recommended in the determination of site specific device cost-effectiveness and trapping efficiency.

Construction Techniques/Expertise

As per Diagram to include: - appropriate sizing to treat a specific ARI event.

* one-piece construction to hold heavy loads.
* provision for permanent access for maintenance.
* portable for maintenance and relocation.
* construction from concrete and Galvanised or stainless steel (perforated metal).

GPTs SMALL LITTER GRATES

Compliance

Hornsby Shire Council - Conditions of Development Consent Hornsby Shire Local Environment Plan (1994)
Local Government Act (1993)
Clean Waters Act, (1970)

References

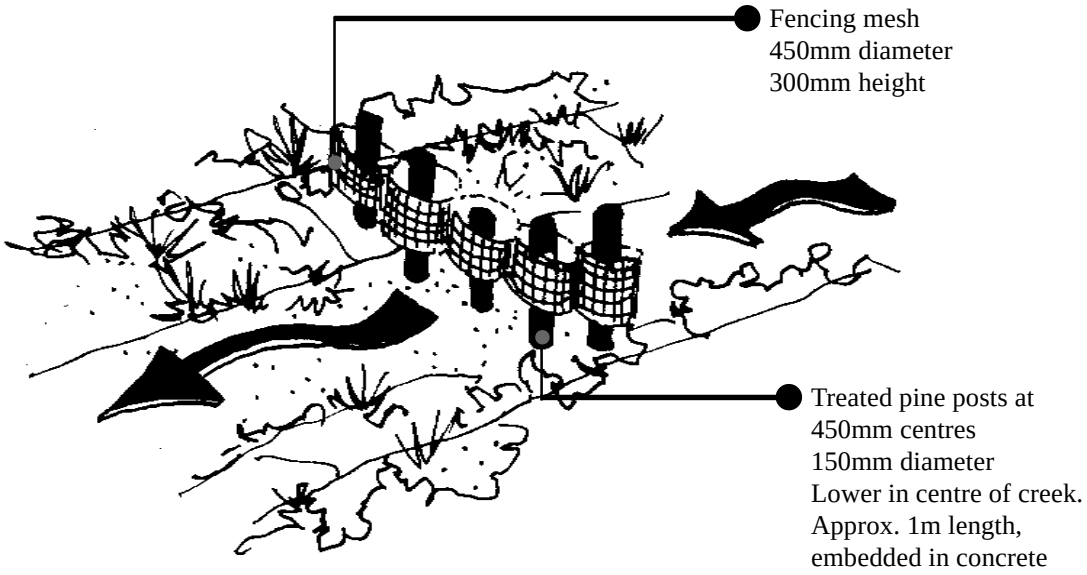
Environmental Protection Authority (1996), Managing Urban Stormwater - Treatment Techniques - Draft, EPA for Stormwater Co-ordinating Committee.

Richardson Pacific Ltd (1996), Stormwater Litter Basket brochure.

SMALL LITTER TRAPS

Description

Small litter traps are designed to collect debris in small open channels with low flows. They are constructed from treated pine posts, surrounded by a wire mesh tubes, to improve the trapping of smaller pieces of debris. They are effective for collecting plastics plus other coarse trash.



Application Where BMP May Apply

* New development
* Existing systems

Conditions When BMP May Apply

* Any small open channel needing to have plastic waste and other small debris trapped.

Purpose

* This BMP will improve water quality by reducing the amount of plastics and other debris passing into downstream waterways.

Limitations

* Only suitable for low flows (less than 1.0m3/s).
* These devices are generally unaesthetic.
* Does not collect fine (dispensable) sediments and soluble pollutants.
* Must be maintained regularly to ensure optimal functioning.

SMALL LITTER TRAPS

Integration Opportunities and Constraints

* No real opportunities due to location in a watercourse.

Cost Effectiveness

* Inexpensive to build ($300 - $1000) and very effective (1996)

Maintenance

* Requires inspection and cleaning after storm events.
* The location must allow for access by the maintenance crew.
* Vehicle access is not required, but is desirable.
* Cleaning is easy, costs $30/week approx. (1996)

Construction Technique/Expertise

* Installation is straightforward and uses simple equipment.
* Requires suitably trained personnel, familiar with the installation technique.

Compliance

Clean Waters Act (1970)

References

Environmental Protection Authority (1989), Litter Control in Urban Waterways, Meri Creek - A Pilot Study, Environmental Protection Authority, Sydney.

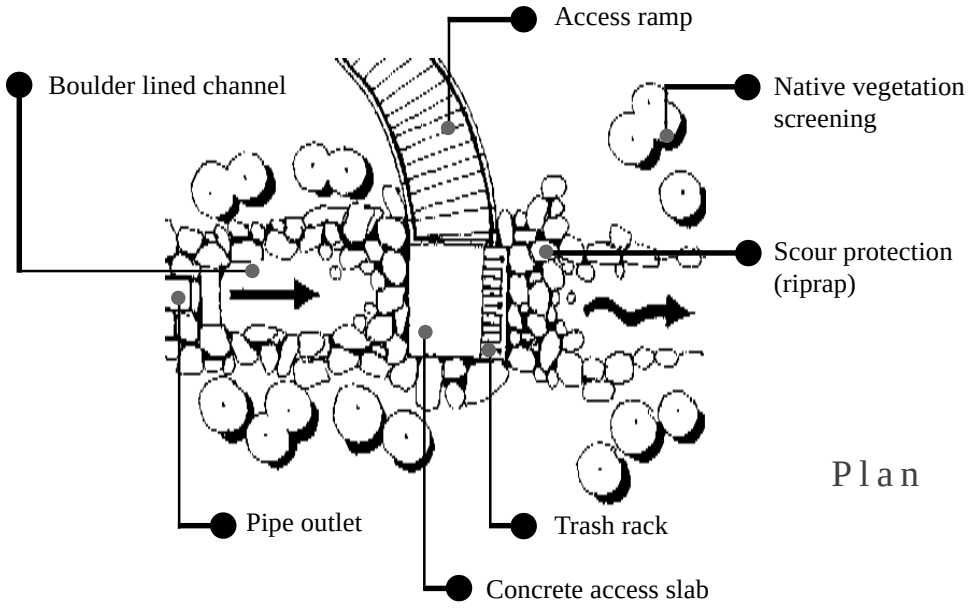
GROSS POLLUTANT TRAPS

Description

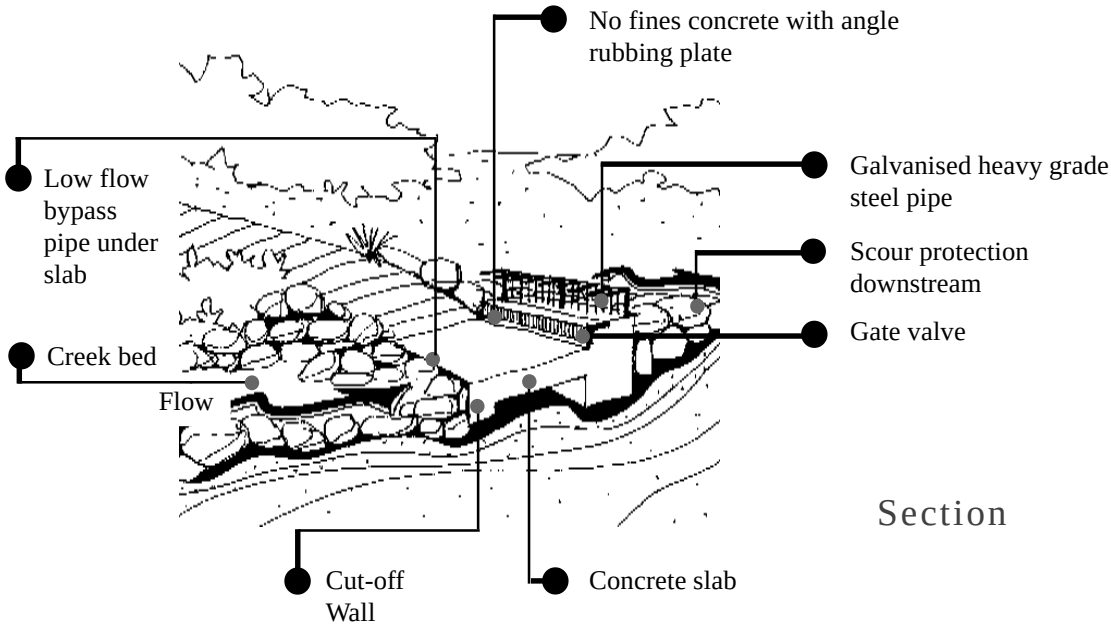
Gross pollutant traps are designed to collect debris in water courses to improve water quality, prevent blockages to pipes, culverts and narrow channels downstream. Gross pollutant traps include:

* 90° lip rack
* pit basket

Trash rack with 90° lip



Plan



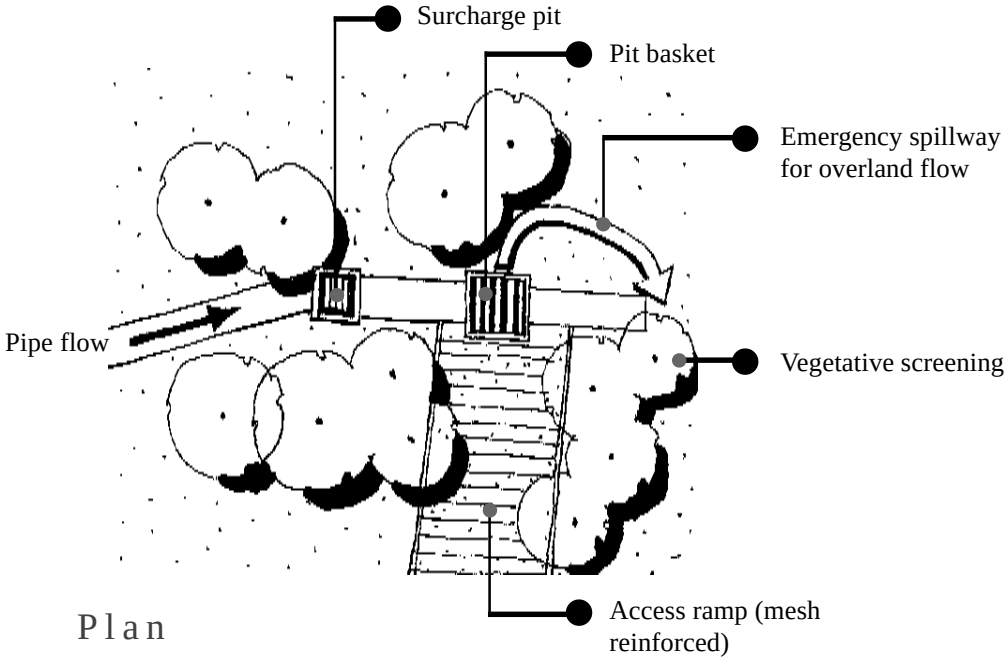
Section

GROSS POLLUTANT TRAPS

Application Where BMP May Apply

* New development. * Existing systems.

Trash pit basket



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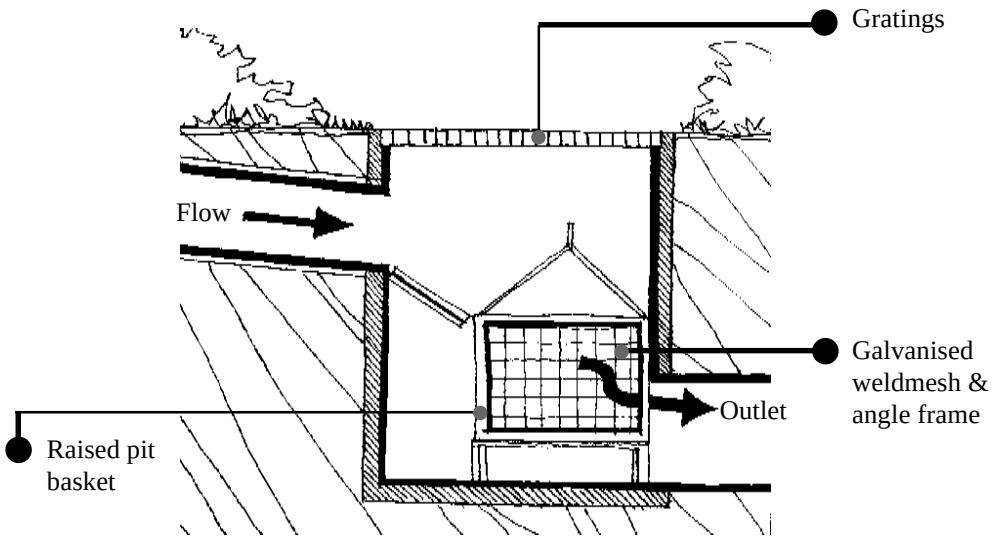


Section

GROSS POLLUTANT TRAPS

Conditions When BMP May Apply

* At pipe outlets or in drainage pits below areas which are a major source of litter eg. shopping centres and schools.
* As a condition of development consent for commercial, industrial or educational facilities, low and medium density multi unit housing.
* Appropriate for retrofitting into existing development with a high litter source.

Purpose

* To improve water quality downstream by interception of litter/organic matter and settling of coarse sediments in closed channels.

Limitations

* Does not collect fine (dispersible) sediments and soluble pollutants.
* Must be maintained regularly to ensure optimal functioning.
* Possible odour and aesthetic problems until cleared out.
* Limited to suitable sites with allowance given for maintenance access.
* Function affected by density of deciduous trees in the catchment. Leaves may result in blockage and dissolved oxygen levels in the water.

Integration Opportunities and Constraints

* Pit baskets can be unobtrusive and easily concealed.
* Trash racks can be integrated into natural systems aesthetically be taking advantage of existing/planted vegetation for screening and use the of natural rock and other materials to disguise any hard engineering components.

Cost Effectiveness

* GPT's are very cost-effective in terms of cost per volume of runoff treatment for coarse sediment, trash and debris.
* Construction Cost: $5,000 - $50,000 (1996).

Maintenance

* Regular inspection of GPT's after storm events is essential for operating efficiency. Clean-out frequency is highly variable (5-10 times per year).
* Records of volume and breakdown of material removed is recommended in determining cost effectiveness.

GROSS POLLUTANT TRAPS

Construction Techniques and Expertise

* Necessary understanding of site hydrology and history of flooding.
* Allowance for overflow/bypass in the event of the device blocking and access for ease of maintenance.
* Preparation of a Sediment & Erosion Control Plan prior to construction.
* Design should consider the aesthetics of the site, particularly if part of an open space system.

90½ lip rack

* Removable trash rack panels to fully span watercourse.

Pit basket

* 50 x 50 x 4mm galvanised mesh (welded to frame)
* 50 x 50 x 8mm angle strengthener
* 75 x 75 x 8mm angle frame
* Frame dynabolted to pit wall.
* Typical basket 1140 x 728 with angled trash rack/slide (max) 60mm gaps) with bars parallel to water flow.
* Pit grating (with 2 opening panels) at top of pit.

Compliance

Clean Waters Act (1970)
Environmental Penalties & Offences Act (1989)
Local Government Act (1993)
Condition of development consent

References

Environmental Protection Authority (1996), Site Practice 4 and 13, in Managing Urban Stormwater, Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Commitee, Sydney.

Institute of Engineers Australia (1992), The Design and Performance of Gross Pollutant Traps and Wet Basins.

Department of Urban Affairs and Planning (1996), Resource Guide, Department of Urban Affairs and Planning, Sydney.

Whelans and Halpern Glick Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

Freeman, G. (1995), Off-Line Improvement Stormwater Quality Controls in Proceedings of Soil and Water Management for Urban Development Conference, Sydney, 1995.

COARSE TRASH RACKS

Description

Coarse trash racks are designed to collect large debris in small open channels to prevent blockages in downstream pipe systems. They are constructed from treated pine posts. They are effective for collecting building material, branches and vegetative material.

Application Where BMP May Apply

* New development
* Existing systems

Conditions When BMP May Apply

* Any small open watercourse with a downstream pipe system, where blockage would increase the flood risk for property.

Purpose

* This BMP will improve water quality downstream by reducing the amount of coarse material passing into down stream waterways.

Limitations

* Only suitable for low to medium flows (1.0 - 3.0 m3/s approx.). Not suitable for small litter items, fines or soluble pollutants.
* Possible odour and aesthetic problems until cleaned out.
* Must be maintained regularly to ensure optimal functioning.

Integration Opportunities and Constraints

* No real opportunities due to location in a watercourse

Cost Effectiveness

* Inexpensive to build ($500 - $2000) and very effective (1996)

Maintenance

* Requires inspection and cleaning after each medium to large storm event.
* The location must allow for access by the maintenance crew.
* Vehicle access is not required, but is desirable.
* Cleaning is easy, costs $300 - $1500/year and produces 0.05 - 0.2 $^{m3/ha/yr}$ of material. (1996)

COARSE TRASH RACKS

Construction Technique/Expertise

* Installation is straightforward and uses simple equipment.
* Requires suitably trained personnel, familiar with the installation technique.
* Design to consist of treated pine posts up to 250mm diameter at 0.6-1.0m spacings, located in a “V” shape.
* Minimum 400mm below ground and 1.0m above ground.

Compliance

Clean Waters Act (1970)

References

Willimott, K.B. (1992), Investigation into the Design and Use of Coarse Trash Racks.

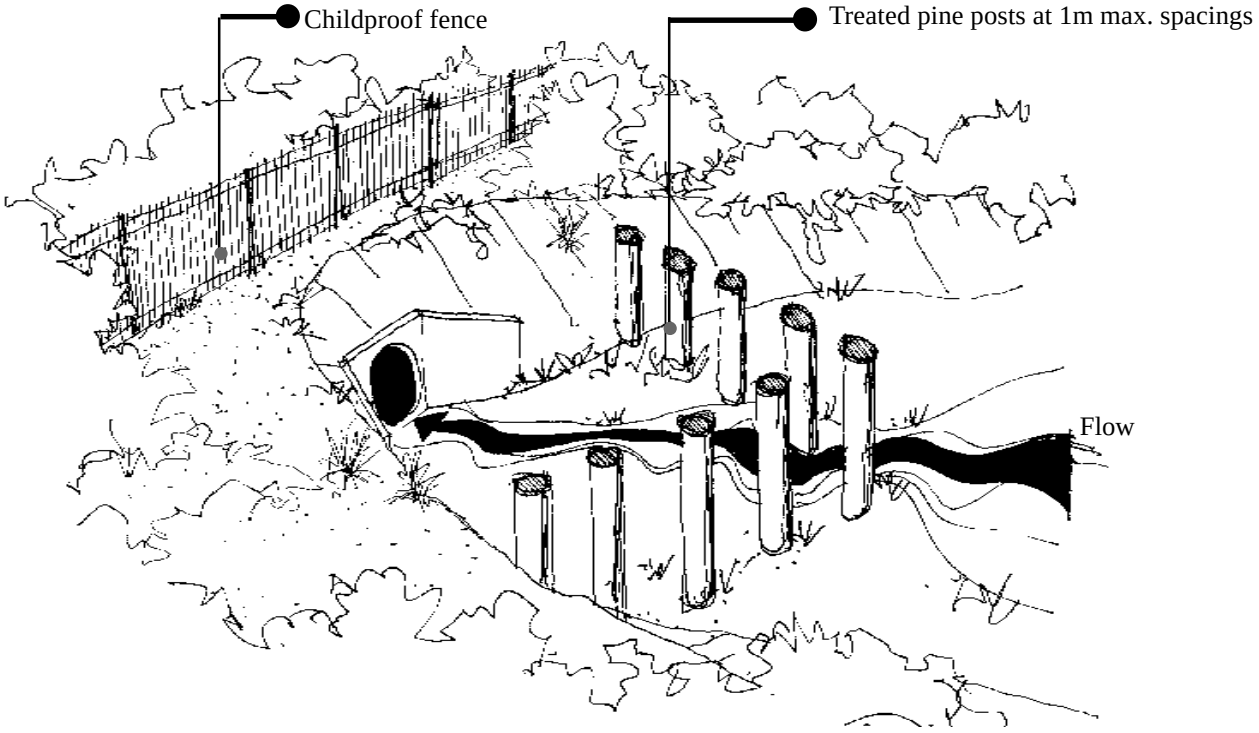
Institute of Engineers Australia (1992), The Design and Performance of Gross Pollutant Traps and Wet Basins.

Department of Urban Affairs and Planning (1996), Resource Guide, Department of Urban Affairs and Planning, Sydney.

Whelans and Halpern Glick Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

Freeman, G. (1995), Off-Line Improvement Stormwater Quality Controls in Proceedings of Soil and Water Management for Urban Development Conference, Sydney, 1995.

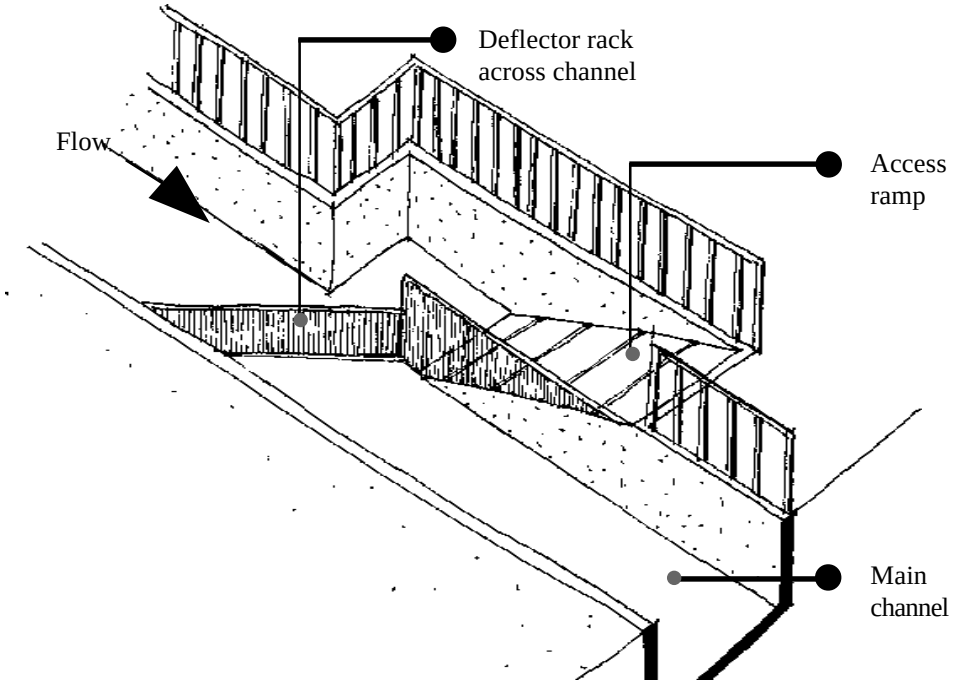
Environmental Protection Authority (1996), Managing Urban Stormwater, Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Commitee, Sydney.



LARGE TRASH TRAP SIDE DEFLECTION

Description

Large side deflection trash traps are designed to collect litter in large open channels. They use a vertical steel rack angled across the channel to deflect litter out of the flow to a side bay for holding the trapped litter until it can be removed.



Application Where BMP May Apply

* New development
* Existing systems

Conditions When BMP May Apply

* Any large open channel with flows of 1 - 10 m3/s with considerable trash and debris content e.g. branches. Suited to retrofitting to existing open channels which have restricted space.

Purpose

* This BMP will improve water quality downstream by reducing the amount of debris passing into downstream waterways.

Limitations

* Possible odour and aesthetic problems.
* Fencing is required for safety.
* Good vehicular access is necessary for maintenance.

LARGE TRASH TRAP SIDE DEFLECTION

Integration Opportunities and Constraints

* No real opportunities due to location in watercourse.

Cost Effectiveness

* Construction cost is high ($50,000 - $200,000) (1996), however it may be the only feasible solution for a particular site.

Maintenance

* Requires inspection and cleaning after large storm events.

* Direct access is required for maintenance equipment.

* Cost of cleaning is $600 - $6,000/year (0.1 - 1.5 m3/yr) (1996)

Construction Technique/Expertise

* Installation involves various specialised construction trades and equipment.

* Requires suitably trained trades personnel, familiar with the methods of construction.

Compliance

Height of rack to be double the critical depth of flow for the 1 year ARI storm to allow for 50% blockage.

$$H = 1.22 (Q / (LrN))^{2/3}$$

where:

H = rack height (m)
Q = 1 year ARI flow (m3/s)
Lr = length of rack panel (m)
N = number of panels

(Source: EPA, 1996)

Channel side walls to be higher than rack to prevent flooding.
Base of side bay to be self draining.
Clean Waters Act (1970)

References

Willimott, K.B. (1992), Investigation into the Design and Use of Coarse Trash Racks.

Institute of Engineers Australia (1992), The Design and Performance of Gross Pollutant Traps and Wet Basins.

Department of Urban Affairs and Planning (1996), Resource Guide, Department of Urban Affairs and Planning, Sydney.

Whelans and Halpern Glick Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

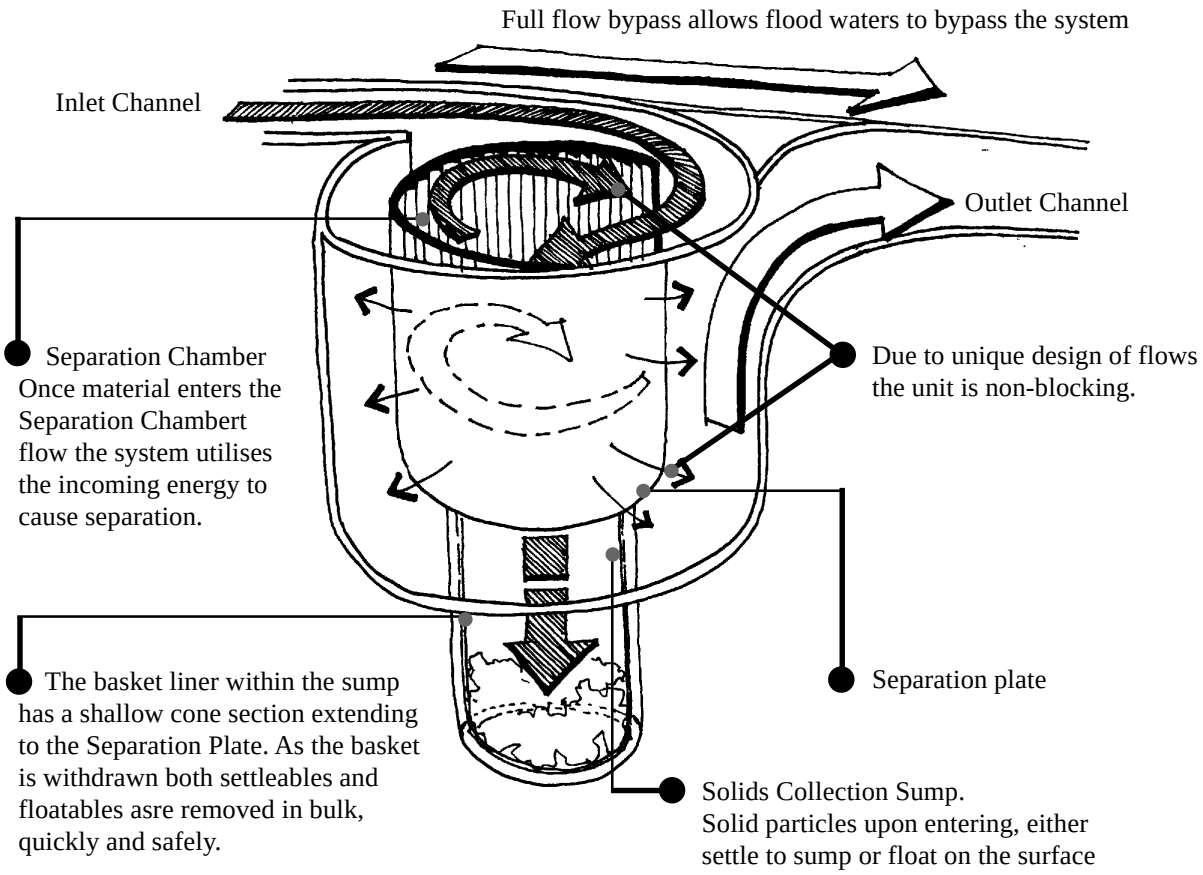
Freeman, G. (1995), Off-Line Improvement Stormwater Quality Controls in Proceedings of Soil and Water Management for Urban Development Conference, Sydney, 1995.

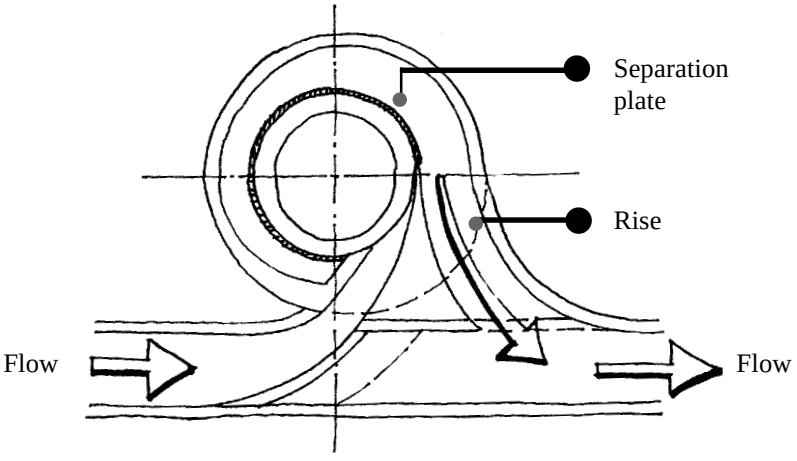
Environmental Protection Authority (1996), Site Practice 4 and 13, in Managing Urban Stormwater, Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Commitee, Sydney.

CONTINUOUS DEFLECTION SEPARATORS

Description

Continuous Deflective Separators (CDS) are stormwater pollutant traps which use a circular or vortex action for separation and containment in a collection sump. They are designed to capture coarse sediment, litter and organic debris.





CONTINUOUS DEFLECTION SEPARATORS

Application Where BMP May Apply

* New development

* Retrofitted into existing drainage systems.

Conditions Where BMP May Apply

Hornsby Council may require developers to install permanent litter/sediment devices as a condition of development approval.

* At pipe outlets or in drainage pits below areas which have the potential to be a major source of litter eg. shopping centres.

* Appropriate for retrofitting into existing development with a high litter source.

* Feasible in the treatment of 'first flush' in stormwater, designed to treat 3 month - 1 year ARI events.

Purpose

* To improve water quality downstream of a pollution source through the interception of litter/organic matter and the settling of course sediments in drainage lines.

Limitations

* Does not collect fine (dispersible) sediments and soluable pollutants.

* Potential odours.

* Must be maintained regularly to ensure optiminal functioning.

* Limited practical experience with use in Sydney metropolitan area (yet encouraging monitoring results).

* Treatment of small rainfall events (less than 1year ARI).

* Moderate to high capital cost.

Integration Opportunities and Constraints

* Collects litter at a single, discrete location (compact) which can be installed below ground and therefore is less aesthetically obtrusive.

* Self-cleaning and non-blocking with moderate maintenance costs.

* Provision for flood event bypass for flows exceeding the design event.

* High efficiency litter removal which relates to cost effectiveness.

Cost Effectiveness

* Moderate to high capital costs, however, smaller units can be precast and may be less expensive to construct than larger cast in-situ units. Costs: $40,000 - $100,000+ Cost comparison studies per cubic metre of material caught and removed show CDS is very cost-effective.

Maintenance

* Regular inspections of the structure after each storm event is essential for operating efficiency, or at least once per month. There needs to be provision for vehicular access to the unit for pollutant removal as well as a lifting device for sump cleaning.

* Records of volume and breakdown of material removed is recommended in the determination of site specific device cost-effectiveness.

Construction Techniques/Expertise

As per Diagram to include:

* appropriate sizing to treat a specific ARI event.

* provision for permanent access for maintenance.

* scour protection below bypass outlet.

* construction from concrete and stainless steel.

Compliance

Hornsby Shire Council - Conditions of Development Consent Hornsby Shire Local Environment Plan (1994)
Local Government Act (1993)
Rivers and Foreshores Improvement Act, (1948)
Clean Waters Act, (1970)

References

Allison et al (1996), Field Trials of the Pollutec Stormwater Pollution Trap in Water, September, 1996.

Environmental Pratection Authority (1996), pp.15-17, Managing Urban Stormwater, Treatment Techniques, Draft, EPA for the Stormwater Co-ordinating Committee, Sydney.

Pollutec (1995), Continuous Deflective Separation (CDS) Technology Brochure, Pollutec.

Wong et al (1996), A Solids Separator Using a Continuous Deflective System, Department of Civil Engineering, Monash University, Melbourne.

NON-SCOURING OIL AND SEDIMENT INTERCEPTORS

Description

Non-scouring oil and sediment interceptors are source pollution control devices which remove oil/floatables and suspended solids (sediment). They have a high flow by-pass to prevent scour and resuspension of previously trapped contaminants. There are some commercial systems available.

Application Where BMP May Apply

* New development
* Existing systems and developments

Conditions When BMP May Apply

* Development that generate high loads of hydrocarbons and sediments (eg. carparks, service stations, transport depot.)

Purpose

* This BMP will improve water quality downstream by reducing the amount of hydrocarbon pollutants in waterways.

Limitations

* Need to account for head loss through the separator on upstream water levels.
* Potential odours.
* Cannot be used as s storm drain inlet.
* Must have 25mm difference between the inlet pipe invert elevation and the outlet pipe elevation.
* The largest standard inlet/outlet size that can be accommodated without customization is 900 mm RCP.
* Cannot remove soluble pollutants.
* Refined space working would apply if entry to structure is required.

Integration Opportunities and Constraints

* Integration is good as the interceptor is fully underground and forms part of the streetscape, ie. there is little visual intrusion.

Cost Effectiveness

* Purchasing and installation costs are moderate and varied depending on size of units selected. The maximum cost of construction is approximately $50,000. The interceptor is capable of removing oil in the order of 95% and removal of suspended solids of approximately 80%.

Maintenance

* The maintain frequency varies depending on the site. Based on in-place performance testing to date, the interceptors will need to be cleaned out once per year. Maintenance is carried out safely from surface level using a vacuum truck. A typical cleaning cost (equipment and personnel) is estimated to be approximately $500 per interceptor including disposal costs on smallest unit. It is recommended the interceptors are inspected on a three monthly basis for sediment and hydrocarbon capture. If excessive levels are present the device will need to be cleaned out.

Construction Technique/Expertise

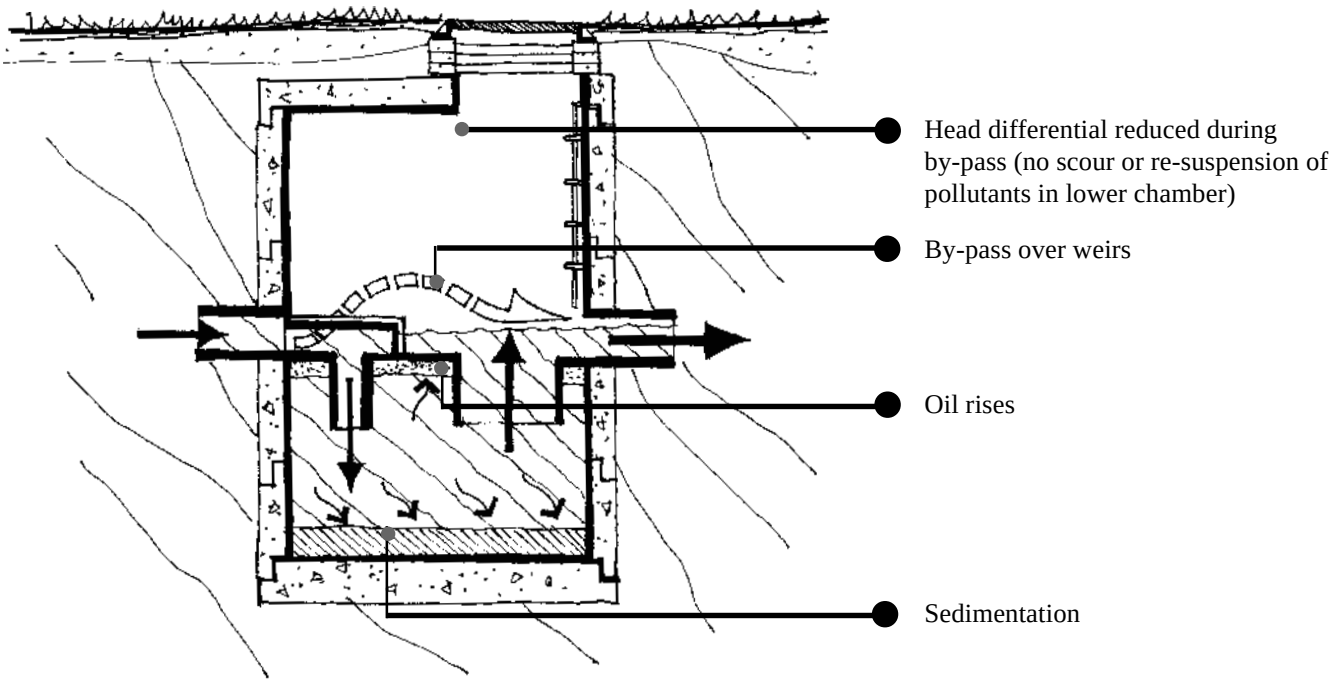
* Installation required suitable qualified plumbers or drainage controls.

Compliance

Clean Waters Act (1970)
Occupational Health and Safety (Confined Spaces) Regulation, (1990)

References

CSR Humes (1996) Schueler et al (1993) Marsalek et al (1994) Marshall et al (1994)



Humeceptor™

SAND FILTERS

Description

Sand filters are used to separate oils and some sediments from flows. They use chambers with various barriers and a sand filter bed to separate the materials from the runoff. Generally used for catchments of less than 2 hectares.

Application Where BMP May Apply

* New development.
* Existing systems and developments.

Conditions When BMP May Apply

* Developments that generate high loads of hydrocarbons and sediments from impervious areas. (eg. carparks, service stations, transport depots.)

Purpose

* This BMP will improve water quality by reducing the amount of hydrocarbon pollutants in waterways. It can also be used to protect groundwater quality.

Limitations

* Litter and coarse sediments must be removed before the water is passed through the sand filter.
* Low flow rates through filter.
* Easily clogged, effectiveness is dependent on regular maintenance.
* Possible odour problems.

Integration Opportunities and Constraints

* The trap is fully underground and forms part of the streetscape with little visual intrusion.

Cost Effectiveness

* Cost of construction is in the order of $5,000 - $10,000 (1996) which is high in terms of the volume of pollutant stored.

Maintenance

* Regular ongoing maintenance is required at least twice a year to ensure proper functioning.
* Direct access is required for maintenance equipment.
* Cost of cleaning is $600 - $2,000/ year.

SAND FILTERS

Construction Technique/Expertise

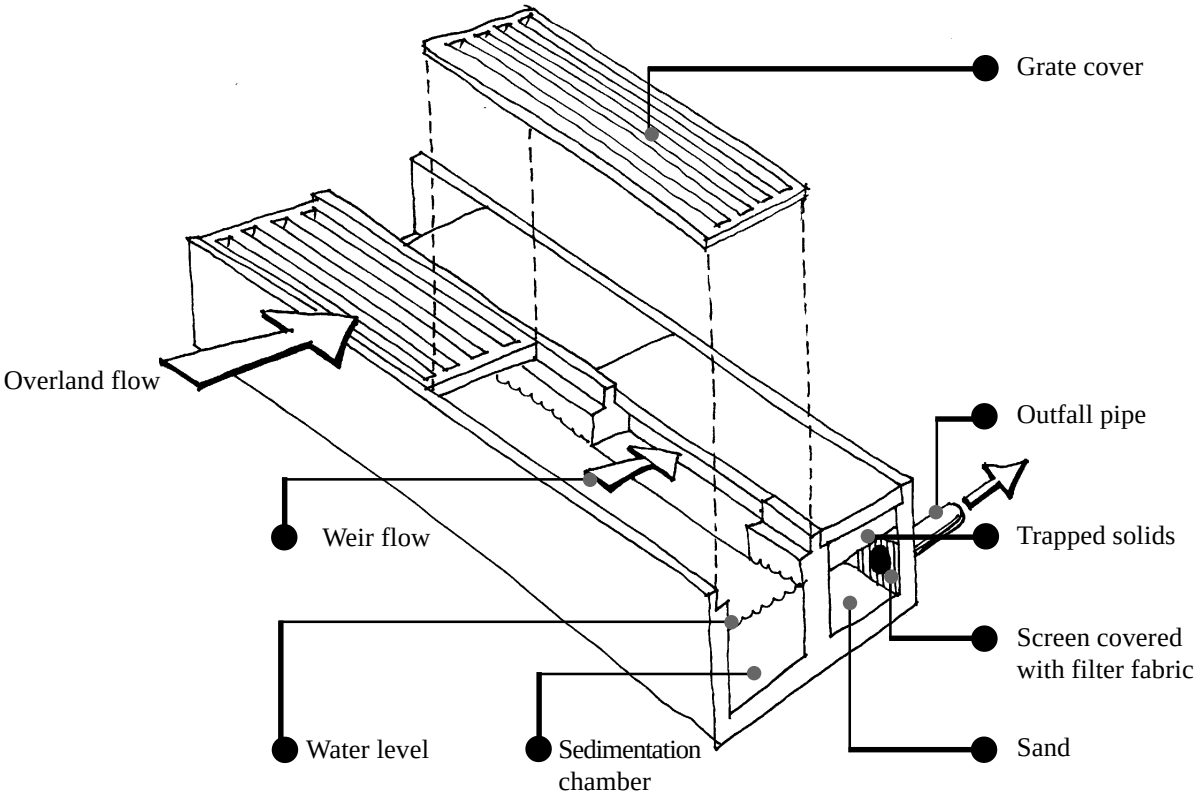
* Requires suitably trained personnel, familiar with design and installation techniques.

Compliance

Clean Waters Act (1970)

References

Environmental Protection Authority (1996), Managing Urban Stormwater, Treatment Techniques, Draft, EPA for the State Stormwater Co-ordinating Committee, Sydney.



DRAINAGE MODEL

Description

* The drainage model is a manual developed to assist in the calculation of diffuse pollutant load export from a land surface.

Application Where BMP May Apply

* Subdivisions. Other large scale developments.

Conditions When BMP May Apply

* Method described in the manual is part of an holistic package for pollution control. It is a tool.

Purpose

* To determine the difference between pre- and post-development pollution export.

Limitations

(* TO BE COMPLETED*)

Integration Opportunities and Constraints

* Not Applicable

Cost Effectiveness

* Not Applicable

Maintenance

* Not Applicable

Construction Technique/Expertise

* Not Applicable

Compliance

Applies to all subdivision applications of 10 or more lots.

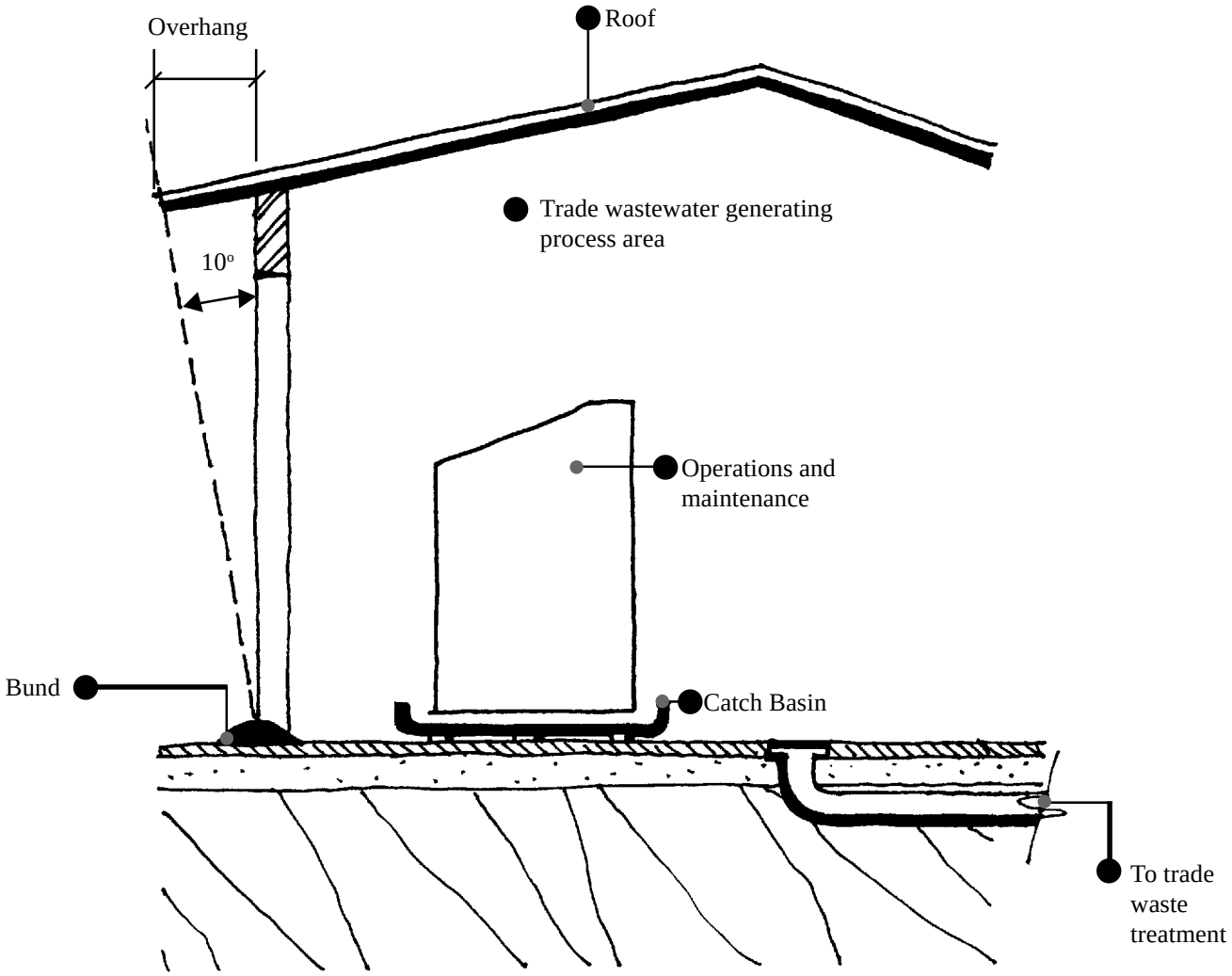
References

Gamtron for Hornsby Shire Council (1995), Urban Runoff Water Pollution Calculation Manual, Hornsby Shire Council, Hornsby.

OPERATION AND MAINTENANCE

Description

To prevent, reduce and control accidental discharge of chemicals to stormwater drainage systems from chemical spillage during the use of mechanical process equipment and operational maintenance, by reducing and controlling waste generated by such processes, through the installation of secondary containment, enclosing of equipment and regular inspections and employee training.



Application Where BMP May Apply

* This BMP is applicable to the LGA covered by the Hornsby Shire Council and on development proposal.

Conditions Where BMP May Apply

* Development proposals shall condition proposals to include safeguards of containment and safe disposal of liquid and solid waste created through the establishment of manufacturing and industrial operational processes.

Purpose

* To ensure stormwater drainage systems are protected from pollutants culminating from industrial operational processes and practices.

Limitations

* Requires protection from climatic conditions through adequate shelter on outside applications.

* Adequate environmental controls require on going maintenance and training/educational awareness to ensure there effectiveness.

Integration Opportunities and Constraints

* Buffer areas should be established to ensure potential high risk areas near stormwater drainage systems are avoided and protected.

* Leak detection monitoring and integrity of safeguards pollution control measures to be incorporated with environmental audit training including the investigation to identify areas and work place practices which generate polluting substances and the disposal of such substances.

* Clear identification of all water drainage systems, differentiating from waste and clean water.

* Water quality oil and sediment interceptors.

Cost Effectiveness

* Moderate capital cost, high maintenance to ensure ecologically sustainable development is subject to environmental safeguards to ensure preventive control measures are undertaken to alleviate pollution and subsequent prosecution.

Maintenance

* Weekly maintenance and monitoring program to be implemented for the detection of pollution leaks, plant failure and may involve sampling and analysis of wastewater quality. The protocol shall examine corrosion, structural, overfills, piping systems (pipes, pumps, flanges, coupling, hoses, and valves) leaks or spills during processing, pumping of liquids and holding tanks. The maintenance program to be an integral part of the proprietors environmental management plan.

Construction Techniques/Expertise

* Outside industrial process activities shall be covered and sheltered preventing stormwater exposure with polluted waste water.

* Methods of wastewater pre-treament shall utilised approved methods of treament these will include grease traps, corrugated plate interceptors, hydrocyclone separation systems, balancing pits, basket arrestors and strainers.

* All waste water discharges to sewer waste water systems shall be subject to an approval from Sydney Water.

* The installation and the use of catch basin/trays/filtration inserts shall be used as a means to capture particulate pollutants.

* Emergency spill controls, containing oil and fuel absorbents (booms, pillows, rolls, pads, mats) to be readily available for emergency spill application.

* Roofed areas to which wastewater is generated shall be suitably constructed to prevent the ingress of rainwater to the sewer. For a structure where one or more sides is open to the weather, 10 degrees from the vertical overhang of the roof is the minimum accepatble cover

* Oil/grit separators applications incoporating three underground retention chambers use for sediment and removal of large debris,oil separation, and a disperse flow chamber. (refer diagram).

Compliance

Hornsby Shire Council - Conditions of Development Consent
Environmental Offences and Penalties Act, 1989
Environmental Planning and Assessment Act, 1979
Clean Waters Act, 1970

References

Environmental Protection Authority (1996), Managing Urban Stormwater, Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Commitee, Sydney.

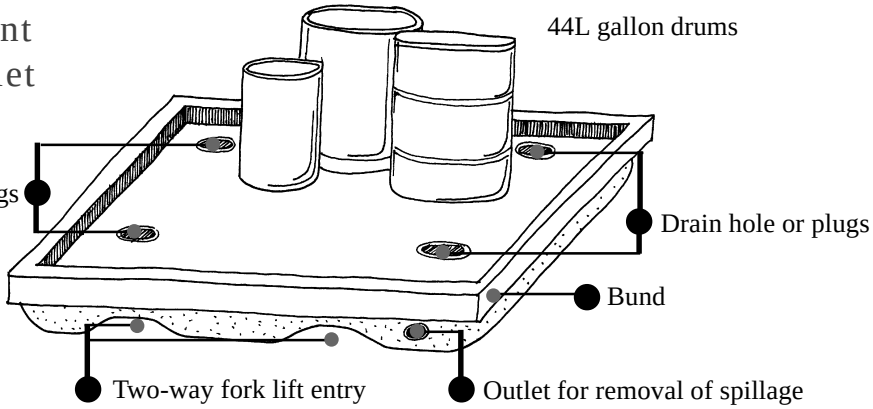
Sydney Water, Guidelines for the On-Site Pre-Treatment of Trade Wastewater Discharges, Sydney Water, Sydney.

STORAGE OF MATERIALS

Description

To prevent, reduce and control accidental discharge of chemicals to stormwater drainage systems from chemical spillageduring delivery, storage and the use of chemicals, installing secondary containment, conduct regular inspections, and training employees and subcontractors in spillage clean up techniques.

Spill containment and storage pallet



Pallet to hold four 105 litre drums. Total storage of spillage 230 litres.

Application Where BMP May Apply

* This BMP is applicable to the LGA covered by the Hornsby Shire Council and development applications .

Conditions Where BMP May Apply

* Development proposals shall condition proponents to include safeguards of containment and safe disposal of accidental chemical spills in the construction, extension and upgrading of industrial facilities.

Purpose

* To ensure stormwater drainage systems are protected from pollutants culminating from chemical spills.

Limitations

* Spill containment pallet to be utilised indoors.
* Outside storage should be protected from climatic conditions through adequate shelter.
* Spill containment capacity is proportional to the pallet capacity of storage.
* Pallet storage shall not encroach outside the bund edges and chemicals must be securely position at all times.
* Environmental clearances from the floors and storage allocation may decrease volume capacity of chemicals.

Integration Opportunities and Constraints

* Storage of hazardous chemicals/materials in potential high risk areas near stormwater drainage systems should be avoided.
* Leak detection monitoring and integrity of safeguards pollution control measures to be incorporated with environmental audit training.
* Clear identification of all water drainage systems, differentiating from waste and clean water drainage.

STORAGE OF MATERIALS

Cost Effectiveness

* Moderate capital cost, high maintenance costs to ensure ecologically sustainable development is subject to environmental safeguards to ensure preventive control measures are undertaken to alleviate pollution and subsequent prosecution.

Maintenance

* On going weekly maintenance and monitoring program to be implemented for the detection of pollution leaks and plant failure. The protocol shall examine corrosion, structural, overfills, piping systems (pipes, pumps, flanges, coupling, hoses,and valves) leaks or spills during processing, pumping of liquids and holding tanks. The maintenance program to be an integral part of the proprietors environmental management plan.

Construction Techniques/Expertise

* Storage pallet design specification of chemical control and containment of potential spills as per diagram.

* Storage pallet and bunded areas shall have a spillage volume capacity of 110% of the total storage volume capacity.

* Storage pallet floor to be removable allowing split liquid to be discharged into separate compartments.

* Storage chemical areas shall have spill tray containment and minimum floor clearance of 300mm to facilitate the identification of leaks and spills.

* Emergency spill controls, containing oil and fuel absorbents (booms, pillows, rolls, pads, mats) to be readily available for emergency spill application.

* Roofed areas to which wastewater is generated shall be suitably constructed to prevent the ingress of rainwater to the sewer. For a structure where one or more sides is open to the weather, 10 degrees from the vertical overhang of the roof is the minimum accepatble cover.

Compliance

Hornsby Shire Council - Conditions of Development Consent
Environmental Offences and Penalties Act, 1989
Environmental Planning and Assessment Act, 1979
Clean Waters Act, 1970

References

Sydney Water, Guidelines for the On-site Pre-Treatment of Trade Wastewater Discharges, Sydney Water, Sydney.

For the community and other stakeholders to adopt principles which will sustain a water balance appropriate for present and projected development in the Shire.

B1.0 WATER CONSERVATION

B2.0 WATER HARVESTING & RE-USE

B3.0 INFILTRATION

B4.0 FLOWS & FLOODING

PLANT SELECTION

Description

The selection of plant species, particularly indigenous species, which consume minimal water is recommended.

Refer also: BMP - Hydrozones, BMP - Minimising Irrigation and BMP - Riparian Vegetation

Application Where BMP May Apply

* General application to all landscape areas but not to be applied on sites with high natural soil moisture levels such as riparian zones.

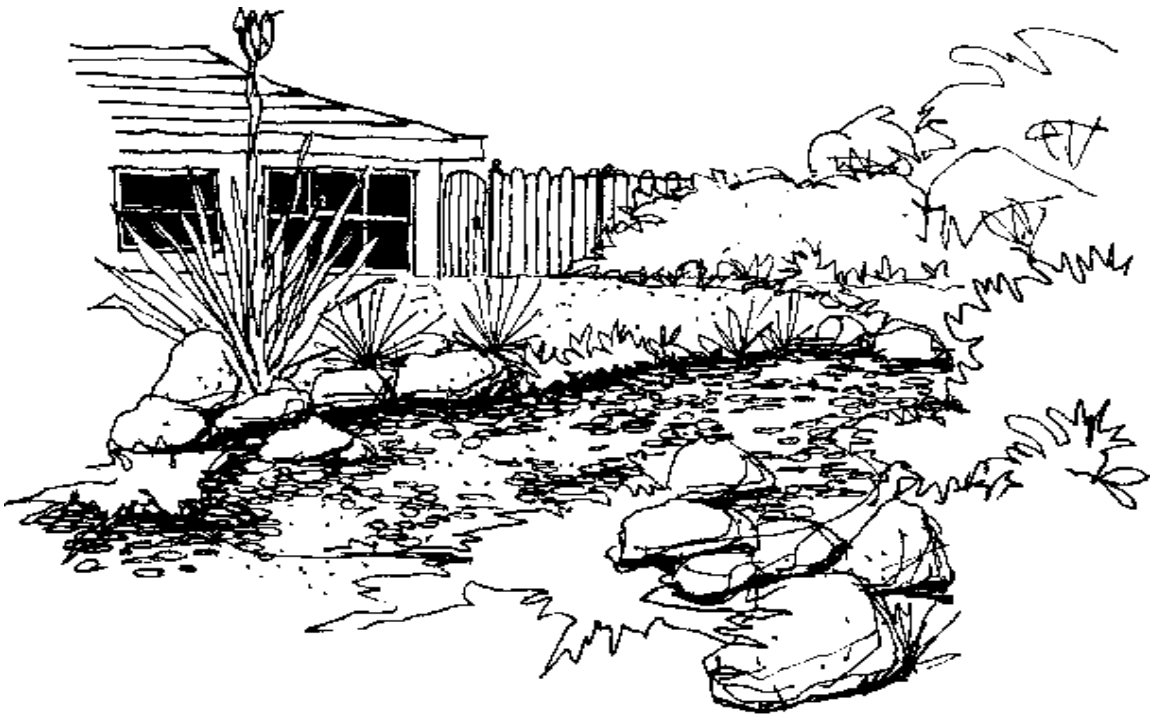
Conditions When BMP May Apply

* Any landscape area where the usage of xerophytic plants or other landscape elements (such as sundials, sculptures, furniture) will provide an appropriate landscape setting.

Purpose

* To conserve water usage.

Xeriscaping



PLANT SELECTION

Trees

Agonis flexuosa	Willow Myrtle	AN	EV
Angophora costata	Sydney Apple or Red Gum	LN	EV
Banksia integrifolia	Coastal Banksia	LN	EV
Brachychiton acerifolius	Illawarra Flame Tree	AN	SD
Brachychiton populneus	Kurrajong	AN	SD
Callistemon viminalis	Weeping Bottle Brush	AN	EV
Callitris columellaris	Murray Pine	AN	EV
Callitris rhomboidea	Port Jackson Cypress Pine	AN	EV
Casuarina glauca	Swamp She Oak	LN	EV
Casuarina torulosa	Forest She Oak	LN	EV
Cedrus deodara	Cedar of Lebanon	E	EV
Cercis siliquastrum	Judas Tree	E	D
Chamaecyparis obtusa ‘Crispii’	Conifer	E	EV
Chionanthus retusa	Chinese Fringe Tree	E	EV
Cupressus spp.	Cypress Pine	E	EV
Eucalyptus cinerea	Argyle Apple	AN	EV
Eucalyptus exima	Yellow Bloodwood	LN	EV
Eucalyptus haemastoma	Scribbly gum	LN	EV
Eucalyptus microcorys	Tallowwood	AN	EV
Eucalyptus scoparia	Willow Gum	AN	EV
Eucalyptus sideroxylon	Mugga Ironbark	AN	EV
Fraxinus excelsior ‘Aurea’	Golden Ash	E	D
Fraxinus raywoodii	Claret Ash	E	D
Gleditsia tricanthos inermia	Honey Locust	E	D
Grevillea robusta	Silky Oak	AN	EV
Hibiscus tiliaceus	Cottonwood	AN	EV
Jacaranda mimosifolia	Jacaranda	E	D
Leptospermum petersonii	Lemon-scented Tea Tree	AN	EV
Melaleuca linarifolia	Snow in Summer	AN	EV
Melaleuca quinquinervia	Broad-leaved Paperbark	LN	EV
Melaleuca stypheloides	Prickly Paperbark	AN	EV
Platanus x hybrida	Plane Tree	E	D
Robina pseudoacacia ‘Frisia’	Golden robinia of False Acacia	E	D
Sapium sebiferum	Chinese Tallow Tree	E	D
Schinus areira	Peppercorn	E	D
Ulmus parvifolia	Chinese Elm	E	D

Legend

AN	Australian Native
LN	Local Native to Hornsby Shire
EV	Evergreen
D	Deciduous
SD	Semi-Deciduous

PLANT SELECTION

Shrubs

Acacia floribunda	Gossamer Wattle	AN	EV
Acacia longifolia	Sydney Wattle	LN	EV
Acacia ulicifolia	Prickly Moses	LN	EV
Banksia ericifolia	Heath banksia	LN	EV
Banksia serrata	Old man banksia	LN	EV
Banksia spinulosa	Honeysuckle	AN	EV
Berberis thunbergii	Japanese Barberry	E	D
Callisemon spp.	Bottlebrush	AN/LN	EV
Chamelaucium unciatum	Geralton Wax	AN	EV
Coleonema pulchrum	Diosma	E	EV
Correa alba	White Correa		EV
Correa reflexa	Native fuchia	LN	EV
Dodonea viscosa	Giant Hop Bush	AN	EV
Eremophila maculata	Spotted Emu Bush	AN	EV
Grevillea spp.	Grevillea	AN/LN	EV
Hakea laurina	Pincushion Plant	AN	EV
Lambertia formosa	Mountain Devil	LN	EV
Melaleuca hypercifolia	Red flowering paperbark	AN	EV
Melaleuca thymifolia	Thyme Honey Myrtle	AN	EV
Murraya paniculata	Cosmetic Bark Bush	E	EV
Myoporum floribundum	Boobialla	AN	EV
Nandina domestica	Sacred bamboo	E	EV
Nandina domestica ‘Nana’	Dwarf sacred bamboo	E	EV
Plumbage auriculata	Plumbage	E	EV
Pultanea spp.	Bacon and Eggs	AN/LN	EV
Thryptomene saxicola	Rock Thryptomene	E	EV
Viburnum tinus	Laurestinus	E	EV
Westringia fruticosa	Coastal Rosemary	LN	EV

Legend

AN	Australian Native
LN	Local Native to Hornsby Shire
EV	Evergreen
D	Deciduous
SD	Semi-Deciduous

PLANT SELECTION

Groundcovers

Brachychome multifida	Cut leaf Daisy	LN	EV
Dichondra repens	Kidney Weed	LN	EV
Gazania spp.	Gazania	E	EV
Grevillea gaudichaudii	Gaudichaudii Grevillea	AN	EV
Grevillea poorinda 'Royal Mantle'	Royal Mantle	AN	EV
Helichrysum spp.	Everlasting Daisy	AN	EV

Accent Plants

Anigozanthos flavidus	Kangaroo Paw	AN	EV
Dianella revoluta	Flax Lily	LN	EV
Doryanthes excelsa	Gymea Lily	AN	EV
Lomandra longifolia	Lomandra	LN	EV
Macrozamia communis	Burrawang	AN	EV

Creepers and Climbers

Hardenbergia voilacea	Native Sarsparilla	LN	EV
Kennedia rubicunda	Dusky Coral Pea	LN	EV
Pandorea pandorana	Wonga wonga Vine	LN	EV

Legend

AN	Australian Native
LN	Local Native to Hornsby Shire
EV	Evergreen
D	Deciduous
SD	Semi-Deciduous

PLANT SELECTION

Limitations

* Some sites have heritage or cultural landscape values where it may not be appropriate to use such plants.

Integration Opportunities and Constraints

* Potential for usage of indigenous species and the reconstruction or regeneration of bushland.

* Potential for habitat creation and aesthetic landscape designed areas.

Cost Effectiveness

* Reduced water consumption and other related maintenance such as reduced plant growth will ultimately reduce management costs.

Maintenance

* General landscape maintenance required e.g. pruning, de-heading of spent flower heads.

Construction Technique/Expertise

* Planting design is best undertaken by landscape designers or landscape architects.

Compliance

The use of indigenous species is recommended for all sites. The species list is recommended only and other species may be selected.

References

Reader's Digest Ed. Spooner, P. (1973), Practical Guide to Home Landscaping, Readers Digest Association, Sydney.

PLANTING TECHNIQUE

Description

The effective planting of new plants to achieve maximum growth to minimise long term irrigation requirements (Refer also BMP - Plant Selection).

Application Where BMP May Apply

* General application for landscaped areas.

Conditions When BMP May Apply

* All public open space areas including sports fields, district and local parks.

* Applies similarly to landscaped areas around residences, industrial, commercial and educational complexes.

Purpose

* To reduce water consumption.

Limitations

Limited by:

* soil permeability

* plant species and size at time of planting

* location of planting relative to solar aspect and any companion planting.

Integration Opportunities and Constraints

* Healthy plant growth will add amenity to any vegetated area.

Cost Effectiveness

* Correct planting techniques can reduce plant replacement costs and reduce requirements for irrigation.

Maintenance

* The most effective planting is maintenance free or at least minimal

* Replacement of mulch may be required and weed removal may be necessary.

PLANTING TECHNIQUE

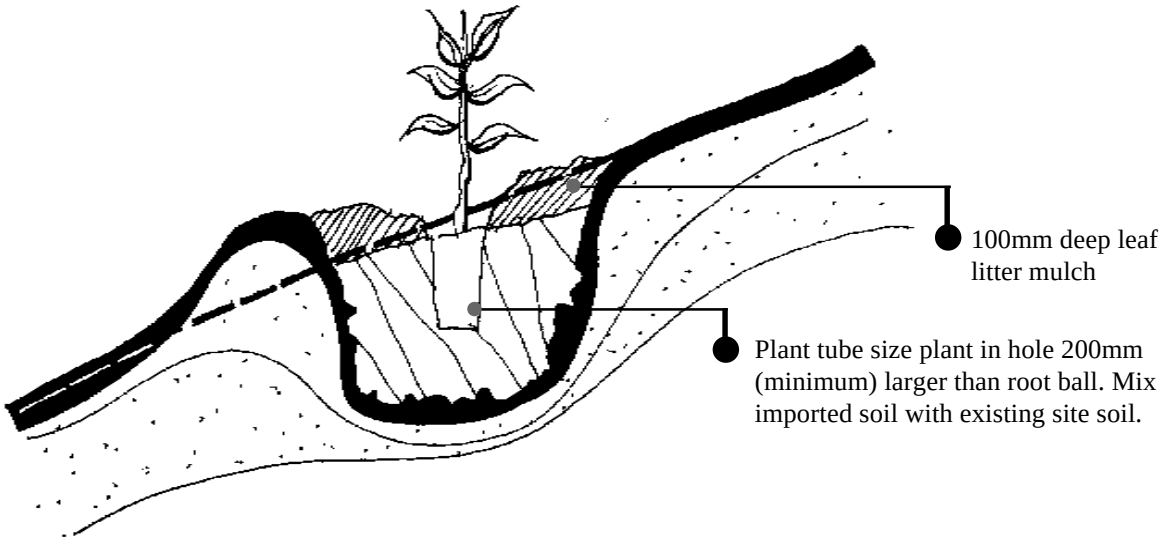
Construction Technique/Expertise

* Installation technique may be site specific.
* All plants should be healthy, not soft, forced or pot bound.
* Planting should occur in a hole 200mm (minimum) larger than the root ball and the existing site soil mixed with any planting soil.
* A depression should be created at the base of the plant to collect water or a watering tube installed.
* A layer of 75mm (minimum) of mulch should be placed to reduce moisture loss and weed growth. Avoid placing mulch against the trunk to prevent collar rot.
* Watering should occur until estabilised.

Compliance

Landscape Code for Development and Building Approval.

Planting pocket



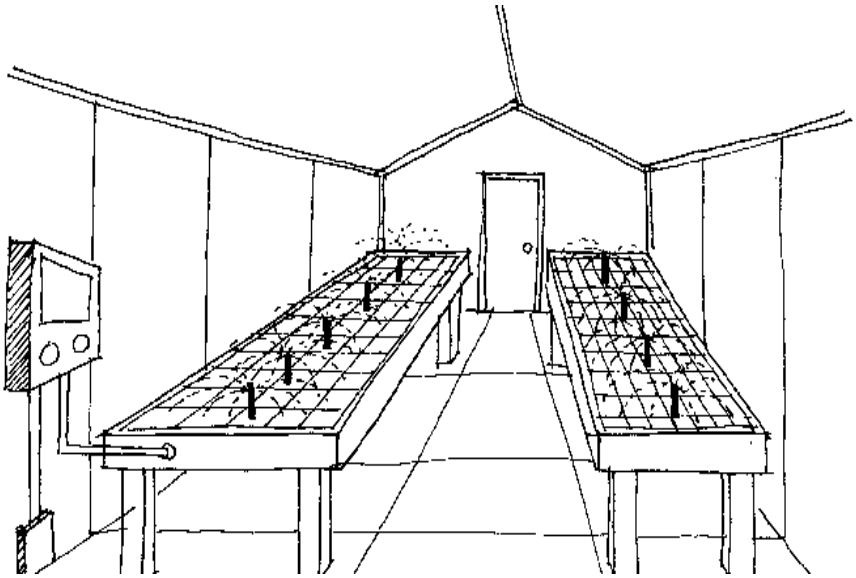
IRRIGATION DESIGN AGRICULTURE

Description

The effective planning and design of agricultural practices with irrigation systems to maintain an appropriate water balance by minimising irrigation, recycling and treating water.

Refer also - BMPs Re-use of Effluent for Irrigation, Rural Dams.

Glasshouse irrigation



Application Where BMP May Apply

* Properties requiring irrigation for agricultural practices.

Conditions When BMP May Apply

* Rural parts of Hornsby Shire on properties undertaking agricultural activities.

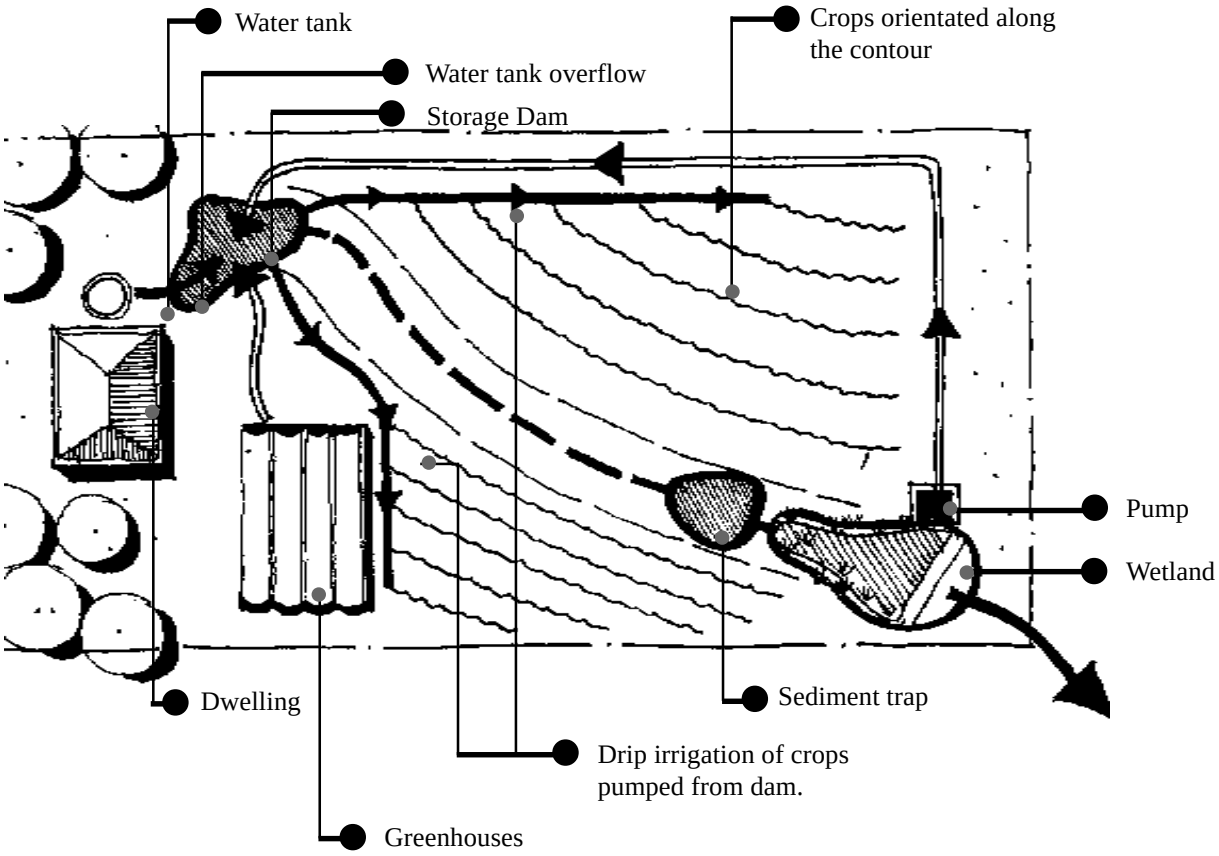
Purpose

* To conserve water through efficient design and by minimising irrigation

Limitations

* Limited by soil permeability.
* Extent of irrigation required.
* Supply of water e.g. dams, bore mains.
* Irrigation of a site should not negatively impact upon indigenous vegetation communities on adjacent sites.

IRRIGATION DESIGN AGRICULTURE



Integration Opportunities and Constraints

* Should be integrated with farm layout design, particularly if dams are to be used for the recycling of water.

Cost Effectiveness

* Irrigation systems are expensive, however the effective design of systems will reduce the usage and cost of water.

Maintenance

* Routine maintenance to ensure the drainage lines and irrigation system are working and the dams are have not silted.

Construction Technique/Expertise

* Construction can be undertaken by the property owner using farm equipment.

* The design of dams may require the services of an engineer.

Compliance

The construction of dams requires Council approval.
The construction of dams on water courses requires a license from the Department of land and Water Conservation.

References

Hornsby Shire Council (1995), Dams in Interim Rural Lands Development Control Plan, Hornsby Shire Council.

IRRIGATION DESIGN OPEN SPACE

Description

The effective planning and design of irrigation systems to maintain an appropriate water balance by minimising water consumption, reducing loss of water through evaporation and run-off and encouraging deep root growth.

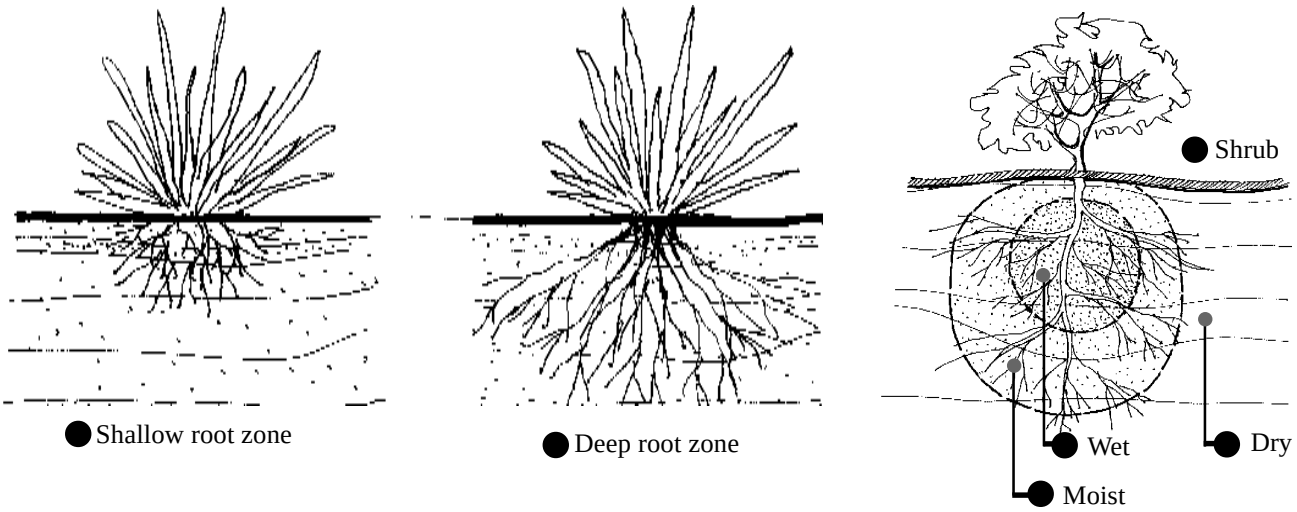
* Irrigation is most efficient in the early morning or evening when there is the least evaporation.

* Irrigation should be reduced during the winter months.

* Deep watering by leaving irrigation on for more than one hour will encourage deep root growth and greater drought tolerance.

Refer also BMP Re-use of Effluent for Irrigation.

Minimizing irrigation



Practise deep watering, soaking each each turfed area to at least 200mm depth and 1.0m for trees to encourage deep rooting.

Application Where BMP May Apply

* General Application for irrigation of landscaped areas.

Conditions When BMP May Apply

* All public open space areas including sports fields, district and local parks. Applies similarly to large open space areas around residences, industrial, commercial and educational complexes where landscaping occurs.

Purpose

* To maintain an appropriate water balance through re-use of grey water where possible and to reduce water consumption.

IRRIGATION DESIGN OPEN SPACE

Limitations

* Soil permeability.
* Function of the area and level of usage.
* Ability of existing vegetation to adapt to irrigation usage or minimised use thereof.
* Extent of incorporation of other BMPs such as other infiltration devices.
* Ability of systems irrigating with grey water to produce a low turbidity effluent.
* Suspended solids block drip and spray systems.
* Limited by concerns for public health risk if grey water is used.

Integration Opportunities and Constraints

* Provides opportunity for groundwater recharge, re-use of stormwater, re-use of grey water for irrigation.
* Irrigation on a site should not negatively impact upon indigenous vegetation on adjacent sites.

Cost Effectiveness

* Capital cost of irrigation systems is expensive.
* By effective design and addition of other water saving devices the usage costs may be reduced.
* Initial cost for water tanks, and/or infrastructure for use of grey water may be expensive.

Maintenance

* Irrigation systems require regular maintenance particularly in public areas due to vandalism.
* Routine maintenance is required to ensure that filters and outlets are not blocked.

Construction Technique/Expertise

* The structure of the soil may need improvement such that it holds moisture effeciently.
* Design is best undertaken by irrigation specialists with advice from a landscape architect/recreation planner as to the function of the area and level of usage.
* Construction technique and design is site specific.

Compliance

Clean Waters Act (1970)

References

Reader's Digest Ed. Spooner, P. (1973), Practical Guide to Home Landscaping, Readers Digest Association, Sydney.

IRRIGATION DESIGN GARDENS

Description

The effective planning and design of garden areas with irrigation systems to maintain an appropriate water balance by reducing water consumption, reducing loss of water through evaporation and run-off.

Typically, drip systems are more efficient than spray systems and should be used wherever possible.

Timing should be controlled to prevent over watering and shallow rooting.

Volume should be appropriate to the soil type and plant species.

* Irrigation is most efficient in the early morning or evening when there is least evaporation.
* Irrigation should be reduced during the winter months.
* Deep watering by leaving irrigation on for more than one hour wilencourage deep root growth and greater drought tolerance.

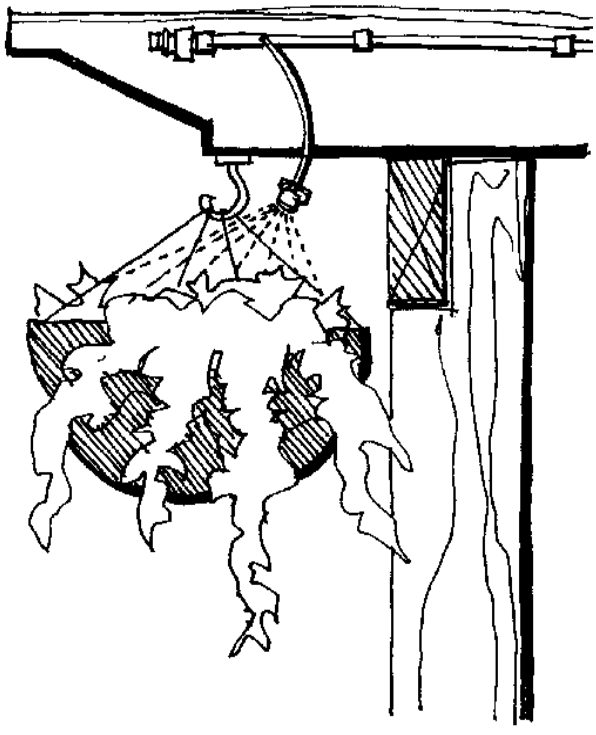
Refer also BMP Re-use of Grey water for Irrigation, BMP - Hydrozones, BMP - Plant Selection.

Application Where BMP May Apply

* Any garden areas requiring irrigation.

Conditions When BMP May Apply

* Residential development - single dwellings to large multi-unit housing projects.
* Commercial development - commercial and industrial buildings and complexes.



Drip system

IRRIGATION DESIGN GARDENS

Purpose

* To reduce water consumption through design and by minimising the extent of irrigation

Limitations

* Limited by soil permeability.
* Extent of building footprint.
* Easier to incorporate in design of new development than retrofitting existing development.
* Ability of vegetation to adapt to irrigation usage or minimised usage thereof.
* Extent of incorporation of other BMPs such as other infiltration devices.
* Limited by concerns for public health risk if grey water is used.
* Irrigation not recommended on sites adjacent to bushland.

Integration Opportunities and Constraints

* Can be integrated with the design of residential and commercial projects.
* Provides opportunities for groundwater recharge, re-use of stormwater re-use of domestic grey water.
* Irrigation of a site should not negatively impact upon indiggenous vegetation on adajcent sites.

Cost Effectiveness

* It is most effective if installed when development occurs rather than retrofitted.
* If an irrigation system is to be installed, the use of a drip system will be more efficient than a spray system.

Maintenance

* Routine maintenance to ensure the filters and outlets are not blocked.

Construction Technique/Expertise

* Small systems can be installed by a handy person. Larger systems should be designed and installed by irrigation specialist such that the level of watering is appropriate to the vegetation type, soil type, function of the area and level of usage.

Compliance

Clean Waters Act (1970)

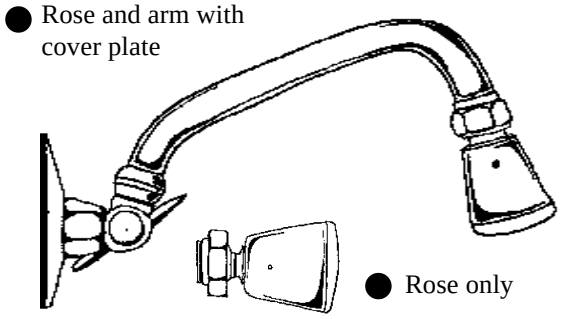
WATER SAVING DEVICES

Description

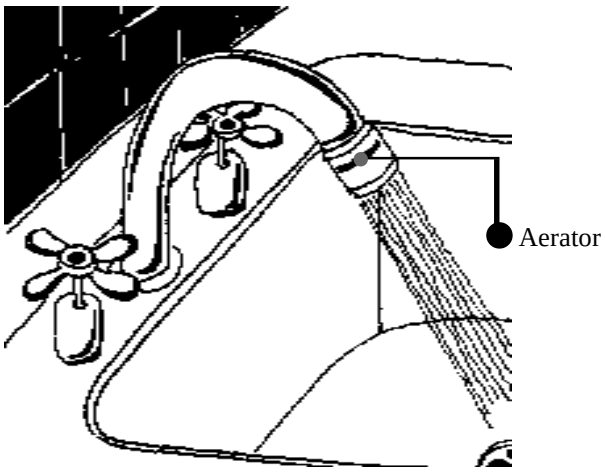
Water Saving Devices for reticulated water include

* dual flush toilets
* low flow shower heads
* low water use laundry washing and dish washing machines.
* tap aerators
* spring return taps

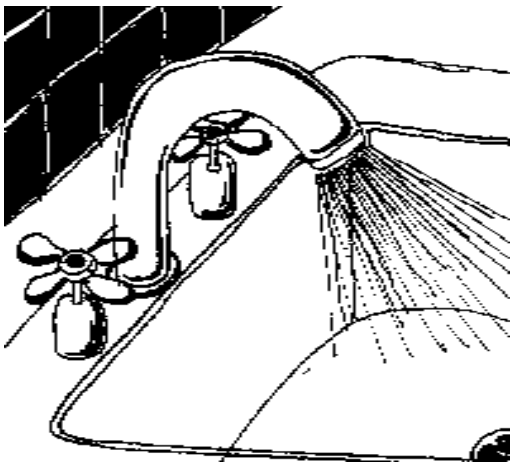
Low flow models water efficient - AAA rated



Kitchen and basin tap aerators



Spray tap



WATER SAVING DEVICES

Application Where BMP May Apply

* New developments

* Existing developments (retrofitting)

Conditions When BMP May Apply

* Wherever reticulated water is used e.g. bathrooms, kitchens, laundries.

Purpose

* To reduce water use and to promote its conservation. Savings of up to 50% water use can be achieved. This has further benefits on energy bills for water heating and water consumption bills generally.

* To demonstrate how significant amounts of water can be saved, with little or not additional cost.

* To reduce the need for new dams and supply systems.

Limitations

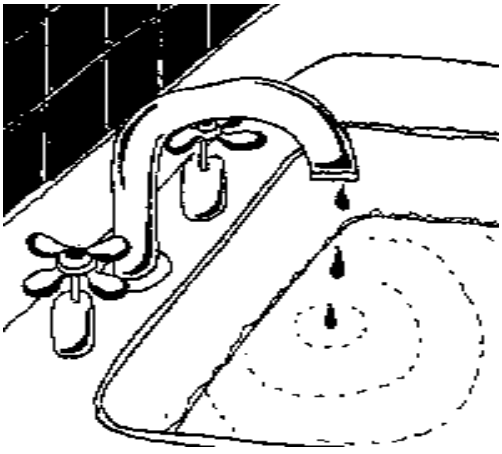
* Difficulties may be experienced when used in conjunction with composting and incineration toilets as these require adequate liquid waste to function optionally.

Integration Opportunities and Constraints

* Overall water consumption can be significantly reduced.

* The replacement of existing equipment with more water efficient types can be done on an ‘as needed’ basis, particularly as renovation is undertaken.

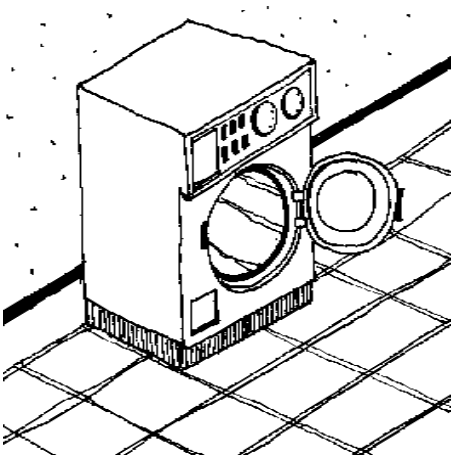
Ceramic seat washers



● Spring return taps ensure taps are not left on.

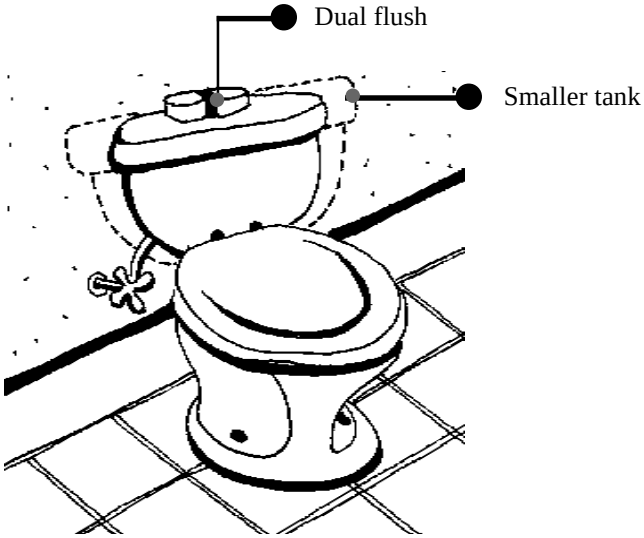
WATER SAVING DEVICES

Low water use clothes washers



Front loading

Dual flush toilet



Cost Effectiveness

* Water conservative devices are generally no more expensive than their high water use counter parts.
* Washing machines and dishwashers now have water consumption ratings
* Cost savings on water are proportional to the volume saved.
* Retrofitting of water-savers will have major long-term monetary savings and the equipment is reasonably priced.

Maintenance

* As required (typical of any plumbing fittings). More complex systems require regular maintenance.

Construction Technique/Expertise

* Self checking/installation; or
* Qualified Plumber/drainer

Compliance

Local Government Act (1993)

References

Whelans and Halpern Glick Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

Standards Australia, MP64 Water Efficient Appliances, Standards Association of Australia.

NSW Public Works (1993), Water Wise Communication Kit, NSW Public Works, Sydney.

Description

Water harvesting implements the temporary storage and/or the slowing of water in shallow depressions to achieve improved groundwater recharge. It implements the reshaping of the land surface to slow the flow of water from paved and roofed areas and the creation of vegetated areas (typically grassed). These areas allow infiltration and filtration of the water before it leaves the site.

Such devices may be easily incorporated into the rural streetscape and particularly into open landscaped areas without significantly compromising their major function.

Refer also BMP - Swales

Application Where BMP May Apply

* New development, particularly residential
* Existing development, particularly residential

Conditions When BMP May Apply

* Any development with suitable land conditions and area.

Purpose

* This BMP will improve water quality by reduction in the water flow velocity as well as allowing filtration and contribute to the maintenance of water balance by infiltration.

Limitations

* Requires a suitable area of terrain and is best suited for low to medium flows.
* Design must ensure that overflows are controlled to prevent scour and flooding.
* Infiltration may be limited by soils with low porosity and permeability.

Integration Opportunities and Constraints

* There are landscaping and re-vegetation opportunities.
* Integration with the streetscape will be possible, particularly in residential areas.

Cost Effectiveness

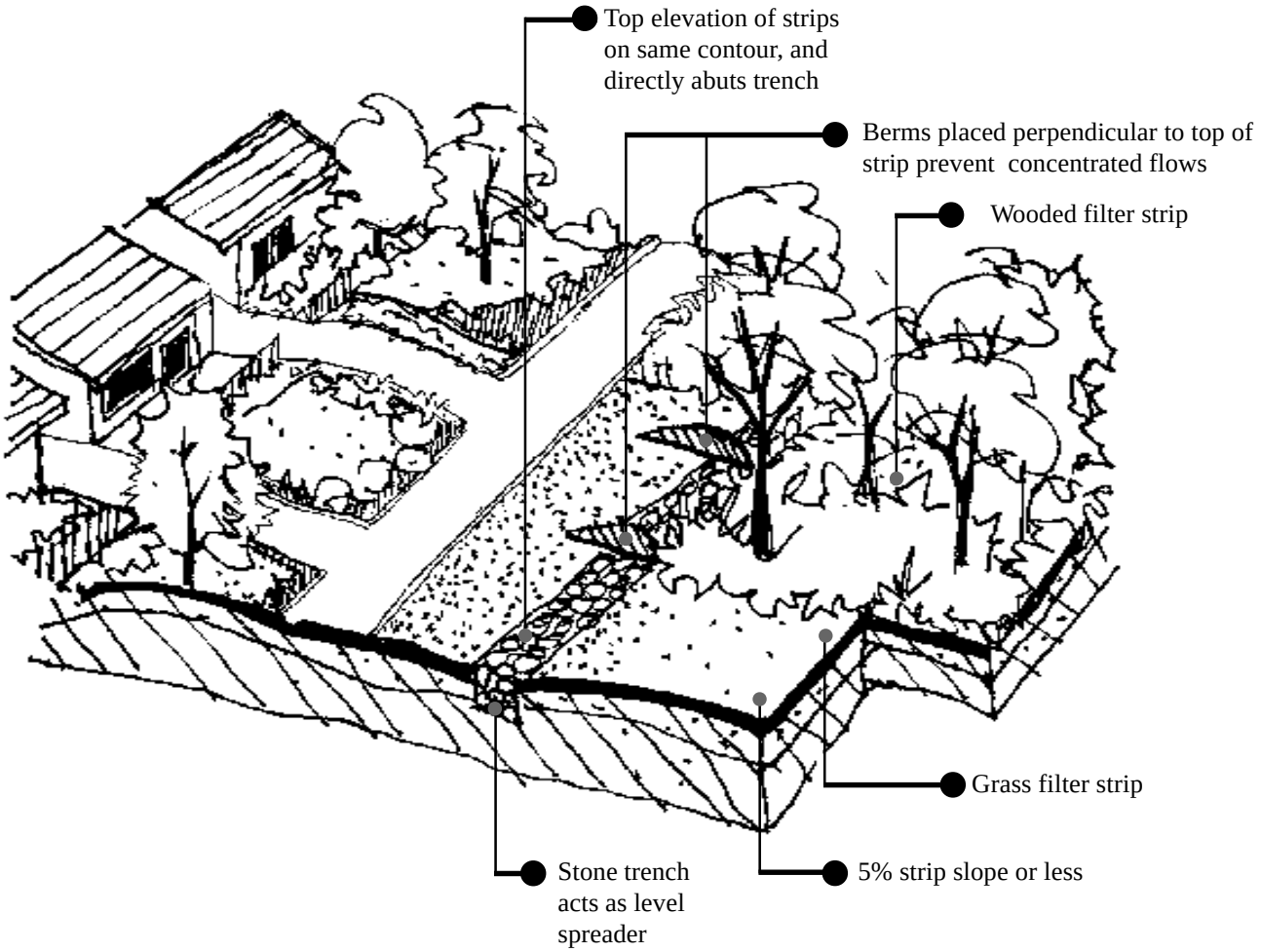
* There is little or no increase in cost for landscaping. If an existing area of grassing is used, the cost will be negligible.

Maintenance

* Normal maintenance of landscaped areas is required.
* Some monitoring of filter areas for scour would be required.

WATER HARVESTING ON SITES

Overland flow filter strip



Construction Technique/Expertise

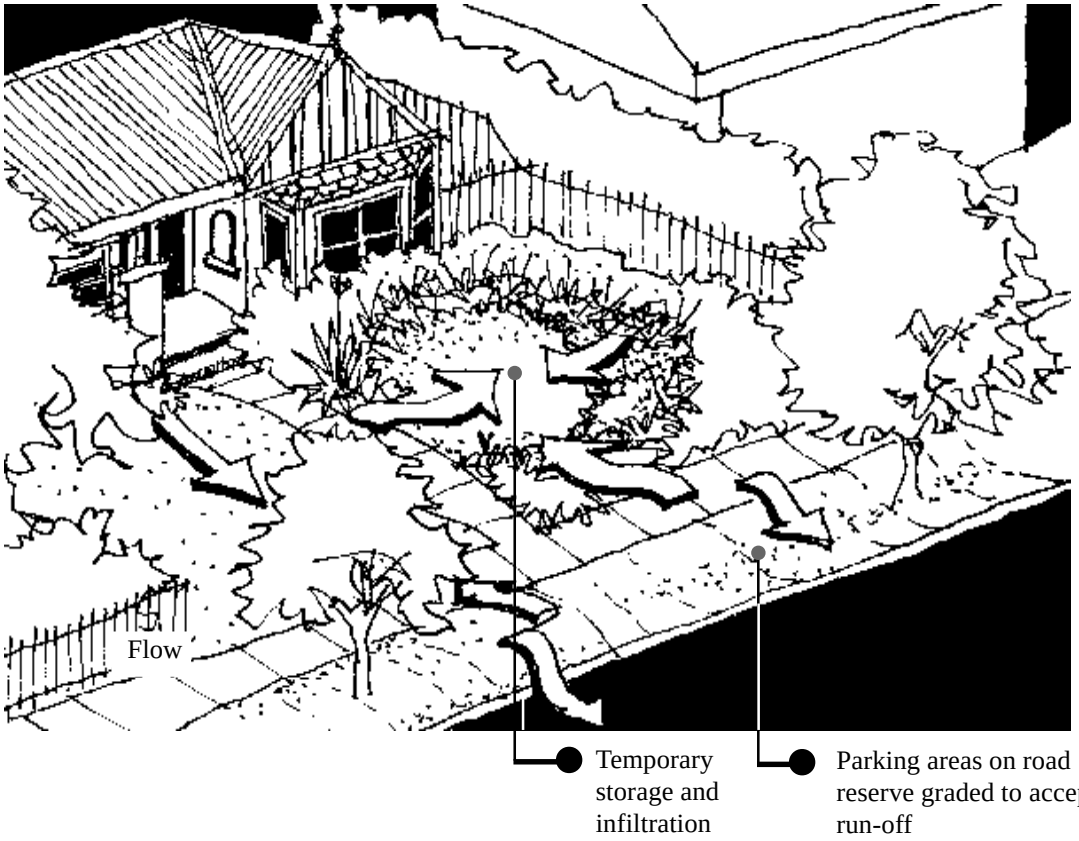
* Construction involves standard landscaping methods and technique.

Compliance

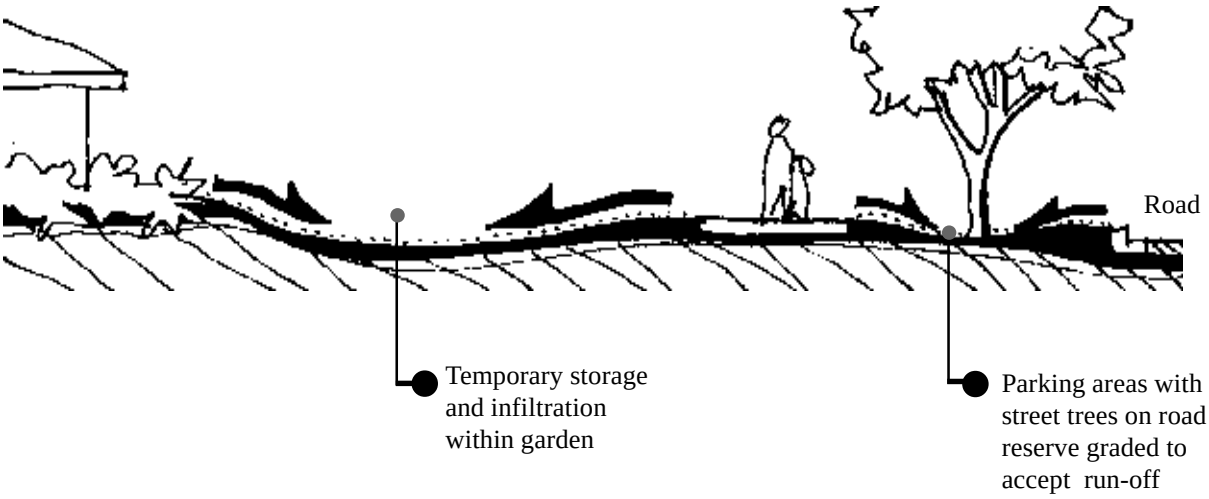
Landscape Code for Development and Building Approval.

References

Whelans and Halpern Glick Maunsell (1994), Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Water Authority for Western Australia and the Environmental Protection Authority, Whelans, WA.


Flow
Temporary storage and infiltration
Parking areas on road reserve graded to accept run-off

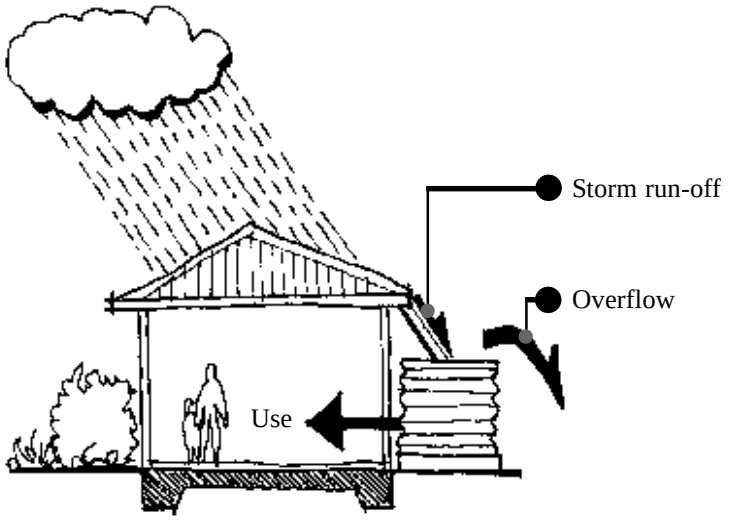
Section

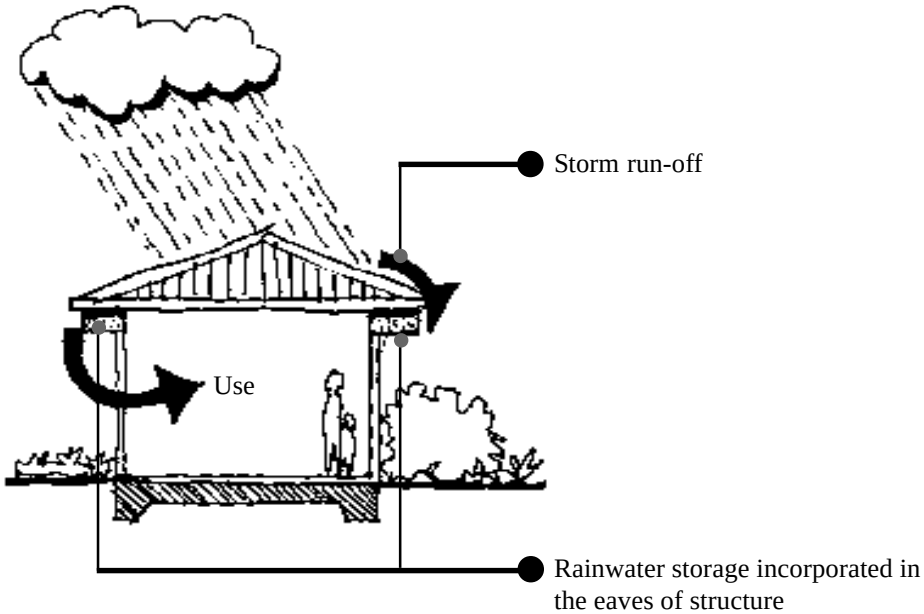

Road
Temporary storage and infiltration within garden
Parking areas with street trees on road reserve graded to accept run-off

RAINWATER TANKS

Description

Rainwater tanks can be used to store runoff water on site for reuse. This can reduce the demand from mains water supply systems and can reduce the peak flow rates in trunk drainage systems resulting from storm water. The tanks can be above ground beside the structure, below ground as part of the building foundations or below ground and separate to the building or in other configurations depending on the site conditions.





RAINWATER TANKS

Application Where BMP May Apply

* New development, particularly residential

* Existing development, particularly residential

Conditions When BMP May Apply

* Any development with a high volume of runoff potential where a reduction in the use of mains water supply is also desirable eg. home units, industrial complexes.

* Any development where there is no availability of mains water supply.

* There may be an opportunity to use rainwater storage to replace part of On Site Detention storage, subject to careful analysis of the water yield, water usage, size of storage required and permanent, regular use of the water.

Purpose

* This BMP will improve conservation of water. The collected water would be suited for flushing toilets, washing vehicles and garden irrigation without any treatment. The water would not be suited to use for drinking or washing.

Limitations

* Trunk drainage flow reduction would become ineffective in long periods of rainfall due to the storage filling to capacity. The effectiveness depends on regular use of the stored water.

* The space required for an adequate storage tank and its aesthetics may be difficult, especially when retrofitting to existing developments

* Problems with mosquitoes and other health risks may occur if the system is not maintained properly.

Integration Opportunities and Constraints

* Can be integrated into the designs of new developments. There may be problems in retrofitting to existing developments due to space limitations.

Cost Effectiveness

* Cost of construction can range from $1000 - $10,000 (1996) depending on the size of installation. This cost can be offset by the savings in payment for mains water, but the payback period may approximately 20 years.

Maintenance

* Regular (annual) cleaning of the gutters, tank and any sediment traps or filters will be required.

RAINWATER TANKS

Construction Technique/Expertise

* Design and installation involves various specialised trades and equipment.

* Property owners need to be informed of the responsibilities for operation and maintenance of the installed system.

Compliance

Clean Waters Act (1970)

References

National Capital Planning Authority (1993), Designing Subdivisions to Save and Manage Water, NCPA, Canberra.

ROOF GARDENS

Description

Roof gardens are constructed gardens located on any roof which are designed to improve water conservation, reduce runoff volumes from roof surfaces as well as providing increased amenity and usable space.

Application Where BMP May Apply

* New or existing development

Conditions When BMP May Apply

* Particularly appropriate for large scale and high density developments such as apartment complexes, industrial and commercial buildings and car parks.

* Practical for sites where limited land for landscaped open space exists and where the amenity of living in high density environments can be enhanced.

Purpose

* Roof gardens will increase water conservation and reduce the volume of runoff from roof surfaces whilst providing increased amenity. Excess water may be collected and stored in retention tanks for re-use or filtered and released in the stormwater system.

Limitations

* Incorporation into new developments is easier and more cost effective than retrofitting where structural reinforcement may be necessary.

* Extremes in microclimate such as western aspect, over-shadowing or wind exposure can limit plant growth and hence water uptake.

* Where water proofing has not been successful, damage may occur.

Integration Opportunities and Constraints

Positive impacts:

* Creation of recreational areas on otherwise wasted space.

* Potentially increased property values

* Buildings can be integrated into the landscape effectively with little visual impact, particularly on sloping sites.

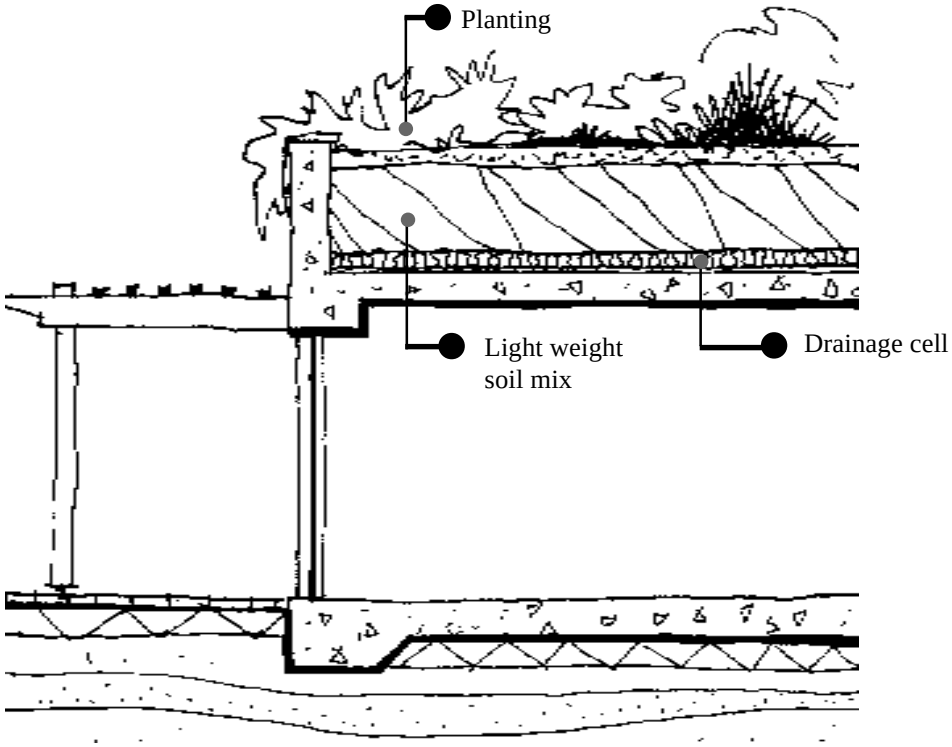
Negative impacts:

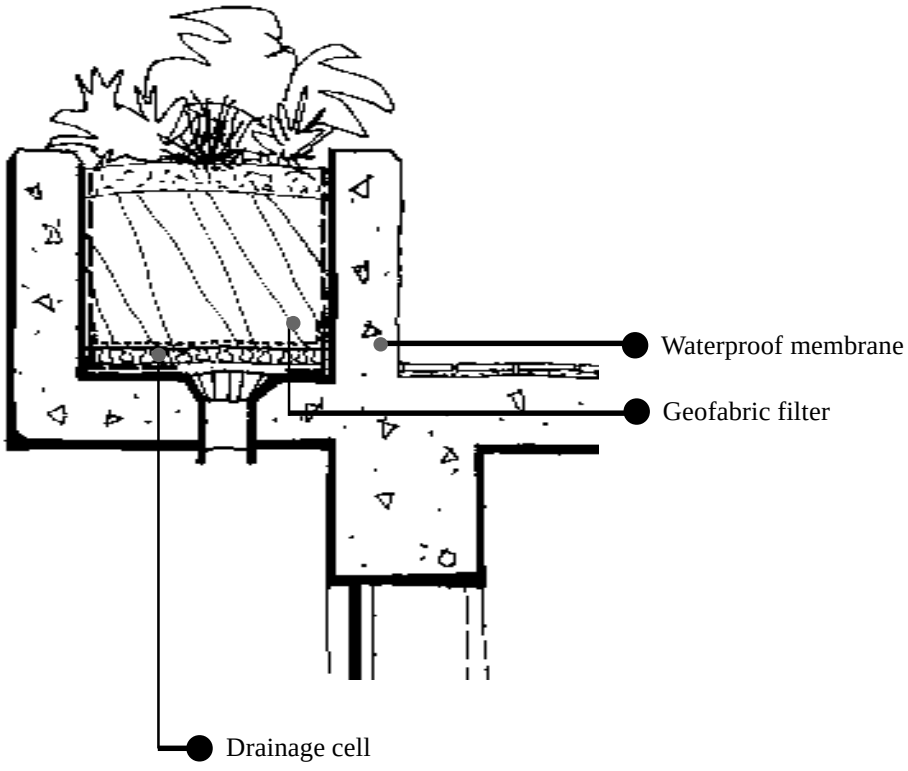
* Building form and appearance may be inappropriate to the existing streetscape in some locations.

Cost Effectiveness

* The potential added costs of reinforcement and landscaping may be outweighed by savings in water usage and by added values/demand to the property.

ROOF GARDENS





ROOF GARDENS

Maintenance

* Regular maintenance is required of the tanks and filters associated with the drainage cells.

* All landscaped areas will also require maintenance.

Construction Technique/Expertise

* Design professionals are recommended to calculate the required structural strength of the building, the drainage and landscape requirements.

* Expertise is required to ensure complete water proofing.

Compliance

To be considered for all building applications, particularly high density residential and commercial developments.
Local Government Act (1993)
Ordinance 70/ Building Code of Australia (1989)
Clean Water Act (1970)

References

Atlantis Corporation Pty Ltd, Brochure on Sub-surface Drainage, Landscaping and Wall Drainage, Atlantis.

GREY WATER RE-USE

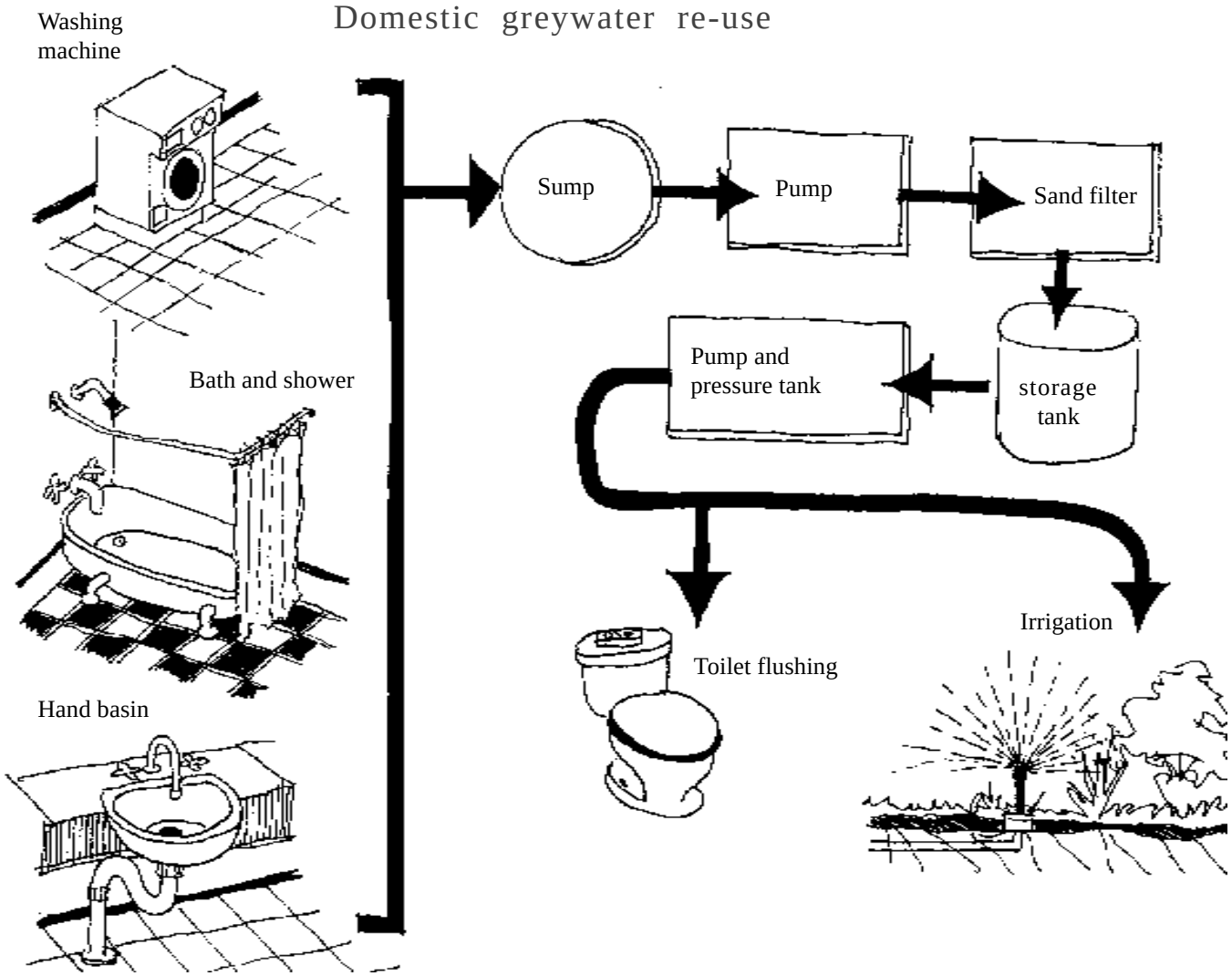
Description

Grey water comprises waste water from the laundry, shower, bath and hand basin. It excludes water form the kitchen waste and toilet due to the level of pollutants. Re-using domestic grey water for the purposes of toilet flushing and garden watering in single family dwellings reduces the demand on water resources.

Conditions When BMP May Apply

* All domestic applications.

Domestic greywater re-use



GREY WATER RE-USE

Application Where BMP May Apply (Note Compliance)

* Grey water systems for irrigation are only feasible in urban areas with sufficient landscaped area and where the soil of the irrigation areas is capable of accepting the discharge.

* Grey water is suitable for the irrigation of areas where direct contact will not occur, including orchards, ornamental gardens and lawns sub-surface irrigation is preferable.

* The re-use of grey water for toilet and urinal flushing is practical in both urban and rural areas, provided the grey water has been effectively disinfected.

Purpose

* To conserve water resources through the re-use of grey water for domestic purposes, and to reduce the environmental impacts associated with the disposal of large volumes of effluent.

Limitations

* Grey water used for the purpose of toilet or urinal flushing must be treated so that turbidity is maintained at a level which allows effective disinfection.

* Grey water should not include water from the kitchen sink, water from washing nappies, or water from a toilet bowl or bed pan. This water is regarded a sewage and must be disposed into the sewer or into an onsite disposal system.

* The use of grey water for irrigation purposes is limited by the soil capacity. It is not suitable in areas close to water ways due to the high level of nutrients .

* Legislation in NSW currently prohibits the re-use of grey water for lawn and garden watering in sewered areas within Hornsby Shire.

* Where grey water is to be used for irrigation purposes, the irrigation area must be constructed and operated in such a manner as to prevent run off from the disposal area and to ensure that the grey water does not pond onsite.

Cost Effectiveness

* High capital and maintenance costs may be partially off set by the savings in water consumption.

Maintenance

* The installer of a grey water system must provide an operation and maintenance manual. Maintenance must be carried out in accordance with the manual. Grey water systems use a variety of straining, filtering and disinfection techniques and a high level of maintenance is necessary to ensure the system is operating correctly.

* The owner/occupier of a premises with a grey water system is to enter into a maintenance contract with the supplier or other authorised person to ensure the correct and efficient operation of the unit.

GREY WATER RE-USE

Construction Technique/Expertise

* Grey water systems can be retrofitted to service existing dwellings by modifying the standard drainage system. The installation of such a system is to be carried out by a licensed plumber or other qualified person.

Integration Opportunities and Constraints

* The reuse of grey water reduces demand for potable water as well as protecting the environment flow the impacts of higher levels of discharge.

* Improved ornamental gardens and lawns, improved agricultural practices.

Compliance

Approval from the NSW Department of Health and Council is required.
It will be subject to certain conditions of approval specific to the site.
The supply of recycled waste water must be in accordance with the Urban and Residential Use of Reclaimed Water (RWCC 1993)
Clean Waters Act (1970)

References

Jeppesen, B. and Solly, D. (1994), Domestic Grey water Re-use: Overseas Practices and its Applicability to Australia, Research Report No. 73, March 1994, Brisbane City Council, Brisbane.

Jeppesen, B. (1994), Grey Water Reuse in 4th Recycled Water Seminar, Newcastle, May, 1994.

Van der Ryn, S. (1978), The Toilet Papers, Capia Press.

Gerber, C. Straub, T. Rose, J. Karpiscak, M., Foster, K. and Brittain, R. (1995), Water Quality Study of Grey Water Sytems in Water Resources Bulletin, Vol. 31, No 1, February, 1995.

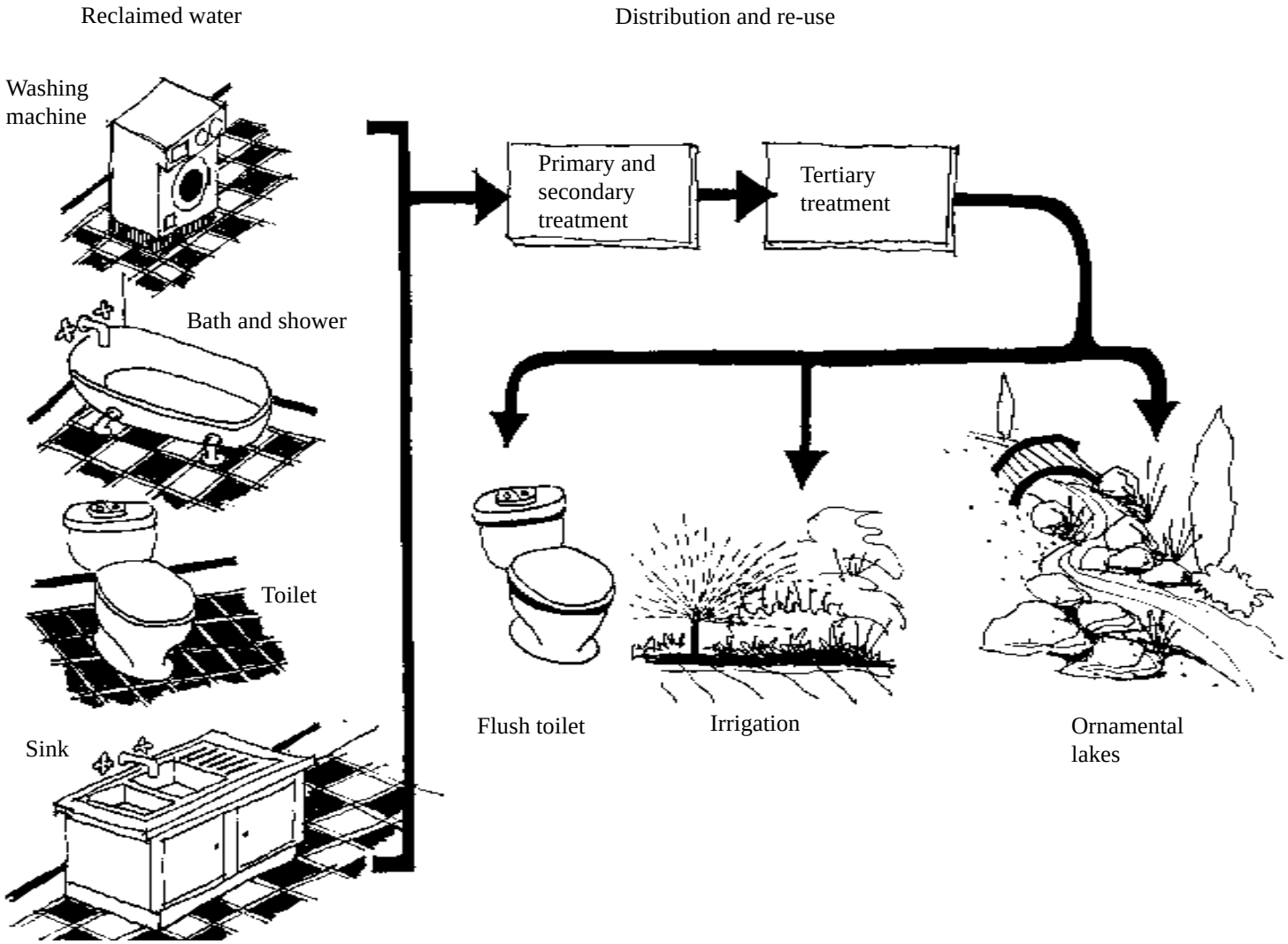
EFFLUENT RE-USE IN BUILDINGS

Description

Wastewater generated from commercial buildings and apartment complexes can be reclaimed and re-used onsite for a variety of activities that do not necessarily require a high quality water supply.

Typical uses for reclaimed water in commercial buildings and apartment complexes include: toilet flushing, air conditioning make-up water, and water for ornamental streams and pools.

Reclaimed water treatment



EFFLUENT RE-USE IN BUILDINGS

Conditions When BMP May Apply

* Appropriate for sites where large volume water demanding facilities such as commercial buildings and apartment complexes are being planned.

* Practical for sites where population levels may be restricted due to the limited capacity of water supply, sewer and wastewater treatment facilities, or where the demand for water supply islikely to place pressure on, or exceed the available supply of water.

Purpose

* To reduce the impacts associated with the disposal of large volumes of effluent into the aquatic environment.

* To reduce the use of potable water for applications where high water quality is not necessary.

Limitations

* Cross contamination measures must be in place to ensure that the reclaimed water does not come in contact with the potable water supply.

* Systems which are designed to service one building, such as an apartment complex, will require the space to provide for the treatment facilities within the building.

* Success of onsite wastewater reclaimation and reuse systems relies on public acceptance of effluent reuse.

Integration Opportunities and Restraints

* Operation of the system contributes to conserving a natural resource, and effluent is converted to a valuable resource.

* Opportunities arise for re-use of the effluent for ornamental streams and pools to enhance landscape settings.

Cost Effectiveness

* These systems have high capital costs, though financially viable in the long term with the aid of government subsidies. Research suggests that for a 30 story office building savings of more than 100,000 KL per annum (or $45,000) may be achievable (1996).

* As effluent discharge requirements become stricter, wastewater reclamation and reuse will become more competitive with the price of potable water in the future.

Maintenance

* Regular maintenance of the system is required to maintain a quality of effluent acceptable for recycling in commercial buildings and apartment complexes.

Construction Techniques/Expertise

* Reclaimed water pipelines and fittings must be clearly identified.

* The possibility of cross connection with water supply pipelines must be avoided at all costs.

* Systems can be designed, constructed and operated by specialised wastewater treatment companies.

Compliance

The re-use of effluent must comply with all relevant legal requirements, including codes, guidelines and standards.
The supply of recycled effluent must comply with the ANZECC water quality guidelines and the Clean Waters Act (1970).
The supply of recycled wastewater must be in accordance with the Urban and Residential Use of Reclaimed Water (RWCC 1993).

References

Australian Water and Wastewater Association (1991), Technical Papers, Vol. 1, from 14th Federal Convention, Western Australia, March 1991.

Australian Water and Wastewater Association (1994), Proceedings from Recycled Water Seminar, Newcastle, May 1994.

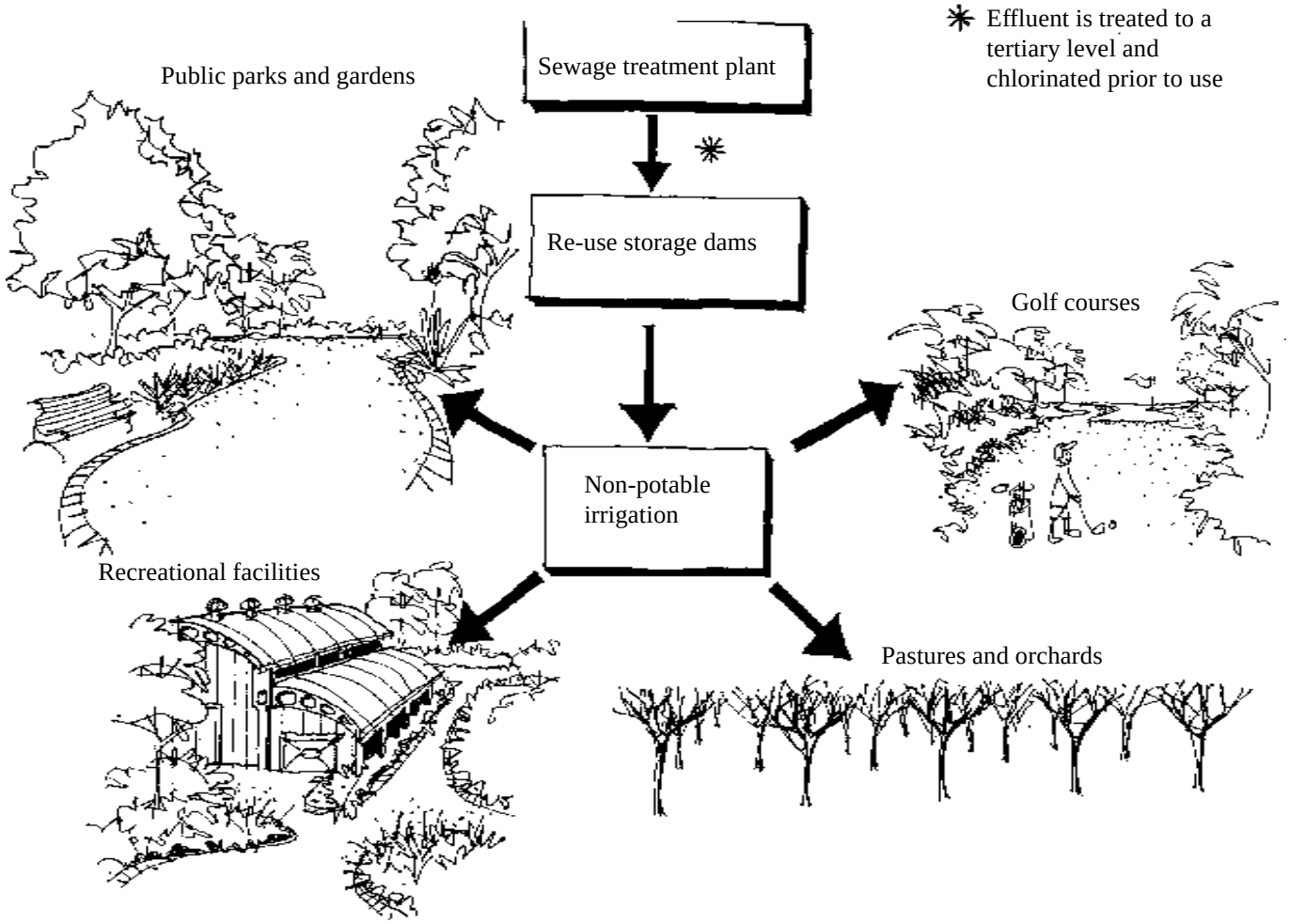
American Water Works Association (1981), Vol. 1, Proceedings from the Water Reuse Symposium 2, Washington D.C., 1981.

EFFLUENT RE-USE FOR IRRIGATION

Description

Effluent that has undergone secondary treatment can be re-used for irrigation purposes. Areas suitable for irrigation with reclaimed water include golf courses, community recreational facilities, gardens and orchards.

Refer also BMPs - Minimizing Irrigation



Conditions When BMP May Apply

* Irrigation with recycled effluent is suitable in areas where a high quality source of water is not required and where large volumes consumed for irrigation purposes.

* The use of recycled effluent is subject to the relevant treatment, operation, management and pollution control requirements.

EFFLUENT RE-USE FOR IRRIGATION

Purpose

* To conserve water resources, through the re-use of effluent for irrigation purposes where high water quality is not necessary and large volumes are consumed.

Limitations

* The use of recycled effluent for irrigation purposes is dependant upon site conditions, including, soil type, topography and proximity to any water courses.

* The recycled effluent is for irrigation purposes only, and must not be used for drinking, cooking, or other related domestic purpose, and must not be used on body contact recreational areas.

* Effluent should not be used to irrigate vegetables that are eaten raw.

* Inappropriate loading can degrade the land and raise public health concerns.

* The use of recycled effluent for irrigation is limited by the soil capability of the irrigation area.

* Control measures must be in place to prevent stormwater run-off entering the irrigation areas and causing pollution.

Integration Opportunities and Constraints

* The reuse of effluent for irrigation purposes reduces the demand on dam storages during times of drought.

* The reuse of effluent for irrigation purposes takes advantage of the high level of nutrient found in the waste water, and saves on fertilizer costs.

Cost Effectiveness

* Lower water quality requirements for irrigation water can result in water costs that are less than the cost of potable water.

* Wastewater reclaimation is most cost effective in areas where the location of the irrigation area is close to the sewage treatment plant, as this minimises the costs associated with the transportation of the effluent.

* These systems are cost effective because they utilize proven, standard components furnished by independent suppliers on a competitive basis.

* Wastewater application is a viable option for application where a large volume of water is used for irrigation purposes, this includes the supply of wastewater for the irrigation of golf courses, public parks and gardens, recreational facilities and orchards.

* Land and equipment must be purchased at considerable expense.

Maintenance

* Regular maintenance of the systems would be required, including the monitoring of the landscaped area and the irrigation system. Such monitoring is carried out by Sydney Water.

Construction Techniques/Expertise

* Irrigation lines for the irrigation of grassed sports areas, public parks and gardens, racecourses etc. can be connected to an established sewage treatment plant.

EFFLUENT RE-USE FOR IRRIGATION

Compliance

The reuse of effluent for irrigation purposes must comply with all relevant legal requirements, including codes, guidelines and standards.
The reuse of effluent must be in accordance with the Draft EPA Environmental Guidelines For Industry - The Utilization of Treated Effluent by Irrigation.
The supply of recycled effluent must comply with the ANZECC water quality guidelines and the Clean Waters Act 1970.
The supply of recycled wastewater must be in accordance with the Urban and Residential Use of Reclaimed Water (RWCC 1993) 19-20 May 1994.

References

Anderson, J M (1994), The Potential for Water Recycling in Australia; Expanding our horizons in 4th NSW Recycled Water Seminar, Newcastle, 19-20 May, 1994 .

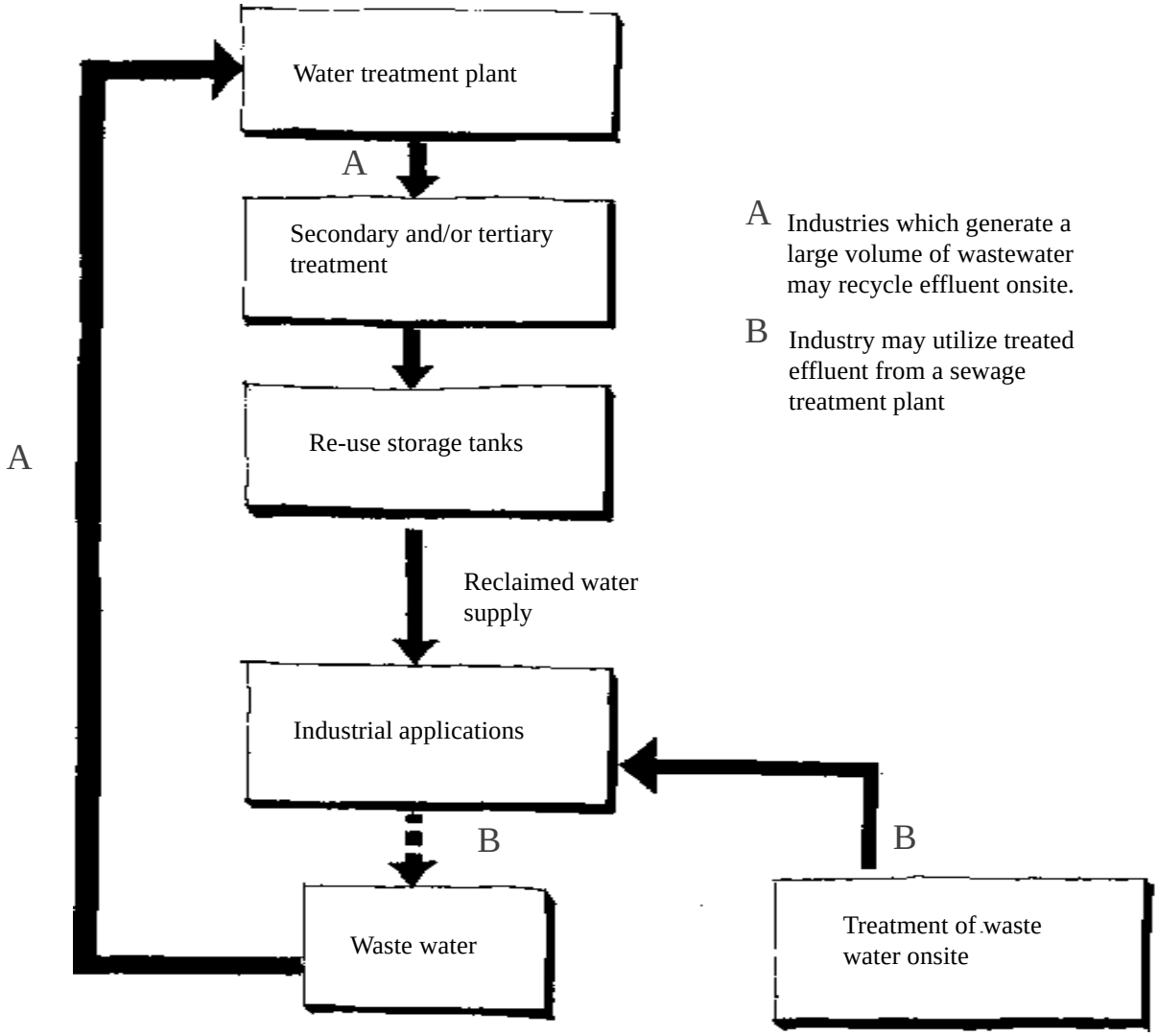
Anderson, J M. Effluent Reuse in Dual Reticulations, in the 14th Federal Convention, Australian Water and Wastewater Association, Western Australia, 17-22 March 1991.

Denton, C N., Recycled Water for Domestic Use; Rouse Hill STP in the 4th NSW Recycled Water Seminar, Newcastle.

EFFLUENT RE-USE FOR INDUSTRIAL APPLICATIONS

Description

The re-use of treated sewage effluent by industry involves the use of treated effluent in place of potable water for applications which do not require a high quality water The three main areas suitable for effluent re-use in industry are those applications involving cooling, washing, boiling, processing and dust suppression.



Conditions Where BMP May Apply

* Suitable for industrial areas with a high potential for the use of less than potable quality water.
* No industrial water shall be supplied for potable needs.
* Installation of the system requires the approval of the relevant authorities.
* Reclaimed water pipelines and fittings must be clearly identified.
* The possibility of cross connection with water supply pipelines must be avoided at all costs.

EFFLUENT RE-USE FOR INDUSTRIAL APPLICATIONS

Purpose

* To reduce the use of potable water in industrial applications through the re-use of effluent.

Limitations

* The demand for the re-use of effluent depends on the nature and the size of the industry, and will generally be restricted to heavy industries with large water demands for low grade uses.

* The reuse of effluent for industrial purposes must be carried out in a way which minimises direct body contact and the formation of aerosols.

* At present the extent of reuse for industrial purposes is limited by economics, as potable water is cheaper and more available than wastewater.

* Only feasible in areas with a concentrated industrial area.

Integration Opportunities and Constraints

* Operation of the system contributes to conserving potable water resources by using wastewater for low grade applications where no special water quality requirements exist.

* Industrial water requirements are growing parallel with the increase of effluent for industrial applications.

* Effluent re-use by industry has no constraints imposed by hygiene or special water quality requirements as its use is generally restricted to low grade applications.

Cost Effectiveness

* The high capital and operating costs may be off set by the high cost of building new infrastructure such as dams and sewage treatment plants.

* Lower clean water costs through re-use.

* The cost effectiveness of effluent re-use for industry will vary according to the size and the nature of the industrial area served and other associated constraints.

* Material and construction costs may be prohibitively high without the aid of government subsidies.

Maintenance

* Wastewater treatment companies provide a full range of services for the reuse of industrial wastewater, these services include maintenance and monitoring.

* Maintenance must be carried out regularly to maintain quality and efficiency.

* Specialist maintenance usually required.

Construction Technique/Expertise

* Reuse systems can be designed, constructed and operated by specialised wastewater treatment companies, and can be adapted to suit the needs of any particular industry.

* Hydraulic and other specialist expertise if required.

Compliance

The re-use of effluent must comply with all relevant legal requirements, including codes, guidelines and standards. The supply of recycled effluent must comply with the ANZECC water quality guidelines and the Clean Waters Act 1970. The supply of recycled wastewater must be in accordance with the Urban and Residential Use of Reclaimed Water (RWCC 1993).

References

Australian Water and Wastewater Association (1991), Technical Papers, Vol. 1, from 14th Federal Convention, Western Australia, March 1991.

Australian Water and Wastewater Association (1994), Proceedings from Recycled Water Seminar, Newcastle, May 1994.

American Water Works Association (1981), Vol. 1, Proceedings from the Water Reuse Symposium 2, Washington D.C., 1981.

Peavy, M S., Rowe, D R. and Tchobanoglous, G. (1985), Environmental Engineering, McGraw-Hill Book Company, USA.

Taylor, M.R.G. and Denvor, J.M. (1984), Reuse of Sewage Effluent, Thomas Telford Ltd.

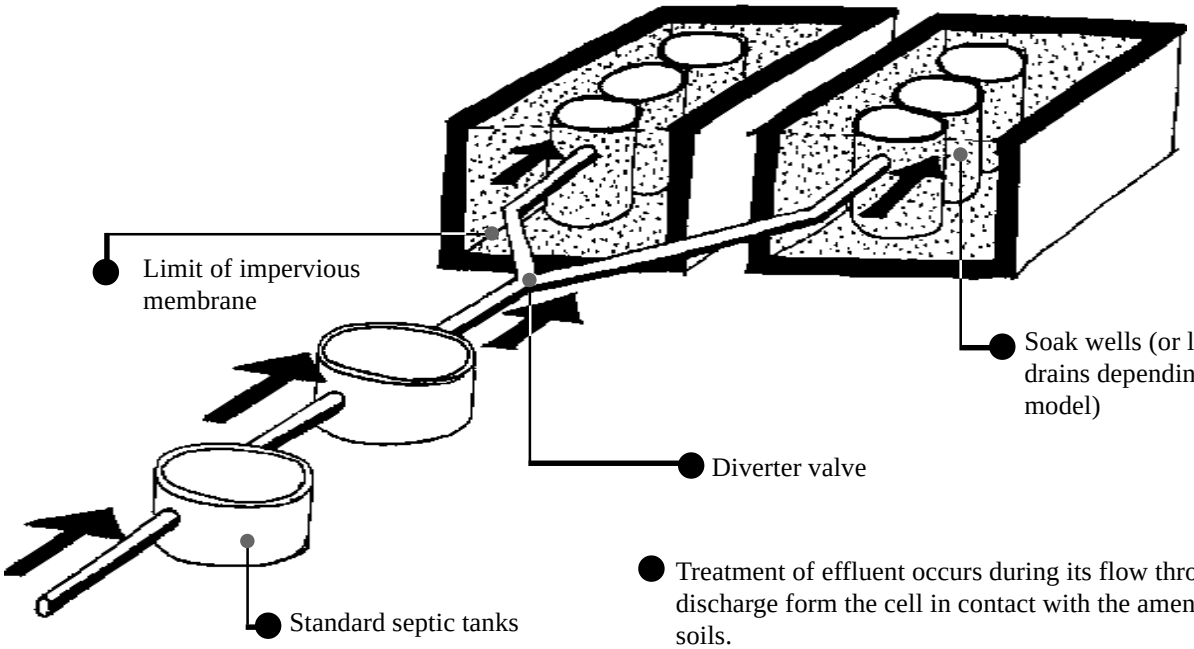
ECOMAX EFFLUENT TREATMENT SYSTEM

Description

The Ecomax treatment system comprises a standard septic tank/s and two Ecomax cells used in rotation. The cells consist of a leak drain or soak well for storage and leaching, an underlining impervious material and an amended soil treatment medium.

The principle active ingredient in the amended soil is red-mud which is high in iron and aluminium sesquioxided which have strong absorption capacity.

Drainage from the house to the septic tank for pre-treatment.



- Treatment of effluent occurs during its flow through and discharge form the cell in contact with the amended soils.

(Source: Ecomax Waste Management Systems)

ECOMAX EFFLUENT TREATMENT SYSTEM

Application Where BMP May Apply

* Ecomax treatment systems are suitable for single residential developments and multiple dwelling developments.

* Due to the quality of effluent, Ecomax treatment systems may be suitable in environmentally sensitive areas where conventional onsite disposal systems are not appropriate.

* Ecomax treatment systems are suitable for all areas, however, an area of at least 500 m^2 is necessary for installation. Larger areas may be necessary for sites with clayey soils.

Conditions When BMP May Apply

* The onsite treatment system for domestic wastewater, which removes nutrients and other pollutants, yielding a quality of treated water of sufficiently high standard to be suitable for direct discharge into the environment.

Purpose

* The onsite treatment system for domestic wastewater, which removes nutrients and other pollutants, yielding a quality of treated water of sufficiently high standard to be suitable for direct discharge into the environment.

Limitations

* Ecomax requires a flat area for installation. Some sites may require considerable site works to enable installation.

Integration Opportunities and Constraints

* Onsite treatment and disposal of wastewater is to a standard suitable for direct discharge to the environment, thus reducing the need for large sewage treatment plants and ocean outfalls.

* Over 99% of the phosphorus is removed from the effluent, thus having the potential for catchment nutrient dis charges to be significantly reduced.

* Due to the high quality of the treated wastewater, there is significant re-use and ground water recharge potential.

Cost Effectiveness

* The Ecomax domestic systems are marginally more expensive than other on-site disposal alternatives to install.

* Unlike the alternative onsite disposal systems however, Ecomax systems do not need a regular maintenance. As a result, the long term cost effectiveness of the Ecomax system compares favourably to the other alternatives.

Maintenance

* A diversion valve, which can be operated by the occupier, needs to be turned at approx. six monthly intervals.

* Septic tanks need to be de-sludged periodically to ensure the efficient removal of solids prior to the effluent entering the Ecomax cells.

ECOMAX EFFLUENT TREATMENT SYSTEM

Construction Technique/Expertise

* The installation of an Ecomax system is to be carried out by a licensed plumber or other qualified person.

* A septic tank of standard approved design is installed as normal. Construction of the disposal area is in accordance with the manufacturers specifications.

Compliance

The Ecomax treatment system must comply with Australian / New Zealand Standard 1547: Disposal Systems for Effluent from Domestic Premises.
The final effluent must meet the NH & MRC Guidelines for reclaimed effluent.
The supply of recycled effluent must comply with the ANZECC water quality guidelines and the Clean Waters Act 1970.

References

Whelans and Halpern Glick Maunsell (1994), E3, E9-E14, Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

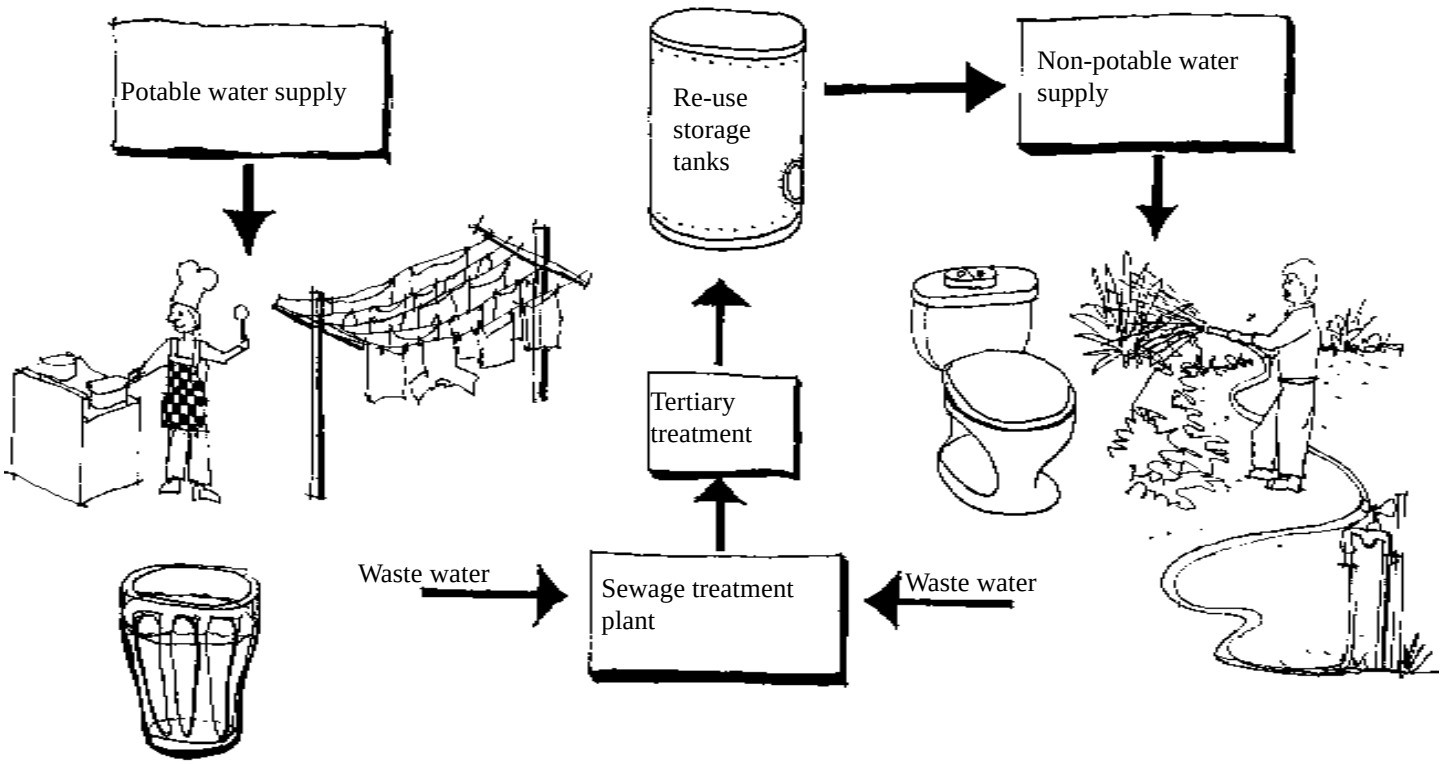
Ecomax Waste Management Systems (1995), Introduction to the Ecomax Effluent Treatment Systems, Unpublished Report.

Marzella, M, Coote, B and Swanson, P., Performance Evaluation of On-Site Wastewater Treatment Systems for Single Households in Australian Water Technologies Ensight Report No. 96/026.

DUAL WATER SUPPLY SYSTEM

Description

Dual water supply systems in urban areas enable the use of recycled treated effluent from sewage treatment plants, for non-potable domestic purposes such as garden watering and toilet flushing.



Conditions When BMP May Apply

* The use of reclaimed water in dual reticulation systems is suitable for subdivisions a large scale developments where the cost of providing potable water is high.

Purpose

* To reduce the demand on water resources through the recycling of wastewater from a sewage treatment plant for non-potable uses.

DUAL WATER SUPPLY SYSTEM

Limitations

* Effluent reuse in dual reticulation systems is not suitable for small communities, or where the community is spread out over a large geographical area.

* Recycled water for domestic use is not suitable for drinking, cooking and kitchen purposes, bath, showers, hand basins, clothes washing or swimming pools.

* The total removal of pathogens can not be assured, therefore human contact with wastewater, even in non-potable uses, carries a risk factor which is largely unknown.

* The supply of reclaimed water must be through a separate reclaimed water reticulation system.

* Cross contamination control measures must be in place to ensure that the reclaimed water does not come in contact with the potable water supply.

* Success of the use of reclaimed water in a dual reticulation system relies on public acceptance of effluent reuse.

* The use of reclaimed water in dual reticulation systems is most practical in areas where the average rainfall is less than 600mm per year.

Integration Opportunities and Constraints

* Dual reticulation systems conserve both water and nutrients, while protecting the environment from the impacts associated with effluent discharge.

* Dual water supply systems contribute to conservation of a natural resource.

* Success of the use of reclaimed water in a dual reticulation system relies on public acceptance of effluent reuse. This can be enhanced by informing and involving the public at all stages of the planning and implementation of the wastewater reuse and the education required.

Cost Effectiveness

* High capital costs, which may be off set by reduced water consumption costs, delivery costs and effluent dis charge costs.

* Dual reticulation systems are cost effective when the potable water source is distant and expensive to deliver.

Maintenance

* High maintenance of the wastewater treatment and reclamation facilities is required to maintain a quality of effluent acceptable for recycling.

Construction Techniques/Expertise

* Dual reticulation systems can be retrofitted to an existing scheme by converting the existing reticulation to non-potable use and constructing a new, smaller diameter reticulation for potable use.

* Reclaimed water pipelines and fittings must be clearly identified. The possibility of cross connection with water supply pipelines must be avoided at all costs.

* The project would need to be designed by a specialised consultant in conjunction with the Sydney Water.

Compliance

The reuse of effluent must comply with all relevant legal requirements, including codes, guidelines and standards.
The supply of recycled effluent must comply with the ANZECC water quality guidelines and the Clean Waters Act (1970).
The supply of recycled wastewater must be in accordance with the Urban and Residential Use of Reclaimed Water (RWCC 1993).

References

Anderson, J M (1994), The Potential for Water Recycling in Australia; Expanding our Horizons in 4th NSW Recycled Water Seminar, Newcastle, 19-20 May, 1994.

Anderson, J M. Effluent Reuse in Dual Reticulations, in the 14th Federal Convention, Australian Water and Wastewater Association, Western Australia, 17-22 March 1991.

Denton, C N., Recycled Water for Domestic Use; Rouse Hill STP in the 4th NSW Recycled Water Seminar, Newcastle.

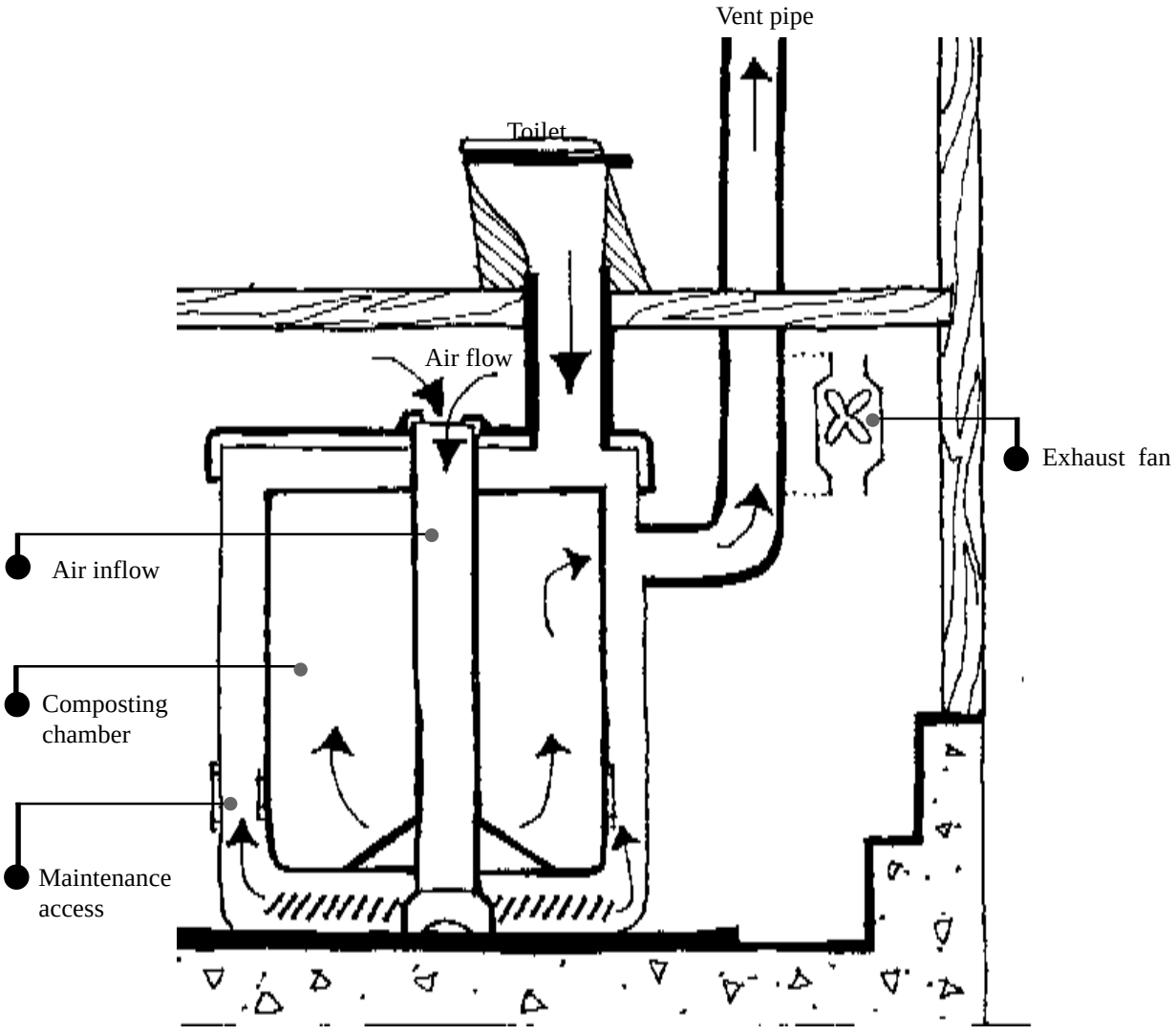
Peavy, M S., Rowe, D R. and Tchobanoglous, G. (1985), Environmental Engineering, McGraw-Hill Book Company, USA.

COMPOSTING TOILETS

Description

Composting toilets use the natural process of decomposition and evaporation to recycle human wastes.

There are a variety of different composting toilets available on the market. Wet composting systems allow for the conventional water flushing toilet pan and dual flush system. Dry composting systems do not require water to flush the waste, but rather, utilise an open floor plan design.



Section of Dry Composting System

COMPOSTING TOILETS

Application Where BMP MAY Apply

* Composting toilets are practical in areas without a central waste water service.
* Suitable for areas, such as river settlements, where pump out and maintenance services are not available.

Conditions Where BMP May Apply

* In approving composting toilets, consideration must be given to the disposal of remaining waste water (greywater).
* In areas not connected to the sewer, a properly designed greywater treatment system must be provided.
* Installation of a composting toilet is subject to Council approval and the conditions attached to that approval.
* Council may only approve composting toilet systems that have been authorised by the NSW Health Department.
* Composting toilets must be vector proof and sufficient ventilation must be provided.

Purpose

* To reduce the use of potable water for flushing toilets and to reduce the level of nutrients and bacteria in domestic waste water.

Limitations

* Certain premises may not be able to accommodate composting toilets due to design constraints of the house.
* Certain household cleaning agents, such as disinfectant, can not be used in the composting toilet as they will kill the composting organisms.

Integration Opportunities and Constraints

* Fear of limited resale opportunities and value may prevent wider interest.
* Wide spread community interest in composting toilets is limited due to the high level of maintenance requirements.

Cost Effectiveness

* Composting toilets are cost competitive with many septic systems. Installation of a waterless composting toilet and sullage disposal system can cost anywhere between $3,000 and $6,000.

Maintenance

* There are many different composting toilets available on the market, and maintenance requirements vary between systems.
* Generally, composting toilets require substantial maintenance; the pedestal must be cleaned, the fan must be maintained and the compost must be removed and disposed of.
* Maintenance must be carried out regularly to maintain quality and efficiency.

COMPOSTING TOILETS

Construction Techniques/Expertise

* Composting toilets can be installed by a licensed plumber. Basic systems can be installed in less than one day.

Compliance

Composting toilets must comply with the Environment and Health Protection Guidelines - Onsite wastewater management systems for domestic households, produced by the NSW Department of Health (Draft).
Composting toilets and associated greywater disposal systems must comply with the ANZECC water quality guidelines and the Clean Waters Act 1970.

References

Hawkesbury-Nepean Catchment Committee (1995), Domestic On-site Sewage Storage, Treatment and Disposal, Discussion Paper, August 1995, Hawkesbury-Nepean Catchment Committee.

Dr T. Lustig (1995), On-site Wastewater Disposal Training Course, Course Notes, 4th - 5th December, 1995, Hawkesbury Nepean Catchment Management Trust, Windsor.

Dr T. Lustig (1995), Composting Toilets - Reducing a Large Problem of Domestic Wastes in Environmental Health Review, Australia, Vol 20. No. 3 May-July, 1991.

NSW Department of Health (1996), Environment and Health Protection Guidelines - Onsite Wastewater Management Systems for Domestic Households, Draft Guidelines for Public Comment, NSW Department of Health.

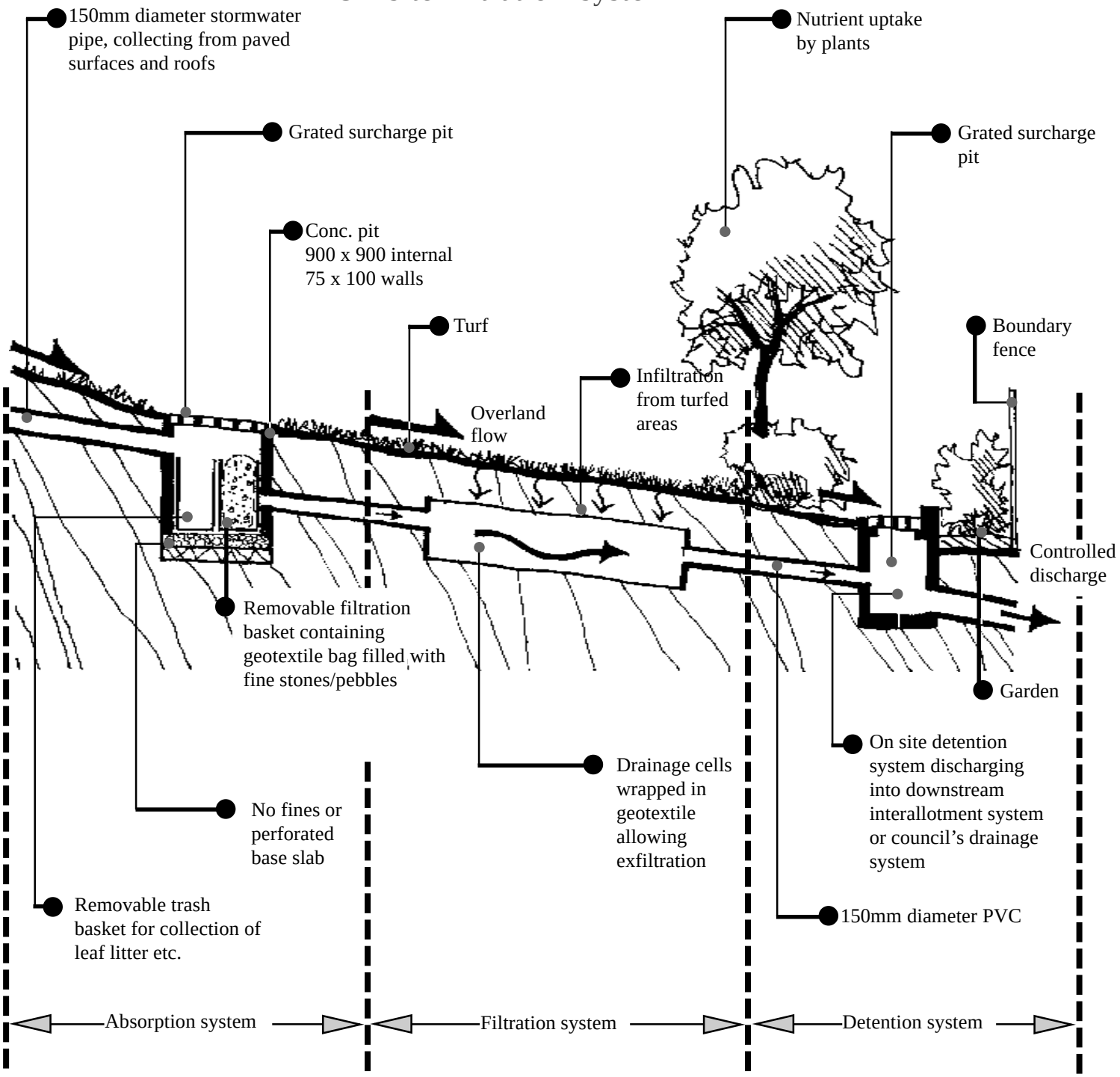
ON SITE INFILTRATION SYSTEMS

Description

On-site Infiltration Systems are designed to be located below ground. They have three functions:

* filtration to improve water quality,
* infiltration to recharge ground water supplies,
* retention/detention to reduce peak flows from run-off.

On site filtration system



ON SITE INFILTRATION SYSTEMS

Application Where BMP May Apply

* New and existing development, particularly residential.

Conditions When BMP May Apply

* Small residential subdivision and developments.

Purpose

* To reduce volumes and runoff velocities by providing stormwater detention and retention of runoff.
* To provide improved water quality through the use of a filtration process .
* To maintain ground water re-charge and infiltration.

Limitations

* Susceptibility to clogging by inadequate upstream erosion and sedimentation controls.
* Requires regular maintenance of upstream drainage systems.
* Cannot be used in areas where nuisance flooding exists or areas of excessive overland flows.
* Cannot be used in areas of high water tables.
* Landscaping has to be located to avoid damage to the system particularly the infiltration cells.
* Not recommended for industrial development where water contamination may occur due to spills.
* Not recommended in water supply catchment areas.
* Cannot be used upslope of road pavements unless subsoil drainage exists or is installed to protect the road pavement

Integration Opportunities and Constraints

* Since systems are located below ground they are not likely to have negative impacts on the existing residential environment

Cost Effectiveness

* Infiltration systems are cost effective for small sites in comparison to the standard on-site detention drainage practices such as basins and wetlands.

Maintenance

* Inspection of the facility annually or after extreme storm events.
* Regular maintenance to upstream sediment sumps/traps and pipe stormwater drainage system is essential to ensure system performance.

Construction Technique/Expertise

* It is important to protect the natural infiltration rate of the facility area by using light construction equipment and procedures that minimise compaction. Stormwater must not be allowed to enter facility until all construction works within the sub-catchment are completed and the land stabilised.

Compliance

To ensure the long term operation, performance and maintenance of the system, appropriate 88B covenants and restrictions on the title of the site must be created.

Sites with sandstone derived (sandy) soils should consider on-site infiltration systems including the following suburbs:

Asquith
Berowra, Berowra Heights
Cowan
Hornsby
Mt Colah
Mt Kuring-gai
River Settlements
Westleigh
Wisemans Ferry

Clean Waters Act (1970)

References

Environmental Protection Authority (1996), Managing Urban Stormwater, Construction Activities and Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Committee, Sydney.

MAXIMUM % OF IMPERVIOUS SURFACES

Description

By minimising the extent of any site covered by impervious surfaces including roof areas, paving, driveways etc, the concentration and runoff of stormwater can be reduced with consequent benefits in infiltration and groundwater re-charge.

Application where BMP may apply

* New or existing development, typically within an urban area.

Conditions when BMP may apply.

* All forms of development where impervious surfaces can be minimised and pervious surfaces maximised to promote infiltration and groundwater recharge. The percentage of impervious areas should generally not exceed 60%, except for commercial or industrial uses.

Purpose

* The application of this practice will decrease the volume of runoff from developed sites as well as promoting the conservation and the re-use of water. Additional benefits will be the installation of landscape works on undeveloped areas of the site, promoting improved site amenity and streetscapes and resultant improvements in water quality through infiltration.

Limitations

* Requires ongoing enforcement and community education where development consent may not be required for installation of impervious surfaces such as concrete pavers.

* Requires appropriate design to ensure integration of impervious surfaces with pervious surfaces to promote infiltration and groundwater recharge.

* Sites should be designed to ensure controlled discharge from impervious surfaces to adjacent pervious areas for infiltration and groundwater recharge.

Integration Opportunities and Constraints

* Impervious surfaces can be designed and integrated to ensure controlled discharge, infiltration and groundwater recharge through pervious areas.

* Reduces the need for kerbs, pipes and drainage systems and reduces volume of drainage discharge into down stream areas.

* Opportunities exist for the development of roof gardens on high density, commercial and industrial sites for both recreational benefits and reducing runoff.

Cost effectiveness

Limitations on the extent of impervious surfaces can increase ongoing costs of the site through the addition of increased maintenance costs to landscaped areas.

MAXIMUM % OF IMPERVIOUS SURFACES

Maintenance

* Maintenance costs will be site specific, however consideration should be given to possible increased maintenance costs of landscape areas that may otherwise be impervious.

Construction Technique/Expertise

* Landscape planners and landscape architects can assist with the appropriate planning of impervious surfaces on sites to maximise infiltration and groundwater recharge and in the detail design of spaces to reduce on-going costs and maximise aesthetic and recreational uses.

Compliance

Local Government Act (1993).
Environmental Planning Assessment Act (179).
Hornsby Shire Development Control Plans.

References

Hornsby Shire Council Development Control Plans

POROUS PAVEMENTS

Description

In suitable locations, porous pavements can be used to reduce the volumes and peak rates of flow by providing for infiltration and detention of runoff from pavements. Water quality can be improved by filtration and bacterial action and some groundwater recharge will occur.

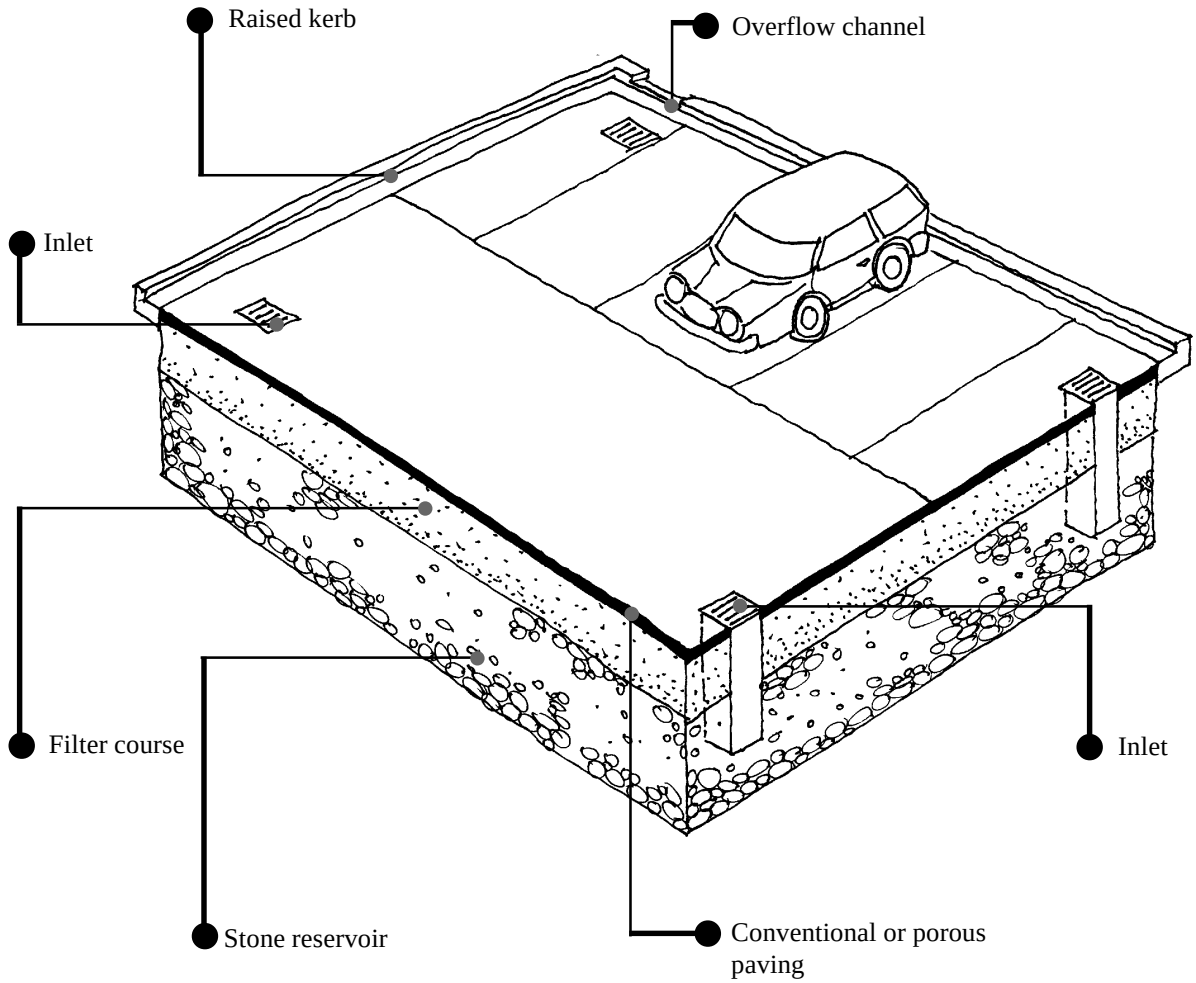
* Porous asphalt consists of an open graded coarse aggregate with a bituminous binder. It is laid over a high void base course material.

* Porous concrete is constructed using special mixes of cement and open graded aggregate. It has a high void content and combined with a high void base course material allows rapid infiltration.

* Modular concrete paving units can also be used, laid over a high void base course. These are generally only used in carparking areas and lightly trafficked access roads.

(Refer BMP - Porous Surfaces - Modular Paving)

Porous asphalt and concrete pavement



POROUS PAVEMENTS

Application Where BMP May Apply

* New development.

* Existing development - carpark pavement reconstruction or extension.

Conditions When BMP May Apply

* Any development with carparking and light traffic access roads on a permeable subgrade soil able to support traffic loads under saturated conditions.

Purpose

* This BMP will improve water quality by reduction in peak rates of flow plus filtration and bacterial action.

* Water balance maintenance will be improved through recharge of groundwater.

Limitations

* The pores in the pavement surfaces can become blocked with oils and fine sediments.

* Not recommended where erosion, heavy or high volume traffic expected to supply large quantities of sediment.

Integration Opportunities and Constraints

* Perimeter landscaping will tend to grow more vigorously

* Vehicles have better skid resistance and noise is reduced

Cost Effectiveness

* Cost of construction is $50 - $120 / m2 (1996).

Maintenance

* A regular maintenance programme is required using high suction sweepers.

Construction Technique/Expertise

* Requires suitably trained personnel, familiar with the methods of construction. Attention to quality of construction workmanship is important.

Compliance

Porous pavement is to have the capacity to store the whole volume from the 1 in 1 year ARI stormflow before overflowing to the outside of the parking area.
Council standard specifications for road and drainage construction.
Clean Waters Act (1970).

References

Whelans and Halpern Glick Maunsell (1994), Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

National Capital Planning Authority (1993), Designing Subdivisions to Save and Manage Water, NCPA, Canberra.

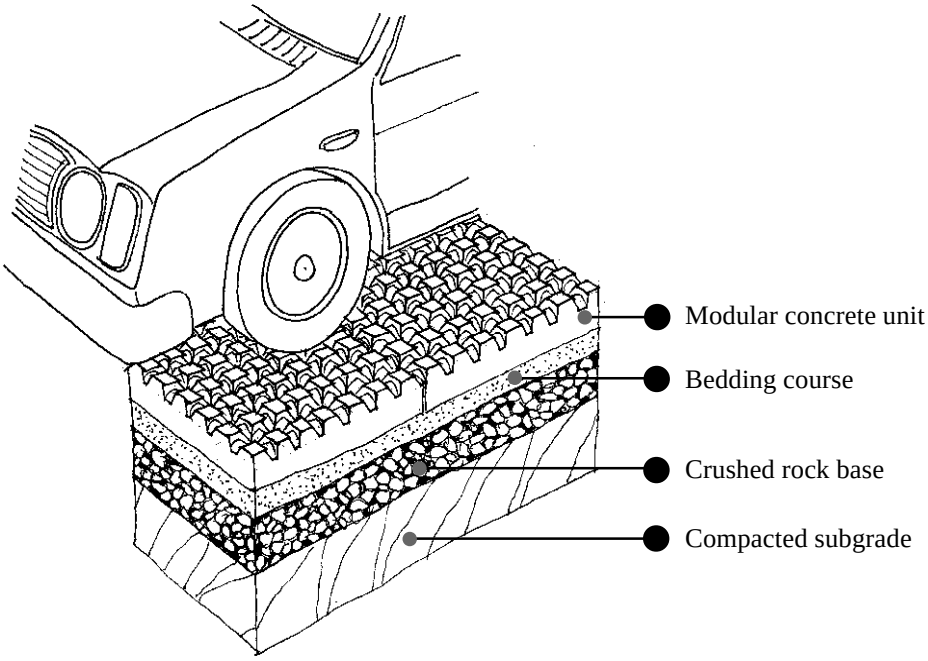
MODULAR PAVING

Description

The use of modular paving to allow infiltration of surface runoff. It may incorporate both groundcover plantings such as turf within the paving module.

Application Where BMP May Apply

* Existing and new developments.



Conditions When BMP May Apply

* As an alternative to impervious surfaces such as concrete, asphalt or road base with high pedestrian and low vehicular usage. Can also be utilised for soil stabilization and roof garden drainage.

Purpose

* To provide infiltration of runoff by reducing volumes and peak flows.
* To maintain groundwater recharge.
* To improve water quality through filtration.

Limitations

* Heavy vehicle traffic may damage the modules and turf (where used).
* Non-sinking, load-bearing base required.

MODULAR PAVING

Integration Opportunities and Constraints

* There are various preformed modular pavers in brick, concrete and heavy duty plastic (grass-cel). The grass cel paving blocks are preferable to concrete as they are located subsurface, maintaining the aesthetically pleasing appearance of lawn and are specially useful in low usage car parks.

Cost Effectiveness

* Quick and easy to install.

Maintenance

* Maintain preformed modulars pavers as per typical pavers (e.g. remove weeds, ensure flush joints). Grass cels should be maintained as a typical grassed area with adequate watering to maintain normal growth.

Construction Technique/Expertise

* Self installation or with aid of commercial landscaper.

* Needs skills associated with site preparation and levelling and laying of paving blocks/turf.

Compliance

To be applied for all areas of paving subjected to light passenger vehicular traffic such as residential driveways and parking areas.
Local Government Act (1993)
Clean Waters Act (1970)

References

Whelans and Halpern Glick Maunsell (1994), Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

Total Erosion Control (Aust), Grass-cel-turf blocks promotional material, Total Erosion Control (Aust).

SWALES

Description

Gently sloping grassed waterways used to reduce runoff, remove pollutants and provide groundwater recharge. These may be incorporated into general landscaped areas or as part of the street drainage. May be used to transport water from one BMP device to another.

Application Where BMP May Apply

* This BMP is suitable for sites with flat to gentle slopes, low water table, low water velocity and a catchment area of less than 2 hectares.

* Particularly appropriate in rural areas.

Conditions When BMP May Apply

* Within any type of development.

* Adjacent to roads, as opposed to kerb and gutter.

Purpose

* To promote the infiltration of runoff, through collection and ponding in order to reduce the volume and velocity of runoff.

Limitations

* Requires flat to gently sloping sites.

* Soil should not have a high clay content or be heavily compacted. Soils which may become compacted from vehicle movement are not suitable.

* Not recommended when high use off-street parking is required or for small lots with numerous driveways.

Integration Opportunities and Constraints

* Can be incorporated into a range of development proposals as part of landscaping works or drainage designs.

* Can be used as an alternative to kerb and gutter, along roads or access-ways. Existing swales should be retained, where road safety not compromised.

Cost Effectiveness

* Cost effective when serving catchments less than 2ha in size. Cheaper to install than kerb and gutter.

* Maintenance may be considerable in summer if mowing is necessary.

Maintenance

* Need to maintain grass cover or other landscape treatment. Mowing may be an expensive maintenance cost.

SWALES

Construction Technique/Expertise

* Can be designed by engineer, architect, planner or landscape architect.

* Constructed using earthmoving equipment by creating a swale.

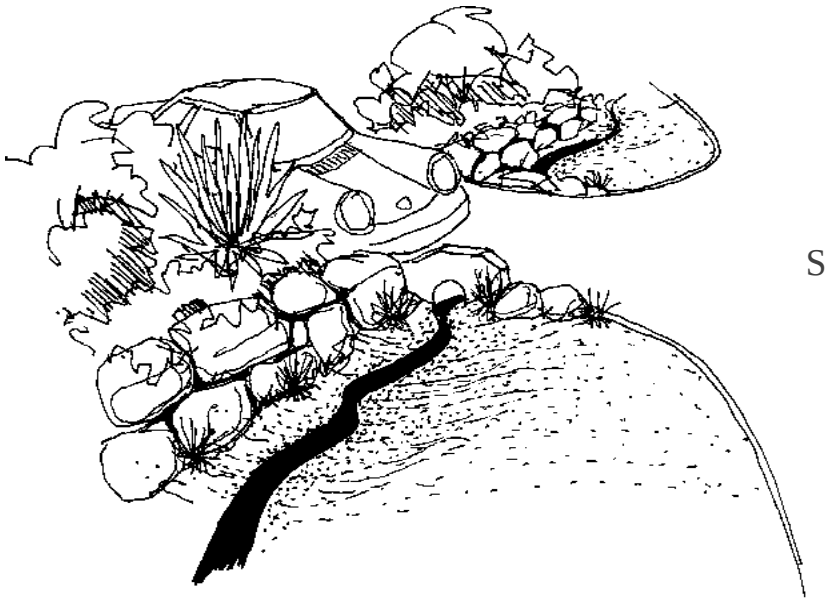
* Can be grassed or planted with water tolerant trees and shrubs.

Compliance

To be applied to all sites with vegetated, including turf-lined swales to reduce flow velocities and promote some infiltration.
To be considered in place of impervious channels, kerb and gutters.
Clean Waters Act (1970).

References

Whelans and Halpern Glick Maunsell (1994), Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

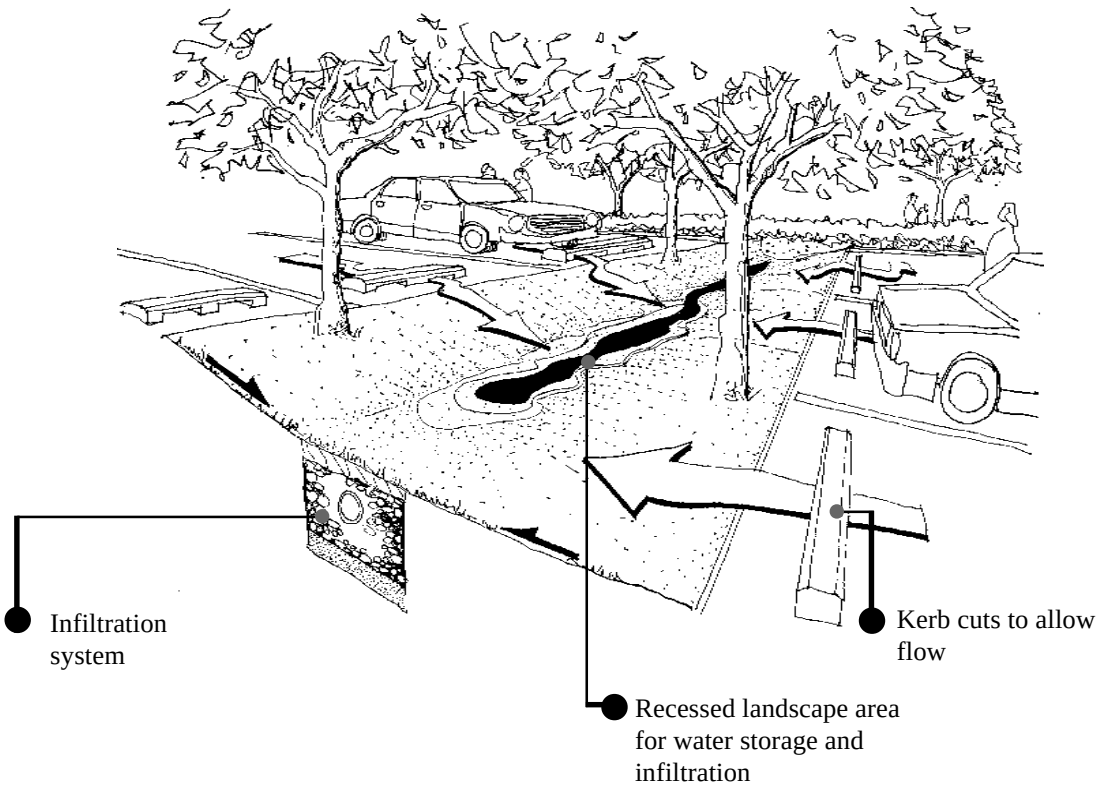


Swale drainage

PARKING LOT STORAGE

Description

Gently sloping landscaped areas incorporated into car parks may be used to pond water to allow for infiltration and desposition of sediment.



Application Where BMP May Apply

* This BMP can be incorporated into the design and construction of new car parks in commercial and industrial developments or public/private carparks.

Conditions When BMP May Apply

* Should be integrated into carpark designs on sites which are flat to gently sloping, with soils suitable for infiltration.

Purpose

* To promote the recharge of groundwater through the use of landscape swales in car parks.

* To promote the deposition of sediment.

PARKING LOT STORAGE

Limitations

* Sites which are too steep.

* Sites where soil have low absorption and permeability e.g. Heavy clays and/or compacted soils.

Integration Opportunities and Constraints

* Can be integrated with car park landscaping proposals which can also be used for site stabilisation on steep sites.

* Can be incorporated with other stormwater detention and infiltration devices (Refer BMP Infiltration Devices)

Cost Effectiveness

* Inexpensive to construct and maintain. This will increase the overall size of the car park, although similar areas would be required if landscape mounding was proposed as in typical car park designs on the perimeter.

Maintenance

* Maintenance requirements are typical of general landscaping e.g. mow grass, maintain plants, remove any collected rubbish.

Construction Technique/Expertise

* Can be designed by engineer, architect, planner or landscape architect.

* Constructed using earthmoving equipment by creating a swale.

* Can be grassed or planted with water tolerant trees and shrubs.

Compliance

To be considered for all parking areas.
Design is to have the capacity to store the total volume of water generated in a 1 in 1 year ARI storm.
Volumes in excess of this are to be conveyed to an adjacent stormwater drainage system.
Clean Waters Act (1970).

References

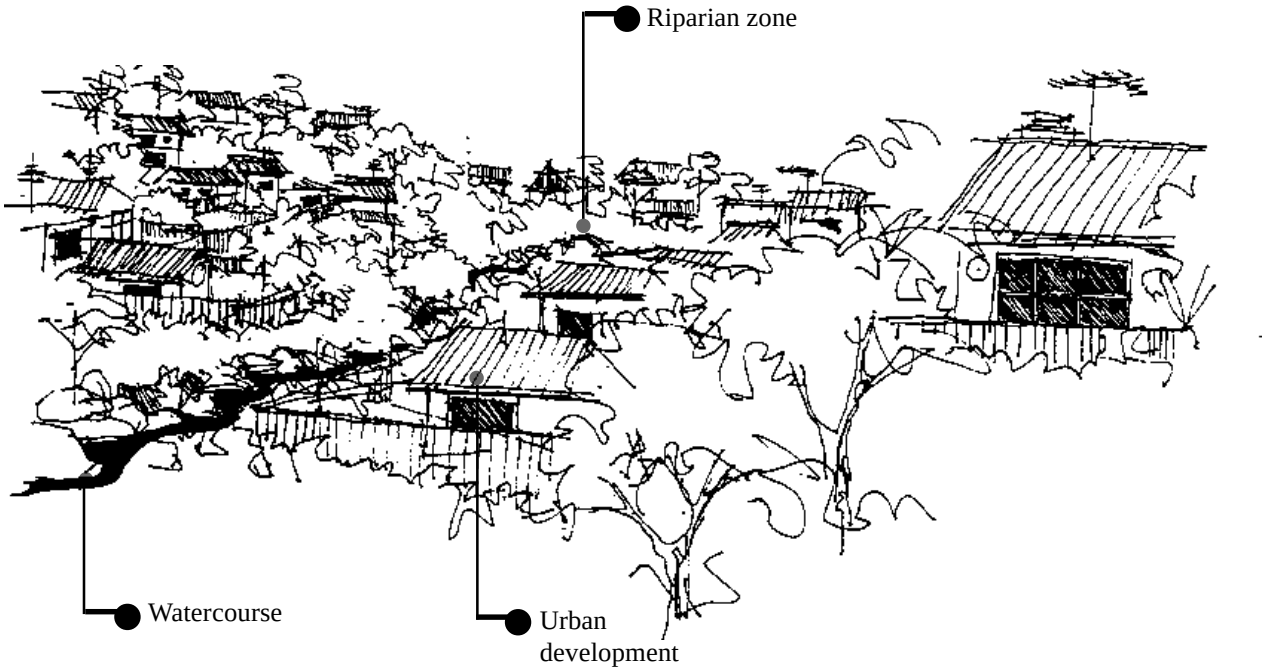
Whelans and Halpern Glick Maunsell (1994), Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

RETAINING EXISTING OPEN WATERCOURSES

Description

Consideration should be given to the re-opening of piped drainage lines with reinstatement of the natural watercourse environment. Existing watercourses are to be retained for the improvement and protection of the environment.

The advantages of retaining open watercourses are that they assimilate and eliminate pollutants, they conserve biodiversity and habitat within and around the watercourseand increase the recreational and the aesthetic value of the watercourse.



Application Where BMP May Apply

* New development.
* Existing development.
* Commercial and industrial activities.
* Council activities.

Conditions When BMP May Apply

* All existing open watercourses.

Purpose

* The protection, renewal and maintenance of urban streams ensures an appropriate water balance is achieved and water quality is improved.

RETAINING EXISTING OPEN WATERCOURSES

Limitations

* There may be loss of profits through reduced serviceable lots in a new development where in the past, water courses were piped.

Integration Opportunities and Constraints

* Through retaining existing open watercourses, there is the potential for re-vegetation to improve the recreational quality of the area. This may include bridging a creek and regenerating existing degraded areas to improve water quality and recreational qualities. These improvements have the potential to increase the value of a property.

Cost Effectiveness

* By retaining existing watercourses there will be reduced maintenance costs of any pipe work that may have been installed.

* There is the potential to reduce the costs of installing water quality improvement/control structures.

Maintenance

* Maintenance of existing open watercourses may include regeneration of riparian bushland.

* Maintenance costs would be low compared with the installation of pipework and the maintenance of these pipes.

Construction Technique/Expertise

* Designs which allow for the retention of existing watercourse should be undertaken by site planning professionals such as Engineers, Landscape Architects and Planners.

Compliance

In consultation with Environment, Works and Development Divisions of Hornsby Shire Council, the criteria listed below are to be considered prior to the determination of any development/building application on properties affected by a watercourse. If the proposal does not meet the applicable criteria, as deemed by Council, the development should not proceed. The criteria are:

* the sustainability of actual or potential biodiversity and habitat;

* the actual or potential ability of the watercourse to enhance water quality;

* the actual or potential visual/aesthetic character of the watercourse;

* the actual or potential recreational value of the watercourse;

* the impact of the proposed alteration to reduce the potential for use by future generations;

* the effect on the watercourse of the existing and likely future development in the catchment;

* the effect on the catchment and existing development of any treatment to the water course;

* the influence of previously altered sections on the watercourse;

* the need for access across the watercourse;

Compliance (cont.)

* the actual or potential influence of the watercourse on public health and safety;
* the mitigation of flooding and the hazard to property; and
* Rivers and Foreshores Improvement Act (1948)
* Water Act (1912)
* Soil Conservation Act (1938).
* Clean Waters Act (1970).

References

Hornsby Shire Council (1995), Policy on the Protection, Renewal and Maintenance of Urban Streams.

TREATMENT OF RUNOFF ENTERING BUSHLAND

Description

Runoff entering bushland requires special treatment to reduce its erosive impact and to minimise the impacts of altering soil moisture, increased nutrients and the dispersal of wed seeds.

Refer also to BMP - Onsite Infiltration Systems.

Application Where BMP May Apply

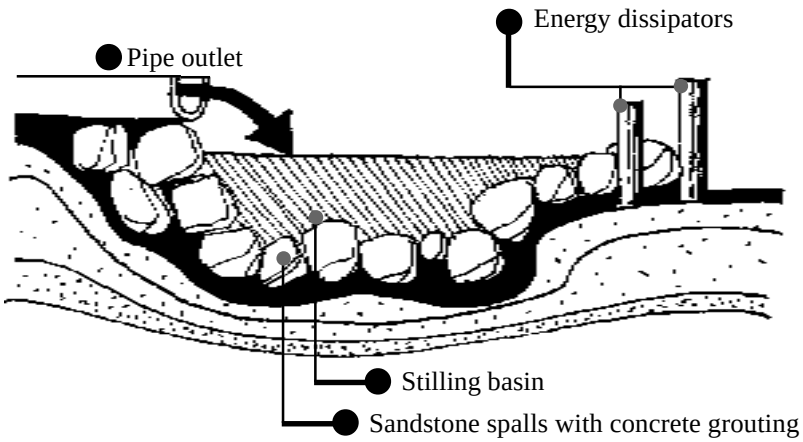
* New and existing urban development

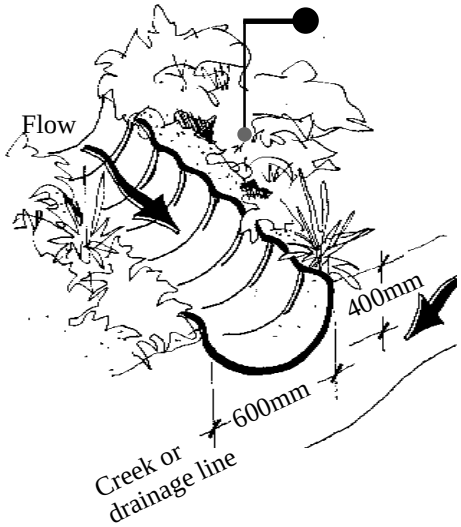
* Council activities - maintenance or construction.

Conditions When BMP May Apply

* Discharge of collected roof and/or surface water to bushland, either directly over land surface or by piping must be directed to street drainage or inter-allotment drainage wherever possible. In circumstances where site specific conditions preclude this requirement, Council may permit the following best management practices.

Galvanised steel corrugated half pipe





Purpose

* To direct runoff through bushland without altering soil moisture status and water quality and prevent proliferation of weeds.

Limitations

* Site specific conditions (eg. surface rock, slope, topography, soil type) and construction access to sites when retrofitting to existing developed areas.

Integration Opportunities and Constraints

* Positive impacts by minimising weed infestation of bushland, by limiting die-back of native vegetation and improving aesthetic appeal of bushland.

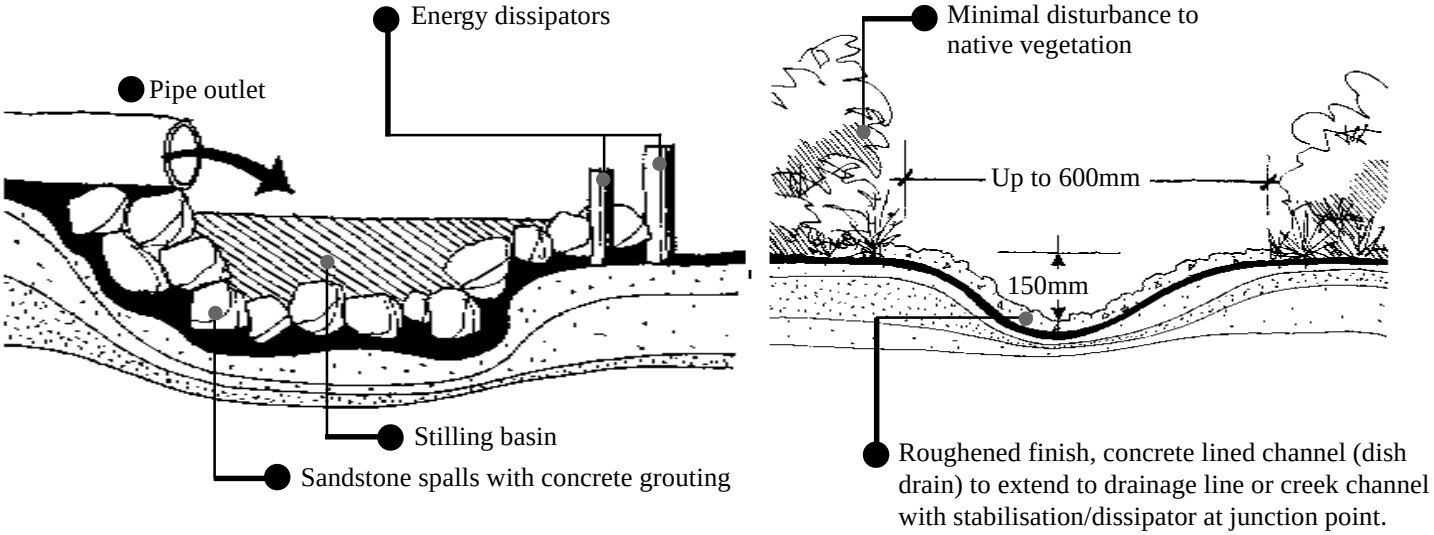
Cost Effectiveness

* Cost effectiveness is dependent on option taken. Stormwater to street/inter-allotment drainage will be the cheapest, whereas dish drains will be costed accordingly to size/length required.

Maintenance

* Minimal, dependent on system blocking in major storm events.

Concrete lined dish drain



Construction Technique/Expertise

* Skilled plant operators/labourers who are wise to minimal site disturbance, during site restoration principles.

Compliance

Clean Waters Act (1970)
Local Government Act (1993)
Rivers & Foreshore Protection Act (1948)
With conditions of Development consent/DCPs/LEPs

References

State Pollution Control Commission (1989), Pollution Control Manual for Urban Stormwater, State Pollution Control Commission.

Lane Cove River Catchment Committee Working Group (1996), Stormwater Structures to Reduce the Impacts of Development on Adjacent Bushland - Casestudies.

Lane Cove River Catchment Management Committee Stormwater Working Group (1997), Casestudies of Treatment Techniques for Stormwater Entering Bushland.

ON SITE STORMWATER DETENTION SYSTEMS

Description

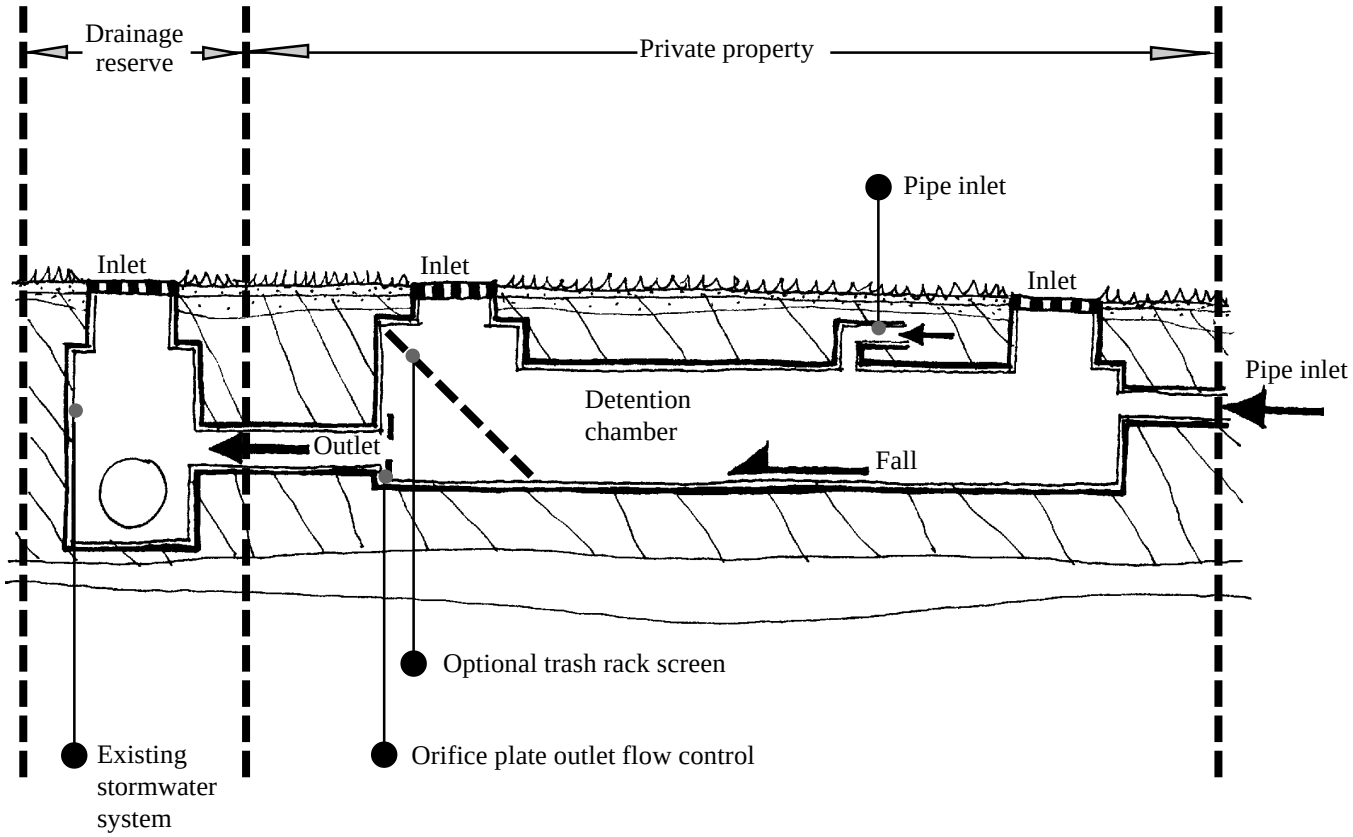
On-Site Detention (OSD) refers to the control of stormwater flow from a development site by the use of a range of storage devices.

With increasing density of development there is a reduction in the capacity for infiltration with a corresponding increase in quantity of runoff and rate of runoff.

The OSD system storage can be provided in underground tanks, driveways or landscaped depressions. To ensure correct operation of the OSD system outlet, the peak discharge must be controlled by a restriction such as an orifice plate.

The use of OSD devices can limit the peak flow from a site or multiple sites to a level which can be handled by the drainage system downstream. This will have financial savings for the community by not requiring larger pipe systems, plus reducing damage to the environment from water scour, erosion, sediment transport and flooding.

Section



Application Where BMP May Apply

* All developments, particularly those with high runoff volumes.

Conditions When BMP May Apply

* Any development where the capacity of the downstream drainage system or waterways will be exceeded.

Purpose

* This BMP will improve water quality and water balance by controlling high peak discharges and high streambank erosion potential.

Limitations

* Outlet can become blocked by debris if regular inspection and maintenance is not carried out, resulting in over flow and uncontrolled discharge.

Integration Opportunities and Constraints

* Landscape and passive recreation area opportunities exist for above ground storages.

* Shallow rooting plants may be incorporated above OSD tanks.

Cost Effectiveness

* On site detention systems are cost effective for the purpose of reducing peak runoff from sites and reducing the cost of upgrading trunk drainage systems and minimising flooding.

Maintenance

* Regular inspections after major storms are required to clear debris from outlets and check for localised scour or erosion.

* The design should allow for mowing of grassed areas and other landscape maintenance requirements above the OSD system.

Construction Technique/Expertise

* Requires suitably trained personnel, familiar with design and installation techniques.

Compliance

To be designed to store and release stormwater so that the 1 in 20 year ARI post development flow is no greater than the 1 in 5 year pre-development flow.

Clean Waters Act (1970)

References

Hornsby Shire Council, Specification for On-Site Stormwater Detention Systems for Drainage Works to be carried out in Developments and Subdivisions, Hornsby Shire Council.

Institution of Engineers, Australia (1987), Australian Rainfall and Runoff, Institution of Engineers, Australia.

Institution of Engineers, Australia (1992), On-Site Stormwater Detention Systems from a One Day Seminar, Western Sydney and Sydney Water Engineering Panels, Institute of Engineers, Australia.

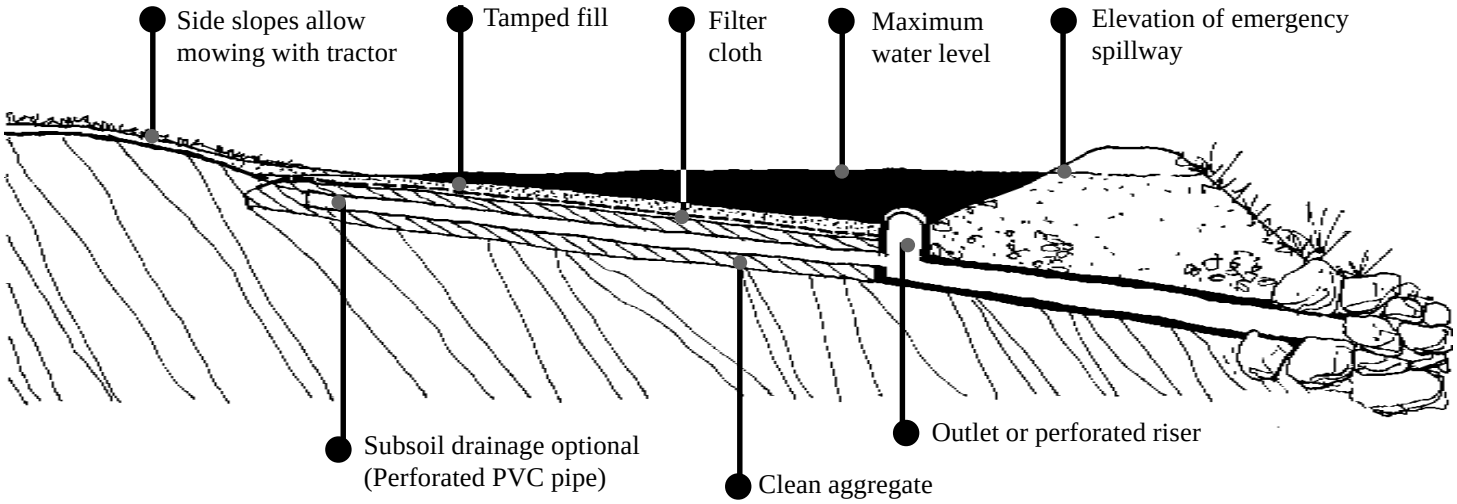
DRY DETENTION BASINS

Description

Dry detention basins are used to reduce increased peak rates of flow from development by temporarily storing stormwater runoff. The discharge is controlled to suit the capacity of the downstream trunk drainage system. Between storms the basin is empty and dry.

The design must take into account dam loadings and Dam Safety Committee assessment may be required.

Dry pond with optional underdrainage



Application Where BMP May Apply

* New development areas.

* Retrofitting to existing residential areas for flood control or during development.

Conditions When BMP May Apply

* Any new development or existing area where the capacity of the downstream drainage system or waterways will be exceeded.

* Where a new development includes disturbance of large soil surface areas.

Purpose

* This BMP will improve water quality and water balance by controlling high peak discharges and high streambank erosion potential and causing sedimentation.

Limitations

* Basins are difficult to retrofit to existing confined, developed areas. Sports fields are one of the few suitable locations.

DRY DETENTION BASINS

Limitations (cont.)

* The area of the basin is unusable during and shortly after heavy rains. Sediment and litter may also be deposited which may cause maintenance problems for sports users.

* Safety aspects due to intermittent filling during storms, safe bank slopes for escape and guards around outlets must be considered.

Integration Opportunities and Constraints

* Recreational opportunities such as sport fields combined with detention basins allow multiple use of an area.

* Landscape and passive recreation area opportunities exist as well as the structures can be converted to wet detention basins or wetlands post construction.

Cost Effectiveness

* Dry detention basins are very cost competitive for the purpose of reducing peak runoff. They range in cost from $15,000 - $200,000 (1996) depending on size.

Maintenance

* No special ongoing maintenance is required. Regular inspections after major storms are required to clear debris from outlets or risers and check for localised scour or erosion. The design should allow for mowing of grassed areas and other landscape maintenance requirements.

Construction Technique/Expertise

* Requires suitably trained personnel, familiar with design and installation techniques.

Compliance

The length to width ratio should be 3:1 minimum.
Basins are to be sized to allow 6 minutes settling time during the 5 year ARI, 1 hour storm event.
Clean Waters Act (1970)
Soil Conservation Act (1938)
Dams Safety Committee assessment requirements, as applicable.

References

Department of Urban Affairs and Planning (1993), Better Drainage - Guidelines for the Multiple Use of Drainage Systems, Department of Urban Affairs and Planning.

Environment Protection Authority (1996), Site Work Practice 34 in Managing Urban Stormwater, Construction Activities and Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Committee, Sydney.

WET DETENTION BASINS

Description

Wet Detention basins are used to reduce increased peak rates of flow from development by temporarily storing stormwater runoff, plus maintaining a volume of permanent storage to improve water quality.

The storm discharge is controlled to suit the capacity of the downstream trunk drainage system. Between storms the basin retains a permanent pool of water for sedimentation, flocculation and bioassimilation. Water habitat and recreational value are created as well. These basins have a longer residence time than dry detention basins, enableing them to settle fine materials.

Safety aspects due to intermittent filling during storms, safe bank slopes for escape and guards around outlets must be considered.

The design must take into account dam loadings and Dam Safety Committee assessment may be required.

Application Where BMP May Apply

* New development areas.

* Retrofitting to existing residential areas.

Conditions When BMP May Apply

* Any new development or existing area where the capacity of the downstream drainage system or waterways will be exceeded.

* Where a development propses to disturb a large area of soil surface.

Purpose

* This BMP will improve water quality and water balance by controlling high peak discharges, high streambank erosion potential and removing pollutants associated with sediments.

Limitations

* A liner system will be required in permeable soils.

* A larger area of land is required to maintain the same flood control volume as for a dry basin.

* Water levels may need to be maintained artificially in dry periods and summer, in order to prevent odours and loss of aesthetics.

* Wet basins may be more difficult to retrofit to existing developed areas than dry basins.

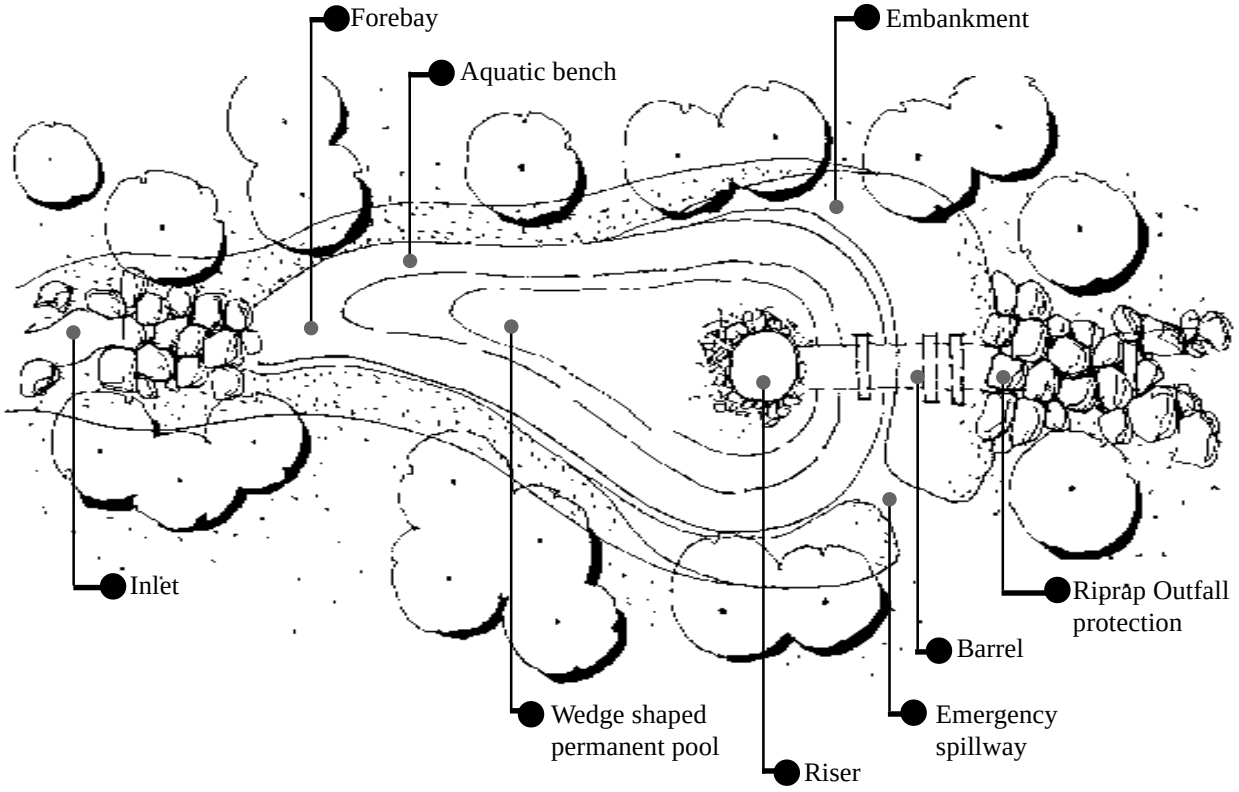
* Wet basins may be subject to structural stress during periods of rapid wetting and draining.

Integration Opportunities and Constraints

* Recreational and landscape opportunities when incorporated into a planned system of open space as a permanent structure.

WET DETENTION BASINS

Plan



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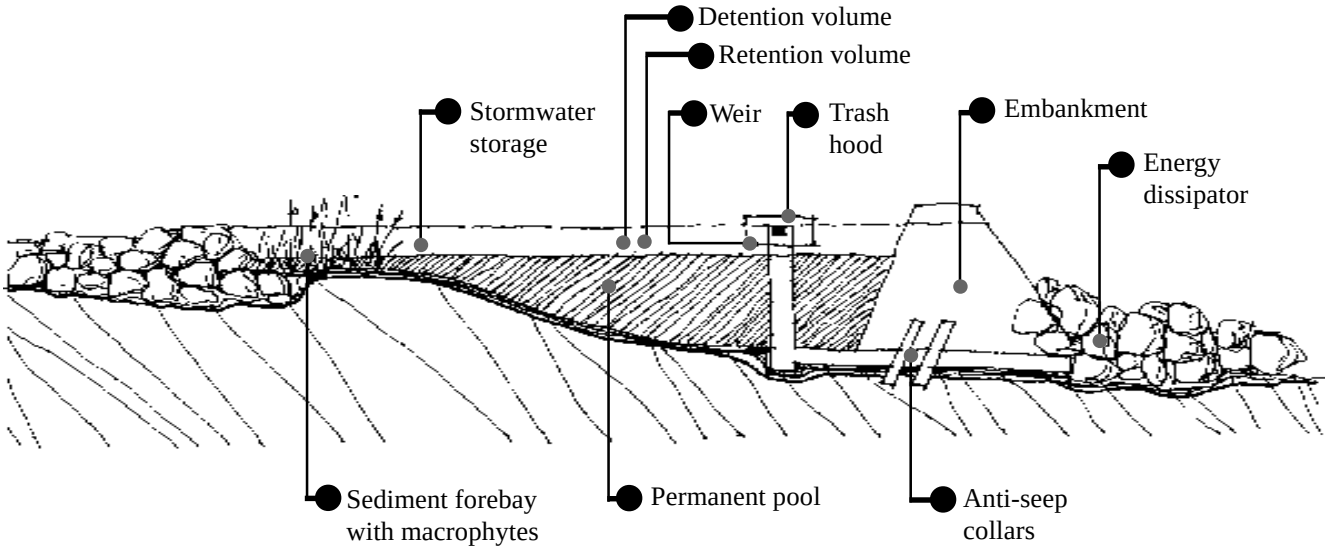


Cost Effectiveness

* More cost effective in larger or more intensive development sites where one central basin is created. For smaller sites other methods may be more suitable. They range in cost from $15,000 - $200,000, depending on size. (1996)

Maintenance

* More maintenance is required than for dry basins. This includes sediment removal and potential odour, algae, mosquito and rubbish control. Costs range from $500 - $5,000/year (1996)

Construction Technique/Expertise

* Requires suitably trained personnel, familiar with design and installation techniques.

Compliance

Length to width ratio should be 3:1 minimum.
Basins are to be sized to allow 6 minutes setting time during the 5 year ARI, 1 hour storm count.
Clean Waters Act (1970)
Soil Conservation Act (1938)
Dams Safety Committee assessment requirements, as applicable.

References

Department of Urban Affairs and Planning (1993), Better Drainage - Guidelines for the Multiple Use of Drainage Systems, Department of Urban Affairs and Planning.

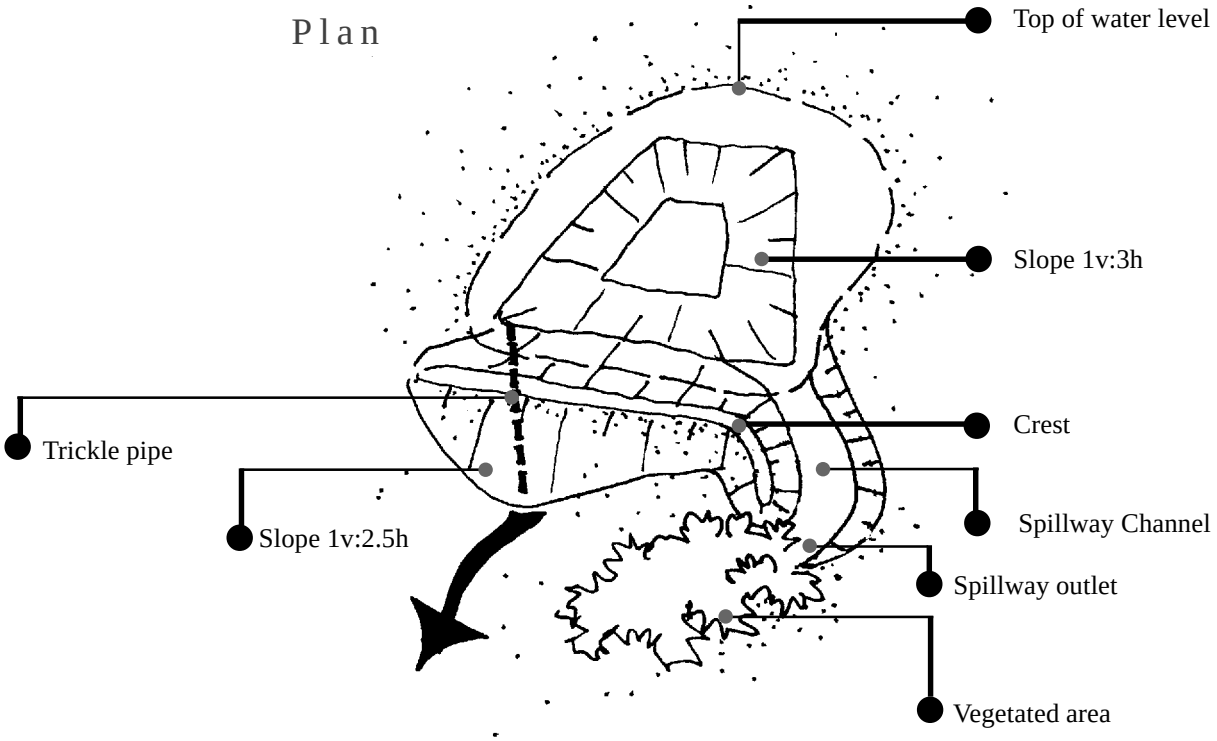
Environment Protection Authority (1996), Site Work Practices 4, 12 in Managing Urban Stormwater, Construction Activities and Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Committee, Sydney.

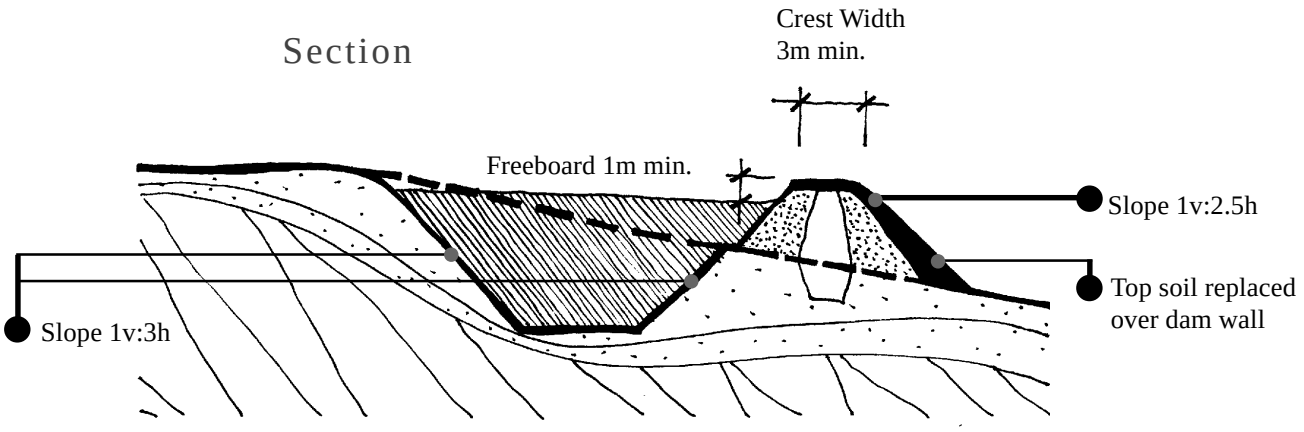
Whelans and Halpern Glick Maunsell (1994), Planning and Management Guidelines for Water Sensitive Urban (Residential) Design, for the Department of Planning and Urban Development, the Environmental Protection Authority, Whelans, W.A.

RURAL DAM CONSTRUCTION

Description

Rural or farm dams are basically wet, non-draining earth basins usually designed without a primary riser outlet. Rural dams are either used for irrigation, watering of livestock or for domestic purposes. Dams also have the potential to improve water quality through the removal of nutrients and sediment. Dams should be constructed in suitable locations in a manner that ensures stability and minimal environmental impacts. Dams should not prevent or significantly alter water flows to adjoining properties or natural ecosystems. As such, the construction of each dam must take into account the potential to improve water quality as well its potential to disrupt environmental flows.





RURAL DAM CONSTRUCTION

Application Where BMP May Apply

* This BMP is applicable to all lands covered by the Hornsby Shire Council - Rural Lands Development Control Plan, 1997, which propose construction of a farm dam.

Conditions When BMP May Apply

* Hornsby Council now requires a suitably qualified consultant is to be engaged to determine the impact that a proposed dam will have on the flows in any affected watercourse. This information is to forwarded to Council in conjunction with the Development Application. Once this is carried out Council can assess the impacts of each particular dam and condition the application accordingly.

Purpose

* To ensure that water storage structures are stable and have minimal environmental impact in terms of environmental flow alteration to downstream areas.

Limitations

* Dams should not be situated on sites with a gradient in excess of 15%.

* Dam capacity and spillway size should be proportional to the catchment area.

* An EIS would be required where the operation of the dam would significantly alter natural flow patterns in a watercourse or where there will be other significant environmental impact.

* A licence from the Department of Land and Water Conservation may be required for dams located on water courses and either used for irrigation or for stock or domestic purposes. Excavations within 40 metres of a water course also require a licence for the Department of Land and Water Conservation.

Integration Opportunities and Constraints

* Dams have the potential to impact on the groundwater resource through evaporation losses and contamination via surface runoff.

* Dams on watercourses are not encouraged and generally are only approved in upper catchments where their impacts are minimal.

* Dams should not be constructed where they will affect wetlands by direct inundation or through other means (eg. altering surface or groundwater flows crucial to the maintenance of wetlands).

* It is recommended that access to at least one third of the foreshore of a storage be restricted and that the area be re-established by planting native seedlings propagated from a seed source onsite to improve water quality within the storage and to provide fauna habitat.

* Consideration should be given to maintaining the flow of runoff to downstream areas

* Measures should be taken to prevent polluted water entering the dam, and to remove pollution from the dam water. Polluted water must not be permitted to leave a dam to a watercourse or bushland and should be treated by removing nutrients through the use of plants or irrigating crops and pastures.

RURAL DAM CONSTRUCTION

Cost Effectiveness

* Rural dams are very cost-effective in that they provide long-term benefits of water supply to the landuser. Rural or farm dams can range in cost from $15,000 - $200,000 depending on their size.

Maintenance

* Maintenance of rural dams should be only necessary on a long-term basis. This would include removal of accumulated sediment (to maintain maximum volume), nuisance algae and/or storm debris.

Construction Technique/Expertise

As per Diagram to include:

* Dam spillways should be located and designed to handle major storm flows safely.

* Dam construction should provide for at least a 1m freeboard.

* Dam wall to be built of impermeable clay compacted in 300mm max. layers to 95% standard compaction.

* Replace the original topsoil and revegetate all exposed or disturbed surfaces. Trees should not be planted on the dam wall.

Compliance

Hornsby Shire Council - Conditions of Development Consent There are no standard conditions of development consent. Development applications for the construction of dams are considered on their individual merit.

Hornsby Shire Local Environment Plan
Environmental Planning and Assessment Regulation, 1994 - Schedule 3
Rivers and Foreshores Improvement Act, 1948
Clean Waters Act, 1970
Hornsby Shire Rural lands (interim) Development Control plan - Dam Construction

References

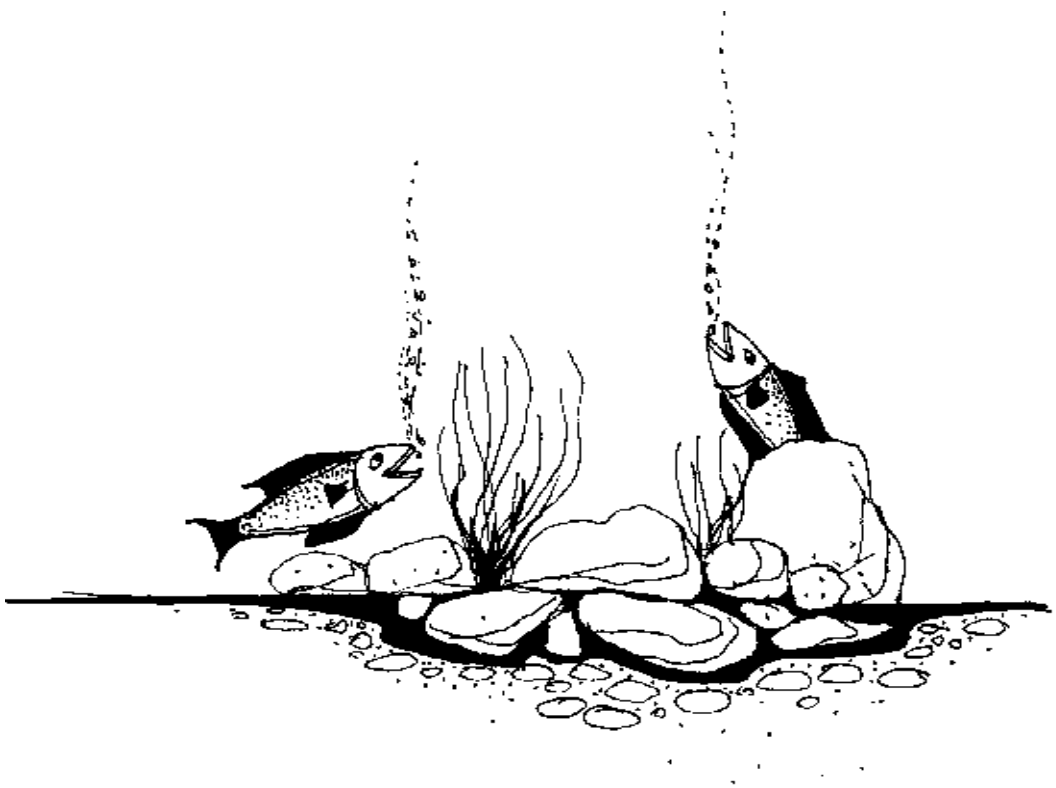
Environment Protection Authority (1996), Site Work Practices 35a in Managing Urban Stormwater, Construction Activities and Treatment Techniques, Draft, EPA for Stormwater Co-ordinating Committee, Sydney.

Hornsby Shire Council (1996), Rural lands (Interim) Development Control Plan, Hornsby Shire Council.

Department of Land and Water Conservation, NSW state Rivers and Estuaries Policy, Department of Land and Water Conservation.

WATER EDUCATION

For the Council to communicate the benefits of water sensitive design and management to all.



EDUCATION PROGRAMME

For council to promote and inform of the water sensitive design and management policy to all.

* To communicate and promote water sensitive design and management to the target audiences so they adopt the principles in planning and implementation.

* To communicate and promote the actions and activities that can be undertaken as detailed in the water sensitive design and management policy.

Target Group Definition

Identify the group to influence/reach/educate.

* Council staff

* Other government departments, authorities, committees etc.

* Developers, builders, contractors, landscapers, consultants, architects

* The general public who live and/or work in the Shire.

Project Objectives and Outcomes

Define what effect is to be achieved as a result of the individual education project.

* Define the specific objectives for the identified target audience.

* Define the information that is to be communicated to the target group.

* Define knowledge, understanding, behaviour that is to be achieved by the education strategy.

Methods

* Identification of the methods and techniques that will best achieve the objectives and outcomes for the defined target group.

Action Plan

* Develop an action plan that identifies the resources and personnel needed for the project.

* Prepare a budget for the project.

* Prepare a time frame for the project.

* Prepare educational materials that will most effectively attain the stated objectives through undertaking the planned actions.

* Undertake the education program designed for the target audience.

* Follow up: Further actions if evaluation indicates objectives not fully obtained. Regular review to refresh and reinforce the messages.

Strategy	Target Groups	Practices
Printed material	All groups	Books, brochures, letters, newsletters, posters
Talks, presentations	All groups	Providing speakers, and/or presentations for advisory groups, large seminars along relevant themes
Seminars/workshops	1, 2, 3	Putting on own events aimed at defined audiences
Media	2, 3, 4	Press releases, advertising, maintaining own internet site
Demonstrations	All groups	Organising own on site practical demonstrations or running as part of larger agricultural field days, trade days, home building and renovation exhibitions
Information displays	3, 4	Putting on display days at local events, shopping stands/ centres, exhibitions
Meetings	2, 3	Holding focus group meetings, consultative groups, advisory groups
Courses	All groups	Providing material to be included in and/or running - in-house sessions available to staff and other interested groups, TAFE courses, community education courses, school sessions

Evaluation and Monitoring

* Evaluate the effectiveness of the program linking it to the stated objectives to demonstrate the success of the actions and to identify the most effective actions.

* Follow up: Further actions if evaluation indicates objectives not fully obtained. Regular review to refresh and reinforce the message.


HORNSBY
SHIRE COUNCIL