Water sensitive development involves simple design and management practices that take advantage of natural site features and minimise impacts on the water cycle. It is part of contemporary trends towards more 'sustainable' solutions that protect the environment. This Water Sensitive Practice Note describes a variety of landscape measures and practices that can be used to manage stormwater flows, utilise stormwater within the site, minimise supplementary watering, promote efficient water use and good plant growth.

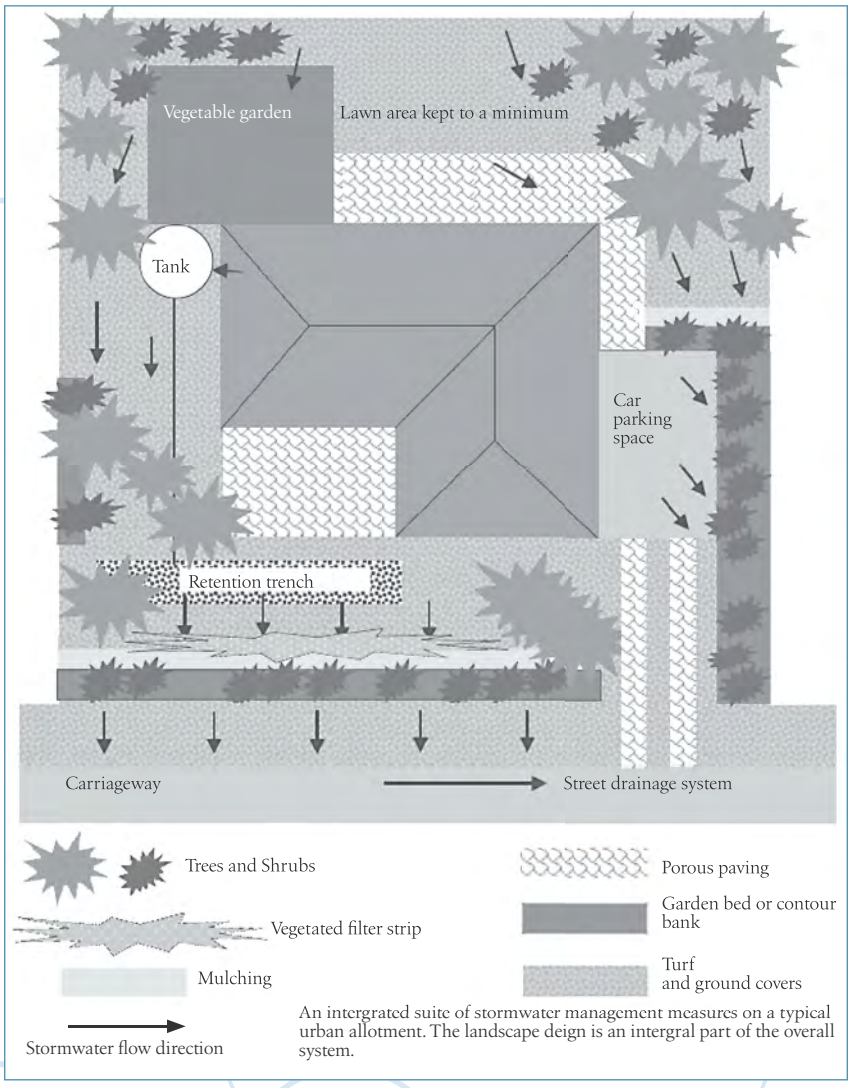
Introduction

This Practice Note describes a variety of landscape measures that can be used to manage stormwater flows, utilise stormwater within the site and minimise supplementary watering of landscaping.

These include:

- rock or gravel basins
- vegetated filter strips
- contour banks
- soak or bog areas
- wind and sun protection
- plant selection
- minimising lawn and lawn selection.
- efficient irrigation

For optimal results, these measures need to be undertaken in conjunction with careful site planning (see Appendix A to Development Type Guidelines), drainage design, and appropriate landscape practices.



An intergrated suite of stormwater management measures on a typical urban allotment. The landscape deign is an intergral part of the overall system.

Common Techniques

Rock or gravel basins

Rock, stone or gravel can be used to line stormwater basins or channels. This can act to slow the rate of flow, dissipate energy and prevent surface erosion. It is a particularly useful method for managing concentrated stormwater discharges due to topography or from adjoining properties, stormwater easements, downpipes or water tank overflow pipes.

Locally-sourced rock should be used wherever possible as this will minimise energy inputs and allow the design to blend with the local landscape. Rock should not be removed from undisturbed areas as this potentially destroys fauna habitat and promotes erosion. Obtain rock from on-site excavation works, other local construction sites or a local quarry. Avoid using blue metal as runoff from it will alter the soil pH.

On steeper slopes, rocks or stones need to be adequately secured to prevent dislodgment and downslope movement.

The size and composition of rocks or boulders must remain in proportion to the scale and style of the project

and the site. Larger sites can accommodate larger features and unit materials without being overwhelmed, although it is possible to contain some large elements within a smaller area provided that it is cohesively designed.

Large pebbles or deep beds of gravel can be used to complement landscape themes. They can be used as an alternative to organic mulches for preventing soil moisture loss.

Vegetated filter strips

Vegetated filter strips are strips of grasses and shrubs placed across stormwater discharge routes. They act to remove pollutants by filtering stormwater runoff, enabling limited infiltration and reducing stormwater discharge velocities.

Filter strips must receive stormwater as sheet flow. Concentrated flow will scour the surface and is likely to dislodge groundcover and plant roots, leading to failure. To ensure sheet flow, minimise the length of unobstructed stormwater discharge upstream of the strip.

Factors such as width of the strip, gradient, soil permeability and density of vegetation influence the effectiveness of filter strips. Various combinations of these variables are possible depending on site features (natural slope, soil properties, choice and placement of plants), and how the filter strip fits into the overall scheme for the site.

Wider strips can hold greater volumes of water, as will those with higher embankments on the downslope side. Filter strips on land with a slope less than 5 degrees (10%) are better able to trap sediment. Soil that is friable (easily crumbled - eg, soils formed on permian, tertiary, triassic, or quaternary geology) and with an open pore structure allows greater infiltration of water, compared to compacted and heavy soils (eg, soild formed on jurassic dolerite geology). Using vegetation to act as a baffle to slow down stormwater flow must be balanced against obstruction of flow that may cause backing up of waters and localised flooding. Plant species chosen must be capable of withstanding conditions of periodic saturation of soil, foliage or trunk.

Filter strips need to be regularly monitored and checked after major storm events. They may require periodic repair, mowing, replanting and sediment removal to remain effective.

Because they offer a form of garden bed (and possibly an area of turf for casual recreation), vegetated filter strips are recommended for low and medium density urban areas as a multi-purpose landscape element.

Contour banks

Contour banks are low earth mounds placed perpendicular to the direction of overland stormwater flow. They are very effective for reducing stormwater peak discharges and volumes, promoting infiltration and controlling erosion. On larger sites they can be used in series, and to link other landscaped areas in a system of stormwater control and harvesting. Combinations of contour banks, mulching and vegetated filter strips provide a very effective suite of stormwater management measures.

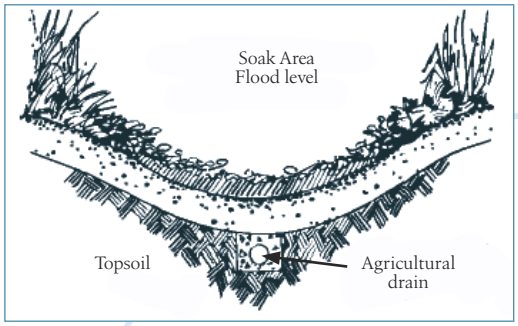
Contour banks are usually quite resilient, and require little or no maintenance. Special attention may be required to establish vegetation (shrubs, turf, grass and other groundcovers) on the contour banks. If constructing a larger dimensioned bank wall (for example, on a steep site or where large volumes of stormwater need to be accommodated), avoid planting trees on the bank as their large root systems will destabilise the earthen embankment.

Sediment may need to be removed from the upstream side of the bank from time to time. Accumulated sediment will smother low-growing vegetation, and will restrict the efficiency and carrying-capacity of the system. Provided that it is free of contaminants, collected sediment can be used to supplement topsoil elsewhere on the site. Ensure that all relocated sediment is contained and stabilised (such as with mulch or matting) to prevent it being the subject of further erosion.

Practice Notes

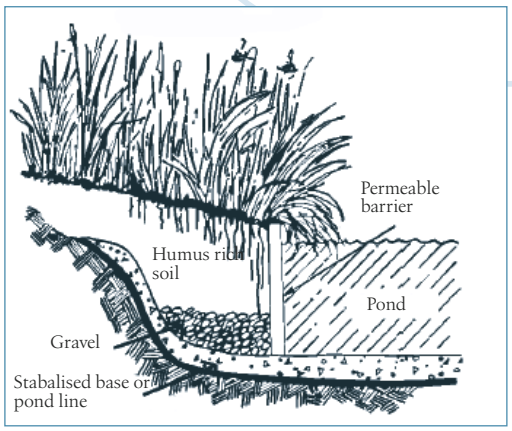
4 Landscaping

Soak or pond areas (includes swales and ponds)



Many sites contain natural depressions or low points containing species that indicate temporary bogginess (for example, sedges, swamp grasses and frogs). Consider utilising such sites within the system rather than altering existing drainage patterns, thereby promoting retention of valuable habitat.

The creation of an area that holds water as a temporary wetland is dependent on underlying geology, water table height, quality and quantity of water received into the soak area and the type of vegetation it contains.



Other landscape devices may be better suited to the site and location of the detention feature.

Avoid any dramatic alteration to the quality and volume of water. Replication of this system elsewhere, given the same geological, soil and drainage conditions, is also possible with careful observation, design and monitoring.

An artificial soak or bog area can also be built at the edge of a pond. This can act as a refuge for fish and other pond creatures when the water level is low.

The practicality and appropriateness of establishing a soak or bog area will depend on whether there is likely to be any impacts on buildings, soil structure or ecosystem values.

Further issues are outlined below.

Expected stormwater volumes

The site may have a small catchment, such as a vehicle parking area or turning circle. This needs to be reflected in the dimensions of the soak area. Maturing vegetation with growing trunks will displace some volume of water as it is received, but this can be taken up more quickly with the more extensive root system and transpiration rate of the larger plant structures.

Plant species selection

Species choice is dependent on the function of the constructed soak area. Some plants are more tolerant of contaminants. For example, runoff from a vehicle washing area can be collected and infiltrate in a separate area that acts as a buffer to other, more sensitive plantings. Select species that will withstand periods of soil saturation and anaerobic conditions.

The species best suited to the site's soil and climatic conditions are those that grow naturally within the local area. In most cases, preference should be given to local provenance species. Exceptions may be required where species do not tolerate a manufactured or disturbed soil profile, or a high nutrient or sediment loading from urban stormwater flows.

Always check with your local council or regional botanical gardens that plants chosen are not environmental weeds in your area.

The following lists includes a combination of native and exotic plants that could be used as part of an ornamental planting scheme. They are suited to conditions of silty or uncompacted soils with some organic matter and a pH of 5-7.

Practice Notes

Matting plants

These species colonise and stabilise the edges of soaks, dams, ponds or wherever water levels may fluctuate, inundating them for a brief period.

Blechnum penna-marina (Alpine Water Fern)

Cotula coronopifolia (Water Buttons)

Crassula helmsii (Swamp Crassula)

Isotoma fluviatilis (Swamp Isotome)

Lilaeopsis brasiliensis

Marsilea species (Nardoo)

Mazus pumilo (Swamp Mazus)

Montia australasica (White Purslane)

Myriophyllum species. (Milfoil)

Pratia species.

Ranunculus inundatus (River Buttercup)

Sphagnum species (Moss)

Viola hederacea (Native Violet)

Low growing plants and shrubs

Colocasia antiquorum (Taro)

Caltha palustris (Marsh Marigold)

Cyperus papyrus (Sedge)

Drosera species (Sundew)

Iris ensata (syn *I. kaemferi*) (Japanese Flag Iris)

Iris pseudacorus (Yellow Flag Iris)

Nymphoides crenata (Wavy Marshwort)

Sagittaria sagittifolia

Thalia dealbata (Water Canna)

Triglochin striata (Streaked Arrowgrass)

Trees & larger shrubs

Check for the local species that suit your site and locality.

Allocasuarina species (Sheoak)

Baekea species

Callistemon species (Bottlebrush)

Casuarina species (River Oak, Swamp Oak)

Eucalyptus species (Gum Tree)

Leptospermum species (Tea-Tree)

Melaleuca species (Paperbark)

Maintenance of soak areas

The biggest threat to a soak or bog area is contaminated waters, so the selection of plants is dependent on the role of the soak area. For example, if it is to collect stormwater directly from paved areas with vehicular traffic, only the hardiest species are likely to survive. More filtered or cleaner waters in a less polluted situation will allow a greater diversity of species to be selected.

Stormwater pollutants

Stormwater quality is adversely affected by fertilisers from gardens and lawns and oily deposits made by vehicles on sealed surfaces. Stormwater pollutants, including nitrogen, phosphorous, potassium and other substances are eventually deposited in the soil, and are toxic to some plants, especially native species. Stormwater pollutants also encourage weeds and the growth of algae in ponds, thereby displacing other less vigorous plants.

Regular monitoring

Check for excess build-up of sediment, especially after major storm events. Silty deposits may smother smaller matting plants, preventing regeneration. Remove any litter or other inorganic debris.

Sun and wind protection

Providing protection from harsh climatic forces makes garden areas more pleasant and reduces moisture loss from soil and plant tissue. Sun and wind exposure helps to strip moisture from leaves, requiring the plant to use greater levels of available soil moisture than in less exposed conditions. In addition, soil moisture levels are reduced by high rates of evaporation. This can unnecessarily stress plants.

Windbreaks can offer substantial leeward protection, but care is required to ensure other planning/management issues/values (*eg, energy efficiency, neighbouring residential amenity, etc.*) are not compromised through overshadowing.

If it is suitable to plant windbreaks, plant garden beds on the leeward side, as this will take advantage of existing wind protection. Do not plant directly underneath the canopy

of established trees as the ground disturbance is likely to compromise the health and functioning of their root zone.

As part of overall site planning, locate trees so as to provide seasonal shade to garden areas with softer plants, outdoor entertaining areas and to north and west-facing walls of the house. Deciduous trees allow winter sun to penetrate whilst helping to break wind flow with their network of branches. Evergreen trees need to be more strategically placed so that they do not cast deep shade on living areas of the house and garden (or on neighbouring properties).

Consider erecting a lattice screen or other structure if there is insufficient room to plant a screen for sun or wind protection. This may double as a boundary fence. A wire fence can support climbing plants providing a privacy screen as well as sun and wind protection. Shrubs can cover the lower part of the fence whilst the climber occupies the top. With solid walls that face north or west, consider the effects of light reflection and heat radiation during the hotter months. Protection structures may need approval depending on their location, scale, construction or other specifications – check with your local council.

Species selection

Planting a variety of species will help ensure that there is not a complete loss of screen planting in the event of unfavourable circumstances such as prolonged drought, attack by a host-specific pest, disease or unsuitable growing conditions. Unless a formal avenue of a single species is required for a landscape theme or style, choose hardy specimens from various genera with a mixture of habits, but with similar horticultural, watering and soil fertility requirements.

If space allows, plant 3–5 rows with staggered spacings along the rows. Place the taller growing species in the centre row and shorter ones to the outside rows. This reduces the effects of turbulent eddies on the leeward side. Calculate spacings of plants to roughly two-thirds of their expected mature canopy width.

Some tree species are genetically more prone to branch loss or have earned a reputation as 'branch droppers'. This may be due to weak structural growth patterns, or susceptibility to pests and disease attack. Seek advice from your local native plant supplier for the most suited mix of species.

Maintenance

A newly planted windbreak will require closer attention during the first two growing seasons to ensure establishment of a balanced root system that is well anchored and widely spread. Depending on local soil and climatic conditions a regime of deep waterings and a 80-100 mm layer of organic mulch will encourage this. The mulch should be topped up annually to help suppress competitive weed growth, stabilise soil temperature and reduce moisture loss.

If planting trees close to houses or water tanks, keep the roof clear of overhanging vegetation and check roofs and gutters weekly for leaves and other debris.

Check plantings after storm events and prune any broken limbs back to major branch junctions. In the event of severe damage, seek professional advice regarding tree surgery or removal. Replacement strategies may be needed to restore the functional nature of the plantings.

Plant selection

Select plants suited to the site's soil and microclimatic conditions. Some species are able to withstand low soil moisture or high wind exposure due to special adaptations such as hard leaf tissue, small leaves, deep root systems, deciduous leaves, silvery or furry leaves (or combinations of these).

Local native plants have evolved to handle local conditions. Other Australian natives also cope with very little water. Some exotic plants from the Mediterranean region, California and Southern Africa are able to survive on limited water and a range of soil conditions.

Some plants are so well adapted to severe conditions that they can colonise and dominate native bush areas. Check with your relevant State government agencies, local council,

lcare group(s), regional botanical gardens or native plant nursery(s) that plants chosen for your site (including native species from other parts of Australia) are not environmental weeds or declared noxious weeds.

Explore your neighbourhood to find out which species grow well, including street trees and other rarely watered plantings.

Group plants with similar water needs together so that watering schedules can suit different parts of the garden. Examples of different levels of water use include the following.

- *High use*: Lawns, leafy vegetables, soft-fruit trees, exotic shrubs like azaleas and camellias, flowering herbaceous annuals and many bulbs.
- *Medium use*: Hardy vegetables like pumpkins and potatoes, hardy fruit trees and vines like nut trees and grapes, many herbs, some exotic shrubs, most grey-leaved or tomentose (hairy) plants, roses and daisies.
- *Low use*: Most Australian natives including banksias, grevilleas, hakeas, wattles and eucalypts. Succulents and cacti and some exotic ornamentals such as bougainvillea also fall within this category.

Place plants in the areas of the garden that suit the conditions provided. For example, place moistureloving plants in protected spots with deeper soils, and hardy silvery-leaved plants in full sun, all with layers of mulch on the surface.

Minimising lawn

Lawns are shallow-rooted groundcovers that generally require regular watering to maintain a green leaf cover. Compared to garden beds, lawn areas require significantly more fertiliser, water and maintenance per unit area to maintain healthy growth. Lawn areas also require greater inputs of energy, time and money. Fertiliser costs money and adds to the nutrient burden in run-off. Mowing is time-consuming and motors rely on petrol or electricity, adding to environmental pollution.

Rationalising the size and design of lawn areas can be easily undertaken, resulting in significant reductions in water use. There are many options.

- Replace lawn areas with vegetable patches, garden beds, screen planting, or a shade tree and garden bench.
- Site turfed areas closer to the house for more efficient watering from roofwater tanks.
- Choose other groundcovers and low-growing shrubs for a green outlook.
- Use other pervious surfaces for trafficked areas, such as mulch, gravel or permeable paving units. This will avoid the need to repeatedly repair worn out tracks across the turf.
- Alter maintenance practices to encourage deeper root growth (reduced mowing frequency, higher blade height, less frequent but deeper watering).
- Replace with grass species that are slower growing and require less fertiliser and water to remain green. Check with your local supplier for native and introduced grasses that suit local conditions.

Table 1 provides brief details on a variety of readily available low maintenance ground covers that can be used to replace conventional lawns. They are all well adapted to coast and ranges of Tasmania.

Table 1 over page.

Efficient irrigation

Only install irrigation systems if needed. Landscape measures that collect and utilise stormwater by slow infiltration can replace reliance on supplementary water. Irrigation will generally not be required if plant species are carefully chosen to suit the soil, climate, aspect and microclimate, and appropriate planting and maintenance techniques are implemented.

However, some gardeners have high expectations, or a preference for species that do not thrive with natural rainfall. The aim in this case is to apply water in the most efficient manner. Points that need to be considered regarding the choice of irrigation system, its installation and use, are outlined below.

Name	*Description*	*Location*	*Soil*	*Sun*	*Watering*	*Mowing*	*Use*	*Establishment*
Dryarna flavius	Aust. native turf	Dry or boggy conditions	Any	Full sun to part shade	Drought tolerant	None or very little	Can filter grey water	Turf rolls available. Needs watering in first 3-6 weeks.
Sporobolus virginicus Nather's Green	Prostrate fine leaf native grass	Dry or boggy conditions, handles heat and light frost	Many (prefers sandy)	Full sun to part shade	Drought tolerant	Few times per year	High traffic. Can filter grey water.	Propagate from small tubes or plant division.
Phyla nodiflora Lippia, Fog Fruit	1-3cm high creeper, up to 2m wide. 2cm lilac flower most of year.	Tropical, sub-tropical & temp. regions. Frost resistant.	Tolerates waterlogging & salt spray.	Full sun to part shade	Some during warmer months.	None	High traffic	Propagate from rooted runners or plant division
Dichondra repens Kidney Weed	Rapid growing, 1-2cm high 1m wide. Small green-yellow flower in Spring.	Moist areas. Does not tolerate cold climates.	Well drained soil.	Sun or shade	None/low	A few times a year	Takes mild traffic; recovers well after wear; good around edges/strips.	Propagate from plant division, seed (purchase from native plant nurseries) or tube stock. Can be invasive – don't plant near less vigorous plants.
Mazus pumilio Swamp Mazus	Forms a dense mat 1m wide. Small white-violet flowers in Spring.	Frost resistant	Tolerates moist boggy soils.	Sun or partial shade	Survives on rainfall if in correct position.	None to few	Tolerates foot traffic in moist, shaded areas.	Propagate from plant divisions or plants purchased from native nursery.
Chamaemelum nobile 'Treneague' Lawn Chamomile	Non-flowering 5-10cm high.	Warm and cold climate	Most soil types	Moderate sun	Very low water needs once established.	When necessary	Good companion plant. Use as a tea, shampoo and fertiliser.	Propagate from plant division, seeds or plants. Needs considerable weeding while establishing.
Mentha pulegium var 'Decumbens' Pennyroyal	2-3cm high, spreads 70cm/yr. Red-purple flowers in Summer, fragrant when stepped on.	Grows in warm and cold climates	Grows in all soil types, preferring moist areas.	Full sun to part shade	Only in extreme heat. Not drought tolerant.	None	Suited to high traffic	Propagate from runners (cut stem pieces that have rooted and replant), plant division, seeds or plants purchased from herb nursery.
Mentha requenii Corsican Mint	3-6cm high green cushion, hardy, tiny flowers early Summer, fragrant when stepped on.	Suited to growing among stones in a path.	Well drained, mildly enriched and moist soil.	Full sun or light shade	Low water needs	None	Can stand some traffic	Propagate from plants (set in early Spring) or plant division (in Spring)
Thymus serpyllum Wild Thyme	3-12cm high carpet, aromatic leaves, rosy to white flowers	Grows in warm and cold climates	Suited to dry, well drained soil as well as damp clay	Full sun	None to low	Withstands mowing but not usually needed	Suited to occasional trampling. Herb that can be used to for tea.	Propagate from seeds, cuttings (rooted stem sections) or plants (in Spring, 20-40cm apart). Apply manure or compost in Autumn and Spring.
Myoporum parvifolium 'prostrate form' Creeping Boobialla	4cm high. 1-2m wide. Small white or pink flowers in Spring-Summer.	Ideal for coastal areas. Frost hardy. Salt tolerant.	Any soil with good drainage.	Full sun	Drought tolerant	None required	Good for weed suppression	Propagate from plants (from native nurseries) or firm tip cuttings (harder areas of the plant stem).

Table 1: Low maintenance groundcovers that can be used to replace lawns. Source: Friends of the Earth.

Practice Notes

- Match the system's design and specifications to the conditions on your site, including water source and quality, soil types and depth, moisture infiltration rates, evapotranspiration rates, frequency and intensity of rainfall, slope, plant choice and layout. Consult an irrigation specialist for a tailor-made efficient system.
- Re-fit an existing system with the most efficient low-flow fittings (jets, sprays and nozzles, etc.). Fix any leaks from joiners, hoses and pipes. Rationalise its layout. Adjust it to suit the changing requirements of plants as they mature (generally reduced water demand).
- Connect each garden area to separate valves to create 'hydrozones'. Plants grouped with similar water needs are precision-watered to suit them. Lawn areas will require the most water.
- Water according to the weather and plant needs, not to a fixed time schedule. Install soil moisture indicators as a guide. Allow soils sensors to override an automated system.
- Reduce the frequency of watering so that plants become less reliant on irrigation. Monitor plants individually and replace systematic watering with manual watering of stressed plants.
- Install drip systems for sparsely distributed plants and underground or surface leak systems for dense garden beds as they are the most efficient irrigators — there is less vapour loss from spray or misdirected water.
- With spray systems, avoid overlapping areas or directing it onto paths and driveways.
- Ensure that the water is directed to the roots as much as possible.
- Set a timer to turn off watering systems if it is not automated. Adjust according to the season and plant needs.
- Maintain the whole system routinely, inspect for blockages, repair leaks and replace worn parts.

Irrigation is best done in combination with mulching of garden beds to conserve applied water. Always avoid over-watering to the point where the soil is saturated and excess water flows away from where it is intended.

The costs and maintenance of an efficient irrigation system should be measured against the benefits. Consider redesigning and replacing with plants that have less demand for constant supplementary water.

Soil preparation

Preparation of the soil is dependent on soil type and site conditions. There are three main types of soil:

- Sandy soils that drain rapidly
- Clay soils that hold water
- Loamy soils containing a mixture of coarse and fine particles.

Soil texture determines the soil's ability to retain water for use by plants. Fine-textured clay soils hold the most water due to the greater surface area around soil particles. These soils may be unsuitable for some types of plants. Sandy soils may dry out quickly in dry weather. Loamy soils that contain plenty of organic matter are ideal for plant growth. Check with your local plant nursery for advice on local soil types and soil testing.

It is best to use plants that are suited to the site's soil conditions. Adding a veneer of the best 'garden mix' is not recommended as this will discourage roots to penetrate deeply into the soil below. Hardy, deep rooted plants can help break up poor soils. Organic matter can be added to soil to encourage microbial and worm activity, thereby improving soil condition and moisture retention.

If soils have been compacted by construction work or vehicles, remediation can be undertaken to open up pore spaces, promote aeration, and improve water infiltration and holding abilities.

There are a number of soil additives that can be used to improve general soil performance. Always seek specialised advice as to the correct rates and situations for application. Common soil additives include the following.

- **Wetting agents** for hydrophobic ('non-wetting') soils, including some sandy soils and soils with lots of organic matter. Watering results in beads of water running-off rather than soaking into the root system. The wetting agent can be mixed with backfill at planting times, or applied later.
- **Gypsum** may be added to dispersive or sodic clay soils. Always test the soil to see if it is needed and to determine the correct application rate.
- **Water-storing crystals** can hold hundreds of times their weight in water. When mixed with water they form a soft gel and retain water. This provides a reservoir of moisture for plant roots during dry periods.

Where construction or landscaping works cut into the soil subgrade, apply the saved topsoil (scraped and stockpiled prior to commencement of work) to a depth of at least 150 mm for turf areas, or 400mm for garden beds. Roughen the surface before applying the topsoil layer, and water with a fine spray prior to planting to eliminate air pockets.

To avoid compaction of heavy clay soils after rain, allow 2-3 days for free drainage before tilling or using mechanical means to work the ground.

Any additional soil required for landscaping works should be specified to satisfy Australian Standard AS 4419 *Soils For Landscaping and Garden Use*, or current standard. This sets requirements for bulk density, organic matter, weed content, wettability, pH, electrical conductivity, ammonium toxicity, phosphorous content, dispersibility, toxicity, nitrogen drawdown, permeability, soil texture and large particles.

Select the range that suits the proposed type of plants for the site. For example, Australian native plants have different requirements and tolerances. As a guide do not use any soil with more than 20% organic matter in it.

Pre-planting

Those parts of the site that are to be landscaped should have all weeds removed prior to the commencement of landscaping work. Use hand tools on smaller weeds. As a last resort, apply herbicide by spot application to larger, perennial or vigorous weeds.

Backfill retaining walls and make other garden beds after brickwork, electrical and drainage works and adjoining pavements have been completed. Apply water to settle the soil down and eliminate air pockets. This must be done with a fine gentle spray to prevent surface erosion.

Mulch should be applied to each area left unplanted in the event that planting is delayed by more than one week from backfilling or other soil preparation.

Planting

Stock selection

The key issues in selecting trees are:

- The trunk has adequate stem taper and is self supporting in its container.
- Good root occupancy of the root ball.
- No girdling or kinking of roots within the root ball.
- Roots fill the container without being over-grown.
- Trees are free from included bark (unless this is typical of the species and is known not to lead to structural failure).
- There is adequate root volume to support and sustain the above-ground sections.

Stock selection should be based on Clarke (1996) *Purchasing Landscape Trees: a Guide to Assessing Tree Quality*.

Tubestock generally give faster growth, but semi-mature seedlings need less watering.

Hardening off plants

Arrange delivery of plants to a location within the locality of the site at least four weeks before planting out. Maintain plant root systems moist at all times, giving particular attention to watering during the on-site installation period before and during planting.

Practice Notes

Planting guidelines

To avoid damage to trunks and root zones of retained vegetation, use hand tools and barrows in adjacent areas. Undertake planting according to any landscape plans and drawings for the site and observe the following guidelines.

- Ensure that there is an adequate depth of drained soil for the stock size to be used.
- Do not plant if the air temperature is over 35°C or if the soil is waterlogged.
- Relocate existing turf or mulch. At each planting site set aside mulching materials if already applied.
- The planting holes are to be a minimum of twice the width of the container and to the depth of the root ball. For tube stock excavate to a depth equal to the root column and, if possible, to a width of 500 mm.
- The sides of the hole should be rough (not smooth) to promote new root growth.
- Organic matter must not be placed in the bottom of the hole or in the backfill.
- Ensure that all containers are fully removed from the root ball and the hole. No part of the plant should be damaged during this process.
- Depending on container size, remove or gently roughen the outer 5-10mm of the root ball of trees.
- The plant should be centred in the hole and then backfilled with site soil in good tilth.
- The top of the root ball must be level with the finished level of the soil and must remain so.
- If fertiliser is to be added it should be placed in the upper section of the backfill. The type of fertiliser, rate of application and area should be to the manufacturer's instructions.
- The backfill must be placed around the root ball to ensure good root contact without being overly compacted.
- Place remaining excavated soil as a mound around the edge of the root ball to create a watering well. This helps retain water.
- Water each plant within one hour of planting. As a rule of thumb, apply one litre of water for every litre of container volume. Apply the water through the root ball, but not so as to damage the plant or dislodge the root ball. For containerised stock up to 45 litres, water the plant bringing the growing medium to container capacity within one hour of planting. For stock over 45 litres ensure that the root ball is moist and that plants are not wilting.
- Depending on soil moisture conditions, additional water may be applied to the soil surrounding the root ball.
- Apply organic mulch to a minimum radius of 500mm from the trunk, and to a depth of 75 mm.
- If tree protection measures are required such as tree guards or marker stakes, these must be installed so that no damage is done to the trees. In most situations, trees should not be tied to stakes (that is, trees should be self-supporting when purchased — see *Stock Selection* above). Where additional support is required, two or three stakes should be used. These should be driven into the soil beyond the root ball and not interfere with branches or foliage. Trees should be attached with jute webbing or other flexible material that will not damage the plant. The ties must be low enough to allow trunk movement but high enough to provide support for the root ball.
- Remove all other ties and labels from the plants.

On-going plant care

Maintenance period

Specify a pre-determined maintenance period (up to two years from completion of landscaping works) for establishment of landscaping. During this period, missing, dead or unhealthy plants should be replaced with identical species of similar size and quality at the contractor's expense.

Practice Notes

Watering

Deeply water all new plantings at least once a week for the first three months, once a fortnight for the next six months and once a month for the subsequent six months. Adjust this frequency to suit local soil, climatic and weather conditions, such as falls of heavy rain. Water should be applied to the root ball and surrounding soil.

Weed removal

Undertake periodic weed removal at least once a month. Hand weeding young plants is recommended as it causes less ground disturbance.

Removing weeds whilst still immature limits their ability to establish a wide root network, set seed and spread.

Herbicide could be used selectively to control the re-emergence of persistent weeds by using cut-and-paint techniques or an applicator where appropriate.

Moderating plant growth

Lightly tip-prune flowering shrubs at the end of their main flowering period to encourage bushy growth. Keep groundcovers 150 mm from tree trunks to allow inspection of the tree trunk. Grasses need to be kept approximately 1m away from new plants for one to two years to prevent competition.

Removing tree stakes

Remove stakes from newly planted trees after the completion of their first growing season. Take care not to cause any damage to the trees.

Mulching

Mulching has many benefits to plant health and water conservation. As well as reducing evaporation, it suppresses weed germination and growth (by reducing light penetration to the soil surface) and stabilises soil temperature (beneficial to root development and soil organisms). Organic mulch slowly breaks down to supply soil nutrients. Use the following guidelines to help ensure efficient water use and good plant growth.

- Apply 75-100 mm of organic mulch over the surface as a blanket on massed plantings. Top up annually. Keep mulch at least 150 mm away from trunks and stems to prevent rot.
- Use a mixture of textures to allow water to pass through. A combination of chipped bark and leaves decomposes at different rates and supplies a variety of minerals and nutrients.
- Avoid introducing pests and diseases from mulch imported to the site. Obtain materials that satisfy Australian Standard AS 4454 *Composts, Soil Conditioners and Mulches,* or current standard.
- Do not apply fresh organic products directly to the soil (such as sawdust, woodchips and pinebark). These materials extract soil nitrogen ('nitrogen drawdown'), competing with plant uptake and causing sickly plants. Add fertilizer (manure or blood and bone) before application, or compost the material before use.
- Inorganic mulch can be used, but does not add humus and nutrients to the soil. Use crushed rock, gravel and brick, silicon chip, coarse river sand, scoria or river pebbles to complement landscape themes or where loose materials may be blown away. Avoid blue metal as this can alter soil pH. Use to a depth of about 50 mm to allow water penetration.
- Mulch matting can be used on slopes where other mulches may slip. When pegged in position, the mat forms a stable surface whilst trees, shrubs and groundcovers establish. Plants can be pocket planted through the matting. Use 100% organic matting, such as jute. The matting must not contain inorganic fibre such as nylon.
- If using an irrigation system, install an underground or surface drip system to make sure the water reaches the soil below the mulch.
- Avoid using mulch in areas where it is likely to be washed away by surface flow during heavy rain.

Design considerations

The design and installation of water sensitive landscape measures needs to be undertaken as part of planning for an integrated functional system for the whole site or area. Specific issues that need to be considered include:

- **Integrated planning:** Landscape measures should be designed in conjunction with the other stormwater management measures. Expected flows and discharge rates should be factored into the design criteria layout, earth shaping and the selection of plants and other materials.
- **Diversification:** Aim to create a diverse system within the landscape that is not reliant on a single device to manage stormwater. This will allow other parts of the landscape to adequately deal with stormwater flows in the event of failure or exceedance of design capacity.

As an example, a gravel-lined pond collects overflow from a water tank, spills over to a turfed filter strip, drains gently to a series of drainage swales spot-planted with species that tolerate temporarily saturated soil, drains to a soak area ... and so on! This interconnecting system collects flow at a point source, reduces its speed and allows it to progressively infiltrate the soil, thereby reducing the risk of erosion, sedimentation and flooding and use of reticulated water supply.

- **Water tanks:** The overflow point from water tanks needs to be positioned or treated so that it does not cause erosion or other damage, such as localised inundation of fragile plants.
- **Vegetated filter strips and turfed areas:** These will become compacted by foot or vehicular traffic, reducing the soil's ability to take up water. Erosion of the surface is also likely, leading to soil loss and downstream sedimentation.
- **Paved areas:** Always consider the safety of users when minimising impervious paved areas. The most frequently used paths (for example, to the front door) must be laid securely on a well prepared base. This prevents pockets of settlement and loose or uneven surfaces that can become a hazard, particularly to the frail or aged.
- **Greywater:** The use of domestic grey water as part of an irrigation or disposal system should not be applied consistently to one area as this can cause a build-up of salts and other contaminants that can alter the pH and ecology of the soil and affect plant health. It is important to know the soil's characteristics, infiltration and capacity rates before relying on such a system.

Maintenance issues

After rain

Avoid walking or driving over wet ground as heavy soils are easily compacted when wet. Soil compaction significantly reduces infiltration rates.

Avoid disturbing plant foliage immediately after rain as plant diseases are more easily transmitted into damaged leaf tissue when moist.

Check for soil erosion, and repair erosion points before they magnify. Identify the cause and undertake corrective measures (redirect drainage, disperse flow and reduce velocity). Check for sediment build-up in vegetated filter strips, drainage swales, soak areas and ponds. Collect sediment and stabilise in areas that are less prone to erosion.

Weeding

Regularly control weeds to reduce competition for both soil moisture and nutrients. Hand-pull or hoe weeds when they are young. Remove weeds before they set seed for the next generation.

Avoid broad-scale herbicide application as this may wash-off into water courses and affect aquatic fauna. If persistent woody weeds do not respond to manual methods, cleanly cut near the stem base stem and paint with herbicide on the fresh wound. Use herbicides only in accordance with the manufacturer's instructions.

Watering

Newly planted areas will require more water than established plants. The first growing season is the most

crucial for good root establishment. New plants need to be monitored, especially in weather extremes. Use the following guidelines to help ensure efficient and effective watering.

- Apply slow waterings to encourage deep root penetration.
- Decrease watering frequency as plants settle in.
- For maximum watering efficiency, group plants together that have similar watering needs together ('hydrozoning').
- Take care that the underlying subsoil is not saturated as this can be a cause of wilting leaves. Rectify by improving subsoil drainage or using species that can cope with the conditions.
- Water according to soil moisture and plant needs rather than to a fixed schedule. Test the soil 50mm below the mulch to see if it is dry before applying water.
- Divide garden beds into sections and alternate between them at watering times, concentrating on one with deep soakings.
- Minimise evaporation by watering in the early morning or late afternoon. Apply water to the roots rather than the foliage, as some plants are susceptible to pest and fungal diseases if left with damp leaves, especially overnight.
- Avoid watering in windy conditions as much water is lost to spray drift.
- If using a handheld hose, use a trigger-operated nozzle to control flow whilst moving between plants.

Care of plants

Protect young plants, especially ornamentals that have large or soft leaves, by shading from strong sun or wind. Use shade cloth or a tee-pee of branches cut from prunings. This reduces moisture loss from their leaves.

Thin out fruit on deciduous trees. Thin apples, peaches, plums to about 20-30 cm apart.

Let fruit trees go dry after harvest and water only if the leaves wilt. Well-established and mulched plants should be able to withstand this regime. Let roses develop hips by not deadheading flowers.

Avoid excessive use of nitrogen-rich fertilisers as this stimulates leaf growth and increases water demand.

Pruning

Minimise pruning by not forcing plants with lush lengthy growth that becomes wayward. This soft growth is more prone to drying out in hot winds and, if not hardened by the end of the growing season, can be damaged in the colder months.

Pruning may be necessary for shaping, crown lifting or the removal of dead or diseased limbs on trees. For a useful guide, see Australian Standard AS 4373 *Pruning of Amenity Trees*.

Recycle any disease-free prunings back into the landscape as mulch so as to return the stored nutrients to the soil.

Grassed areas – watering

Grassed areas are the biggest user of water. Consider reducing size of lawns, substituting with other groundcovers or converting to a less water-dependent garden bed.

Give lawn areas a good soaking rather than frequent shallow waterings. During prolonged dry periods it may be necessary to water every third day to the equivalent of 15mm of rain. Use a cup to measure how much water has been applied.

For summer, dormant turf species, restrict foot traffic whilst the turf is dormant.

Grassed areas – mowing

Mow less often. Where possible, use a hand-pushed mower — a great incentive to reduce lawn areas!

Set mower blades higher. Aim to cut only the top one-third of the grass. Mowing too low weakens the grass, increases susceptibility to weeds and pest damage, and increases evaporation from the soil.

Use a mulching mower to recut the grass finely, self-mulch the lawn and return soil nutrients. Mow when the grass is dry to allow clippings to filter down to the soil for self mulching without clumping.

Avoid fertiliser application as this stimulates leaf growth, increasing moisture loss and nutrient enriched

run-off. It also requires more frequent mowing.

Grassed areas – maintenance

Aeration helps water penetrate to the root zone. This can be done by inserting the prongs of a garden fork to a depth of at least 10cm in a regular pattern over the surface of the lawn, or use a motorised roller with spikes.

De-thatch the lawn. Lawns that grow by creeping stems sometimes form a thick layer of stems and leaves under the green parts, called thatch. Remove this layer using a special mower (available for hire) to improve water penetration. This is best done between spring and early summer or in autumn.

Organic fertilisers, such as fishmeal, seaweed extracts and pelletised poultry manure help stimulate microbial activity that removes thatch naturally.

Other issues

Swimming pools

Swimming pools loose an enormous quantity of water through evaporation. In a shaded wind-protected setting evaporative loss may be about 15mm per week over the surface. For a 60 m2 pool this is about 3700 litres per month! The same sized pool in a hot, sunny, windy site looses about four times that amount. A pool cover can cut potential losses by more than 90%, and reduce the need for chemical additions and pump and filter use. Pool covers are commercially available as either floating or fixed covers that satisfy budget, use and safety needs.

Gutters

Prune back overhanging branches and remove leaf and other debris from roofs and gutters to reduce possible contamination of water collection tanks and systems.

Vehicle washing

Washing cars or boats on lawns prevents water and detergent from entering the stormwater drainage system. Lawns and garden beds have a limited ability to absorb nutrients contained in detergents. Wash the car in a different location each time. If the lawn deteriorates or becomes water-logged, your vehicle may be compacting the soil or the nutrient levels may be too high. Aerate the soil and rest it by taking the car to a commercial car wash for a few months. Select a car wash that recycles water and detergent.

Regular maintenance

Sweep paths and driveways rather than using a hose. Maintain and repair leaking taps, hoses and other fittings of watering systems.

Useful websites

Environment Australia (2001). *Your Home: Technical Manual and Consumer Guide*: *www.greenhouse.gov.au/yourhome*.

Friends of the Earth (Sydney): *www.homepages.tig.com.au/~foesyd/SustainableConsumption/garden/gardenhome*.

Australian web site dedicated to promoting better water conservation: *www.savewater.com.au*.

Environment Australia (2001). *Your Home: Technical Manual and Consumer Guide*: *www.greenhouse.gov.au/yourhome*.

Friends of the Earth (Sydney): *www.homepages.tig.com.au/~foesyd/SustainableConsumption/garden/gardenhome*.

Australian web site dedicated to promoting better water

conservation: *www.savewater.com.au*.

References

Archer, J., Le Hunt, R., & Hodges, J., (1993). *The Water Efficient Garden: a practical and innovative guide, from planning through to established gardens*. Random House, Milsons Point NSW.

Clarke, R. (1996). *Purchasing Landscape Trees: a guide to assessing tree quality*. Natspec Guide No.2, Construction Information Systems, Milsons Point NSW.

Deeks, B. & Milne, T., 2005, 'WSUD Engineering Procedures for Stormwater Management in Southern Tasmania 2005', Derwent Estuary Program, Department of Primary Industries Water and Environment, Hobart.

Environment Protection Authority and Department of Land & Water Conservation (2001a). *Model Landscape Development Control Plan*. (Draft, unpublished).

Environment Protection Authority and Department of Land & Water Conservation (2001b). *Model Environmental Management Plan for Landscaping Works*. (Draft, unpublished).

Handrek, K. (2001). *Gardening Downunder: A guide to healthier soils and plants*. CSIRO Landlinks Press, Collingwood Vic.

Nottle, T. (1996). *Gardens of the Sun*. Kangaroo Press, Kenthurst NSW.

Patrick, J. (1994). *Beautiful Gardens With Less Water*. Lothian Publications, Port Melbourne, Vic.

Romanski, Nick, (1998). *Planting wetlands and dams – a practical guide to wetland design, construction and propagation* UNSW Press, Sydney.

Standards Australia. *Australian Standard AS 4419 Soils For Landscaping and Garden Use*. Standards Australia, Homebush, NSW.

Standards Australia. *Australian Standard AS 4454 Composts, Soil Conditioners and Mulches*. Standards Australia, Homebush, NSW.

Standards Australia. *Australian Standard AS 4373 Pruning of Amenity Trees*. Standards Australia, Homebush, NSW.

Taylor, J, (1993). *The Dry Garden: Gardening with Drought-tolerant Plants*. Lothian Publications, Port Melbourne Vic.

Thompson, Paul (1991). *Water in your garden – constructing ponds, waterfalls and fountains*. Lothian Publications, Port Melbourne, Vic.

Van Dok, W. (2000). *The Water Efficient Garden: water efficient gardenscapes*. Glen Waverley, Vic. [Includes detailed information on greywater irrigation].

Walsh, K, (1995). *Water-Saving Gardening: waterwise plants and practices in Australia*. Reed Books, Chatswood NSW.