Constructed Waterways in Urban Developments Guidelines

healthy waterways

Victoria
The Place To Be

Melbourne Water

Working together to ensure a sustainable water future

Contents

Melbourne Water is owned by the Victorian Government. We manage Melbourne's water supply catchments, remove and treat most of Melbourne's sewage, and manage rivers and creeks and major drainage systems throughout the Port Phillip and Westernport region.

Introduction

Melbourne Water is proud to be the caretaker of the rivers, creeks and drainage systems of the Port Phillip and Westernport region.

Yet if our waterways are to be healthy it will be because we have all shared in the responsibility for their management and care.

These guidelines have been developed to assist land developers to design and construct healthy waterways in developing areas. We hope that this publication will also be of value to local government, consultants and the community.

We look forward to working with you to ensure that waterways in urban developments are designed and constructed to provide appropriate drainage and to enhance ecological, social and amenity values.

Purpose

The purpose of these guidelines is to:

- identify principles of waterway management that are to be considered when modifying or constructing a waterway
- improve the consistency of works along a waterway where separate developers are designing separate sections
- assist in the planning, design and construction of integrated waterways that are constructed or modified due to urban development
- provide references and links to sources of more detailed design information (see Fig. 1).

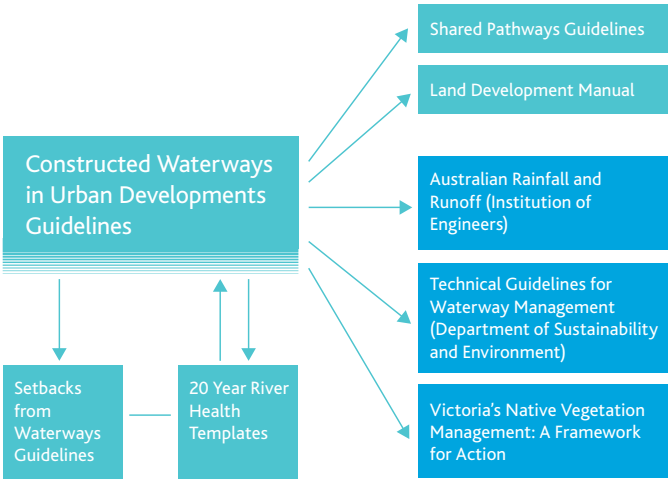


Figure 1 The Constructed Waterways in Urban Developments Guidelines provide references to other key industry documents and Melbourne Water projects. (Aqua boxes are Melbourne Water projects/documents; blue boxes are other industry documents.)

Application of the guidelines

The guidelines apply to the creation of new waterways resulting from:

- the alteration of runoff patterns due to urban development
- the upgrade of a minor drainage line depression to allow for increased flow capacity as a result of urban development
- the modification of a drainage line to accommodate adjoining urban development areas.

In terms of the planning process, the guidelines link with the Melbourne Water process of preparing Development Services Schemes (see Development Services Scheme section).

Urban development and stormwater runoff

Urban development results in significant changes to the amount and frequency of stormwater runoff into waterways.

Urbanisation leads to a dramatic increase in the area of impervious surfaces — reducing the amount of water infiltrating the soil and increasing surface runoff. These changes can alter flow regimes, impact on stream form and degrade water quality and in-stream health.

Best practice planning for urban development requires that the catchment's hydrologic response is maintained as close as practicable to pre-development conditions. Appropriately conceived and designed water management infrastructure can achieve this outcome.

Drainage lines

Often minor drainage lines (Fig. 2) need to be upgraded and stabilised when a catchment is developed to cater for larger and more regular flows.

Without these upgrades, increased flows can erode drainage lines and can lead to excessive sediment entering the main stems of the receiving waterways.

Figure 2 Typical minor drainage line prior to development of surrounding areas.

Figure 3 Concrete-lined channel with poor ecological and social values, and no water quality treatment.

Concrete-lined channels

Past design practices have often turned minor drainage lines (Fig. 2) into straight-line, trapezoidal concrete channels (Fig. 3) or other concrete-lined channels that possess very limited ecological, social or amenity values (Fig. 4).

While designed primarily to increase hydraulic capacity in response to urban development, the construction of concrete channels resulted in increased rates and volumes of stormwater quickly reaching our waterways — ultimately carrying high levels of pollutants into the Port Phillip and Westernport bays.

Constructed waterways

We advocate the development of constructed waterways that retain the characteristics of a natural waterway for that area. These new waterways — constructed in keeping with contemporary waterway management philosophies — have greater ecological, social and amenity value.

Figure 4 Before – a grassed floodway with a concrete-lined channel that has very limited ecological value.

Figure 5 After – following waterway rehabilitation works. The constructed waterway has a more natural form, with improved habitat and water quality treatment.

As waterways differ from site to site (Figs. 5–7), constructed waterways will similarly vary depending on:

- location
- land use constraints
- catchment requirements
- financial considerations
- stakeholder needs.

Development Services Schemes

Development Services Schemes are a plan of the drainage, waterway and water quality treatment works required to provide the most effective and environmentally sound stormwater management.

Melbourne Water prepares Development Services Schemes to plan for new waterways and to mitigate hydrologic and water quality impacts in developing areas, thereby protecting waterways from development-related increases in stormwater runoff. The schemes play an important role in protecting the health of receiving waterways and reducing pollutant levels entering the Port Phillip and Westernport bays.

Development may be in the form of new urban areas or urban consolidation in existing urban areas as anticipated by the Melbourne 2030 strategy.

Development Services Schemes provide an integrated solution to drainage and stormwater treatment works including:

- adoption of an integrated catchment approach to stormwater management
- protection of people and properties from flooding
- protection of waterway health and biodiversity values (both within the development area and in the receiving waterways and environments downstream)
- incorporation of environmental requirements based on the best available scientific information
- user-based pricing that is based on full cost recovery of the works from developers, and removal of cross-subsidies.

Preparation of the Development Services Scheme

A number of catchment investigations are undertaken in the preparation of the Development Services Scheme.

- Hydrological and hydraulic calculations determine the flows and dimensions of the waterway.
- Preliminary investigations are conducted on environmental, geomorphic, and cultural heritage values.

The impact on these values is taken into account in the design of the waterway.

Figure 6 Constructed waterway with greater ecological value compared to concrete-lined channels.

Figure 7 Constructed waterway showing recent revegetation works.

Our objective is a unified and consistent approach to planning, designing and constructing of channels and waterways

Constructed waterway design stages

The three stages in the design of constructed waterways are:

1. Concept design
2. Functional design
3. Detail design.

Melbourne Water's review and approval is required at all stages of the design process (Fig. 8).

The Development Services Scheme addresses the hydraulic requirements in the design process, resulting in a functional design for the new waterway.

During the Development Services Scheme process we also consult relevant landowners and agencies. The additional details of waterway form and environmental requirements described in these guidelines are developed further in subsequent stages of the development process.

The developer/consultant undertakes, in consultation with us, the detailed design for the reach of waterway within their development.

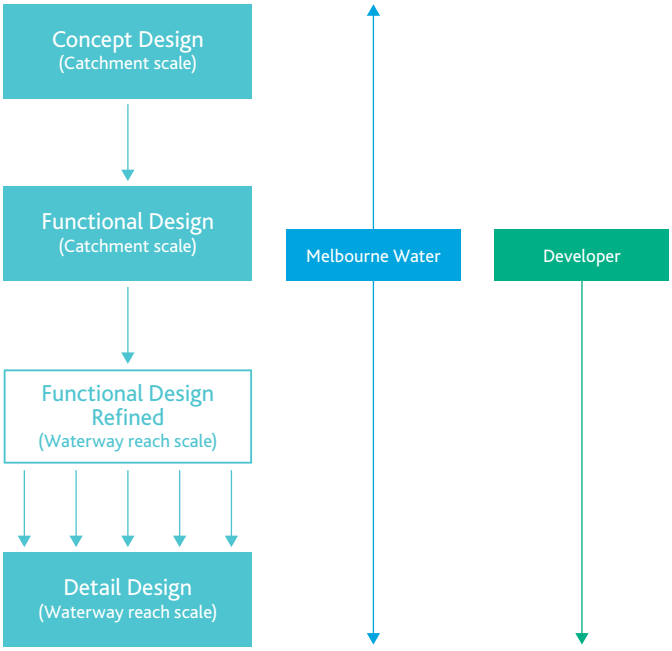


Figure 8 Constructed waterway design stages and stakeholder involvement.

The Development Services Scheme layout in Figure 9 is an example of a concept plan showing the proposed drainage, waterway and water quality treatment works required for a drainage catchment area.

However, the scheme layout represents proposed waterways as mere straight lines and offers limited information about the waterway's preferred form.

In subsequent stages of the design process a landscape drawing is required to effectively communicate the preferred outcome of the proposed waterway (see Waterway Form section). The landscape drawing can show, among other things, a meandering waterway with geomorphic features such as pools and riffles, the retention of remnant native vegetation and the extent of revegetation, as well as showing the design width of the waterway and riparian area (Fig. 11).

Consistency along waterways

In practice, properties are not always developed in sequence (i.e. downstream to upstream), which in turn leads to the construction of waterway sections out of sequence (Fig. 10).

In addition, developers often have responsibility for different sections of the same waterway, and consulting teams have varying approaches to waterway design (particularly from the perspective of landscape design and public open space management).

Our objective is a unified and consistent approach to planning, designing and constructing of channels and waterways in urban developments — resulting in an integrated drainage system.

Figure 9 A typical layout of a Development Services Scheme (above top) and a proposed waterway for major flows (above). The scheme needs to allow sufficient land for waterway and riparian areas to incorporate all the required environmental and social outcomes described in these guidelines.

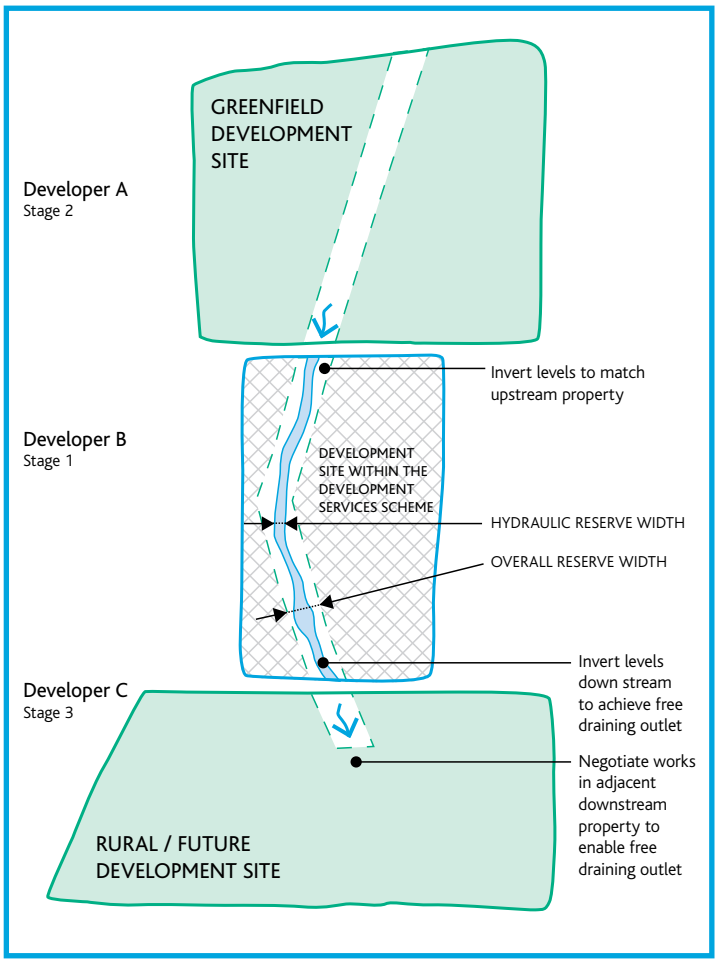
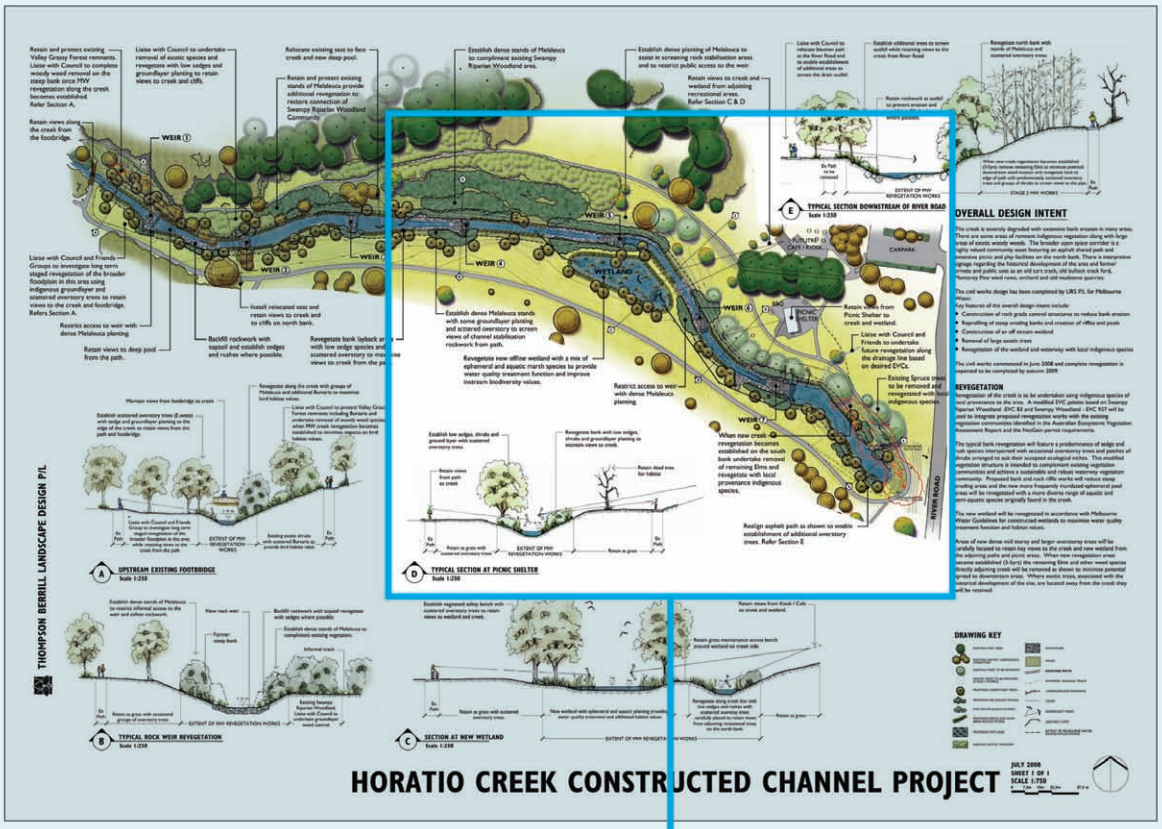
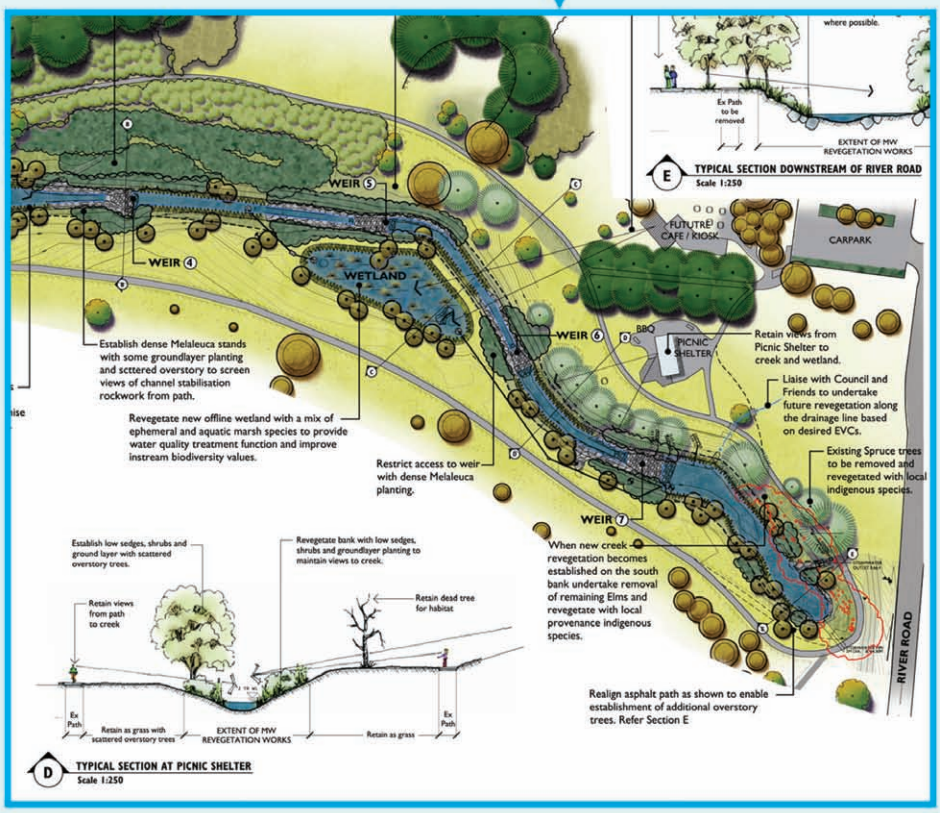


Figure 10 Developments along waterways can occur out of sequence (not necessarily downstream to upstream), involving different developers.

Figure 11 Landscape drawing example (Horatio Creek – fictitious).





THE GUIDELINES

The guidelines are intended to promote constructed waterways that have greater environmental and social values, while providing appropriate drainage services for adjacent urban developments

Waterway form

The design of constructed waterways should, wherever practicable, mimic the natural stream forms in the immediate region.

The waterway design detailed in the Development Services Scheme will define the following objectives.

Waterway alignment

The horizontal alignment needs to allow for:

- waterway meander
- the inclusion and protection of existing environmental, geomorphic and cultural heritage features.

The vertical alignment needs to:

- be variable
- retain or provide pools and riffle/run sequences as required for aquatic habitat diversity.

Waterway slope

The longitudinal slope of the waterway needs to be designed:

- so that peak velocities are not too high
- to include natural features such as pools and riffles — without these features being subject to undue disturbance from high flow events.

Waterway width

The waterway needs to be wide enough to:

- convey the peak design flows allowing for mostly vegetated or rocked banks
- incorporate bank slopes that are safe where free access is allowed.

The scheme design will provide (for each waterway):

- typical cross-section shapes that accord with these guidelines
- plans that accord with the natural templates of the region.

Where there are no other constraints or significant values to protect, the waterway should:

- be deep enough for property outlets
- be shaped to allow for the identified hydraulic factors.

Where there are geomorphic or other environmental values requiring protection, additional measures will need to be outlined in order to achieve ongoing protection of those values.

Regional variations

Across the Port Phillip and Westernport region, natural waterways are varied in their physical form and shape. This variation results from many factors including geology, topography, soils, climate, and hydrological conditions.

To the west of Melbourne, minor streams are often seasonal or ephemeral and can be weakly incised within the relatively flat basalt plains of the region.

Waterways in the east of Melbourne can receive much higher rainfall and carry flows all year round. Soil types in the east more commonly support ground and surface water movement, while valley forms are more pronounced.

While these guidelines describe typical waterway cross-sections and form, it should be clearly noted that these forms are not intended to be applied with uniformity. We do not advocate the homogenous design of waterways. Rather, we describe approaches that will assist you to produce a design that optimises the health of the specific waterway you are constructing.

The designer of constructed waterways needs to be guided both by the principles described in this document and by the natural form of the waterways in the area under development. This will necessarily include understanding the site's natural topography, geomorphology and vegetation regimes.

The 20 Year River Health Templates (see References and Resources for further details) will provide advice on the geomorphic forms of waterways throughout the Melbourne Water region.

Waterway roughness

Waterways with a more natural form will convey flows less efficiently than traditional straight-lined channel forms. As a result, a natural-form waterway will require a larger cross-sectional area to convey the same flow.

Designs for natural-form waterways need to take this into account and be designed with sufficient width from the point of concept design through to detailed design.

The most common design approach that accounts for waterway roughness is the use of the Manning formula and the roughness parameter 'n'. While precisely defining the design roughness parameter can be a challenge, it is clear that parameters for newly-constructed waterways will need to be increased from the past parameters used for channelised waterways.

Guidance on design values is provided in Australian Rainfall and Runoff, Institution of Engineers, 1997. Book VII contains the relevant sections 1.7 and 1.8. Factors that affect the overall roughness include surface texture, form of the channel and bed, channel irregularities and vegetation. The effect of vegetation can be significant but also complex (table 1.1 in the section of Australian Rainfall and Runoff (AR&R) lists some representative values).

It is expected that natural-form waterways will typically be designed with a Manning roughness parameter in the range of 0.05 to 0.07 (cross-sectionally averaged). These values allow for a winding stream alignment and a waterway with some pools and/or rocks that produce bed irregularities and low vegetation on the bed and banks.

Different values can be used but need to be justified in the design process. For example, where denser vegetation design is intended (such as the recreation of a melaleuca swamp-type waterway environment) appropriate higher values should be used.

Different roughness can also be appropriate for different parts of the waterway cross-section. AR&R recommends methods for calculating composite values (equations 1.30 and 1.31). This design approach should be applied in cases where planting regimes along the banks are different from those in the bed.

Protecting constructed waterways from scouring flows

In order to be sustainable, constructed waterways will often require rockwork, revegetation and other stabilising treatments. The extent of rockwork required will depend upon factors including stream power/velocity, bed control, batter slopes and local soil types.

In some instances where channel definition is shallow, the underlying soils alone may be stable enough to sustain a stream with low flows and limited grade. However, rockwork and revegetation will generally be required to prevent erosion resulting from high velocity flows. Adequately designed rockwork will offer ongoing protection to banks and the stream bed.

Rockwork may be specifically needed in parts of the waterway (such as outside bends) where erosive forces are greater. But it is important to bear in mind that excessive rockwork can reduce amenity and aesthetic values, making constructed channels appear 'unnatural'.

Geotechnical investigations should be carried out to assess the existing ground conditions and their influence on waterway design.

Vegetation and rocks have other ecological benefits for stream health, including the diversity of habitat opportunities they provide. Rocks may be widely used if they are appropriate to the regional geology of the local waterway, and if they are available and cost effective.

In all regions, rockwork is likely to be the best material for the construction of riffles and drop structures. Rockwork needs to be embedded in situ to prevent disturbance in higher flow events.

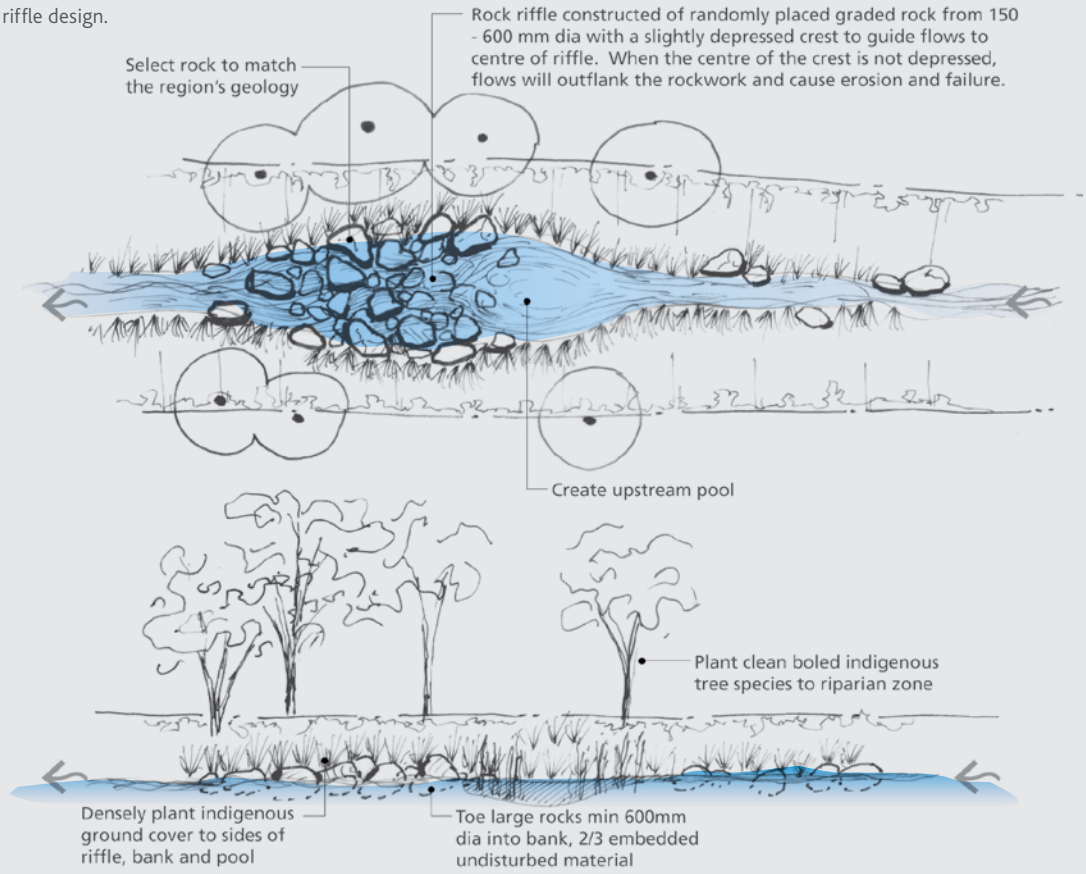
It is important to note that rockwork can be subject to weed invasion — sediments collected in the rock voids can encourage weed growth that is difficult to manage.

Further information on waterway protection and rehabilitation is given in the Land Development Manual link below:

http://melbournewater.com.au/ldm/rp

For geological maps of Victoria refer to GeoVic at the Department of Primary Industries website (see the References and Resources section for the website link)

Figure 12 An example of pool and riffle design.



Pools and riffles

Pools and riffles should be incorporated where:

- there is an identified need to control flow velocities
- such features are likely to be sustainable under the expected hydrologic regime following development
- they are consistent with the natural waterway form in the catchment (Fig. 12).

To the west and north of Melbourne in particular, naturally ephemeral streams can consist of a series of deep pools separated by runs that dry out over summer and autumn. These pools provide refuge for native fish and other in-stream life in dry periods and are critical to enabling the stream to recover in times of improved flows.

The placement of pools and riffles should incorporate the following geomorphic principles.

- Rock riffles constructed of randomly placed graded rock, typically between 150 and 600 mm diameter, with a slightly depressed crest to guide flows to the centre of the riffle (see Fig. 13). If the centre of the crest is not depressed, flows will outflank the rockwork causing bank erosion, possible damage to vegetation and flow failure.
- Non-submerged rock should be well embedded, interlocked and sealed, and should be greater than 450 mm in size.
- Riffles should be placed so that a lower riffle does not inundate the next riffle upstream. However, it is permissible and often desirable for the apron zone of a riffle to be backwatered by the next riffle downstream at times of low flow.
- Where riffles are larger and have more in common with rock chutes, exit conditions must account for the orientation of flows and guard against directing flows to banks where undercutting or other problems may be experienced. Adequate bank rockwork will resolve any outflanking.
- The rock used in the riffle must match the local area's natural geology.

While on-stream ponding may be deemed visually attractive and can at certain locations form a compatible over-looking feature for new estates, excessive ponding is discouraged.

Not only is ponding generally unnatural, but the slow moving water (and the mix of nutrients and hot weather) can result in algal blooms — raising potential risks for in-stream life and public health.

Densely planted indigenous ground-storey species should be incorporated into the sides of the riffle, bank and pool. Aquatic and semi-aquatic species, terrestrial sedges, tufting grasses and groundcovers should be used where appropriate.

Further information on pool and riffle design is given in the Land Development Manual available at the link below:

http://melbournewater.com.au/ldm/pr

Vegetation and rocks have other ecological benefits for stream health, including the diversity of habitat opportunities they provide

Figure 13 An example of pool and riffle design.

Batter safety design for pools

Batters on approaches to waterways, particularly waterbodies, must have suitable grades and must reflect these landscape constraints and current safety standards:

- the edge of any deep, open water should not be hidden or obscured by embankments or terrestrial planting, unless measures preventing access are incorporated (such as barrier plantings)
- approaches to batter slopes should be no steeper than 1:5 Vertical to Horizontal (V:H) unless there is special landscape edge treatment that will provide appropriate safety measures
- the batters of the waterbody should be smoothed off at 1:5 slope for ease of construction and safety
- the safety bench must be densely planted with emergent macrophytes so that casual entry will be difficult.

Safety measures such as permanent fencing or combined fencing and densely vegetated buffer zones should be used in the following circumstances:

- adjacent to zones of deep water (greater than 350 mm at normal top water level)
- in areas where safety benches do not meet the width criteria
- adjacent to potentially unsafe structures
- where high velocities may be encountered
- where batters are steeper than 1:5.

Maintenance access areas should be signed, fenced and gated to discourage access where the basic safety measures described above are not met (see section on Maintenance).

Non-maintenance access to the top of weirs, orifice pits and outlet structures must be restricted by appropriate safety fences and other barriers.

If any part of the water body is deeper than 350 mm, interim fencing may be required between the periods of construction and the establishment of vegetation.

For further safety design details for waterbodies, refer to Melbourne Water's Guidelines for Constructed Wetlands.

Stormwater outlet design

Stormwater outlets require careful design — and softening with appropriate revegetation — to avoid the possibility of negative physical and visual impacts, including bank scouring.

All connections should be oriented in a downstream direction and have a 5 m band of surrounding vegetation to assist screening of wing walls, rockwork and safety fences. Design should be in accord with the Melbourne Water Standard Drawing (Fig. 14).

All outfalls are required to be designed so that the default maximum permissible outlet velocity is 1.5 m per second (in the absence of an assessment of stream type and vegetation condition).

The design should further ensure that flow from the outlet will not cause undermining, erosion or scouring of adjacent and opposite bed and banks.

Further recommendations:

- flows from outlet structures must be directed downstream, preferably at an angle less than 45° to the flow within the waterway
- outlet structures should discharge to waterways via protected (either rock or vegetated) flow paths
- the velocity along the flow path should not exceed 1.5 m/s
- the discharge point from an outlet structure should be set as near as practical to the 'normal' water level
- rocks abutting the pipe to have a mortar pad between the rock and the outside edge of the pipe (no point loading)
- the bed and banks should be protected with rockwork, from the end of pipe to the low flow water level
- rock protection for the full erosion projection of the opposite bank and bed as required for the water flow profile when the outlet is flowing full
- rocks should be placed on a fine crushed rock (FCR) bedding to ensure the stormwater discharge is flowing over and around the rocks down into the creek, not underneath them (the remaining exposed dimension of the rockwork is to be a minimum of 150mm)

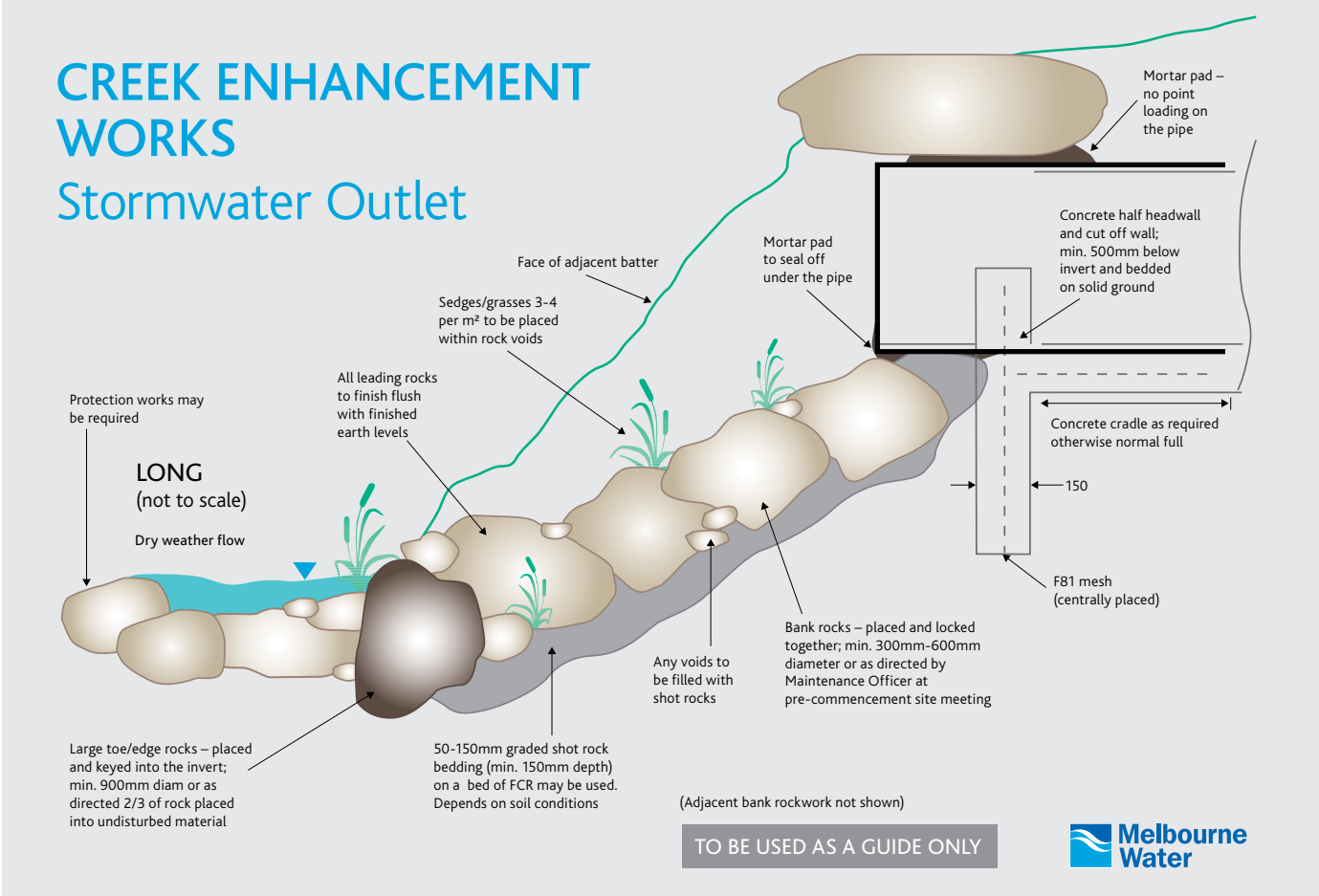


Figure 14 Stormwater outlet design. (Note that this figure is to be used as a guide only as the size of the rock and extent of the rock beaching will depend on pipe size, creek profile and expected discharge from the outlet.)

- ensure there is minimum disturbance to existing banks
- ensure that areas of existing bank disturbed by works are stabilised by revegetation
- make allowance for the protection of outlet structure from overland flows
- toe and side rocks should be adequately keyed into the bed of the waterway
- all voids should be filled with smaller rocks
- plant sedges and grasses in between voids within the rock chute (at 3–4 plants per m²) to provide additional screening
- plant shrubs and small trees around the post barrier to screen flows and stabilise the ground where needed
- integrate the outlet into the bank and surrounding landscape to maximise aesthetics and minimise impacts
- install appropriate silt and debris control measures
- outlet structures should also be compatible with any water quality treatment employed at the estate, for example, sediment or litter traps.

For Melbourne Water Standard Drawings see the following links to the Land Development Manual:

http://melbournewater.com.au/ldm/outlet
http://melbournewater.com.au/ldm/stormwater

Environmental objectives

Revegetation

The establishment of viable riparian vegetation is critical to the successful construction of waterways in urban developments.

Vegetation plays an essential role in maintaining a healthy waterway by:

- stabilising the channel form
- providing habitat diversity along the stream margin
- helping to moderate stream temperatures, especially during summer
- contributing organic matter — thereby providing food for in-stream life
- filtering nutrients and sediments from adjacent land
- providing aesthetic and amenity values.

Revegetation along constructed urban waterways needs to be planned in keeping with the objectives of Development Services Schemes previously outlined.

The following considerations will assist you to plan for the successful management of aquatic, ephemeral and terrestrial environments along constructed waterways:

- the capacity and hydraulic function of the waterway
- an integrated approach to planting and hydraulic planning to prevent or reduce flooding
- consideration of roughness issues and potential impacts on localised flooding where Manning's 'n' values are increased due to excessive use of shrubs in revegetation
- planting for the purpose of mitigating problems associated with increased flows resulting from greater impervious surfaces due to urban development (i.e. for erosion and bank stabilisation control)
- planting according to the identified EVC (Ecological Vegetation Class) of the site, with advice from Melbourne Water.

Protecting remnant vegetation

Wherever possible, existing remnant native vegetation should be retained and protected.

This especially applies to relatively intact stands of vegetation.

Victoria's Native Vegetation Management: A Framework for Action outlines the strategic direction for the protection, enhancement and revegetation of native vegetation in Victoria.

The framework established the strategic direction for a state-wide reversal of the long-term decline in the extent and quality of native vegetation — with the ultimate objective of a net gain in native vegetation (net gain is achieved when overall gains in native vegetation are greater than overall losses and where individual losses are avoided where possible).

Where development proposals affect remnant vegetation, the framework identifies a three-step process to ensure an overall increase in the extent and quality of native vegetation across the State:

1. Avoid adverse impact resulting in vegetation clearance
2. Where impact cannot be avoided, minimise impact through careful planning, design and management
3. Offset any vegetation loss through appropriate offsets.

A planning permit is required to remove native vegetation — the three-step approach is an integral part of the decision making process relating to these permits.

The Department of Sustainability and Environment has developed a standardised approach for estimating the quality of an area of vegetation. Known as 'Habitat Hectares', the approach measures a site's condition, landscape and context and is an important tool in determining good quality native vegetation. The assessment is likely to be required where an intact area of vegetation is proposed for clearing as part of development.

Flora and fauna species and ecological communities listed as matters of national environmental significance are protected under the *Environment Protection and Biodiversity Conservation Act 1999*.

Protecting other values

The following environmental values should also be protected.

- Dead and fallen trees provide valuable habitat for wildlife.
- Limiting access to riparian zones can facilitate regeneration.
- Existing geomorphic features including prominent rock escarpments, stony rises, ephemeral wetlands, springs, and especially rare geomorphic features like chains of ponds should be maintained.
- Where existing rock is encountered, the rock can be incorporated into a natural looking feature with suitable 'under-break' and 'over-break' (Fig. 15).

Figure 15 A bridge crossing during construction showing in situ rock, with 'over-break' and 'under-break' occurring.

Managing revegetation and weed control

Urban and peri-urban waterways are typically disturbed and often degraded. Weeds commonly play a central role in this degradation.

Successful revegetation and weed control efforts are driven by the following actions.

- Thorough weed management before and after revegetation will enable local native species to establish, improving their long-term survival against weed invasion.
- Bare ground resulting from the removal of weeds must be planted with native vegetation to prevent the re-establishment of weeds.
- Use strongly competitive species in key areas (as specified by the relevant desired EVCs) to establish a healthy, sustainable vegetation community that will limit the opportunity for weed invasion.
- Ensure that an ongoing program of weed control management is implemented.

Although it is not always possible in the context of land development and tight contractor works schedules, a site preparation timeframe of two years is usually seen as a minimum to address weed management issues. This is especially so if there are bulbous or other difficult-to-manage weeds present.

Effective weed management is grounded in a thorough assessment of the site's flora and fauna values as part of an initial waterway management strategy for the development. Once weeds have been identified and control methods established, contractors should be engaged at the earliest opportunity to begin weed control in preparation for revegetation.

Revegetation planning and design

Even with the best site preparation efforts, large soil-stored weed banks could still be present and capable of causing re-invasion of revegetation sites following the initial plantings.

While this underlines the need for a regular and consistent management presence at the site to ensure weeds do not dominate or inhibit the growth of revegetation, the selection and use of robust, competitive species in the revegetation design will greatly assist plant establishment and the success of the design.

The design of revegetation plans should adopt zones across various moisture gradients on the site. This avoids the need for plans showing each individual plant species and simplifies the process of assessment and approval by Melbourne Water. The zones can be broadly represented through the use of cross-sectional drawings that indicate the various moisture gradient zones on the site.

Figure 16 presents a simplified planning section showing the zonings and planting location of suitable wet bank species and dry bank species.

At some sites with extensive bank areas, it may be necessary to identify a mid-bank zone in order to limit the use of species adapted to more moist conditions outside their range.

To assist with weed suppression and plant establishment through increased moisture retention, a suitable mulching material needs to be incorporated into the revegetation design

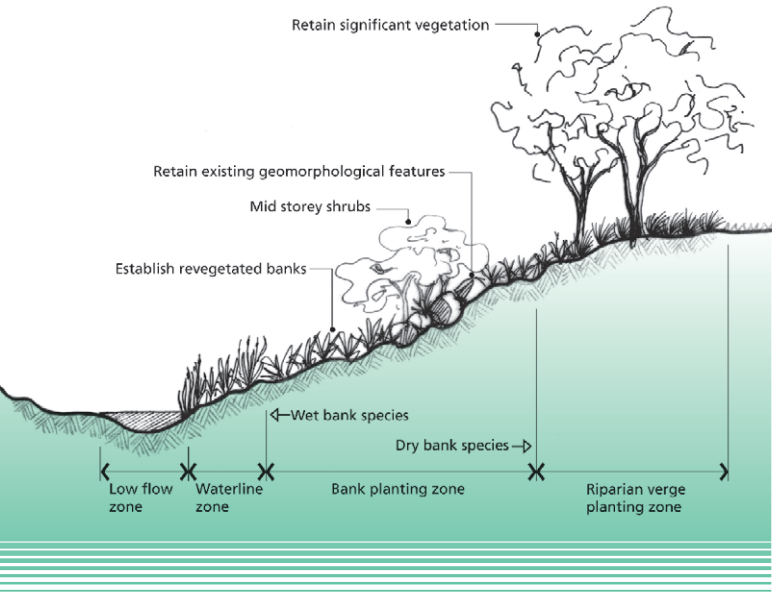


Figure 16 An example of a cross-section showing zones according to moisture gradients along the stream bank and verge.

along constructed waterways (i.e. continuous weedmat using a fabric or jute material is best employed in areas subject to frequent flooding — see Fig. 17).

A more detailed approach to revegetation planning/design will be outlined in Melbourne Water's 20 Year River Health Templates.

Figure 17 Waterway re-alignment, showing jute-matted banks prior to planting.

Plant selection

Plant selection will normally draw upon species listed under the EVC for the site. However, in urban areas these lists may be modified to provide a more robust selection of native species suitable for waterway plantings.

Unlike waterways in undeveloped catchments, urban waterways commonly exhibit greater environmental disturbance, changed hydrological conditions and limited management options. In these circumstances, the selection of plants should still reflect the original EVC but may have reduced diversity and an increased cover of selected species. In some cases, two or three desired EVCs may apply to a development site to cover the range of site conditions.

Revegetation design also needs to consider the impact of hydraulic roughness and potential barriers to flow. The increased resistance to flow from denser vegetation growth tends to slow the passage of flood water, thereby reducing channel conveyance and raising water levels for a given flow.

The 20 Year River Health Templates will provide more detail on appropriate species lists. In the meantime, you are advised to visit the DSE website to determine the expected EVCs for your site. The EVC benchmark species lists will provide guidance on species suitable to the area, but are not intended as revegetation lists. It is advised that you consult a specialist – who should consider the expected EVC – to determine a specific revegetation plan for your site.

Figure 18 Woody debris provide important habitat for many ground-dwelling species.

Habitat creation

Within urbanised catchments, waterway corridors are often a last refuge for native fauna.

Waterway corridors can offer important links to other habitats of greater size and diversity in undeveloped parts of the catchment.

As far as possible, design of constructed waterways should take into consideration the creation or protection of habitat. Key objectives to incorporate into your planning include:

- retaining remnant mature trees that support hollow-dwelling animals. These remnants can be supplemented by revegetation to ensure a more diverse range of age classes and replacement of older trees as they age and die
- introducing a shrub layer to offer habitat to small birds where this may not have been available previously
- retaining standing dead trees and woody debris which offer bird roosting sites and hollows for various ground-dwelling species (Fig. 18).

As previously mentioned, shading of the waterway with terrestrial vegetation can assist in creating variation in water temperatures, and can help control native plants (e.g. Phragmites and Typha) that aggressively colonise stream margins and can cause major flood debris management problems.

Vegetation can also introduce organic leaf litter and large wood into the stream which in turn increases the in-stream habitat and food supply of aquatic wildlife and macro-invertebrates. Pools and riffles also provide valuable habitat and refuge for in-stream fauna (see Pools and Riffles section).

Further information on habitat management is given in the Land Development Manual link:

http://melbournewater.com.au/ldm/habitat

Aquatic wildlife passage

Where there is potential for fish migration, blockages to fish passage and other aquatic wildlife are to be avoided (Fig. 19). Aquatic habitat and fish passage are protected by a number of Victorian legislative Acts. These include the Water Act 1989, the Fisheries Act 1995, Flora and Fauna Guarantee Act 1988 and the Conservation, Forests and Lands Act 1987.

Culverts can provide a barrier to fish passage and other aquatic wildlife. Appropriate culvert design measures should be used to facilitate fish movement (Fig. 20).

Culvert design should:

- provide for the entry of light (some fish species won't enter dark spaces)
- not reduce the stream cross-section to the extent that flow velocities are in excess of the fish burst speed
- contain flow velocity diversity and depth suited to target species
- have a natural substrate (DSE 2007).

For further detail see "Fish Passage Through Culverts" section 3.3.19 of DSE's Technical Guidelines for Waterway Management:

http://www.ourwater.vic.gov.au/environment/rivers/guidelines/waterway-management

Further detail on legislative requirements on fish passage is described in the following Department of Primary Industries link:

http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/access-dams-fishpassage

Platypus passage

The following design requirements should be considered to allow for the safe passage of platypus (Serena & Williams 2008).

- Pipes and culverts accessible to platypus should measure at least 30 centimetres in diameter.
- Vertical 'breathing bays' (approximately 1 m in diameter) should be provided at intervals of no more than 30 m along relatively lengthy pipes or culverts to ensure that platypus do not drown.
- Grilles or mesh barriers should be designed with grid spacing or apertures of a minimum of 12 cm.
- Barriers intended to exclude platypus should be constructed of solid materials or have grid spacings or apertures of 2 cm or less.
- Concrete drop structures and weirs should be designed to allow platypus to scramble up and down safely.
- Pipes and culverts should not be designed to overhang the surrounding substrate.

Figure 19 Examples of barriers to fish passage.

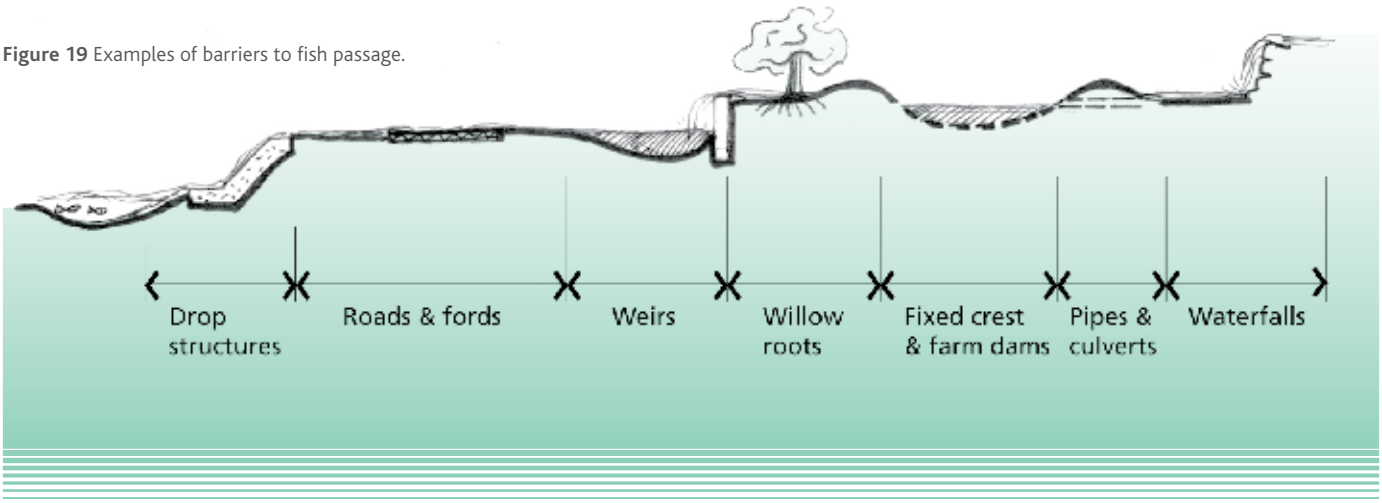
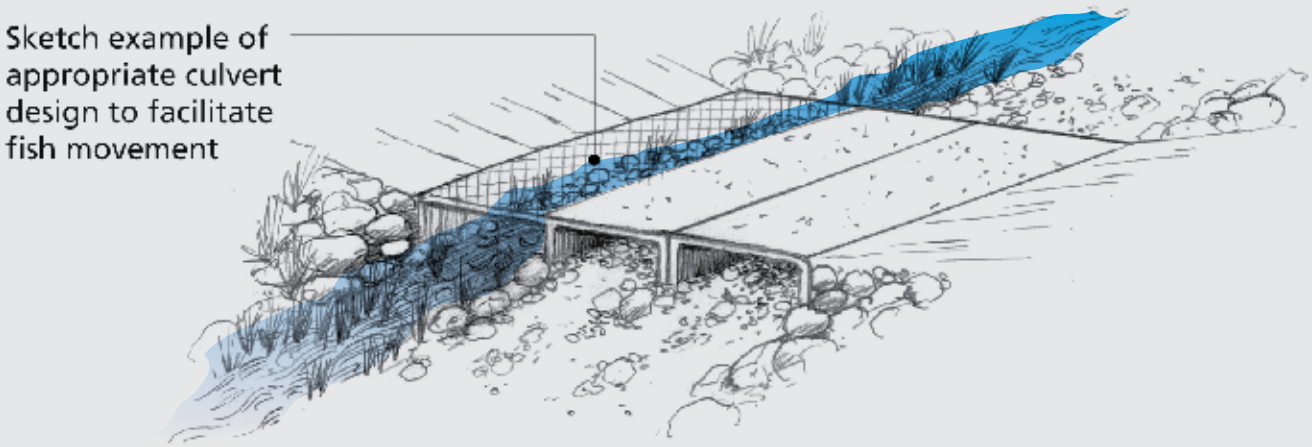


Figure 20 An example of a typical solution to fish passage. The design should be flat. Not to be used for vehicle/pedestrian crossing.



Paths and waterway access

Paths and tracks are usually incorporated alongside constructed waterways for maintenance and recreational access — these functions can often be combined. Councils usually define the need and extent of recreational trails and shared paths.

Locations for all types of paths should be designed with due consideration of user safety and the environmental features that are identified along the waterway.

Paths should have a minimum offset of 5 m from the top of bank. Areas of environmental, aesthetic or recreational value should not be adversely impacted by the construction of paths.

Pathways agreements

Prior to the development of any pathways along land owned/managed by Melbourne Water, the responsible party will be required to enter into a Pathways Agreement.

This agreement acknowledges that while Melbourne Water will provide all possible assistance in the planning for the pathway, Melbourne Water does not have ongoing responsibility for the ownership and maintenance of paths and crossings. The Pathways Agreement specifies that the responsible party indemnifies Melbourne Water for any loss or damage suffered as a result of the design, construction or maintenance of any path on Melbourne Water owned/managed land.

Consultation with Melbourne Water is recommended early in the design process

Bridges and crossings

Where pedestrian crossings are proposed, the safety of users and the impact on the hydraulic regime need to be considered.

As responsibility for public amenity rests with Council, their safety and maintenance requirements must also be adhered to. Although dependent upon structural design, our preference is for clear span bridges.

The freeboard required (300 or 600 mm) is dependent on waterway characteristics, hydraulic loads and debris threats.

Important design features include the following.

- Crossings over waterways should not increase flood heights or flow velocities.
- There should be no crossings in the upstream or downstream general vicinity of critical culverts or bridges, except where the proposed crossing is above the 1 in 100 year ARI flood level (this minimises potential impacts to critical culvert functions during flood events).
- The underside of the pedestrian bridge should be set at or above the 1 in 10 year ARI flood level and should not result in an increase up to and including the 1 in 100 year ARI level.
- Rock armouring is required under bridges and decks where vegetation cannot grow due to lack of sunlight (Fig. 21).

For further details refer to Melbourne Water's Shared Pathways Guidelines:

http://melbournewater.com.au/sharedpathways

Maintenance

We require access to waterways for ongoing maintenance activities and emergency response.

Access is required on both sides of the waterway and must have a minimum offset of 5 m from the top of each bank (Fig. 22). This access can often be incorporated with public amenity objectives via shared paths.

Careful planning of maintenance access and paths can limit vehicular disturbance that leads to damage to riparian vegetation and weed invasion.

Where vehicular access is required, sufficient regular access points to the reserve should be provided. This may involve ramps with suitable grades.

Your design should also consider:

- suitable materials for vehicle loadings
- the prevention of non-authorised vehicle access.

Particular features in or near waterways such as large culverts, sediment basins, pools and wetlands will require specific design considerations in relation to maintenance needs, including:

- de-silting
- machinery sizes
- turning circles
- lifting distances.

Consultation with Melbourne Water is recommended early in the design process.

Floodway safety

In some urban development locations, waterways are designed so that only the more frequent flows are contained within the main waterway and higher flows up to and including the 100-year event are conveyed along a reserve and/or roadways adjacent to the waterway. In these situations, it is important that the risks to safety are assessed by determining design velocities and depths.

Detailed guidance is given in the Land Development Manual, covering the following cases:

- residential streets used as floodways
- industrial streets used as floodways
- streets crossed by floodways

- grassed floodways in drainage reserves
- grassed/composite floodways in easements through residential or commercial property.

http://melbournewater.com.au/ldm/floodwaysafety

Waterway reserves and responsibilities

Reserve widths, ownership and management responsibilities for waterways are considered on a case-by-case basis in consultation with Melbourne Water and Council.

Reference should also be made to the environmental and cultural heritage values identified in the investigations carried out for the Development Services Scheme.

Determining reserve width will depend on many factors including:

- the extent and form of the natural floodplain
- river health
- significant flora and fauna species
- riparian biodiversity
- recreational objectives
- Council's desire to use waterway corridors as open space reserves and linkages
- Council's commitment to managing reserves of a certain width.

A contemporary approach to constructed waterway design should include a buffer zone within the reserve.

The buffer zone should incorporate environmental factors, as well as maintenance and recreation requirements (Figs. 23 and 24). Where there are suitable opportunities, this buffer width could extend beyond the hydraulic reserve width.

A natural form waterway will have greater roughness than grass-lined or concrete channels and so will require a larger cross-sectional area to convey the same flow.

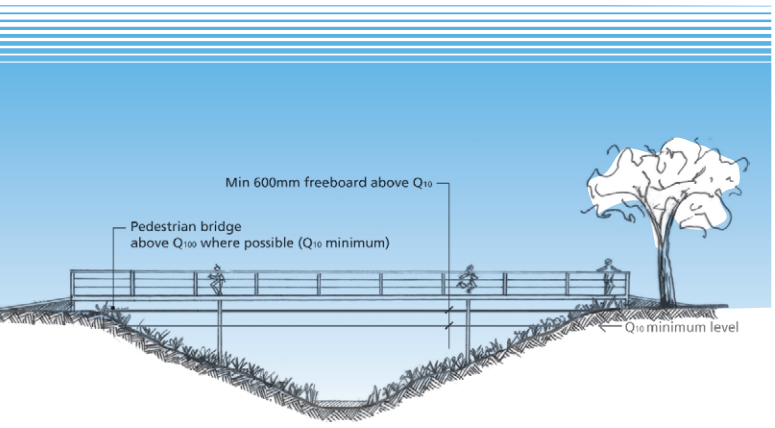


Figure 21 An example of a pedestrian crossing.

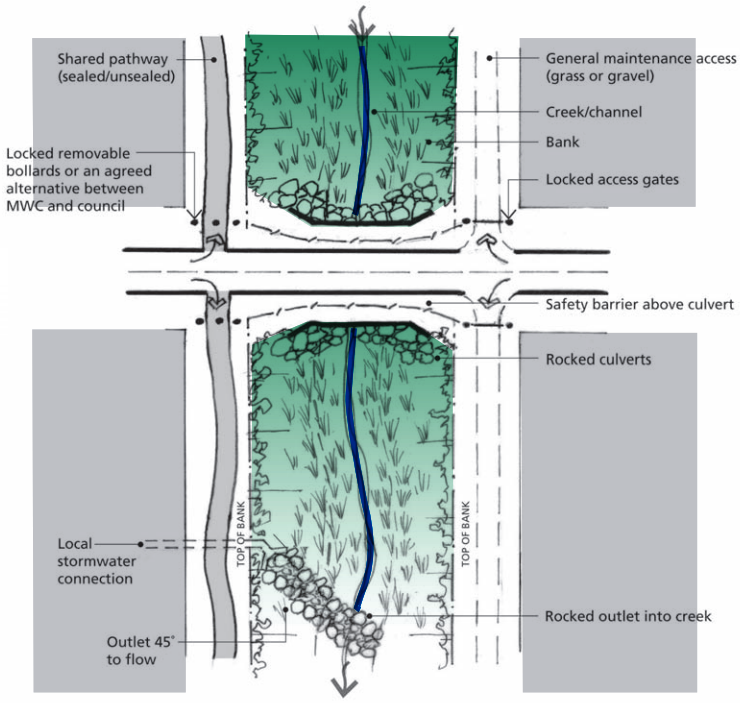


Figure 22 An example of a constructed waterway showing shared pathway on one side and general maintenance access on the other. A minimum offset of 5 m from the top of the bank is required.

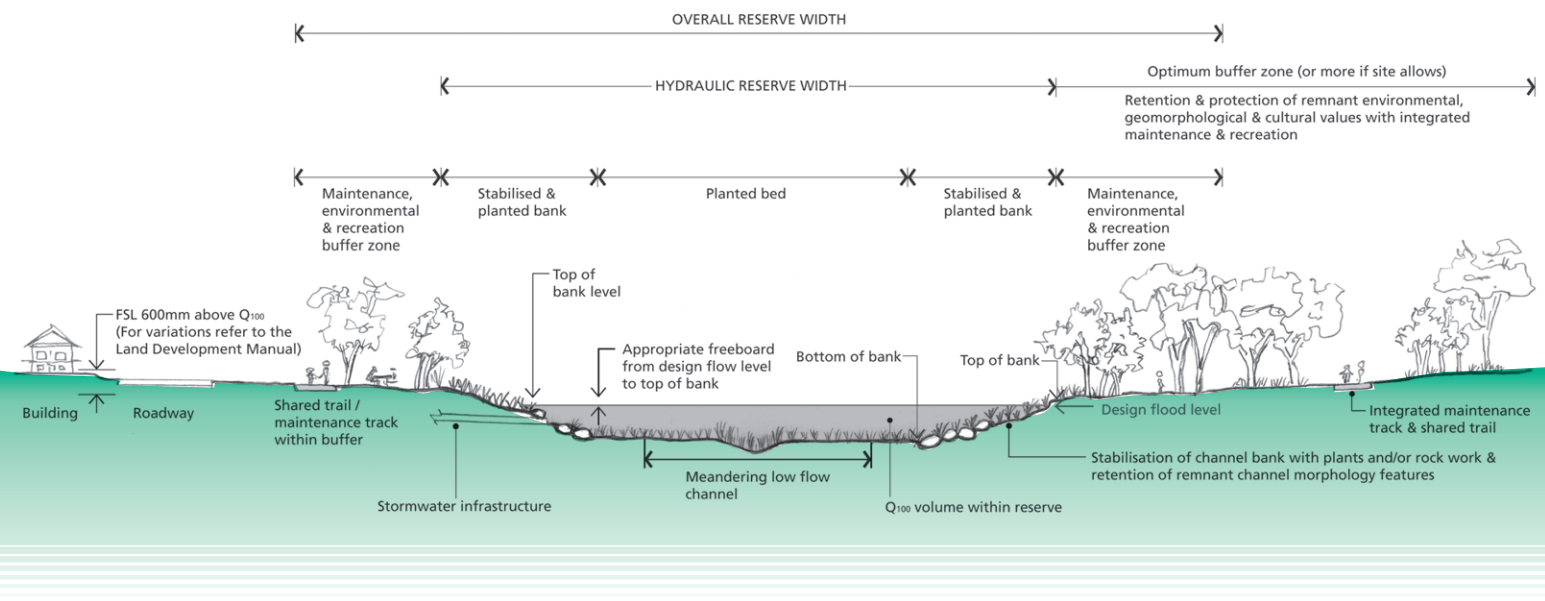


Figure 23 Contemporary waterway design showing the 100-year event contained within the main waterway in urban development areas. The hydraulic and overall reserve width will vary for each waterway.

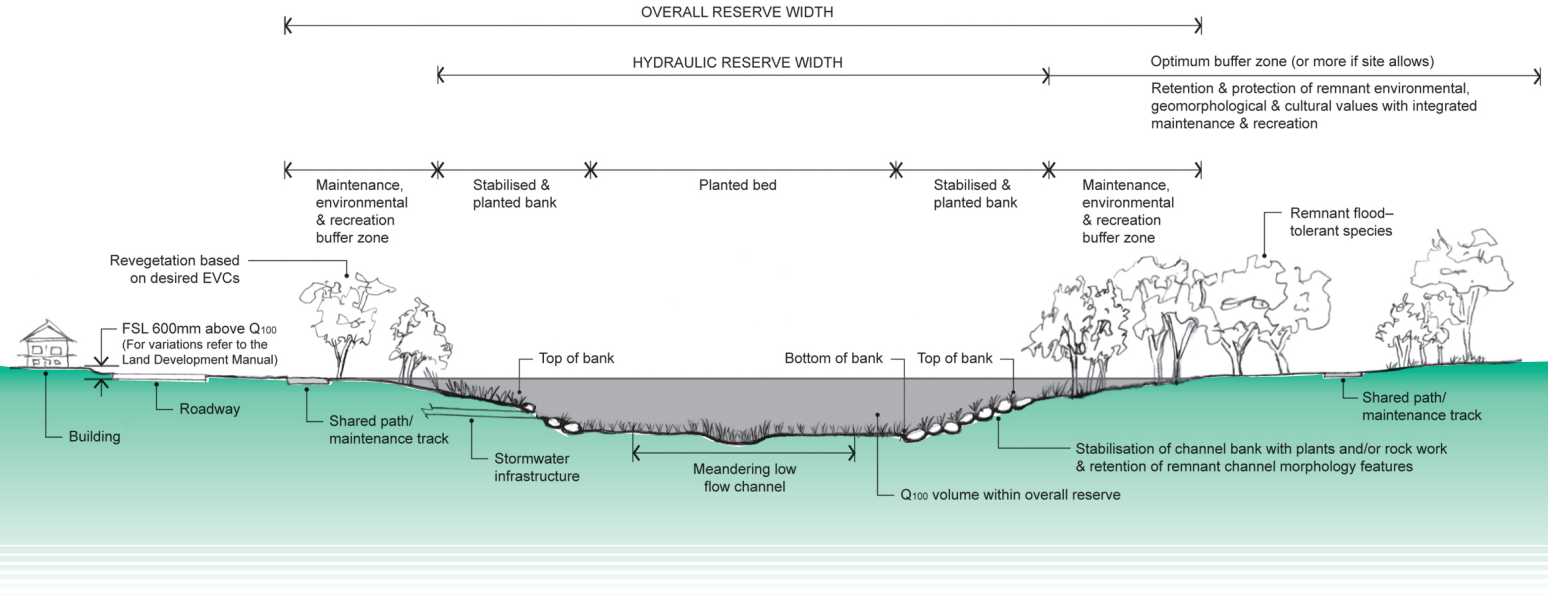


Figure 24 Contemporary waterway design showing the 100-year event contained within the overall reserve in urban development areas.

Appropriate roughness parameters should be used to calculate the flow area needed to contain the 100-year ARI flood flow and the corresponding flow widths (refer to section on Waterway Roughness).

In suitable locations, higher flows up to and including the 100-year event could extend beyond the main waterway, and should be contained within the overall reserve area (see Figs. 24 and 25).

Once constructed, waterways will require ongoing care and management to ensure their continued health. Management responsibilities are determined from the following benchmarks.

- Melbourne Water has management responsibility for the waterway within the defined bed and banks of the channel/ waterway, including the vegetation (it should be noted that the extent of flood flows may not be confined to this area and can extend to the adjacent land and roadways).
- Council is responsible for the public open space and associated assets such as shared paths, picnic facilities and the vegetation in this area.
- There may be shared responsibility for assets such as tracks, which provide a community function as well as providing maintenance access.

Ultimately, land ownership and responsibility is determined through consultation, a process that takes account of the above factors. A typical case is a Council reserve with a Melbourne Water drainage easement over the waterway bed and banks. If there is no public access, an option is for the full width to become a Melbourne Water reserve.

Stormwater quality

In new residential subdivisions, only treated stormwater should be discharged into the waterway.

While stormwater quality treatment systems, such as litter traps and sediment basins, have been directly connected to waterways in the past, positioning them as close to the source as possible is the preferred approach and is required of all new residential subdivisions (Clause 56.07 of the Victorian Planning Provisions).

Clause 56.07 provisions also require that:

- all new residential subdivisions maintain discharges to pre-development levels (unless there are no detrimental downstream impacts)
- the discharge is approved by the relevant drainage authority.

Further guidance is given in Land Development Manual link below:

http://melbournewater.com.au/ldm/stormwaterquality

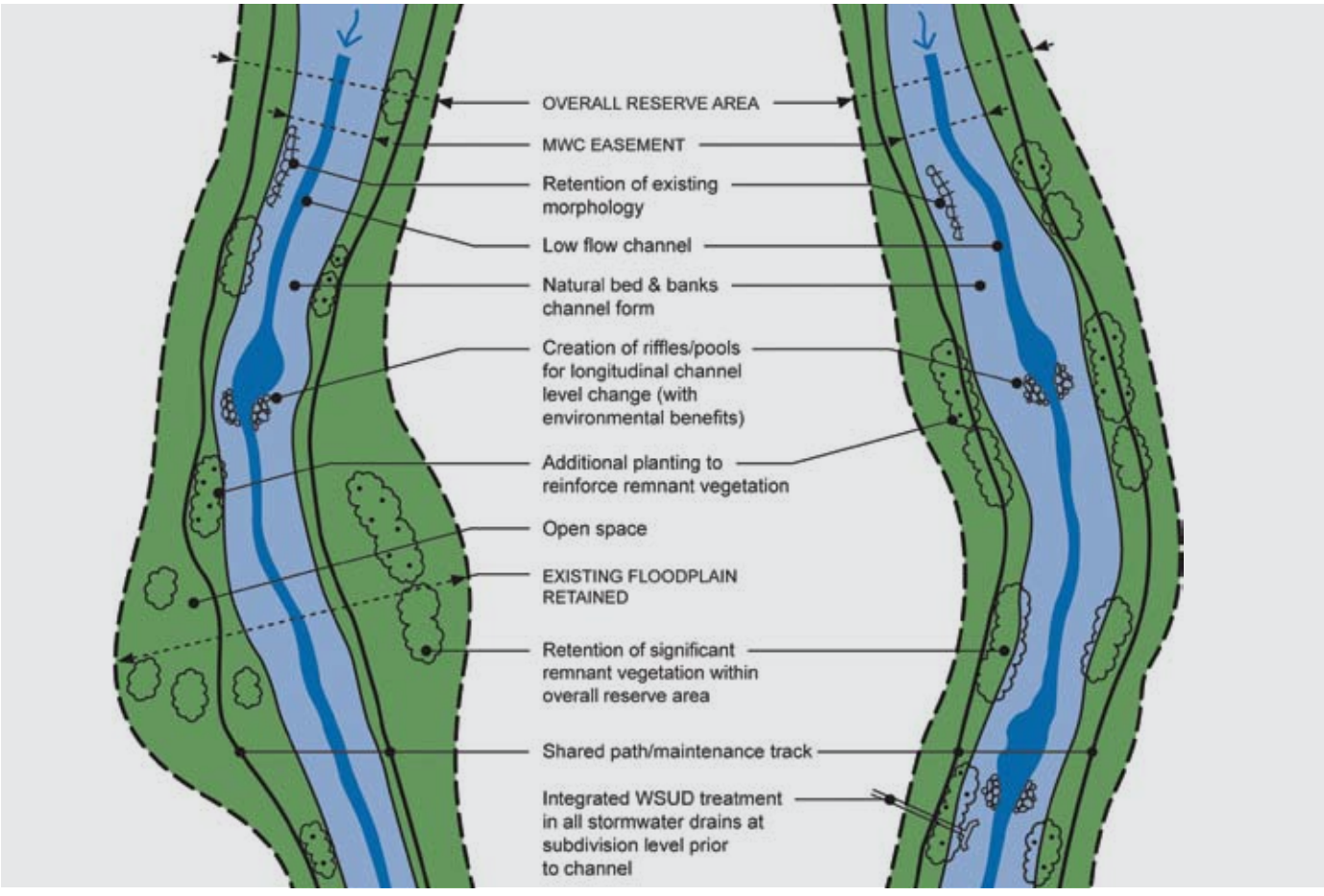


Figure 25 Contemporary waterway designs with increased ecological and social values. In suitable locations the higher flows up to and including the 100-year event could extend beyond the main waterway, and should be contained within the overall reserve area. The channel form on the left shows an extended reserve width with open space. This example shows that in an area with existing environmental values, such as remnant vegetation and/or a floodplain, the reserve width could be extended beyond the minimum width to accommodate these values. The channel form on the right shows a reserve width relative to the top of the banks.

References and resources

Land Development Manual

- The Land Development Manual is a website produced by Melbourne Water outlining the requirements of Developers when providing draining infrastructure in new development.

  http://ldm.melbournewater.com.au/

Further references

- Australian Rainfall and Runoff (AR&R), Institution of Engineers, 1997.
- DSE 2007, Technical Guidelines for Waterway Management.

  http://www.ourwater.vic.gov.au

  > Water in the Environment > Rivers, Streams & Creeks > Waterway Management Guidelines > 2007 Technical Guidelines for Waterway Management
- Farm Dams – Protecting Fish Passage & Aquatic Habitat: Legislative Requirements

  http://new.dpi.vic.gov.au/home

  > Quick Links – Victorian Resources Online > Water > Access to Water > Access to Surface Water > Farm Dam Construction Requirements > Protecting Fish Passage & Aquatic Habitat
- Serena, M. and Williams, G.A. 2008, Distribution and Management of Platypus in the Greater Melbourne Region, July 2008, (Report to Melbourne Water), Australian Platypus Conservancy, Melbourne.
- Victoria's Native Vegetation Management: A Framework for Action

  http://www.dse.vic.gov.au

  > Land Management > Native Vegetation > Victoria's Native Vegetation Management: A Framework for Action

Other useful links and resources

- Melbourne Water Guidelines for Constructed Wetlands
- Shared Pathways Guidelines by Melbourne Water

  http://melbournewater.com.au/sharedpathways
- Department of Primary Industries – Explore Victoria Online – GeoVic

  http://new.dpi.vic.gov.au/home

  > Earth Resources > Quick Links – GeoVic: Explore Victoria Online

Other Melbourne Water projects

20 Year River Health Templates

The River Health Template project has developed a clearly articulated vision of what our waterways will look like and how they will function in 20 years time.

Templates outlining eight different components of a river (geomorphology, riparian vegetation, riparian buffer width, water quality, fauna, flow, recreation and heritage values) will be available via a web-based GIS system. Users will be able to click on a particular part of a waterway and information on that section of the waterway will be displayed.

The information presented will be a combination of text and numerical data, supported by diagrams and pictures (where appropriate) on each of the eight components detailed above.

The templates will help guide an achievable vision for the look and function of waterways under our care, and will aid developers to design in keeping with Melbourne Water's long term goals for waterway health.

The templates provide an important guide to the aspects of revegetation, planning, design, plant selection and habitat creation detailed in these guidelines.

Setbacks from Waterways Guidelines

Melbourne Water is the manager of regional drainage, waterways and floodplains, and as such plays a key role in establishing setbacks from waterways in urban developments. This project is aimed at establishing clear guidelines for Melbourne Water and other stakeholders in the application of setback requirements.

The setbacks guidelines will cover the following issues: scientific understanding of setbacks under a range of settings, rationale for a number of setback types, legislative and planning requirements and mapping of the different setback types.

The setbacks guidelines are being developed in association with the 20 Year River Health Templates. The setbacks will be formalised as Melbourne Water policy following appropriate consultation.

Once finalised, the setbacks guidelines will contribute to a more consistent approach to determining the widths of the reserve and riparian buffer zone. The project will be an important guide to the themes of revegetation planning/ design, plant selection and habitat creation addressed in these guidelines.

Shared Pathways Guidelines

Melbourne Water's Shared Pathways Guidelines outline a standardised approach to path design, construction, upgrade and maintenance. They have been developed to help ensure that where shared paths are constructed along waterways within Melbourne Water land, the community is able to enjoy the highest standards of safety and that the condition of waterways, and any adjacent Melbourne Water asset, is protected.

In addition to addressing key design themes, these guidelines also describe the way in which the responsible party can most effectively liaise with Melbourne Water to ensure the successful construction of a shared path.

Glossary

ARI (Average Recurrence Interval): A statistical estimate of the average period (in years) between the occurrence of a flood of a given size or larger. The ARI gives no indication of when a flood will next occur.

Batter: A uniform slope.

Easement: Acquired right or privilege held by a person or public authority, including Melbourne Water, to make specific use of land owned privately or by another authority.

EVC (Ecological Vegetation Class): A level of classification developed by the Department of Sustainability and Environment. An EVC consists of one or a number of vegetation communities that are associated with a recognisable environmental niche, and which can be grouped together based on shared floristic, structural and ecological features.

Floodplain: Area of land adjacent to a creek, river, estuary, lake, dam or artificial channel, which is subject to inundation by the probable maximum flood.

Geomorphology: A system for classifying land at a broad level in order to understand the land in terms of form and process.

Macrophyte: An aquatic plant (Macrophytes underpin many wetland processes and dictate the presence of other wetland plants and animals).

Manning's roughness coefficient: A value that expresses the friction or resistance to flow due to the surface texture of a channel or pipe.

Peri-urban: The zone of land located between metropolitan centres and rural areas.

Riffle: A shallow section of water with a fast flow over the face of a small natural or raised section of stream bed.

Riparian: Streamside vegetation zone.

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