Repairing flow: what to do in the catchment

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CRC for Water Sensitive Cities

Strategy 1. Reduce flow volume

Suitability of strategy: most readily achieved where the catchment is small with relatively low imperviousness (< 10 per cent), such as in peri-urban areas, because there are fewer impervious surfaces and therefore less stormwater that needs to be attenuated. That said, we recommend this strategy be implemented whenever possible across an urban area, because stormwater initiatives associated with infill development can lead to improvements in the long-term.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
1a. Harvest rainwater at the lot scale using rainwater tanks and roof gardens	Local consumption of rainwater reduces stormwater runoff or excessive infiltration rates, such as those associated with the localised infiltration of roof runoff below houses in Perth.	Water tanks most efficiently collect water in climates where rainfall is relatively uniform throughout the year. Green roofs are more effective where plants are not exposed to protracted periods of drought – hence this action is more appropriate for urban areas in coastal eastern Australia than for Perth or Adelaide.	[1-6]	[1, 4, 7-9] See relevant WSUD guidelines and MUSIC tool
1b. Infiltrate stormwater at the lot scale using soakwells and permeable paving. Discourage the use of fake lawn	Local infiltration of roof, driveway and garden runoff reduces the volume of water entering stormwater drainage.	Stormwater infiltration is most effective where soils are highly permeable (e.g. sand).	[1-3, 5]	[8, 10] See relevant WSUD guidelines and MUSIC tool
1c. Infiltrate stormwater at the street scale using rain gardens, swales and tree pits	As per action 1b.	As per action 1b.	[1, 3, 5, 11, 12]	[8, 13] See relevant WSUD guidelines and MUSIC tool
1d. Increase overland flow paths between stormwater sources and urban drainage	Extending the flow path between a stormwater source (e.g. a road) and stormwater drainage (e.g. a pipe or a creekline) increases the opportunity for infiltration. This can be done in many ways, such as using flush-kerbing or a kerbless design on the road adjacent to a waterway, or by terminating stormwater pipes into riparian swales rather than directly into the waterway.	Where soils are permeable (clay, sand, gravel). Where the land slope is moderate to low. Where there is enough overland distance for infiltration. It can still be achieved when permeability is low and slopes are high – but greater distances are needed for infiltration.	[14]	

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
1e. Remove (daylight) pipes and remove channel hard-lining	Stormwater pipes and hard-lined drainage channels prevent the infiltration of stormwater. Removing these hard-linings increases the potential for water to infiltrate along its flow path.	Most sites, particularly where the substrate below the hard-lined channel is highly permeable (e.g. sand, gravel).		
1f. Infiltrate stormwater at the precinct scale using biofiltration basins	Infiltrating stormwater at the precinct scale reduces the volume of stormwater entering downstream receiving waters during wet weather, and recharges local groundwater to improve flow during dry periods.	Most catchments, particularly where soils are highly permeable (sand, sandy/clay mixture).	[2, 3, 5, 12]	[8, 10] See relevant WSUD guidelines and MUSIC tool
1g. Detain stormwater at the precinct scale using detention basins	Detaining stormwater in clay-lined basins reduces stormwater volume by trapping and evaporating stormwater.	Most catchments, particularly where soils are low permeability (clay) and evaporative demand is high due to the climate and/or plant biomass. Where basins have smaller multi-level offtakes.	[15, 16]	See relevant WSUD guidelines and MUSIC tool
1h. Strategically place biofiltration basins and stormwater wetlands in locations that receive the most stormwater	Not all infiltration basins are as effective as one another.	Where space permits the placement of the basin.	[17]	
1i. Redirect or retrofit subsurface drainage so it empties into wetland basins or riparian swales – not directly into waterways (see also action 5m)	Subsurface drainage may also deliver stormwater inputs into the stream. While subsurface drainage water cannot be infiltrated at the site where it is gathered, it can be infiltrated on the edge of a riparian buffer (i.e. swale) or into a low-lying wetland.	Where the riparian swale/ wetland has highly permeable soils. Where some level of geologic disconnection occurs between the site of groundwater collection (drain input) and the swale/wetland – otherwise the drainage system will fail.		

Strategy 2. Reduce the velocity of instream flow, particularly peak flows

Suitability of strategy: as per Strategy 1, but see action 2b for the specific suitability of this strategy.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
2a. Harvest, infiltrate and detain stormwater. See all actions in Strategy 1	Minimising the volume and timing of stormwater inputs into the waterway helps reduce the velocity of instream flows.	See Strategy 1 this factsheet.	See Strategy 1	See Strategy 1
2b. Use existing dams and weirs to trap water	Man-made structures such as weirs can be used to trap flashy urban flows and moderate outflow spikes, reducing the velocity of downstream flows.	Where there are significant inputs of stormwater upstream of the dam or weir and relatively few stormwater inputs downstream of the weir – at least for some way. Where the regulating structure has capacity to store high flows behind it. Not suitable where dams and weirs act as barriers to biota (e.g fish). This action does NOT advocate for the creation of new dams or weirs.		Few instructions, but flows need to be slowly released during dry periods to create storage room to trap fast-moving flows when they occur. Storages should also be managed to reinstate natural components of the flow regime, such as minimum flows and freshes.

Strategy 3. Reduce the frequency of flow pulses

Suitability of strategy: as per Strategy 1.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
3a. Harvest, infiltrate, detain and disconnect stormwater. See all actions in Strategy 1 this factsheet	Harvesting, infiltrating and disconnecting stormwater across the catchment will reduce the likelihood that small rain events turn into instream flow pulses.	See all actions in Strategy 1.	See all actions in Strategy 1	See all actions in Strategy 1

Strategy 4. Slow the rate of flow rise and fall

Suitability of strategy: as per Strategy 1.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
4a. Infiltrate, detain and disconnect stormwater.	Infiltrating, detaining and disconnecting stormwater across the catchment increases the time for water to travel from the catchment to the stream via surface or subsurface pathways, which will slow the instream rate of flow rise and fall.	See Strategy 1, actions 1b–1h.	See Strategy 1, actions 1b–1h	See Strategy 1, actions 1b–1h
4b. Use existing dams and weirs to trap water – as per action 2b this factsheet	Trapping excess urban flows behind a dam or weir and slowly releasing it will moderate the speed of flow rise and fall in the downstream waterway.	Where there are significant inputs of stormwater upstream of the dam or weir and relatively few stormwater inputs downstream of the weir – at least for some way. Where the regulating structure has capacity to store high flows behind it.		Few instructions, but see action 2b this factsheet

Strategy 5. Repair stream baseflow

Suitability of strategy: The height of the local watertable is likely to be controlled by larger off-site processes; hence actions to repair baseflow at the site scale are likely to be less effective than catchment-scale strategies.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
Where urbanisation has led to a decrease in baseflow				
5a. Infiltrate stormwater throughout the catchment – see Strategy 1, actions 1b, 1c, 1d, 1f and 1g this factsheet	Stormwater runoff over hard surfaces and its direct piping to streams/drains reduces natural infiltration, lowering the local shallow watertable and reducing baseflow.	Where infiltration occurs or is focused on groundwater recharge areas.	[18-20]	See actions 1b–1d, 1f and 1g
5b. Repair leaks from wastewater and storm drainage infrastructure	Old infrastructure (sewers, stormwater drains, water pipes) that has cracked can drain the local watertable and reduce baseflow. Urban infrastructure (e.g. sewer trenches) can also intercept infiltrated water and may affect sub-surface flow paths to waterways.	Where significant leakage of groundwater into piped infrastructure occurs (old infrastructure).	[18]	

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Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
5c. Reduce groundwater pumping	Pumping of groundwater for residential use (e.g. bores) or industrial use can cause the watertable to fall, hence decrease baseflow.	When pumping occurs predominantly during low-flow periods. When bores are close to the stream. When large volumes of water are being removed.	[18]	
5d. Buy back, limit or suspend water pumping from the waterway	Water pumping out of the waterway reduces instream flow and should be restricted or suspended during periods of extreme low flow.	Where legislative powers exist to suspend water abstraction. Where the sites of water abstraction are located at or upstream of the river reaches experiencing reduced baseflow. Where critical flow refuges have been identified.	[21]	
5e. Use environmental water releases during pronounced low-flow periods	A controlled water release from an upstream dam/weir or large detention basin can be used to supplement low flows, creating a more natural baseflow.	Where a flow regulating structure (dam, weir) exists upstream. Where water pipelines run alongside the waterway so that scour releases can easily deliver water.	[21-24]	[21, 25, 26]
5f. Controlled water release	The slow release of water (i.e. treated effluent) from a wastewater discharge plant can supplement low baseflows.	Where wastewater treatment plants discharge water into the catchment – especially catchments where the discharge point is high in the catchment. This should be done with caution and appropriate environment risk assessments as it could cause unintended impacts.	[27, 28]	
5g. Use the periodic release of flushing flows to reduce the clogging of coarse bed sediments	Flushing flows from dams/weirs, water supply pipes, wastewater treatment plants or fire hydrants can remove fine sediments that are preventing subsurface water (groundwater) from entering the stream. If upstream flow regulating structures are available they can be used to send down flushing flows to improve local groundwater input.	Where the site has silt deposited over naturally porous bed material (e.g. gravel, coarse sand). Where an upstream water release point is available and produces enough flow to move sediment. Where flows can move fine sediment onto the floodplain rather than just transporting it downstream.	[29, 30]	
5h. Avoid urban development in areas with naturally shallow groundwater	Waterways that run through areas with naturally shallow groundwater – such as wetlands, swampland or floodplains – will be more affected by falling watertables associated with urbanisation. For this reason, development should not occur in these areas.	All areas		
Where urbanisation has led to an increase in baseflow (e.g. south-eastern Perth)				
5i. Harvest rainwater at the lot scale using rainwater tanks and roof gardens	Stormwater harvesting for domestic use reduces the amount of water available to recharge the groundwater.	As per action 1a.	[18, 19, 31, 32]	As per action 1a

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
5j. Lined bioretention with controlled outlet, or distributed 'trickle tanks'	Controlled infiltration from detention wetlands can be used to ensure infiltration takes place at suitable times of the year to create appropriate baseflow.	Where detention basins sit in groundwater recharge areas.	[18]	[33]
5k. Catchment-wide planting of native trees	Tree planting will promote evapotranspiration of groundwater, reducing watertable height and unnaturally high baseflow.	Where trees have long-enough roots to reach the shallow watertable. Where evaporative demand on trees is high (e.g. warm, dry conditions).	[18]	
5l. Irrigation using stormwater up to, but not above, evaporative demand	Watering residential gardens or playing fields using just enough stormwater, such that the vast majority of water is transpired, will minimise groundwater recharge.	Where automated smart technology is available to link watering with climatic conditions. Where information on plant water use is known.	[18, 32]	
5m. Irrigation using pumped groundwater during periods of high evaporative demand	None known	Areas that receive the majority of annual rainfall during the cool months.	[18, 34]	
5n. Treat and reuse local groundwater for drinking rather than import water into the catchment	Importing water from outside the catchment brings in excess water that can raise the watertable – particularly where drinking water is used to irrigate residential gardens. Treating and using local groundwater can repair the natural water balance.	Where groundwater treatment technology is available and economically viable.	[18]	Not applicable
5o. Repair leaks from water supply or wastewater infrastructure	Leaks from water supply pipes or wastewater infrastructure can recharge local groundwater. Efforts should be made to reduce this unnatural input of water.	Where significant leakage of groundwater into piped infrastructure occurs (old infrastructure).	[18]	
5p. Avoid urban development in areas with naturally shallow groundwater	Waterways that run through areas with naturally shallow groundwater – such as wetlands, swampland or floodplains – will be more affected by rising watertables associated with urbanisation. For this reason, standard development should not occur in these areas. Alternative development, such as houses on stilts, may be appropriate.	All areas		

Supporting documents

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Other useful tools

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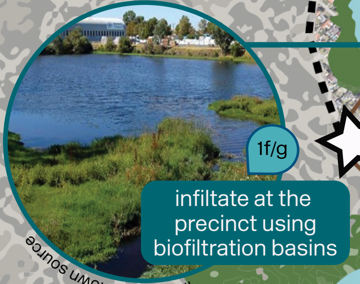
- Strategy 1. Reduce flow volume
- Strategy 2. Reduce the velocity of instream flow, particularly peak flows
- Strategy 3. Reduce the frequency of flow pulses
- Strategy 4. Slow the rate of flow rise & fall
- Strategy 5. Repair stream baseflowrise



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