



Department of Biodiversity,
Conservation and Attractions



**PARKS AND
WILDLIFE
SERVICE**

Bannister Creek Catchment Local Water Quality Improvement Plan Review Summary

December 2019



Acknowledgements

Thank you to the Cities of Canning and Gosnells, the Bannister Creek Catchment Group and the South East Regional Centre for Urban Landcare (SERCUL) for their contributions to the review of the Bannister Creek Catchment Water Quality Improvement Plan (WQIP).

Purpose and use of this document

The Department of Biodiversity, Conservation and Attractions (DBCA) Parks and Wildlife Service, with the support of the organisations noted above, has reviewed the implementation of the Bannister Creek Catchment WQIP. The purpose of this document is to summarise that review and inform future updates of the Bannister Creek Catchment WQIP. The Swan Canning Water Quality Improvement Plan is proposed to be reviewed by 2021 and the updated catchment modelling will be used to inform updates of the local WQIPs. It is intended that these documents will be used by partner organisations that will continue to have a role in implementing the WQIPs.

Front cover photo: Bannister Creek Living Stream, June 2016. Photo – SERCUL.

Local Water Quality Improvement Plans (WQIPs)

The Department of Biodiversity, Conservation and Attractions (DBCA) Parks and Wildlife Service works to reduce nutrients and other contaminants entering the Swan and Canning rivers.

DBCA (and previously the Swan River Trust) developed and invested in the implementation of local WQIPs. The WQIPs were designed to provide stakeholders with a mechanism to prioritise recommendations and resources and seek funding to improve water quality in catchments contributing the greatest amount of nutrients and contaminants.

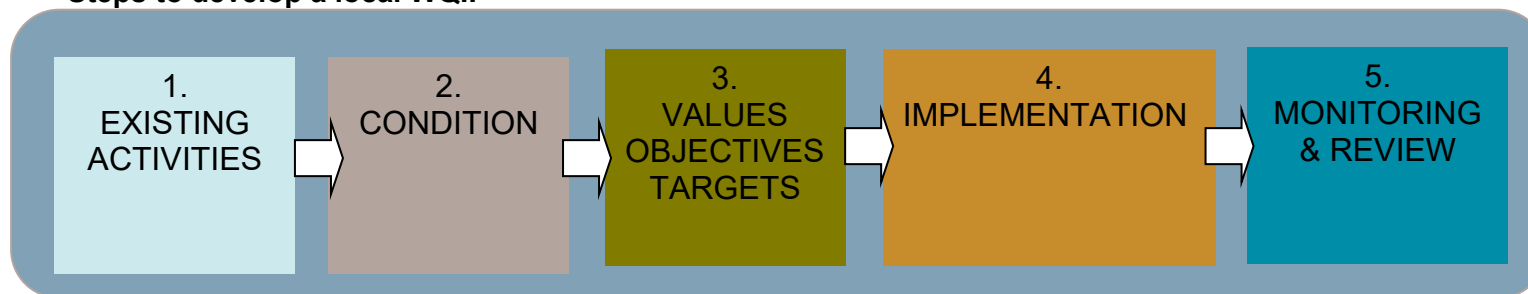
WQIP implementation adopts a treatment train approach with actions categorised by the following stages in the pathway of nutrients and non-nutrients from the source to the discharge point:

1. **Prevention** (Land use planning)
2. **Minimisation** (Ecoefficiency)
3. **Reduction** (Source control)
4. **Amelioration** (Conveyance and transmission)
5. **Treatment – Reuse – Disposal**

Water Quality Improvement Plans:

- identify water quality issues and hot spots;
- identify environmental values of water bodies and water quality objectives required to protect the values; and
- identify and commit to a set of cost-effective management measures to achieve and maintain those values and objectives.

Steps to develop a local WQIP



Local WQIP Review

Ten local WQIPs were developed between 2008 and 2012 with strong involvement of key stakeholders. Implementation of the WQIPs is ongoing, however, many of the actions are complete or require review. There are also actions that are still underway and others that will require an ongoing commitment and additional resources to maintain and improve water quality. This review of the Bannister Brook Catchment WQIP is based on achievements and stakeholder participation.

There has been significant investment allocated to on-ground nutrient interventions in the Bannister Creek Catchment through the completion of the Bannister Creek Living Stream project and the restoration of upstream waterways such as Vellgrove, Hawksberry and the inlet basin for Tom Bateman Wetland. The water quality monitoring of Bannister Creek's living streams project provides evidence that these interventions are improving water quality in this catchment. Monitoring the effects of non-structural WQIP actions, such as community education and behaviour change programs, and changes to local government policies and procedures, on catchment water quality is more complicated. Therefore, statistically linking WQIP actions to changes in overall catchment water quality is not attempted at this stage. Variations in annual flow, changes in catchment land uses, and the long timeframes required for some catchment management practices affecting water quality at the catchment discharge point are other factors that can contribute to discharge water quality.

The Swan Canning River Protection Strategy supports the development and implementation of the Swan Canning and local WQIPs as an action to achieve nutrient load reduction targets and provides the framework for DBCA to update local WQIPs. This review will determine the local WQIPs to be updated based on the level of support from key stakeholders and the need for further water quality improvement. Modelling of water quality improvement targets is proposed as part of an update of the Swan Canning WQIP by 2021.

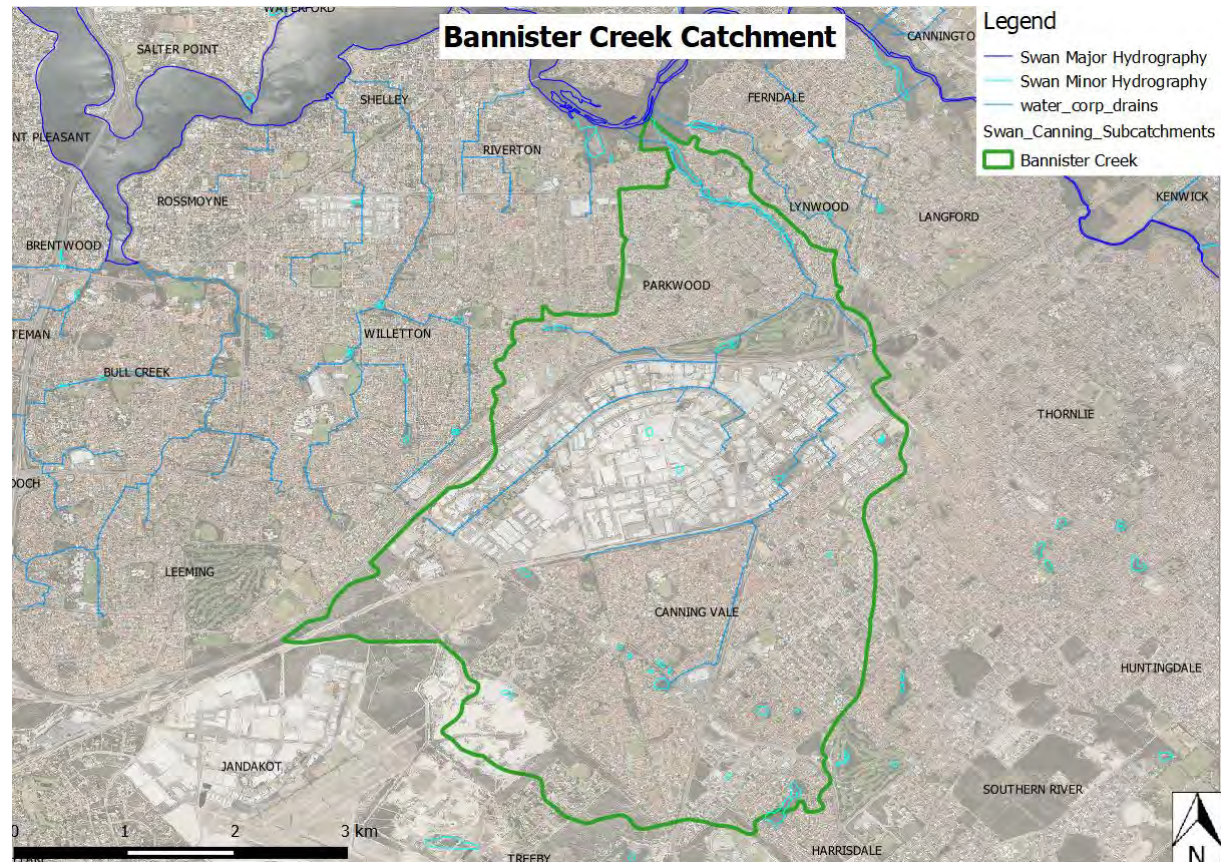
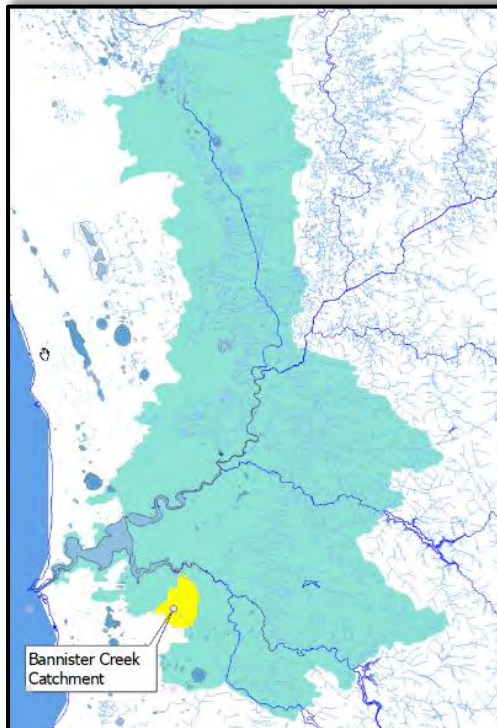


Local WQIP front cover for illustration purposes only

Bannister Creek Catchment

The Bannister Creek Catchment is a large urban catchment covering approximately 23-square kilometres with little remnant vegetation remaining due to clearing for residential and industrial purposes. The Bannister Creek catchment is a highly modified drainage system comprising open and piped drains, and compensating basins. The network is within the areas of Parkwood, Lynwood and Canning Vale. A small portion of the catchment also falls within the Jandakot Underground Water Pollution Control Area. The drains flow into Bannister Creek and enter the Canning River downstream of the Kent Street Weir.

The Water Corporation manages the main drains for flood protection of the commercial and residential areas. Local government managed drains feed into the Water Corporation main drains. Many of the compensating basins connected to the main drains are within parks and recreation reserves managed by the local government. The soils in the catchment are predominately Bassendean and Southern River sands. Surface water runoff and groundwater supply the drainage network with a base flow for the majority of the year.



Bannister Creek WQIP Review Summary

The Bannister Creek WQIP has a total of 28 actions; 100 percent of those have been addressed: including 15 that have been completed or are on track to completion, and 13 that are implemented but will require ongoing commitment or further investment for catchment-wide implementation. (see Appendix 1 for details).

Considerable progress in improved catchment management has occurred in the Bannister Creek Catchment since the development of the WQIP. Major on-ground drainage improvement projects have been completed with the Bannister Creek Urban Waterway Renewal (UWR) project and the Bannister Creek Final Stage Project completing the transformation of Bannister Creek into a living stream. Additional on ground works include the restoration of the inlet basin at Tom Bateman Wetland and the maturation of the restoration projects at Hawksberry Lake and Vellgrove swale.

Intensive water quality monitoring efforts have resolved the long-standing issue of foaming events within Bannister Creek. A persistent effort by the Bannister Creek Catchment Group and the South East Regional Centre for Urban Landcare (SERCUL) with ongoing support provided by the City of Canning, Water Corporation and Department of Water and Environmental Regulation (DWER) led to a two-year intensive monitoring program focusing on pH fluctuations in the stormwater coming from the Canning Vale Industrial Area. The results of this program have enabled DWER to work directly with industry in the area to improve their systems.

The City of Canning participated in the *Light Industry Audit Program* in partnership with DWER and DBCA to undertake audits of industry within the Canning Vale Industrial Area. The program has led to the City engaging an officer to continue the program in liaison with DWER.

The revision of the Bannister Creek Management Plan provides a direction for priorities within the catchment. The City of Canning is taking a leading role through the adoption of an Urban Forest Strategy, a Local Biodiversity Strategy, a Waterway Management Strategy, an Environmental Management Strategy and as a participant in the Cooperative Research Centre (CRC) for Water Sensitive Cities (WSC) setting a positive outlook for the City's future direction in the catchment.

The development of the Tom Bateman Management Plan provided the direction and priorities for the management of this wetland within the upper catchment. The City of Gosnells has adopted the recommendations, implementing a turf management program for the ovals within the Tom Bateman sporting complex adjacent to the reserve.

The final stages of the restoration of Bannister Creek have been completed, transforming this waterway from a trapezoidal drain to a living stream. This is the culmination of 20 years of effort by the Bannister Creek Catchment Group with support from many groups and organisations. Bannister Creek is a beautiful ecologically functioning system providing habitat for many species, improving water quality, adding measurable financial value to residential property in the area and has become a valued asset by the local residents.

Major projects:

- Completion of the restoration of Bannister Creek from a trapezoidal drain to a living stream through the implementation of stages two (UWR project) and three (final stage).
- Tom Bateman inlet redesign and restoration project in partnership with DBCA.
- Whaleback lake data logger monitoring surfactant progressing to the isolation of the issue from within the Canning Vale Industrial Area, in partnership with SERCUL, the City of Canning and DWER.
- 2015-17 Light Industry Audit Program - the City of Canning is participating in the partnership program with DWER and DBCA.

WQIP Review Summary							
WQIP catchment	Release date	Total number actions	of	Actions fully achieved or on track	Actions implemented ongoing commitment required	Actions with little or no progress	% of actions being implemented
Bannister Creek	March 2011	28		15	13	0	100%

Summary of investment in WQIP (from commencement of WQIP in March 2008 to June 2018)				
	DBCA investment	Other State & Federal Government investment	Local Government and Community	Total Investment (approximate)
Investment in Bannister Creek WQIP projects	\$274,167	\$1,474,444	\$447,737	\$2,196,348

Future priorities and actions – Bannister Creek Catchment

- Relevant government and non-government organisations work collaboratively to implement the actions of the Swan Canning River Protection Strategy.
- Continuation of the Light Industry Audits within the Canning Vale Industrial Area.
- Restoration of basins within the upper catchment.
- Ensure all development proposals are in line with the State Government's *Waterwise Perth Action Plan* and *Vision and Transition Strategy for Water Sensitive Greater Perth Implementation Plan 2019-2021*.
- Ensure that all local government planning schemes and policies support the *Waterwise Perth Action Plan* and *Vision and Transition Strategy for Water Sensitive Greater Perth Implementation Plan 2019-2021*.
- Land-use planning decisions to ensure the State Planning Policy 2.10 (or equivalent) requirement for developers to maintain or improve water quality is upheld.
- Ensure all new developments are connected to sewer and aim for infill sewer to all existing urban areas.
- Continue to look for and take opportunities to improve water quality, habitat, and community benefit of waterways and vegetated areas in the catchment.
- Investigate projects to reduce gross pollutants such as litter entering Bannister Creek and the Canning River.
- Discourage the planting of deciduous trees near drainage infrastructure to reduce organic loads and excessive nutrients entering stormwater.

Bannister Creek case study: Bannister Creek Living Stream (Stage 2 – Urban Waterways Renewal project)

The restoration of Bannister Creek has been the culmination of 20 years of effort by the Bannister Creek Catchment Group with over 2 km of the creek transformed from a fast flowing, channelised drainage system to a functional living stream. The project was undertaken in three large stages, as funding became available. Stage 2 of the creek restoration was the *Urban Waterways Renewal* (UWR) project between the Acacia Place weir in Lynwood and Hybanthus Road in Ferndale. This section was funded through a \$1,186,500 investment by the Australian Government through *Water for the Future – National Water Security Plan for Cities and Towns* program. The project was a collaborative effort involving the Australian Government, State Agencies, local government, community NRM organisations, Friends groups and volunteer individuals.

Bannister Creek was deeply incised and disconnected from its flood plain. The banks were severely eroding, threatening infrastructure with limited access along one side of the creek line. The flood plains were infested with Blackberry (*Rubus* sp), Giant reed (*Arundo donax*), Morning Glory (*Ipomoea indica*), Chilean Willows (*Salix humboldtiana*) and numerous other weeds. The project involved 1.2 km of channel management with a total restoration area of 6 Ha.

The Bannister Creek UWR project removed severe weed infestations, realigned a section of the channel, recontoured the banks, removed sediment, installed six rocky riffles and revegetated the banks and flood plain. A total of 131,147 plants were installed within the project area. Most of this planting effort was undertaken by community volunteers, school groups, corporate groups and the Bannister Creek Catchment Group. With community engagement being one of the objectives of the program, a total of 583 individuals participated in the project contributing 2,677 volunteer hours.

The project involved surveys and monitoring of water quality, vegetation, animals and insects. This information forms a baseline data set with the potential to be revisited as the project establishes to improve the understanding of these types of projects over time.

Bannister Creek flows through this system engaging a recreated floodplain covered with native riparian vegetation. The capacity of the system has been increased with the velocity of the water being significantly reduced. The banks have been stabilised and native fauna has repopulated the creek line with marron, turtles, and a range of native birds regularly sighted.

The reserve has become an asset with residents regularly utilising the reserve for recreation, exercise or just sitting to enjoy the water flowing past. Studies undertaken by the CRC for WSC have demonstrated the ecological and amenity benefits of the Bannister Creek project which has also led to an increase in the nearby residential property values. The Bannister Creek project has become a reference project for living streams within an urban environment and demonstrates the potential multiple benefits that can be achieved within stormwater conveyance infrastructure.



Bannister Creek UWR project, 2019

Bannister Creek Urban Waterways Renewal Project



Before restoration, 2011



Stream restoration, 2019

Total length of living stream:

1.2 km

Total area of restoration:

6 Ha

Number of seedlings planted:

131,147

Project partners:

Bannister Creek Catchment Group, SERCUL, City of Canning, DWER, Water Corporation and community volunteers

Cost of project construction:

\$1,186,500

Awards and presentations:

UWR project finalist in the 2011 WA Landcare Awards

UWR oral and poster presentation at 2012 River Symposium in Melbourne

UWR site tours, oral and poster presentation at 2012 International Wetlands Conference and Society of Ecological Restoration Conference at Murdoch University.

Appendix 1: Bannister Creek Catchment WQIP - Action Review

Tally and explanation of WQIP actions review categories – Bannister Creek			
Total number of actions	28	Percentage	Explanation
Action achieved	4	14.3%	The action has been completely fulfilled.
Action on track	11	39.3%	Significant progress has been made and the action is likely to be completed in the near future.
Ongoing action	9	32.1%	This action will require ongoing commitment or maintenance.
Projects/Programs implemented	4	14.3%	There are projects and programs in place that address this action, however significantly more investment is required to enable catchment wide implementation.
Little or no progress	0	0%	Little or no progress has been made on this action. This can be for various reasons.
No longer relevant or viable	0	0%	Can be for various reasons.
Summary categories			
Total number of actions	28	Percentage	Explanation
Action fully achieved or on track to being achieved	15	53.6%	First two categories above combined.
Action implemented but ongoing commitment required	13	46.4%	Second two categories above combined.
Little or no progress	0	0%	Last two categories above combined.

Bannister Creek Catchment WQIP – Action Review							
Treatment train approach	Management strategies	Implementation actions	Lead organisations	Supporting partners	Timing	Status comments	Review category
1. Prevention	1.1. Review urban and infrastructure planning to incorporate best management practices	1.1.1 Integrate the use of DWER predictive modelling and decision support tools to determine priority sites to reduce nutrient exports and improve water flow management (AH)	City of Canning (CoC), City of Gosnells (CoG), Department of Planning, Lands and Heritage (DPLH)	Department of Biodiversity, Conservation and Attractions (DBCA), Department of Water and Environmental Regulation (DWER), Main Roads WA, South East Regional Centre for Urban Landcare (SERCUL), Western Australian Local Government Association (WALGA)	Starting 2010/2011	<ul style="list-style-type: none"> Modelling was used to determine priority sub-catchments for nutrient reductions and key strategies in the development of the Swan Canning Water Quality Improvement Plan (WQIP). Through DBCA the hydrological and nutrient re-modelling of the Swan Canning Catchment and Estuary has commenced and is planned to be completed by 2021. The CoC drainage design team are trained in the use of DWER's Urban Nutrient Decision Outcomes (UNDO) tool. 	
		1.1.2 Ensure water sensitive urban design is part of all coordinated redevelopment structure plans consistent with the requirements of the Better Urban Water Management,				<ul style="list-style-type: none"> CoC has developed a new local planning policy, the Incentive-Based Development Assessment Policy. This Policy includes water efficiency and water sensitive urban design incentives for single houses, grouped dwellings, multiple dwellings and mixed development. The Incentive-Based Development Assessment Policy will encourage sustainable development that goes beyond minimum compliance. This policy was approved by Council at the October 2019 Ordinary Council Meeting. The policy will be implemented once Scheme LPS42 is approved by the Western Australian Planning Commission. CoC is a participant in the CRC for Water Sensitive Cities (WSC) and has been benchmarked using the WSC Index. This will help the City focus investment on areas most needing improvement in the transition to becoming a water sensitive 	

		State Planning Policy 2.9 Water Resources and local environmental conditions (AH)				<p>city. The new CoC town centre redevelopment project planning incorporates Water Sensitive Urban Design (WSUD).</p> <ul style="list-style-type: none"> • CoG states that the local government (LG) officers need to have policies to rely on when regulating the developers (preferentially state government policies as these are seen as having more authority than LG policies). Specific design criteria required for developers to refer to and LG officers to use in planning assessments. • It is now a standard approach for consultants to refer to the Better Urban Water Management (BUWM) framework for new developments. Consideration of water quality outcomes in a development are generally a requirement of the BUWM framework. The BUWM does not apply to brownfield or infill developments. However, if a large-scale development was proposed covering a large area of an industrial estate, then the BUWM would apply. 	
		1.1.3 Identify and map opportunities to reduce groundwater interception, increase biofiltration treatment in open drain sections of the system and identify potential acid sulphate soils (AH)**	CoC, CoG	DBCA, DPLH, DWER, Main Roads, SERCUL, WALGA	Starting 2010/2011	<ul style="list-style-type: none"> • State NRM project (2012-15) within Southern River investigated soil amendments around sub soil pipes within new developments with shallow ground water. The soil around the pipes was treated with a 10% mix of Iron Man Gypsum. •The trial was found to be successful in reducing phosphate export from the development area within the first six months of monitoring (noting that data from a longer time period is required). • CoG contracts water quality monitoring and interpretation services which should provide management recommendations. • The CoC water quality monitoring program identifies high priority areas within the catchment with recommendations for areas of intervention. • The CoC has completed and endorsed a Local Biodiversity Strategy. This strategy identifies priority areas within the City which may also be suitable in contributing to the outcomes of this action. 	
		1.1.4 Develop and implement standard development	CoC, CoG	DBCA, DWER, SERCUL	Starting 2010/2011	<ul style="list-style-type: none"> • BUWM document from DWER, is now a standard reference for LGs, consultants and developers. The BUWM document however applies primarily to new development in greenfield sites, as such existing or brownfield development may not 	

		conditions for small to medium sized enterprises in industrial areas to incorporate appropriate wastewater treatment and disposal (AH)**				<p>comply with the BUWM. In the absence of a state policy on this, there is still a need for LGs to develop a local government policy on this matter.</p> <ul style="list-style-type: none"> • The Light Industry Audit program works with businesses to improve their facility's in order to comply with current BMP. • The CoC has standard conditions which are being applied to new commercial and industrial premises to install a bin/equipment wash down facility that is connected to sewer, so as to prevent unauthorised disposal to stormwater. Car wash bay conditions have also been standardised. • A possible new action may be around ensuring planning officers know what to look for in the Development Application (DA) stage where industrial premises are proposing stormwater connections, washdown bays and siting workshops etc. around a site. • A recognised difficulty with this action is that although the premise is conditioned, the tenants and the business operations change regularly. Given this the direct engagement approach, such as through the light industry program, is required. 	
		1.1.5 Review the catchment boundary and update the dataset (SF)**	DBCA	CoC, CoG, SERCUL	Starting 2010/2011	Completed. The catchment boundary now incorporates the confluence with the Canning River and Tom Bateman Reserve to enable investment in these key areas.	
	1.2. Application of water sensitive urban design (WSUD) practices	1.2.1 Develop a policy to ensure existing local government open drains remain open systems and where possible implement living	CoC, CoG	DWER, SERCUL	Starting 2010/2011	<ul style="list-style-type: none"> • The Stormwater Management Manual has been developed and is updated by DWER. This provides information on the implementation of WSUD in open drains with the aim to implement living streams where appropriate. • The CoC has developed a Water Management Strategy and an Environmental Management Strategy both of which address considerations for local government open drains; https://www.canning.wa.gov.au/Community/Parks-and-Conservation/Conservation-and-Environment/Water-Management-Strategy 	

		stream principles (AH)				https://www.canning.wa.gov.au/Community/Parks-and-Conservation/Conservation-and-Environment/Environmental-Management-Strategy <ul style="list-style-type: none"> • The CoC Water Management Strategy is currently under review, with the intention of using this document as the vehicle to transition CoC towards its 'Vision for a Water Sensitive Canning'. • Although there is no policy, the current approach by the CoG is an informal collaboration between the drainage maintenance engineering team and the environment team. The informal approach to managing open drainage assets is for conveyance maintenance and vegetation filtration by maintaining sections of vegetation within the drainage line keeping the remaining sections of the drainage lines open. 	
		1.2.2 Ensure WSUD accommodates other uses, functions (e.g. recreational use) and existing environmental values of the particular location to facilitate safe use for the whole community (RA, CS)			Starting 2010/2011	<ul style="list-style-type: none"> • Incorporated into the Bannister Creek UWR project and the Bannister Creek Reserve Management Plan (BCRMP). The management table for the BCRMP has been endorsed by the CoC. • Incorporated into the Tom Bateman Wetland Management Plan. • The Drainage for Liveability Partnership between Water Corporation (WC) and DWER provides an opportunity to review WC assets and capital works program to identify new drainage improvement opportunities that may not have been an option previously. 	
		1.2.3 Include Stormwater Management Manual WSUD principles in	CoC, CoG, Main Roads	DWER, SERCUL	Starting 2010/2011	<ul style="list-style-type: none"> • Main Roads became a member of the Sediment Task Force in 2014 and remains a proactive member of the group. Case Study 1 in the Sediment Task Force document <i>Taking Action to Control Sediment</i>, outlines the steps undertaken by Main Roads: https://www.perthnrm.com/wp- 	

		future road capital works programs (AH)				content/uploads/2016/08/17489-Perth-NRM-Sediment-Task-Force WEB1.pdf	
	1.3. Continue to monitor water quality	1.3.1 Seek funding to continue and extend the water monitoring program (AH)**	DWER, Perth NRM, DBCA	CoC, CoG, SERCUL	Starting 2010/2011	<ul style="list-style-type: none"> • DBCA and CoC contributed funding towards an intensive Bannister Creek Catchment water quality monitoring program for the 2012-13 year. The CoC has continued to fund the water quality monitoring program for the Bannister Creek Catchment from 2014 – 2017 with support provided from DWER. The City now engages consultants to undertake the ongoing water quality monitoring within the catchment. The results have focused further monitoring efforts particularly within the Canning Vale industrial area. The information is available for further investigation through the light industry audits and to inform on-ground works. • CoC committed \$10,000 towards placing a data logger into the Whaleback Lake to try to understand the surfactant input and timing of these foaming events. The results of this investigation were provided to DWER. DWER and WC funded SERCUL to focus further monitoring of a sub-catchment within the Canning Vale industrial area. This resulted in DWER officer inspecting three premises. DWER is currently working with the premises involved to rectify the issues. • CoG undertook a nine-year assessment of all water quality data from CoG. CoG now engages consultants to conduct long term water quality monitoring within the LG. This monitoring is for the management of water bodies within the City with findings showing much of the nutrient is bound to the sediments. Water quality treatment research was undertaken in 2018 to look at proactive opportunities for water quality management. • DBCA is one of the numerous supporting partners in the research into efficiency of constructed sites in catchments through the CRC for WSC program. 	

2. Minimisation	2.1. Expand urban education in efficient fertiliser management	2.1.1 Reduce urban fertiliser use through education and accreditation programs (AH)	DBCA	CoC, CoG, Phosphorus Awareness Program, SERCUL	Ongoing	<ul style="list-style-type: none"> • DBCA continues to support the Phosphorus Awareness Program delivered by SERCUL. From 2011 – 2017, DBCA provided funding for the Fertiliser Wise Fertiliser Training offered through SERCUL. • Fertilise Wise brochures have been developed and are available for distribution by LG's or other interested parties. • CoG have developed a new policy to guide revegetation and rehabilitation of natural areas. • CoG noted that staff have attended the training but the implementation on site is undertaken by contractors, many of which have not attended the training. Therefore contractor management, policy and contract conditions become a high priority. • CoC Biodiversity Strategy promotes the conversion of private lawn verges to native vegetation. Current actions arising from the Biodiversity Strategy are: <ul style="list-style-type: none"> ○ To develop a native vegetation incentive package for private landholders; ○ To adopt a local plant subsidy scheme for ecological linkages; and ○ Develop a verge information package.
	2.2. Reduce nutrient and non-nutrient input from industry	2.2.1 Encourage local governments to adopt an auditing process and implement education and awareness programs for small to medium enterprises to ensure compliance with the Environmental	CoC, CoG	DBCA, Perth NRM	Ongoing	<ul style="list-style-type: none"> • CoC committed to supporting the implementation of the Light Industry Program. CoC participated in the 2015-17 Light Industry Program in partnership with DWER and DBCA, providing an Environmental Health Officer to undertake audits in conjunction with a DWER officer within the Canning Vale industrial area (addressing practices regarding storage, containment and disposal of waste). Following this period, the CoC Health Officer continues this role while DWER provides ongoing support to the officer as required. • All CoG Environmental Health Officers are now authorised officers and have obtained on-the-job training with DWER officers to attend promptly and confidently to compliance matters. • Letters were sent out to all light industries in the Canning Vale area to inform them of water quality monitoring results during the 2015-17 Light Industry Program.

		Protection (Unauthorised Discharges) Regulations 2004 and reducing stormwater contamination (AH)**					
		2.2.2 Encourage uptake and participation in the Small Factory Environmental Management Support Program (AH)	SERCUL	CoC, CoG, DBCA, DWER	Completed	<ul style="list-style-type: none"> • There was insufficient funding to continue the Small Factory Environmental Management Support Program. • The Light Industry Audits program run in partnership with DBCA, DWER and local government fulfilled this need. The program resulted in the appointment of an officer within the CoC to continue this role with support from DWER as required. 	
	2.3. Reduce nutrient input from recreational areas	2.3.1 Develop and implement nutrient and irrigation/water conservation plans that includes soil and leaf nutrient testing, use of soil amendments and irrigation water efficiency for all public open space and	CoC, CoG, Department of Education		Starting 2010/2011	<ul style="list-style-type: none"> • CoG are implementing a Water Conservation Plan and Nutrient Plan for Tom Bateman Sports Complex, which is a key recommendation from the Tom Bateman wetlands management plan. • The nutrient and irrigation/water conservation issues are embedded into the Bannister Creek Park Management Plan. • Staff within the CoC and CoG have attended Fertilise Wise training. A key future action is around follow-up training on fertiliser use to ensure the knowledge is put into practice and to account for staff turnover. • CoC undertake a program of soil and leaf tissue testing to inform their on-ground management for active spaces. • SERCUL's annual Nutrient Management Survey asked the local government about their nutrient monitoring practice and provides each participating city with a nutrient management score card. Since 2014, the CoC has achieved a best practice rating in nutrient monitoring and nutrient education. The City 	

		school reserves (AH, RA)				has also achieved a best practice rating in fertiliser applications and water quality monitoring since 2017.	
3. Reduction	3.1. Apply best management practice for nutrient outputs management	3.1.1 Ensure developers, builders and landscapers implement best management practices to control erosion and sedimentation to protect waterways (AH, CS)**	CoC, CoG, SERCUL, DBCA	DBCA, DWER, Main Roads, Perth NRM, WC	Starting 2010/2011	<ul style="list-style-type: none"> The Sediment Taskforce was established in 2014. Member organisations contributing to the Taskforce include DBCA, City of Armadale (CoA), City of Gosnells (CoG), City of Kwinana (CoK), WALGA, Master Builders Association (MBA), Housing Industry Association (HIA), Urban Development Industry of Australia (UDIA), DWER, SERCUL, Main Roads WA and WC. The taskforce is administered by Perth NRM (with funding from DBCA to June 2020). Through this forum the following documents have been developed; <ul style="list-style-type: none"> - Taking Action to Control Sediment poster - Taking Action to Control Sediment brochure - Local Law information sheet - Case studies on how various councils address sediment loss from building sites Sediment Control Guidance for developers and builders is being developed. Guidance will include current sediment control methods and costings. A two-year research project through the CRC for WSC to quantify sand/soil loss from subdivisions and individual dwellings during the construction phase has commenced. The outcomes from the project should be available in early 2020. CoG applies sediment and erosion management plans to subdivision works and refers these to DBCA when relevant. 	
		3.1.2 Create vegetated buffer zones/verges and implement WSUD principles between waterways and turf in council reserves and road reserves to help	CoC, COG	Main Roads, SERCUL	Starting 2010/2011	<ul style="list-style-type: none"> Components of this action have been implemented throughout the Bannister Creek living stream projects. The projects at Vellgrove and Hawksberry Lake also contribute toward this outcome. The Tom Bateman Inlet project has improved the vegetation buffer around the Tom Bateman wetland. Recommendations to address turf management issues are included in the Bannister Creek Park Management Plan and the Tom Bateman Wetland Management Plan. CoC has adopted a no-irrigation approach to the grassed public open space along Bannister Creek so the City no longer draws water from Bannister Creek to irrigate the reserve. 	

		prevent herbicides, fertilisers and grass clippings entering waterways, where practical (AH)					
		3.1.3 Maintain street sweeping program and develop a monitoring plan to assess efficiency of current schedules and future procedures (AH)	CoC, CoG		Ongoing	<ul style="list-style-type: none"> • Street sweeping continues in CoG and CoC but there is no new monitoring program. • Street sweeping is routine rather than strategic, with the purpose of reducing leaf litter and gross pollutants in the system. • CoG noted that street sweeping's primary aim is to keep the streets clean so that people don't complain, in this process there is the removal of contaminants before they enter the stormwater network. • SERCUL's Annual Nutrient Survey collects information of LG street sweeping activities and provides the participating LGs with a Nutrient Management Score Card. 	
	3.2. Reduce outputs by building community capacity and through regulation and education of industry	3.2.1 Encourage use of local native plants in landscaped areas and streetscapes (AH, CS, RA)**	CoC, CoG, Main Roads	AGLG, BCCG, SERCUL	Ongoing	<ul style="list-style-type: none"> • CoG has a landscaping policy and local guidelines for development approvals using native vegetation. • CoC has adopted a Local Biodiversity Strategy with actions arising as outlined in 2.1.1 	
		3.2.2 Raise community awareness through involvement in revegetation and education	AGLG, BCCG, SERCUL	CoC, CoG, Main Roads	Ongoing	<ul style="list-style-type: none"> • CoC supports the Bannister Creek Community Officer role to enable the engagement of schools and the community within the Bannister Creek Catchment. The officer regularly engages with the Bannister Creek Primary School and Lynwood Senior High School, incorporating the Harmony Gardens Project and all projects with the Bannister Creek Catchment Group. 	

		activities (AH, CS, RA)				<ul style="list-style-type: none"> • The Bannister Creek Community Officer works with the schools Sustainability Committee, providing advice and assistance to their school programs. • BCCG and the CoC are working with the schools in the development of an interpretation trail for Bannister Creek. • The CoC works with CREEC to present Earth Day and the Science Day education event opportunities for local residents. • The Phosphorus Awareness Program visits a number of schools in this catchment each year. • Each stage of the Bannister Creek living stream project has had many community consultation opportunities through onsite visits, brochures, signage and involvement in revegetation activities. • The Tom Bateman inlet project also had opportunities for community involvement through onsite visits and engagement in revegetation activities. • CoG has held several National Tree Day planting events at Tom Bateman Wetland engaging large numbers of people within the local area. 	
4. Amelioration	4.1. Improve urban drainage design and support structural nutrient intervention	4.1.1 Undertake an ecological study to identify and prioritise sites requiring nutrient reduction to achieve ecological restoration (e.g. through living stream projects) (AH) (links to 1.1.1)**	CoC, CoG, DBCA	AGLG, BCCG, DWER, SERCUL, WC	Starting 2010/2011	<ul style="list-style-type: none"> • UWR project prioritisation project led to the selection of priority sites within the catchment for nutrient intervention works. • The SCWQIP investment project identified key sub catchments for this work. Subsequent water quality monitoring within the sub catchments focuses the on-ground effort. • A 'post UWR' prioritisation meeting (linked to a CFoC planning meeting) identified water quality and biodiversity priorities in the south east region including Bannister Creek catchment. • From 2014 -2017, the water quality monitoring undertaken by SERCUL and funded by the CoC, assessed nutrient inputs from the catchment and made recommendations for actions where opportunities are available. • DBCA has commenced a prioritisation framework to assist in the site selection process when funds become available for implementation. 	

						<ul style="list-style-type: none"> • CoG water quality monitoring is continuing. Water quality treatment research was undertaken in 2018 to look at proactive opportunities for water quality management. 	
		4.1.2 Increase biofiltration treatment and retention time in identified high priority sites (AH) (links to 1.1.1)**	CoC, CoG	Main Roads	Starting 2011/2012	<ul style="list-style-type: none"> • The restoration of Bannister Creek was undertaken in three main stages. The second and third stages were implemented during this period. The Bannister Creek restoration project provides over 2km of continuous restoration along the creek line before it enters the Canning River. The project has restored Bannister Creek to an attractive parkland and living stream while maintaining its stormwater conveyance function. The restoration includes weed control, planting of natural vegetation and installation of rock riffle to capture sediment and increase oxygen levels within the water. • Tom Bateman wetland restoration work has been completed resulting in increased bio filtration and retention time within the wetland, removing significant amounts of accumulated sediment and revegetating the inlet basin. • The restoration of Hawksberry and Vellgrove compensation basins required an extensive establishment phase through this period. Both projects are now well established and require minimal ongoing maintenance. 	
		4.1.3 Review the Bannister Creek Reserve Management Plan (SF, AH)**	CoC	BCCG, DoW, SERCUL, WC	Starting 2011/2012	<ul style="list-style-type: none"> • DBCA funded SERCUL to review the management plan for Bannister Creek and identify the management actions to reduce nutrient inputs to Bannister Creek through a catchment management approach. The plan clarifies the responsibilities of key partners and indicative costs for long term management of the reserve. The plan was completed in June 2014 and the management table has been endorsed by the City. 	
		4.1.4. Develop a management plan for Tom Bateman Wetlands	CoG	AGLG, BCCG, DWER, SERCUL		<ul style="list-style-type: none"> • DBCA and the CoG funded SERCUL to develop a management plan for Tom Bateman Reserve Wetlands that identified the management actions to reduce nutrient input to the wetland and runoff from the surrounding areas. The plan clarifies the responsibilities of key partners and indicative costs for long term management of the reserve and wetlands. Completed in June 2014. 	

		4.1.5. Seek opportunities for retrofitting stormwater management systems to achieve improved water quality outcomes (i.e. in council road reconstruction programs).	CoC, SERCUL, WC	BCCG, DWER, DBCA	Starting 2010/2011	<ul style="list-style-type: none"> • Tom Bateman inlet redesign and restoration has been completed. • Investigations were conducted into the potential of a gross pollutant trap (GPT) being installed prior to stormwater leaving the Canning Vale Industrial area and entering Tom Bateman wetlands. The GPT for Tom Bateman wetland was not implemented. The inlet pond currently acts as the containment area for any pollutants occurring within the upper catchment. • The completion of the Bannister Creek conversion from a trapezoidal drain to living stream was completed during this period, establishing over 2km of living stream prior to the stormwater discharging into the Canning River. • The Hawksberry and Vellgrove compensation basins have been converted from grass and concrete lined stormwater systems into an established biofiltration basin and vegetated swale. • The CoC's Engineering Team are routinely installing stormwater collection and infiltration chambers into road construction designs, which assist in localised infiltration of stormwater. This would assist in dropping out suspended pollutants from water flows that ultimately enter natural receiving waters, and also utilise natural filtration of water as it seeps through the ground and into groundwater aquifers. 	
		4.1.6. Maximise localisation of road runoff treatment.	CoC, CoG, Main Roads		Starting 2010/2011	<ul style="list-style-type: none"> • Road runoff is a key concern into the Tom Bateman wetland and has been integrated into a CFoC project. • Rain gardens and WSUD have been installed within new developments as a requirement in the upper catchment. • As per 4.1.5, the CoC's Engineering Team routinely install stormwater collection and infiltration chambers into road construction designs. 	
5. Treatment-	5.1. Achieve zero nutrient contribution from sewage	5.1.1. Explore connection to sewer for dog kennel zone.	CoC	WC	Ongoing	<ul style="list-style-type: none"> • Unsewered areas have been mapped. These areas are in the very upper catchment, half of kennels in this area are not in Swan Canning Catchment. General discussions are ongoing with WC regarding sewerage connections in light industrial areas which would include dog kennel zones. 	

Reuse- Disposal		5.1.2. Manage wastewater scheme to reduce spills to the environment.	WC		Ongoing	<p>WC has an ongoing program of work to reduce spills to the environment from wastewater assets that have the potential to negatively impact on water quality in the Swan and Canning Rivers. Measures include:</p> <ul style="list-style-type: none"> • Full 24hr monitoring of the pump stations via the Supervisory Control and Data Acquisition (SCADA) network • Increased on-site storage capacity (typically 3-6 hrs at peak). • Duplicating infrastructure to maintain operability (back-up pumps). • On-site and mobile generators to maintain operability during power outages. • Clean-up plans and capability in case of overflow. • Documented on-line contingency plans for all sites. 	
	5.2. Promote urban drainage initiatives	5.2.1. Encourage the use of structural and non-structural controls to address litter, sediment and vegetative materials at source.	CoC, CoG, Main Roads	DWER, SERCUL	Ongoing	<ul style="list-style-type: none"> • UWR project addressed some improved structural controls for litter and sediment. This resulted in a proposed GPT west of Tom Bateman wetlands within the Canning Vale Industrial Area. • The DWER Stormwater Management Manual for Western Australia encourages structural controls amongst other stormwater management strategies. • The Light Industry Audit program run by DWER works with business owners to improve their on-site compliance and BMP. • The Sediment Task Force is working with all stakeholders to improve the management of sediment at the source. 	
		5.2.2. Install and/or regularly maintain gullies, and stormwater/gross pollutant traps, oil and sediment separators and spill control devices to enable pollution spills to be contained before entering the waterways.				<ul style="list-style-type: none"> • CoG has a regular drainage maintenance program, with the primary aim being to maintain flows. A potential improvement could be made with maintenance procedures to identify and address pollution potential. • CoC also has a regular drainage maintenance program. 	

*new management strategy

**new management actions

(SF) = streamflow

(CS) = cultural and spiritual

(AH) = aquatic ecosystem health

(RA) = recreation and aesthetics