Urban stormwater management guidance

Publication 1739.1 June 2021

Publication 1739.1* June 2021
This replaces publication 1739 published October 2020.

Authorised and published by EPA Victoria
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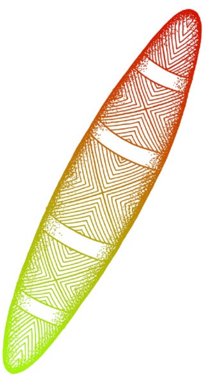

EPA acknowledges Aboriginal people as the first peoples and Traditional custodians of the land and water on which we live, work and depend. We pay respect to Aboriginal Elders, past and present.

As Victoria's environmental regulator, we pay respect to how Country has been protected and cared for by Aboriginal people over many tens of thousands of years.

We acknowledge the unique spiritual and cultural significance of land, water and all that is in the environment to Traditional Owners, and recognise their continuing connection to, and aspirations for Country.

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Contents

1 Purpose

Uncontrolled urban stormwater run-off poses a risk to the values of waterways and bays. This guide is intended to help improve the management of urban stormwater in Victoria by recognising current science and the risk of harm from urban stormwater flows. It supports minimising the risk of harm (https://www.epa.vic.gov.au/for-business/how-to/manage-environmental-risk) to human health and the environment through good environmental practice and provides information that will support the planning and design of new urban stormwater management systems. This guide:

- highlights the risk to waterways and bays the creation of sealed (impervious) surfaces causes
- provides general objectives and information to support risk assessment and minimisation
- explains stormwater management for communities in Victoria.

This guide is provided for developers who create new impervious surfaces, such as roads, subdivisions and other developments. It is also relevant to those who inform infrastructure planning and design, including technical consultants. It supports these parties to minimise the risks to human health and the environment from their design, planning and development activities, as the general environmental duty (GED) [1] requires. It also supports those involved in the assessment of urban stormwater treatment proposals.

Relevant parties include:

- the land development industry
- small and large-scale developers
- technical consultants and practitioners
- 'responsible authorities' as defined in planning legislation, that consider applications for approval of proposed developments, including local government
- public sector entities, including the Victorian Planning Authority, EPA, Melbourne Water, catchment management authorities, the Major Transport Infrastructure Authority and road authorities.

1.1 How to use this guide

You can use this guide to help minimise risks from urban stormwater so far as reasonably practicable (https://www.epa.vic.gov.au/about-epa/laws/new-laws/what-is-reasonably-practicable). Doing what is reasonably practicable means putting in proportionate controls to minimise the risk of harm to human health and the environment. Reasonably practicable also considers what controls are available and their cost, and considers what an industry generally knows about the risk and control options. The approach and steps you take to do this will also

[1] The *Environment Protection Act 2017*, as amended by the *Environment Protection Amendment Act 2018,* applies from 1 July 2021. This includes the general environmental duty. 'Minimise' means (a) to eliminate risks of harm to human health and the environment so far as reasonably practicable; and (b) if it is not reasonably practicable to eliminate risks of harm to human health and the environment, to reduce those risks so far as reasonably practicable.

depend on the scale and complexity of your project, the receiving environments, and the nature of the risks you need to manage.

1.2 Scope

The guidance relates to stormwater run-off from urban areas in Victoria. It addresses key environmental risks associated with generating new impervious surfaces, covering pollutant loads and flow impacts on the environment. While it covers a range of environmental risks, it provides environmental objectives for only a subset of these risks.

It does not provide guidance for those parties responsible for the ongoing management and operation of stormwater management systems, mobile business activities or the broad range of construction activities and risks, which is covered in other EPA guidance, including the *Civil construction, building and demolition guide* (publication 1834) (https://www.epa.vic.gov.au/about-epa/publications/1834). There is also wide-ranging technical guidance that already exists on maintenance of stormwater management systems provided by many water corporations (https://www.melbournewater.com.au/sites/default/files/WSUD-Maintenance-manager-guidelines.pdf) and councils.

Run-off from rural land is dealt with separately in the *Victorian Rural Drainage Strategy* (https://www.water.vic.gov.au/water-for-agriculture/rural-drainage/final-strategy).

Urban stormwater can be used as a resource with many benefits for the environment. This guidance does not directly address the maximisation of these benefits, which should be pursued in line with government policy. Some of these benefits are recognised in Appendix 1 ('Social impacts').

1.3 Status

This is not a compliance document. It contributes to the **state of knowledge**[2] (https://www.epa.vic.gov.au/about-epa/publications/1741-1) — the general body of knowledge about the harm or risks of harm to human health and the environment, including the controls for eliminating or reducing those risks. It is expected that the state of knowledge will improve over time as new knowledge and opportunities to better manage risk are established.

A range of obligations apply to stormwater, including under Victoria's planning system[3], and it is your responsibility to ensure your operations comply with all applicable laws. The content of this guidance complements and adds to the state of knowledge established through previous guidance and planning requirements.

[2] See industry guidance: *Supporting you to comply with the general environmental duty* (publication 1741) for information about other kinds of resources that can contribute to the state of knowledge.
[3] This includes Victoria Planning Provisions (https://planning-schemes.delwp.vic.gov.au/schemes/vpps) Clause 53.18 Stormwater management in urban development, 55, 56 and others.

2 Managing urban stormwater risks

This guidance focuses on how to (https://www.epa.vic.gov.au/for-business/how-to/manage-environmental-risk) assess stormwater risks and implement associated controls. Its approach is consistent with the risk management framework (https://www.epa.vic.gov.au/about-epa/publications/1695-1) EPA published, with a focus on stages 2 and 3 as is relevant to those planning the development of impervious surfaces.

For information on the hazards associated with uncontrolled urban stormwater generated by land development, see Appendix 1. For more information on checking controls see EPA's website (https://www.epa.vic.gov.au/for-business/how-to/manage-environmental-risk/risk-management-process).

Figure 1 – Steps in controlling hazards and risks associated with stormwater

This section provides tools you can consider using to support the assessment and minimisation of the risk of harm. Effective risk management is a continuous and iterative framework. This means considering how the implementation of appropriate controls will reduce the initial risk and what the remaining risk will be, to help determine the need for any further actions.

2.1 Assess risks: factors to consider

Assessing the risks associated with urban stormwater run-off from your site will help you determine the appropriate management controls to design and install. Assess the risks to human health and the environment.

Consider the following factors to help you understand the risk of harm:

- the general risks from land development as outlined in Appendix 1
- site-specific risks of harm to human health and the environment
- any other relevant state of knowledge, including relevant strategies, policies and guidance – for example the CMA/Melbourne Water *Healthy Waterways Strategy* (or equivalent policy), and place-specific advice from relevant authorities
- the pre-development flow regime
- monitoring and modelling data – including rainfall – to understand stormwater quality

and quantity and its potential impact, noting that climate change will influence rainfall patterns

- the size, scale and location of activities
- potential impacts to sensitive receivers, including aquatic ecosystems connected either longitudinally (downstream) or laterally (wetlands) and ecological conditions of specific receiving waters or other affected natural environments (such as riparian zones)
- waterway values, such as those identified in the Environment Reference Standard and relevant regional waterway strategies – this includes ecological, cultural, social and economic values
- soil conditions and properties, for example, these may be relevant to infiltration and also risks such as from sodic soils
- controls that are already in place and their effectiveness
- the volume of run-off your site is likely to generate
- the potential presence of pollutants in the run-off your site is likely to generate.

Metrics to assist you to evaluate risk of harm

The following table is an additional tool to assist in evaluating risk of harm. Performance against the objectives in Table 1 can be used as a signal of the level of risk of waterway values being lost or impacted (the further below the objectives indicates increased risk). The use of objectives specific to rainfall bands enables the developments to be better suited to their specific locations, in effect representing place-based objectives.

A suitably qualified and experienced professional making an assessment against these objectives enables a better understanding of the risk of harm and the extent of stormwater management that is adequate to support values in Table 1.

Note that the:

- reduction levels for solids, phosphorous and nitrogen are longstanding and there are requirements (https://www.water.vic.gov.au/liveable-cities-and-towns/stormwater/Stormwater-management-for-urban-development) to achieve them under other regulatory instruments, such as the Victoria Planning Provisions
- level of flow volume performance to achieve will depend on what is reasonably practicable (https://www.epa.vic.gov.au/about-epa/laws/new-laws/what-is-reasonably-practicable).

To assess these performance objectives, use an appropriate software tool. MUSIC (Model for Urban Stormwater Improvement Conceptualisation) (http://www.melbournewater.com.au/planning-and-building/stormwater-management/storm-and-music-tools) can be used for all indicators and developments.

For small, low-risk developments, less complex modelling may be acceptable based on current existing tools, such as STORM (Stormwater Treatment Objective – Relative Measure). STORM (http://www.melbournewater.com.au/planning-and-building/stormwater-management/storm-and-music-tools) only covers the nitrogen indicator and is under review. In these cases, a more simplified risk assessment, with common controls applied to minimise risk of harm may be appropriate.

As some councils require use of specific modelling tools in assessments, check with your local council.

Table 1: Quantitative performance objectives for urban stormwater

Indicator	Performance objective				
Suspended solids	80% reduction in mean annual load (Note:1)				
Total phosphorus	45% reduction in mean annual load (Note:1)				
Total nitrogen	45% reduction in mean annual load (Note:1)				
Litter	70% reduction of mean annual load				
Flow (water volume)		**Priority areas (Notes 2, 4, 5, 6)**		**Other areas (Notes 3, 4, 5, 6)**	
	rainfall band (ml)	**Harvest/evapotranspire (% mean annual impervious run-off)**	**Infiltrate/filter (% mean annual impervious run-off)**	**Harvest/evapotranspire (% mean annual impervious run-off)**	**Infiltrate/filter (% mean annual impervious run-off)**
	200	93	0	37	0
	300	88	0	35	0
	400	83	0	33	0
	500	77	5	31	4
	600	72	9	29	7
	700	68	11	27	9
	800	64	14	26	11
	900	60	16	24	13
	1000	56	18	22	14
	1100	53	19	21	15
	1200	50	21	20	17
	1300	48	22	19	18
	1400	46	23	18	18
	1500	44	25	18	20
	1600	42	26	17	21
	1700	40	27	16	22
	1800	38	28	15	22

Notes to table 1:

(1) 'Reduction in mean annual load' refers to the reduction in load discharged from the development with management. This is compared to the load that would be discharged without management. Load (or pollutant load) means the mass per unit time of an indicator/pollutant.

(2) These areas are priority areas for enhanced stormwater management. They have high ecological value waterways. The *Melbourne Water Healthy Waterways Strategy* identifies these areas. A map of them can be found here: https://data-melbournewater.opendata.arcgis.com/datasets/hws2018-stormwater-priority-areas. Note the map needs to be downloaded to distinguish the urban areas.

A transparent process is required to identify priority areas for enhanced stormwater management outside the greater Melbourne area.

(3) These objectives are to help arrest further degradation in these areas. To *restore* a waterway to pre-urban conditions, in an already degraded environment (highly modified waterway), it is likely that the priority objective or better would need to be applied.

(4) Mean annual impervious run-off volume refers to the percentage of run-off from the impervious surface.

(5) Note, council or other authorities may have specific requirements that will apply, for example, on-site detention requirements.

The infiltration performance objective may be inapplicable if the site is subject to requirements in an EPA permission directing that stormwater infiltration be minimised or is subject to an environmental audit statement that restricts stormwater infiltration. Victoria's planning framework includes requirements to identify potentially contaminated land at the planning scheme preparation/amendment stage and to manage any potential risks, including via EPA's environmental audit system. More information is available on DELWP and EPA websites.

(6) For further understanding about how to model objectives, see *Healthy Waterways Strategy Stormwater Targets: Practitioners Note* (https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/guidelines-drawings-and-checklists/guidelines)

2.2 Implementing controls

There are many controls that can be implemented to minimise risks from urban stormwater run-off. Melbourne Water has developed a practitioner's note (https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/guidelines-drawings-and-checklists/guidelines), which includes case studies and practical discussion, as well as examples of different controls at different scales.

Note, to help you identify what is reasonably practicable under the GED, you can use the following questions:

1. Eliminate first – can you eliminate the risk? For example, reduction of a given volume of stormwater run-off flowing to a stream removes 100% of the pollutants in that flow. If it's not reasonably practicable to eliminate the risk, think about how you can reduce it. You should be able to demonstrate how elimination of risks was considered in your decision-making.
2. Likelihood – what's the chance harm will occur? Has the harm occurred before on your site or has it commonly occurred on other sites? Seek information from water corporations, council and industry.
3. Degree – how severe could the harm be to human health or the environment? This includes impacts that add up over time (known as 'cumulative' impacts).
4. Your knowledge about the risks – what do you know, or what can you find out, about the risks your activities pose? How can you address those risks to human health and the environment?
5. Availability and suitability – what technology, processes or equipment are available to control the risk? What controls are suitable for use in your circumstances? Consultation with water corporations and councils can help confirm this.
6. Cost – how much does the control cost to put in place compared to how effective would it be in reducing risk? Importantly, the most effective solution won't always be the most

expensive. Likewise, a cheaper solution may not be the most effective available to control the risk.

Before you select a control, consider the above, how it will be used, and its effectiveness. The controls you select should be proportionate to the risk.

Before you put controls in place, consider your approach to planning and site management. For example:

- Does your site layout help or hinder your control of hazards and risks from stormwater run-off?
- Do your business processes, systems and activities help you prevent harm?

The hierarchy of controls can be used to support the identification and selection of controls by providing a prioritisation framework (Figure 2).

Figure 2: Hierarchy of controlling hazards and risks.

Managing urban stormwater to achieve water quality and flow regimes that can support healthy stream ecosystems and other waterway values involves:

- eliminating specific impervious surfaces where reasonably practicable. For example, use of porous pavement
- capturing stormwater run-off
- eliminating or reducing pollutants such as nutrients, sediment, heavy metals and other toxicants found in stormwater
- infiltrating a portion of stormwater run-off.

Consider the ongoing management requirements to control stormwater risks and try to choose interventions that do not rely on administrative controls to be effective. Controls need to be fit for purpose and installed and maintained correctly, so also consider the information required to support future maintenance and management.

Some examples of stormwater treatments that may be used to minimise risk of harm from urban stormwater run-off include:

- artificial wetlands
- rainwater tanks
- stormwater harvesting
- swales and raingardens
- other water-sensitive urban design features.

Other engineering solutions to adequately capture sediment loads from your site may involve the installation of primary, secondary or tertiary treatment controls listed below. The implementation of the controls should be based on site-specific hazards and the level of risk at the site. A sequence of controls, commonly referred to as a 'treatment train' (https://www.epa.vic.gov.au/about-epa/publications/1893), may be needed if pollutants such as nutrients and fine sediment are encountered:

- **Primary treatment controls** include physical screening of sediment in grassed swales, sediment basins, sediment ponds and litter traps.
- **Secondary treatment controls** consist of fine particle sedimentation and filtration in swales, infiltration trenches, filter bags and porous paving.
- **Tertiary treatment controls** include removal of nutrients and dissolved heavy metals in wetlands and bio-retention systems.

See Section 3 for indicative stormwater management examples. These are indicative only to support understanding of some existing risk control measures. As each site is different, an appropriate system to minimise risk of harm may differ for the relevant site, and also based on any relevant policy or authority's advice. Depending on the scale, this may require developers to engage early with relevant water corporations, planning authorities, catchment management authorities and local councils to identify waterway values and help understand what controls may be available and suitable. Based on this, a developer would develop appropriate risk management strategies as part of the planning process. Water corporations and councils may have more information on appropriate treatment options relevant to your development site, so we recommend engaging early. For example, Melbourne Water can provide advice in the Port Phillip and Western Port Region.

Victoria's Integrated Water Management Framework (https://www.water.vic.gov.au/liveable/integrated-water-management-program/iwm-framework) provides a framework for working together in an integrated way to deliver greater community value.

The design of controls should also consider any risks of the control itself, and options to eliminate or reduce these at the design stage. For example, considering the need to treat sediments for trapped contaminants or limit plant growth to maintain efficient wetland functioning and limit nuisance species, such as mosquitoes. To minimise risk, check the quality of your plumbing and ensure plumbing controls are in place so that there is no cross-connection between the rainwater system for non-potable uses and drinking water supply. In relation to rainwater use, follow any relevant health advice (https://www2.health.vic.gov.au/about/publications/policiesandguidelines/Rainwater-use-in-urban-communities-Guidelines-for-Nondrinking-Applications-in-Multiresidential-Commercial-and-Community-Facilities) regarding risks and management.

In addition to designing and installing an appropriate stormwater management system, it is also important that appropriate controls are implemented during construction to prevent industrial and commercial chemical pollutants and other toxicants entering stormwater. It is also important to manage erosion and sediment from the site. The following EPA publications and resources may be used to inform appropriate controls to implement at the development site and may be useful references for assessing or preparing a permit application:

- *Civil construction, building and demolition guide* (publication 1834) (https://www.epa.vic.gov.au/about-epa/publications/1834)
- *Liquid storage and handling guidelines* (publication 1698, June 2018) (https://www.epa.vic.gov.au/about-epa/publications/1698)
- *Solid storage and handling guidelines* (publication 1730, July 2019) (https://www.epa.vic.gov.au/about-epa/publications/1730)
- *Construction - guide to preventing harm to people and the environment* (publication 1820, October 2020) (https://www.epa.vic.gov.au/about-epa/publications/1820)
- Erosion and sediment advice for businesses (https://www.epa.vic.gov.au/for-business/find-a-topic/erosion-and-sediment/advice-for-businesses)

3 Indicative stormwater management scenarios

These scenarios show typical assets and different options that may control risk. These are only examples of a broad range of approaches that may be taken. The approach you take will depend on your site and risk assessment.

Scenario 1: Other areas. Development type: residential development, greenfield subdivision.

Stormwater management

Development type: residential development greenfield subdivision

Objectives

Flow management

Stormwater pollutant load reductions achieved with treatment

What might be done?

- 60% of every lot's roof area is connected to a 2.5 kL rainwater tank for non-drinking water uses.
- All of the precinct's runoff is treated by a constructed wetland sized at 3.8% of the development area. Partially un-lining the wetland will achieve the infiltration objective.

Urban form

A residential development is constructed as part of a greenfield subdivision.

Water context

The new greenfield subdivision generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

Property owners

New property owners would like to live in an attractive low maintenance environment. Owners reduce water bills with the rainwater tank.

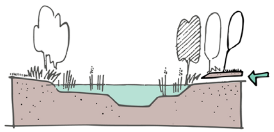
Did you know..

Constructed wetlands are usually used close to a catchment outlet or within a reserve where there is plenty of space. They are best built in land subject to flooding, but outside the main waterway channel. Many developers and councils prefer wetlands because they are reliable and provide amenity for the community.

Rainfall

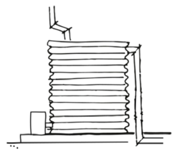
Results based on 700mm MAR.

1 Wetland



All of the precinct's stormwater runoff is treated with a constructed wetland. The stormwater is filtered by physical and biological processes through a series of shallow, densely-planted areas. The treated water is released to the local waterway.

2 Rainwater tank



Rainwater from each lot's roof area is stored in a rainwater tank. This rainwater is used for toilet flushing, laundry washing, and watering the garden.

Scenario 2: Other areas.
Development type: residential development, greenfield subdivision.

Stormwater management

Development type:
residential development
greenfield subdivision

Objectives

Flow management

Stormwater pollutant load reductions achieved with treatment

What might be done?

For 30% of total lots, 30% of the lot roof area is connected to a 2.5 kL rainwater tank for non-drinking water uses. All of the precinct's runoff is treated by a constructed wetland and sponge, sized at 3.8% and 2% of the development area respectively. 22.5 ML/yr of treated stormwater is harvested for oval and green space irrigation.

Urban form

A residential development is constructed as part of a greenfield subdivision.

Water context

The new greenfield subdivision generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

Property owners

New property owners would like to live in an attractive low maintenance environment. Owners reduce water bills with the rainwater tank.

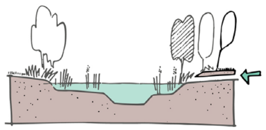
Did you know..

Harvesting large volumes of urban stormwater protects local waterways as well as providing a valuable resource for irrigating ovals and green spaces within the community.

Rainfall

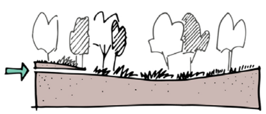
Results based on 700 mm MAR.

1 Wetland



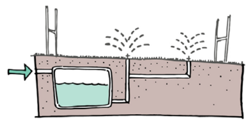
All of the precinct's stormwater runoff is treated with a constructed wetland. The stormwater is filtered by physical and biological processes through a series of shallow, densely-planted areas.

2 Sponge



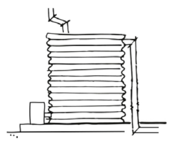
A low lying sponge in the floodplain collects the treated stormwater from the wetland and allows it to slowly soak into the soil and evaporate into the air. Any excess water flows to the local waterway.

3 Harvesting



Treated stormwater from the wetland is temporarily held in storage tanks and used to irrigate large sporting facilities.

4 Rainwater tank



Rainwater from lot roof areas is stored in a rainwater tank. This rainwater is used for toilet flushing, laundry washing, and watering the garden.

Scenario 3: Priority areas.
Development type: residential development, greenfield subdivision.

Stormwater management

Development type:
residential development
greenfield subdivision

Objectives

Flow management

Stormwater pollutant load reductions achieved with treatment

What might be done?

- All of the precinct's runoff is treated by a constructed wetland sized at 4% of the development area. Including an unlined portion of wetland would promote infiltration.
- Treated stormwater is further cleaned to supply 760 kL/day of water for external use.
- It is rare in practice to rely on a single management system – the inclusion of street trees would be beneficial and help limit the wetland size needed.

Urban form

A residential development is constructed as part of a greenfield subdivision.

Water context

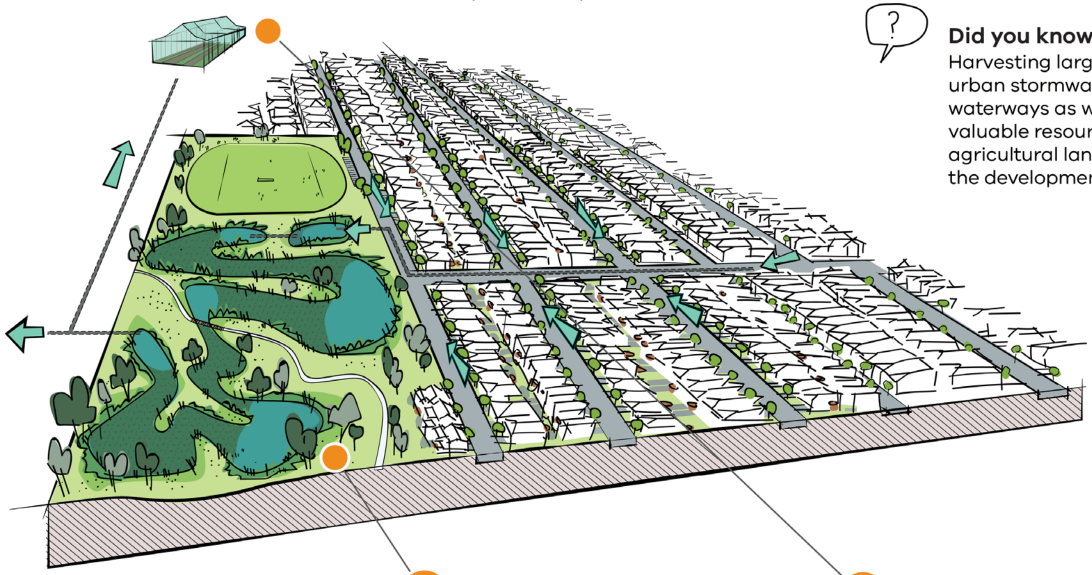
The new greenfield subdivision generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

Property owners

New property owners would like to live in an attractive low maintenance environment. Owners reduce water bills with the rainwater tank.

Did you know..

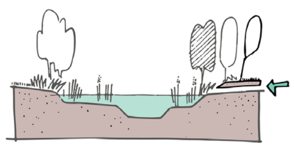
Harvesting large volumes of urban stormwater protects local waterways as well as providing a valuable resource for irrigation of agricultural lands in areas near the development.



Rainfall

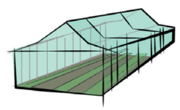
Results based on 700 mm MAR.

1 Wetland



All of the precinct's stormwater runoff is treated with a constructed wetland. The stormwater is filtered by physical and biological processes through a series of shallow, densely-planted areas. The treated water is released to the local waterway.

2 Treatment and use



Treated stormwater from the wetland is polished via a new treatment facility. This highly treated water supply is pumped to neighbouring commercial and agricultural operations for use.

Scenario 4: Priority areas.
Development type: residential development, greenfield subdivision.

Stormwater management

Development type:
residential development
greenfield subdivision

Objectives

Flow management

Stormwater pollutant load reductions achieved with treatment

What might be done?

- 100% of every lot's roof area is connected to a 4 kL 'leaky' rainwater tank for non-drinking water uses. The top 25% of the rainwater tank's volume leaks to the lot's garden area.
- All of the precinct's runoff is treated by a constructed wetland sized at 3.5% of the development area. To meet the harvesting objective in this scenario, demand would need to be sufficient, or potentially the wetland increased in size. Whether this is practicable will depend on the situation.

Urban form

A residential development is constructed as part of a greenfield subdivision.

Water context

The new greenfield subdivision generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

Property owners

New property owners would like to live in an attractive low maintenance environment. Owners reduce water bills with the rainwater tank.

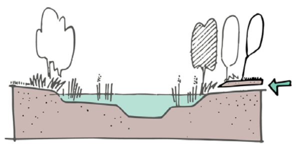
Rainfall

Results based on 700mm MAR.

Did you know..

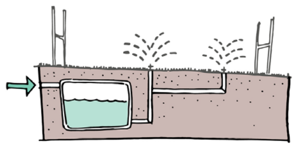
Harvesting large volumes of urban stormwater protects valuable local waterways, provides significant volumes of water for non-drinking uses and contributes to greener, cooler suburbs.

1 Wetland



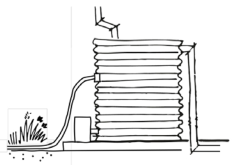
All of the precinct's stormwater runoff is treated with a constructed wetland.
The stormwater is filtered by physical and biological processes through a series of shallow, densely-planted areas.
The treated water is released to the local waterway.

2 Stormwater harvesting



Treated stormwater from the wetland is temporarily held in storage tanks and used to irrigate large sporting facilities.

3 Leaky rainwater tank



Rainwater from each lot's roof area is stored in a rainwater tank for hot water use, toilet flushing, laundry washing, and watering the garden.

Each tank is designed to slowly release (or 'leak') a portion of the tank's volume to the garden area. This reduces flood impacts during storms by ensuring there is some capacity available for the next rain event.

Scenario 5: Priority areas.
Development type: residential development, greenfield subdivision.

Stormwater management

Development type:
residential development
greenfield subdivision

Objectives

Flow management

Stormwater pollutant load reductions achieved with treatment

What might be done?

- 80% of every lot's roof area is connected to a 4 kL rainwater tank for non-drinking water uses.
- All of the precinct's runoff is treated by a constructed wetland and sponge, sized at 2.8% and 2.6% of the development area respectively.
- The addition of harvesting to the wetland would meet the harvesting objective. However, this may not be practicable in some situations. Also, if maximising your re-use opportunities the size of the sponge could be reduced.

Urban form

A residential development is constructed as part of a greenfield subdivision.

Rainfall

Results based on 700mm MAR.

Water context

The new greenfield subdivision generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

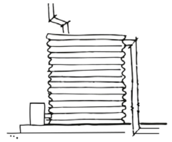
Property owners

New property owners would like to live in an attractive low maintenance environment. Owners reduce water bills with the rainwater tank.

Did you know..

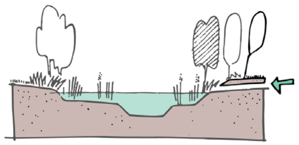
Vegetated stormwater treatment assets located in the streets and parklands contribute to cooling, improving local habitat and providing attractive and enjoyable spaces.

4 Rainwater tank



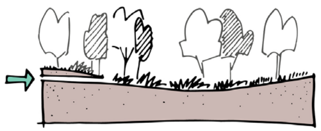
Rainwater from the roof of each lot is stored in a rainwater tank and used for hot water use, toilet flushing, laundry washing, and watering the garden.

1 Wetland



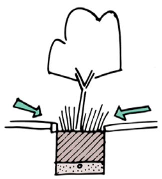
All of the precinct's stormwater runoff is treated with a constructed wetland. The stormwater is filtered by physical and biological processes through a series of shallow, densely-planted areas. The treated water is released to the local waterway.

2 Sponge



A low lying sponge in the floodplain collects the treated stormwater from the wetland and allows it to slowly soak into the soil and evaporate into the air. Any excess water flows to the local waterway.

3 Self-watering street trees



Street trees are designed to capture and treat stormwater from road reserves. Stormwater runoff improves soil moisture and resulting tree health and canopy growth.

Scenario 6: Other areas.
Development type: industrial development, greenfield subdivision.

Stormwater management

Development type:
industrial development
greenfield subdivision

Objectives

Flow management

Stormwater pollutant load reductions achieved with treatment

What might be done?

30% of every lot's roof area is connected to a 3 kL rainwater tank for toilet flushing. Each lot is 1000 m^2. All of the precinct's runoff is treated by a constructed wetland and sponge, sized at 5.8% and 0.8% of the development area respectively. Increasing sponge area will achieve infiltration objective while increasing evapotranspiration simultaneously. If sponge size is increased, wetland can be reduced without compromising harvesting.

Urban form

A industrial development is constructed as part of a greenfield subdivision.

Water context

The new greenfield subdivision generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

Property owners

New property owners would like to work in an attractive low maintenance environment. Owners reduce water bills with the rainwater tank.

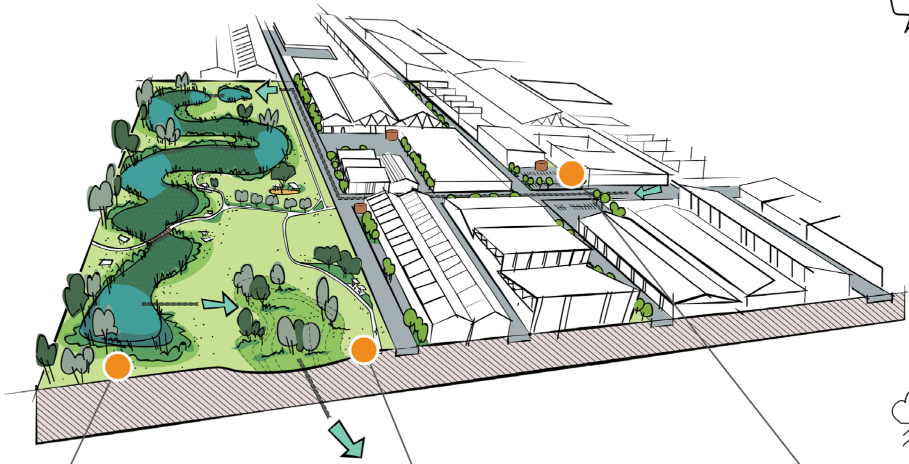
Did you know..

The property owner must ensure that industrial chemical pollutants and other toxic substances do not enter the stormwater system.

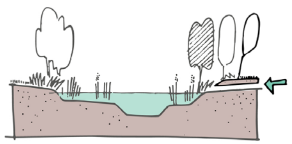
Measures such as bunding and covering or roofing of storage, loading and work areas must be used to minimise the likelihood of these substances entering the stormwater system.

Rainfall

Results based on 700mm MAR.

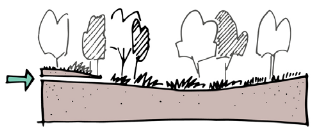


1 Wetland



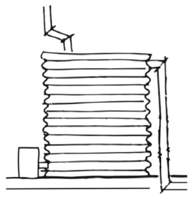
All of the precinct's stormwater runoff is treated with a constructed wetland. The stormwater is filtered by physical and biological processes through a series of shallow, densely-planted areas. The treated water is released to the local waterway.

2 Sponge



A low lying sponge collects the cleaned runoff from the wetland and allows it to slowly soak into the soil and evaporate into the air. Any excess water is released to the local waterway.

3 Rainwater tank



Rainwater from the roof of each lot is stored in a rainwater tank and used for toilet flushing.

Scenario 7: Other areas.
Development type: townhouse infill multi-dwelling.

Stormwater management

Development type:
townhouse infill multi-dwelling

Objectives

Flow management

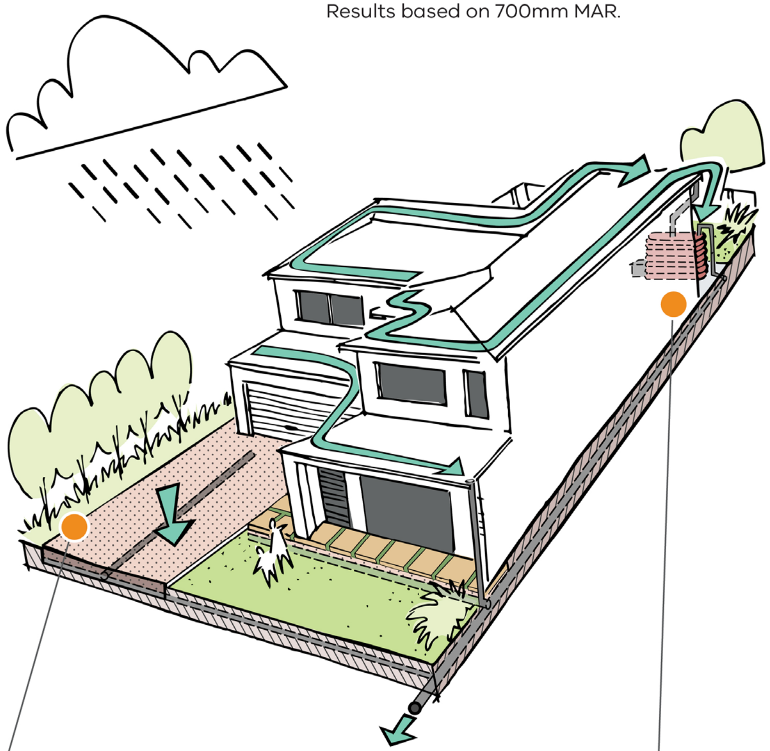
Stormwater pollutant load reductions achieved with treatment

What might be done?

- 80% of the roof area is connected to a 2 kL rainwater tank for non-drinking water uses.
- 100% of paved areas are porous and allow rainwater to soak directly into underlying soils.

Rainfall

Results based on 700mm MAR.



Urban form

A townhouse is constructed as part of a infill development in an inner urban suburb.

Water context

The new infill development generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

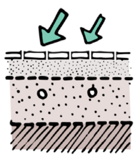
Property owners

New property owners would like to live in an attractive low maintenance environment. Owners reduce water bills with the rainwater tank.

Did you know..

At least 20 per cent of the site should have surfaces that can absorb water – such as garden beds, lawn and other unsealed surfaces (Clause 55.03-4).

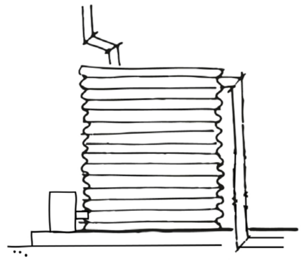
1 Porous pavement



Rainwater falling on porous pavement used on the driveway, paths and patio soak directly into underlying soils.

This limits the generation of stormwater runoff by allowing some of it to soak into the ground. The rest is slowly collected by an underdrain and is released to the local waterway via drains in the street.

2 Rainwater tank



Rainwater from the roof of each lot is stored in a rainwater tank and used for toilet flushing, laundry washing, and watering the garden.

Scenario 8: Other areas.
Development type: townhouse infill multi-dwelling.

Stormwater management

Development type:
townhouse infill multi-dwelling

Objectives

Flow management

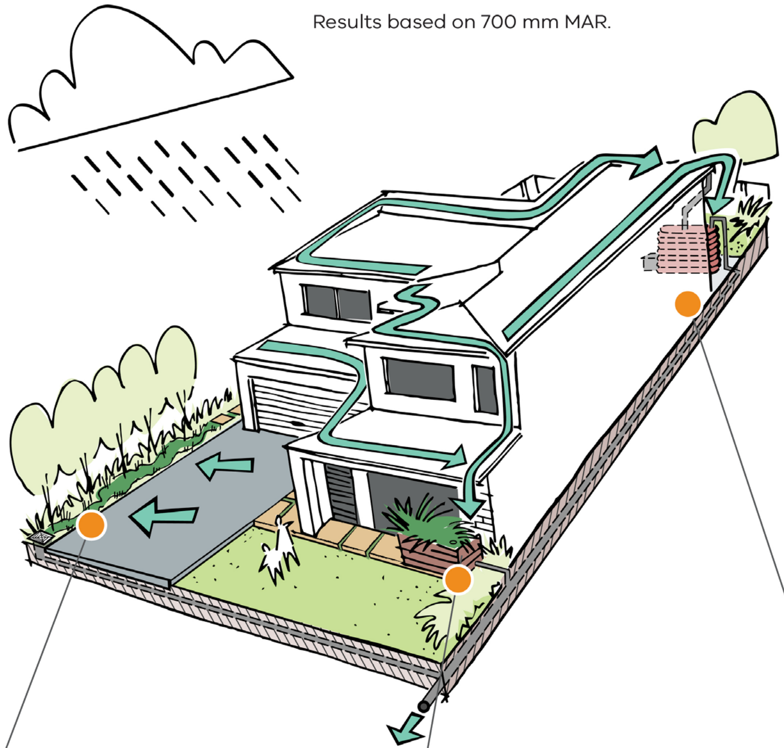
Stormwater pollutant load reductions achieved with treatment

What might be done?

- 60% of the roof area is connected to a 2 kL rainwater tank for non-drinking water uses.
- 40% of the roof is connected to a raised raingarden of 1 m^2. Driveway slopes to a swale of 1 m^2. All other paved surfaces slope to other permeable areas.
- A leaky tank / unlined raingarden system would promote improved infiltration.

Rainfall

Results based on 700 mm MAR.



Urban form

A townhouse is constructed as part of a infill development in an inner urban suburb.

Water context

The new infill development generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

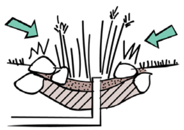
Property owners

New property owners would like to live in an attractive low maintenance environment. Owners reduce water bills with the rainwater tank.

Did you know..

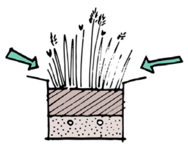
At least 20% of the site should have surfaces that can absorb water – such as garden beds, lawn and other unsealed surfaces (Clause 55.03-4).

1 Swale



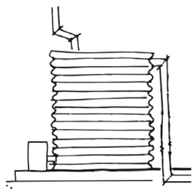
Rainwater falling on the driveway drains to a vegetated swale. This treats stormwater runoff and allows it to soak into the ground. Any excess water is collected by an overflow drain and is released to the local waterway via drains in the street.

2 Raingarden



Rainwater from the roof drains to a raised raingarden which is designed to temporarily hold and filter stormwater. Some water is used by the plants and the rest is collected by an underdrain and is released to the local waterway via the drains in the street.

3 Rainwater tank



Rainwater from the roof of each lot is stored in a rainwater tank and used for toilet flushing, laundry washing, and watering the garden.

Scenario 9: Other areas.
Development type: detached house, infill subdivision.

Stormwater management

Development type:
detached house,
infill subdivision

Objectives

Flow management

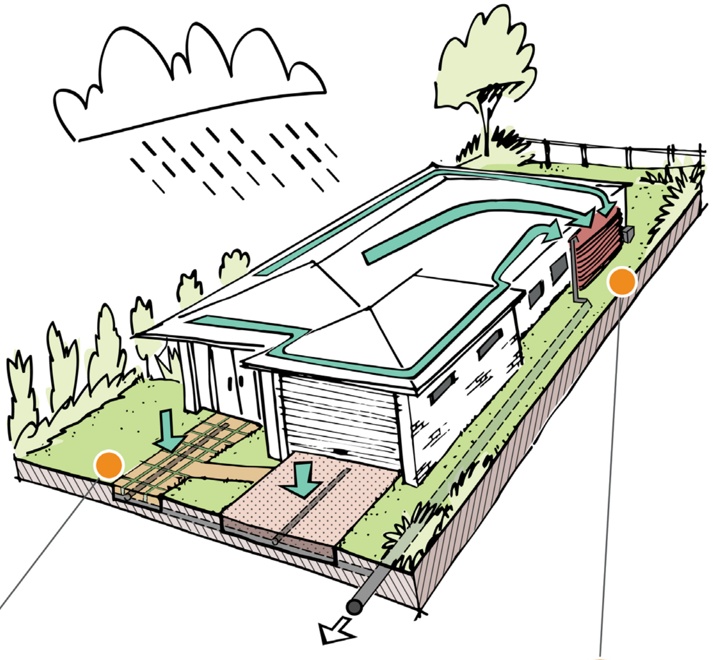
Stormwater pollutant load reductions achieved with treatment

What might be done?

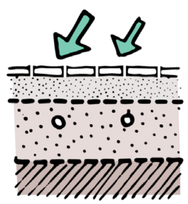
- 100% of the roof area is connected to a 3 kL rainwater tank for non-drinking water uses.
- 100% of paved areas are porous and allow rainwater to soak directly into underlying soils.
- Directing tank overflow into a raingarden would improve evapotranspiration.

Rainfall

Results based on 700 mm MAR.



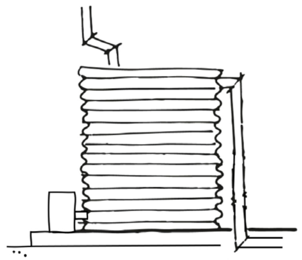
1 Porous pavement



Rainwater falling on porous pavement used on the driveway, paths and patio soak directly into underlying soils.

This limits the generation of stormwater runoff by allowing some of it to soak into the ground. The rest is slowly collected by an underdrain and is released to the local waterway via drains in the street.

2 Rainwater tank



Rainwater from the roof is stored in a rainwater tank and used for toilet flushing, laundry washing, and watering the garden.

Urban form

A detached house is constructed as part of a infill development in an urban suburb.

Water context

The new infill development generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

Property owners

New property owners would like to live in an attractive low maintenance environment. tOwners reduce water bills with the rainwater tank.

Did you know..

There are many different types of porous paving to suit a range of land uses, existing soils types, aesthetic preferences, and price points.

Scenario 10: Other areas.
Development type: detached house, infill subdivision.

Stormwater management

Development type:
detached house,
infill subdivision

Objectives

Flow management

Stormwater pollutant load reductions achieved with treatment

What might be done?

- 60% of the roof area is connected to a 2 kL rainwater tank for non-drinking water uses.
- 40% of the roof area and all paved areas are connected to a 3 m² in-ground raingarden.

Rainfall

Results based on 700 mm MAR.

Urban form

A detached house is constructed as part of a infill development in an urban suburb.

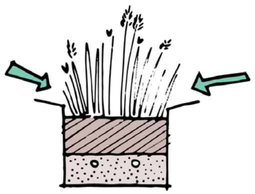
Water context

The new infill development generates increased stormwater flows that can damage local waterways. Capturing and using stormwater will protect your local waterway and enhance the blue and green elements of your development.

Property owners

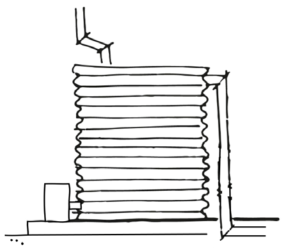
New property owners would like to live in an attractive low maintenance environment. Owners reduce water bills with the rainwater tank.

1 Raingarden



Stormwater runoff from the driveway, paths and roof drains to an unlined, in-ground raingarden in the front garden. The raingarden is designed to temporarily hold and filter stormwater. Some water is used by the plants and some soaks into the underlying soils.
The rest is slowly collected by an underdrain and is released to the local waterway via drains in the street.

2 Rainwater tank



Rainwater from the roof is stored in a rainwater tank and used for toilet flushing, laundry washing, and watering the garden.

4 Glossary

Development

Includes construction or carrying out of works, including building and road construction.

Evapotranspiration

Water that is lost to the atmosphere. That is the sum of evaporation from the land and water surfaces plus transpiration from vegetation.

Infiltrate/filter

Run-off from impervious surfaces that soaks into the ground (infiltrates) or is slowly (mimics infiltration rates of the surrounding soil) released to the drainage system from a stormwater management system (filter).

Flow regime

The range of flows a waterway experiences throughout the seasons and years, which may include baseflows, low flows, high flows, overbank flow and cease to flow (drying) events.

Harvest

Rain that is captured and prevented from entering the waterway.

Impervious

Impermeable; sealed surfaces.

Mean annual impervious run-off

Mean annual volume of surface run-off generated just from impervious surfaces, that is, not from the total area of a development.

Receptor

Something of value that hazards can harm, including humans and the environment. For example, animals, vegetation and waterways. We use 'receptor' and 'receiver' interchangeably in this guide.

Sensitive receivers

Sensitive areas or species from a human or environmental context, which include, but are not limited to:

- social surroundings (houses, hospitals, schools, playgrounds, public amenities)
- waterways, streams, sources of drinking water for people or livestock
- parks and recreational areas
- areas of public interest and cultural significance
- land or water with identified flora, fauna, vegetation, ecosystem or environmental value.

Stormwater

Surface run-off from rain and storm events.

Treatment train

A sequence of treatment controls designed to manage potential impacts to the environment.

Urban

Areas that are well developed for residential, industrial or commercial activities, including roads.

Waterway

Has the same meaning as in the *Water Act 1989* and includes a river, creek, lake or other body of water.

5 Appendix 1

5.1 Identify hazards: why uncontrolled urban stormwater is a hazard

Urban run-off carries a range of pollutants that degrade waterways, including wetlands, beaches and bays. Changes to waterways' flow regimes that urban stormwater run-off causes also damages aquatic ecosystems and reduces amenity by, for example, erosion and litter transport.

Activities that generate urban stormwater

The creation of impervious surfaces – including roads, residential or commercial development –generates urban stormwater. In forested or vegetated catchments, rain or surface water is taken up by trees and plants, or infiltrates into the soil and travels to waterways as subsurface flows. However, in urban catchments impervious surfaces like roofs and roads replace this natural landscape. Rain runs off these surfaces and drains rapidly transport it into rivers, lakes, estuaries and bays. This run-off is called urban stormwater and has the potential to cause harm to human health and the environment.

The impacts of urban development on the water cycle are shown in Figure 3, which compares the urban water cycle in an undeveloped catchment (left) and an urban catchment (right). It shows the relative scale of evaporation, transpiration and surface run-off in each setting. The size of the arrows represents the volumes of water these processes transport.

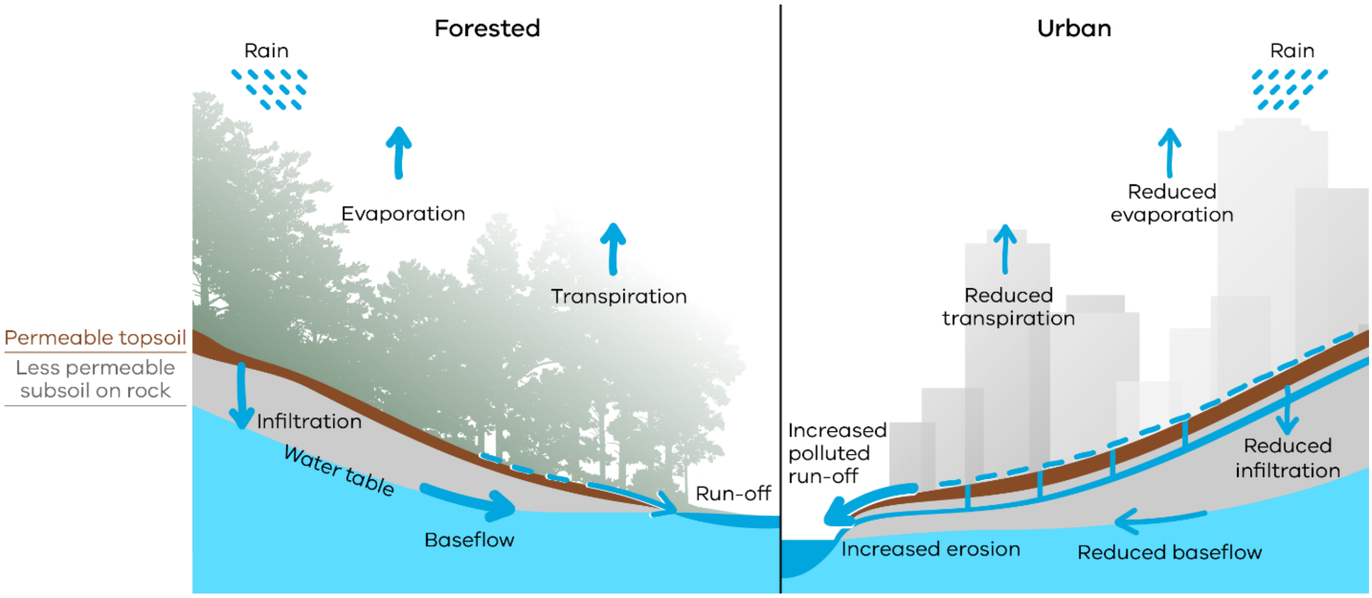


Figure 3: Melbourne Water 2013 (adapted from Walsh et al., 2004).

Potential impacts of urban stormwater discharges

The changes to stormwater volume and quality resulting from urbanisation can have a significant impact on surface waters, including:

- rivers
- streams
- lakes
- estuaries
- wetlands
- bays
- coastal waters.

The increased flows of polluted stormwater can have significant adverse consequences in urbanised areas.

Degradation of urban waterways

Urban stormwater impacts contribute significantly to the degradation of waterway ecologies.[4] Even at low levels of urbanisation, significant adverse impacts can occur when impervious surfaces are connected to urban streams through drainage pipes[5]. These impacts can cause significant harm to aquatic ecosystems, particularly sensitive species of invertebrates, fish, and also platypus.

Modelling suggests that to maintain the ecological values of many relatively healthy streams in Melbourne's growth areas, very high volumes of stormwater have to be retained or reused. In particular, streams in the northern and western growth corridors are in drier parts of the city, and therefore would need higher stormwater flow reductions, as a proportion of total flow volumes, to avoid impacts.

Conventional drainage practices transport stormwater to urban waterways as quickly as possible. The continued use of these practices is expected to cause the degradation of an additional 900 km or more of stream length when Melbourne is developed to its urban growth boundary.[6]

Many of Victoria's regional cities and towns are also growing substantially. There is similar potential for degradation of waterways associated with these centres unless stormwater management practices improve.

Degradation of downstream waterbodies and human health impacts

Uncontrolled stormwater run-off can also harm downstream bays, lakes and coastal waters, and pose a risk of harm to human health. This is because it carries sediments, nutrients, toxicants, pathogens and litter. Examples of common human health risks are increased risk of gastroenteritis and skin irritations.

The *Port Phillip Bay Environmental Management Plan* (https://www.marineandcoasts.vic.gov.au/coastal-programs/port-phillip-bay) emphasises the

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[4] Fletcher, T.J., et al. 2011
[5] Walsh, C. J., et al. 2005
[6] Vietz, G. J., et al. 2014

need to control the levels of pollutants that stormwater carries to the bay to avoid increases in pollutant loads as Victoria's population and urbanisation continue to expand.

Storm events can flush stormwater and other forms of pollution into bays, lakes and streams, making them less safe for swimming, as evidenced by beach advisories in Port Philip Bay following storms.

Catchment management authorities develop regional waterway strategies identifying priority waterways and management actions to reduce the threat of poor water quality.

Economic impacts

There are other adverse impacts associated with urban stormwater's degradation of urban waterways and downstream water bodies. These include economic impacts on tourism, commercial fishing and aquaculture. These impacts are likely to grow along with Victoria's population levels. If current management scenarios continue it is expected there will be:

- greater stormwater-related flooding
- adverse impacts on commercial fisheries and water-related tourism
- reduced public safety
- damage to community infrastructure and private property.

Social impacts

The conventional drainage practices that transport stormwater to urban waterways as quickly as possible result in lost opportunities to use stormwater more productively, for example:

- mitigating the 'urban heat island' effect (discussed below)
- reducing potable water consumption. For example, through open space watering
- supporting greener, more pleasant urban landscapes
- improved health and resilience of urban vegetation - maintaining vegetation in community spaces during extended periods of low rainfall.

The urban heat island effect refers to the general increase in temperatures in urban areas, compared with surrounding rural land.[7] There is evidence that this effect exacerbates the increased mortality and morbidity associated with extreme heat events.[8] Effective use of stormwater has been identified as a way to mitigate the urban heat island effect, including by increasing evapotranspiration and increasing the availability of water to support urban vegetation.[9]

In summary, conventional stormwater management can cause:

- significant harm to receiving environments
- additional financial costs for the community and waterway managers
- waste of a useful resource, in particular for urban green spaces.

Without changes in management practices, these impacts on the environment and human health will continue.

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[7] Arnfield, A. J. 2003.
[8] Alexander, L. V. and Julie M. A. 2009.
[9] Mitchell, V.G., et al. 2008, and Coutts, A. M., et al. 2013.

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