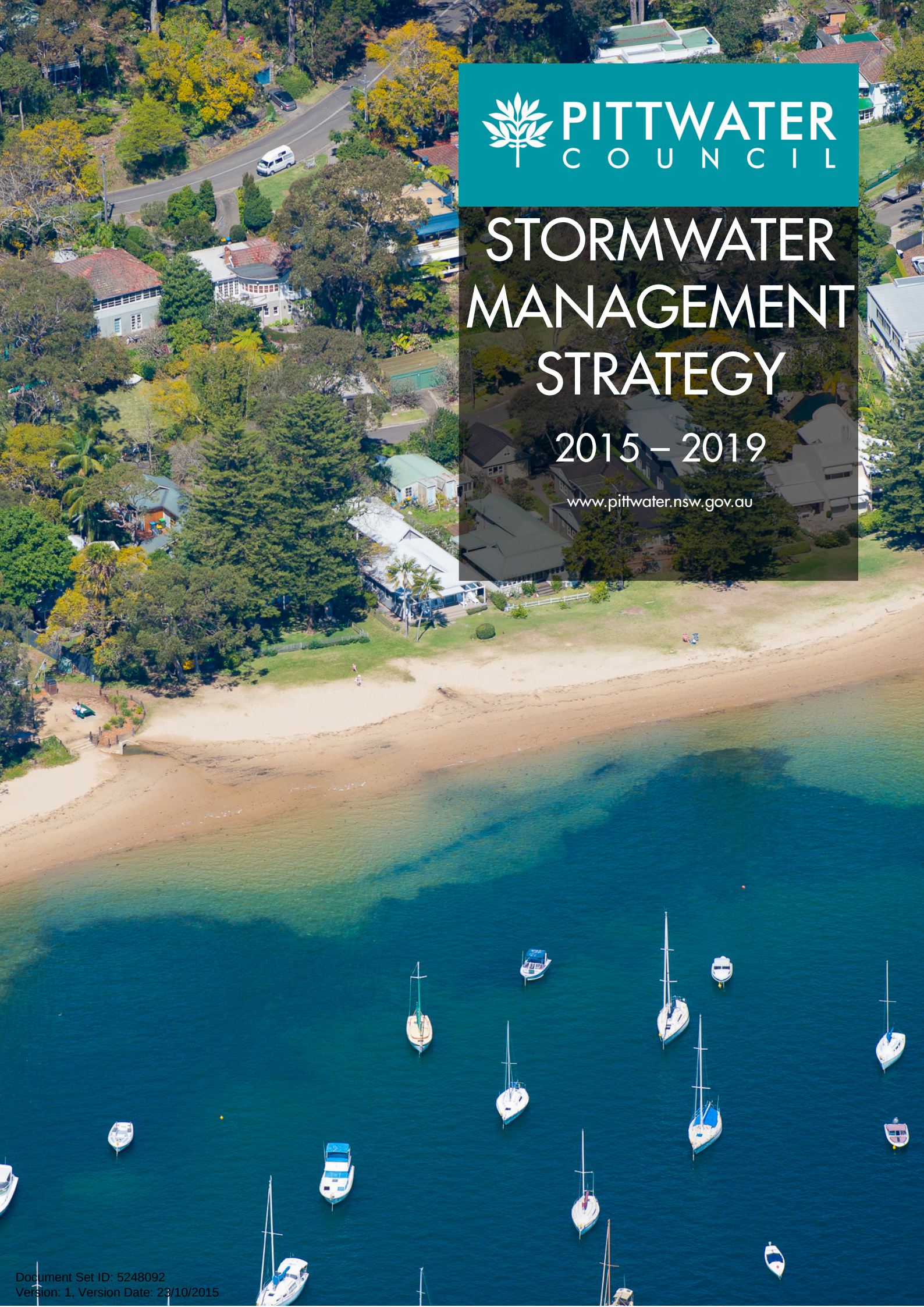

PITTWATER COUNCIL

STORMWATER MANAGEMENT STRATEGY

2015 – 2019

www.pittwater.nsw.gov.au

ACKNOWLEDGEMENTS

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ABBREVIATIONS AND GLOSSARY

ANZECC	Australian and New Zealand guidelines for fresh and marine water quality
COAG	Council of Australian Governments
DCP	Development Control Plan
EPA	Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESD	Ecological Sustainable Development
GPT	Gross Pollutant Trap
IPA	Intertidal Protected Area
LGA	Local Government Area
NWQMS	National Water Quality Management Strategy
OEH	Office of Environment and Heritage
RMS	Roads and Maritime Services
STP	Sewage Treatment Plant
WSUD	Water Sensitive Urban Design

EXECUTIVE SUMMARY

Australia is one of the driest continents in the world and its rainfall and run off is highly variable. Three major water bodies, Pittwater Waterway, Narrabeen Lagoon and the Tasman Sea all receive run off from 23 primary sub-catchments in the Pittwater Local Government Area.

Urbanisation has greatly altered the flow of water through catchments causing negative impacts on aquatic environments. The demands and impacts on water resources, aquatic environments and catchments continue to increase with population growth and climate change impacts.

In response to demands and pressures affecting stormwater and water security, responsible water management is required. Development and implementation of strategies or plans which address and minimise demands and pressures, provide numerous benefits to the economy, environment and community.

The *Stormwater Management Strategy 2015 – 2019* replaces the *Stormwater Management Strategy 1999* with a current and renewed approach for Council in managing stormwater.

Development of this strategy involved a review of, Council's stormwater management approach, internal consultation to identify constraints and opportunities and the development of a 2025 stormwater management vision.

Findings from the review guided by the stormwater management vision were used to develop recommendations. Strategy recommendations address the constraints identified in the review and drive best practice stormwater management across Council's operations and projects.

Through implementing the recommendations within this strategy, it is aimed Pittwater will move towards becoming a water sensitive city.

1 Introduction

Water is a valuable and limited natural resource. The demand and pressures placed on water resources continue to grow, from population growth and climate change impacts (NSW OOW, 2015).

Australia is one of the driest continents in the world and its rainfall and runoff is highly variable. A city's stormwater runoff is relatively equal to the amount of potable (drinking water) that is supplied. However little stormwater is harvested, instead it is directed into waterways causing pollution and water quality issues (Environment Australia, 2002).

Urbanisation greatly alters the way water flows through catchments. This alteration of water flow negatively impacts aquatic environments (NSW DEC, 2006).

In response to these pressures and demands affecting stormwater and water security, the responsible and efficient management of water resources is required. The development and implementation of strategies and plans which address and minimise these pressures and demands, provide numerous benefits to the economy, community and environment.

1.1 Background

Stormwater Management at Pittwater Council historically has been driven through the development and implementation of the *Stormwater Management Plan 1999*. NSW Local Council's continue to develop various management plans to drive best practice water management.

1.1.1 Stormwater Management Plan 1999

In May 1998 NSW Councils were issued a formal Section 12 Direction under the *Protection of the Environment Administration Act 1991* by the NSW Environment Protection Authority (EPA). This Direction required Councils to develop Stormwater Management Plans for urban areas.

Pittwater's first Stormwater Management Plan was developed in 1999 and focused on improving and facilitating the management of urban stormwater impacts on the environment within the Pittwater catchment.

As a result numerous stormwater pollution control devices were installed around the Local Government Area (LGA) to remove pollutants from entering Pittwater's waterways. Stormwater and ground water harvesting are utilised at some sports fields, replacing potable water used for irrigation.

Stormwater Management Plans are no longer a legislative requirement however, Councils continue to produce various water management plans and strategies as best practice to protect and improve catchments and waterways.

1.2 Moving forward

Developing and implementing the strategy, continues Council's commitment to enhancing and protecting the economic, ecological and social values of Pittwater's catchments through stormwater management and water sensitive urban design (WSUD).

The *Stormwater Management Strategy 2015 – 2019* replaces the *Stormwater Management Plan 1999*.

2 Stormwater Management Strategy 2015 – 2019

How the *Stormwater Management Strategy 2015 – 2019* was developed is identified, along with

2.1 Developing the strategy

Development of the strategy included reviewing:

- Council's *Stormwater Management Plan 1999* and its implementation
- Council's current management approach to stormwater and WSUD
- Water quality data record keeping
- Council's stormwater quality and harvesting studies and reports
- Relevant policies, plans, strategies and legislation

Consultation with relevant Council staff responsible for the design, planning, construction, monitoring and maintenance of pollution control devices and WSUD projects was also undertaken.

2.2 2025 Stormwater Management Vision

The 2025 Stormwater Management Vision below was developed to guide the development of recommendations of the strategy and the future decision making, design and planning of projects implemented by Council.

"By 2025, Pittwater has become a sustainable water sensitive city by maximising harvesting, reuse and water sensitive urban design principles. Catchments are effectively managed to improve stormwater quality thereby protecting and enhancing aquatic environments, habitats and biodiversity."

2.3 Consultation

2.3.1 Internal consultation

Consultation was undertaken during the development of the strategy with key Council business units and staff involved in the design, planning and management of stormwater, including:

- Catchment Management and Climate Change
- Urban Infrastructure
- Reserves and Recreation
- Planning and Assessment
- Natural Environment and Education
- Environmental Compliance and Waste
- Commercial Property and Projects
- Place Management

Internal consultation was carried out via one on one meetings with staff, to identify and discuss Council's opportunities and constraints for stormwater management.

Council's Senior Management Team (SMT) was invited to provide comment on the draft strategy to assist in its development.

2.3.2 Agency consultation

No Government agency consultation was required for the development of this strategy. Relevant agencies however, must be consulted during project development, implementation and maintenance of stormwater projects, where:

- The land on which works are to be carried out on are not managed by Council
- Works may impact land and or receiving waters managed by another Agency
- Works involve harvesting from a water source managed by another Agency
- There are risks and or benefits to infrastructure managed by another Agency

2.3.3 Community consultation

The strategy did not require community consultation. Community consultation should be carried out for recommendations provided within this strategy, in instances where a stormwater project may impact private property and or a community area (e.g. park, beach, facility, sports field, reserve, natural area).

2.4 Scope

The *Stormwater Management Strategy 2015 – 2019* covers water created from rainfall, which also includes any soluble and insoluble material collected off surfaces during its journey to and through drainage systems (natural and constructed) which end up in waterways (marine and freshwater).

The Plan does not cover:

- Flooding*
- Potential impacts from increased run off from urban areas on stream bank erosion and subsequent receiving water sedimentation,
- Sewage overflows (responsibility of Sydney Water),
- Roads under authority of Roads and Maritime Services (RMS)
- Direct community water efficiency / stormwater management initiatives
- Monitoring/smart metering of potable water (drinking water)

**See Councils flood studies, plans and maps regarding flood management, available on Council's website (http://www.pittwater.nsw.gov.au/property/natural_hazards/flooding/where_does_it_flood/flood_studies_and_plans).*

2.5 Study area

The strategy study area covers catchments included within the Pittwater Local Government Area (LGA) (refer to Appendix B Figure 1). In instances where a stormwater project is to be carried out on land where Council is not the managing authority, Council will engage and collaborate with relevant Agencies before commencing work.

2.6 Purpose and aims

The purpose of preparing a stormwater management strategy is to:

- Provide Council with a current and renewed approach to managing stormwater.
- Assist in achieving *Pittwater 2025* strategies and objectives impacted by stormwater management (refer to Appendix A).
- Develop recommendations with drive ESD

The implementation of the *Stormwater Management Strategy 2015 – 2019 aims* to:

- Achieve best practice in stormwater/WSUD management within Council's operations and projects.
- Protect and enhance the economic, ecological and social values of Pittwater's catchments and waterways (refer to Appendix 7.7).
- Drive Pittwater towards becoming a 'water sensitive city'.
- Identify the demand for future stormwater management funding.
- Increase harvesting and reuse of water sources to, secure water for the future to reduce demand on potable water and adapt for climate change effects.

2.6.1 Best practice stormwater management

The NSW Office of Environment and Heritage (OEH, 2013a) describe best practice in stormwater management as one, which:

- Minimises the negative impacts to environments and species (flora and fauna) of waterways
- Creates an alternative water source to potable water (town water)
- Recharges groundwater
- Minimises stormwater flooding

The *Stormwater Management Strategy 2015 – 2019*, aims to drive and achieve best practice in all of Pittwater Council's projects, infrastructure and operations where stormwater is involved.

2.6.2 Water sensitive cities

The *Stormwater Management Strategy 2015* – 2019 aims to drive Pittwater towards becoming a water sensitive city.

Water sensitive cities sustainably use various water resources (e.g. stormwater, groundwater, rainwater, wastewater, watercourses, desalination), to not only ensure future water security vital for economic success but to also strengthen its resilience to the effects of climate change and drought.

2.7 Strategy Linkages

The strategy has been prepared with reference to a range of relevant legislation and policies related to stormwater protection.

2.7.1 Pittwater 2025 and Delivery Plan and Budget 2015 – 2019

Pittwater Council's Community Strategic Plan '*Pittwater 2025*' identifies main priorities and goals for the future and presents strategies for achieving these goals.

Pittwater 2025 is structured with 12 strategies, each with their own objectives under five key directions. These five directions are:

1. Supporting & Connecting our Community
2. Valuing & Caring for our Natural Environment
3. Enhancing Our Working & Learning
4. Integrating our Built Environment
5. Leading an Effective & Collaborative Council

Stormwater management is a key factor in achieving a large proportion of *Pittwater 2025* strategies and objectives. Appendix A identifies the strategies and objectives which require best practice in stormwater management in order for their success and achievement.

Council's Delivery Program identifies key actions to be completed over a four-year period to meet the needs of the community. The Delivery Program also provides the operating framework for Council's activities and is the foundation for the development of all other organisational plans (e.g. business unit and individual performance plans). The recommendations of the *Stormwater Management Strategy 2015 – 2019* should be used to guide the development of future organisational plans and delivery programs, to ensure resources and budgets are planned to carry out recommendations.

2.7.2 Ecological Sustainable Development (ESD)

In 1990 the Commonwealth Government defined Ecological Sustainable Development (ESD) in Australia as:

"using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased".

The *Stormwater Management Strategy 2015 – 2019* drives ESD through providing recommendations which support and implement the objectives of Council's *Sustainability Policy*, the *National Strategy for Ecological Sustainable Development* and drives compliance with the *Environment Protection and Biodiversity Conservation Act 1999*.

2.7.3 Pittwater Sustainability Policy

Council's *Sustainability Policy* defines ESD as:

"development that improves the quality of life, both now and into the future, in a way that maintains the ecological processes on which life depends"

Council's *Sustainability Policy* incorporates ESD within its objective:

"To provide a clear statement of Pittwater Council's commitment to ensuring that progress towards sustainability is an ongoing objective and to exercise community leadership on sustainable development within the Pittwater Local Government Area".

Best practice

2.7.4 National Strategy for Ecological Sustainable Development

The *Stormwater Management Strategy 2015* - 2019 links to the objectives of the Australian Government's *National Strategy for Ecological Sustainable Development*. Adopted in 1992 by all levels of Australian Government, the National Strategy for Ecological Sustainable Development, was created to provide the strategic and policy framework to further drive consideration of ESD principles during decision making.

Under Objective 18.1 of the National Strategy for Ecological Sustainable Development, governments will:

"continue to encourage and support actions to develop and adopt an integrated catchment management approach to water resources".

And

"consider the whole hydrological cycle in water management planning, including stormwater, waste waters and effluents".

2.7.5 Environment Protection and Biodiversity Conservation Act 1999

ESD is driven in Australia via the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), which promotes conserving and sustainably using natural resources.

Achieving best practice in stormwater management and driving water sensitive urban design (WSUD) principles in all of Council's projects and operations ensures Council complies with the EPBC Act.

2.7.6 Local Land Services Greater Sydney (LLS)

The *Local Land Services Act 2013* created the Local Land Services (LLS). This Act repealed the *Rural Lands Protection Act 1998*, the *Rural Lands Protection Amendment Act 2008* and the *Catchment Management Authorities Act 2003*.

The LLS now operates with a collective focus, having absorbed Catchment Management Authorities, Livestock Health and Pest Authorities and some Department of Primary Industries advisory services (LLS, 2015).

The LLS is currently developing a 10-year State Strategic Plan and a 5-year Greater Sydney Strategic Plan. These Strategic Plans will set the vision and goals for LLS for the State and Greater Sydney regions by outlining strategies and goals to be achieved.

Further information on the LLS and the State and Greater Sydney Strategic Plans can be found at http://greatersydney.lls.nsw.gov.au/

The strategic objectives and strategies of the LLS State Strategic Plan (LLS, 2015a) and the Greater Sydney Strategic Plan (LLS, 2015b) supported by *Stormwater Management Strategy 2015 – 2019* recommendations are:

- **Strategic Objective 3: Healthy harbours, rivers and waterways**
    - Strategy 3.3: Improve the condition of Greater Sydney's harbours and estuaries to maximise recreational, commercial and environmental values
- **Strategic Objective 4: Healthy native vegetation and habitats**
    - Protect and restore key biodiversity assets such as wetlands and rainforests to improve ecosystem health and resilience

2.7.7 Relevant Legislation

- *Administration Amendment (Water and Energy) Act 2005*
- *Catchment Management Authorities Act 2003*
- *Environmental Planning and Assessment Act 1979*
- *Environmental Planning and Assessment Amendment Act 1997*
- *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*
- *Fisheries Management Act 1994*
- *Local Government Act 1993*
- *Noxious Weeds Act 1993*
- *Protection of the Environment Administration (Amendment) Act 1993*
- *Protection of the Environment Operations Act 1997*
- *Sydney Water Act 1994*
- *Threatened Species Conservation Act 1995*
- *Water Act 1912*
- *Water Industry Competition Act 2006*
- *Water Management Act 2000*
- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*
- *Water Sharing Plan for the Greater Metropolitan Unregulated River Water Sources 2011*
- *State Environmental Planning Policy (SEPP) No. 71 – Coastal Protection*

2.7.8 Related Policies and Plans

- Council Plan – Pittwater 2025
- Council Plan – Delivery Plan and Budget 2015 – 2019
- Council Policy – No 164 Sustainability Policy
- Council Policy – No 176 Climate Change Policy
- Council Policy – No 193 Pittwater Road Reserve and Streetscape Management Policy
- Council Policy – No 194 Integrated Water Cycle Management Policy
- NSW Coastal Policy 1997
- NSW Estuary Management Policy 2005
- NSW Groundwater Quality Protection Policy 1998

- NSW Guidelines for Preparing Coastal Zone Management Plans 2013
- NSW Wetlands Management Policy 1996
- Pittwater 21 Development Control Plan
- Stormwater Management Plan 1999

3 Managing local stormwater

3.1 Pittwater Stormwater Management Program

Council current approach to managing local stormwater is through its Stormwater Management Program, which consists of;

- Installing and maintaining stormwater pollution control devices
- Stormwater Management Services Charge
- Stormwater Management Services Charge Program
- Stormwater treatment investigations
- Stormwater monitoring (when required)

3.2 Current stormwater treatment devices

Pittwater Council has 75 stormwater pollution control devices installed across the local government area in 2014/2015. These 75 stormwater pollution control devices consist of:

- 37 Gross pollutant traps (GPTs)
- 5 trash racks
- 4 litter booms
- 2 nets
- 27 detention basin / ponds

Stormwater pollution control devices are currently maintained by different Council departments, depending on the location of the treatment device.

3.3 Funding Stormwater Management

The cost for the construction and maintenance of stormwater management devices vary depending on:

- Types of pollutants wanting to be removed from stormwater
- The volume of water the device treats
- The location of the device
- The size of the catchment (surface area) the device will treat

Pittwater Council funds stormwater management via the Stormwater Management Services Charge. Council also applies for any suitable grant funding opportunities when appropriate.

3.3.1 Stormwater Management Services Charge

Introduced in 2007/08, the Stormwater Management Services Charge funds additional investigations and activities towards improving stormwater quality, managing stormwater flows and flooding and harvesting and reusing of stormwater.

3.3.2 Stormwater Management Services Charge Program

Funded by the Stormwater Management Services Charge, the program assists with a range of capital projects and recurrent activities. In 2015/16 $528,047 of contributions were allocated to contribute to the implementation of various capital projects and recurrent activities.

3.3.3 Grant funding

State and Federal grant funding when available can supplement already allocated Council funds. However, grant funding is increasingly becoming limited and should not be relied on to fund stormwater management. Grant funding does not apply for the ongoing maintenance of a treatment device.

3.4 Value of stormwater treatment assets

In this this strategy a 'stormwater treatment asset' is defined as any stormwater pollution control device (e.g. GPT, boom, pit etc.). The definition does not including stormwater pipes. Presently some GPT's have been assigned a value based on construction costs at the time of installation. A current valuation of all stormwater treatment devices and an overall value of all assets have not yet been calculated.

Values for each stormwater treatment device and an overall value of assets is important to determine if the funding assigned to maintain these assets is at a level that protects the investment (asset).

3.5 Maintenance schedule

Maintenance of stormwater treatment devices includes removal of captured pollutants from device and repairs (when required). The frequency of maintenance varies between devices depending on;

- type of device
- types of pollutants being captured
- the catchment (surface area) the device treats
- frequency of rainfall and storms
- volume of stormwater treated
- Access restriction due location and developments

Devices are required to be maintained regularly to ensure that the device is operating correctly and does not cause any flooding and or water quality risks upstream of the device.

Current maintenance schedule for GPTs were developed during the 2011 GPT Audit. This maintenance schedule was included within the 2014 GPT maintenance and cleaning tender.

3.6 Stormwater treatment investigations

Council undertakes stormwater treatment investigations and assessments to ensure funding is directed to projects which have the greatest benefits for:

- Improving stormwater quality
- Improving habitats of receiving waters (estuary and oceans)

- Improving future water security (stormwater harvesting and reuse)
- Protecting economic and community activities carried out in waterways

3.6.1 GPT Audit 2011

In 2011 a consultant was engaged to undertake an audit of Council's 36 gross pollutant traps (GPTs), the project aims and objectives of the audit were:

- monitor all 36 Councils owned GPTs
- confirm type and model of each GPT
- confirm depth and dimension of GPT
- identify and confirm if the GPTs are being cleaned correctly by the contractors
- list any rectifications that need to be made (access etc)
- inspect diversion chamber, both upstream and downstream of the GPT
- suggest locations for additional GPTs and/or decommissioning of GPTs (if required)
- assess current cleaning frequencies and estimate appropriate cleaning frequency, compared to current frequency
- estimate a revised annual cleaning and regular cleaning timetable, to ensure GPTs are 'properly cleaned'
- obtain an individual data sheet for each of the 36 GPTs.

All rectification works recommended by the audit were completed.

3.6.2 2012 Stormwater harvesting feasibility assessment

In 2012 Council engaged a consultant to undertake a feasibility assessment of 8 sites throughout the Local Government Area (LGA) to replace or supplement current potable water (drinking water) consumption and to sustainably increase water use at public open spaces and sports fields which substantially use large amounts of potable water for irrigation, toilet flushing, boat wash down and other uses.

The main objectives of the feasibility assessment were to:

- Provide alternative water supply through the use of treated stormwater for non-potable uses
- Reduce demand on mains water at all 8 sites
- Identify the potable water cost savings associated with replacing potable water for non-potable water
- Improve downstream water quality

Study areas included in the assessment:

- Kitchener Park – Mona Vale
- Newport Oval – Newport
- Warriewood Playing Fields (Jackson Road) – Warriewood / North Narrabeen
- North Narrabeen Reserve (back fields)
- Careel Bay Playing Fields / Hitchcock Park – Avalon
- Lakeside Park – North Narrabeen
- Rowland Reserve – Bayview
- Winnererremy Bay

The feasibility study identified stormwater harvesting systems which could be implemented for each site. Preliminary budgets for each site were also identified.

None of the stormwater harvesting recommendations from the feasibility assessment have been implemented due to financial constraints for both construction and ongoing maintenance.

These concepts should be used for future grant funding opportunities and to inform future studies and budget planning.

3.6.3 2011 Stormwater harvesting from Boondah Depot feasibility assessment

In 2011 Council engaged a consultant to undertake a feasibility and concept design for a stormwater harvesting scheme to irrigate the sports field next to Council's Depot at Boondah Road Warriewood.

A stormwater harvesting system was designed that used water collected from the hard surface area at Boondah Depot. A preliminary budget was also provided.

The concept was not progressed due to financial constraints. This stormwater concept should be used for future grant funding opportunities.

3.7 Stormwater monitoring

Developers undertake monitoring of stormwater as required during large development projects which post a risk to the quality and or quantities of stormwater to ensure there are no negative impacts to the environment.

Council conducts stormwater testing in response to complaints from local residents regarding waterways which have a noticeable smell or are visually polluted.

There is currently no monitoring program run by Council which constantly tests stormwater quality.

3.7.1 Streamwatch

Pittwater Council supports the Australian Museum Streamwatch program. Streamwatch groups through assistance of local volunteers, collect data on local waterways including water quality and catchment and ecosystem health.

Collected data is used to assist identify local issues and outcomes of remediation projects. The Streamwatch program is managed through Pittwater Council's Coastal Environment Centre (CEC).

4 Stormwater Management

4.1 Pittwater Stormwater Management Program Review

Pittwater's current Stormwater Management Program has achieved the installation of 75 stormwater pollution control devices across the LGA. In 2013/14 these devices removed 204,764kg of gross pollutants from entering our local waterways.

In 2013 Council won an Award for Excellent from Stormwater NSW in 2013 for management of local stormwater pollution traps.

Successfully obtaining grant funding assistance from the Federal Government's Community Water Grants Program in 2013, Council implemented a stormwater harvesting and reuse system at Porters Reserve Newport. Additionally stormwater harvesting and reuse systems have been implemented in North Narrabeen Reserve.

Historically the approach to identifying locations to implement stormwater pollution control devices has been reactive or ad-hoc, due to the absence of a developed and implemented review and assessment process to identify the priority and suitability of stormwater pollution control devices and their locations. Additionally limited catchment and water quality data has reduced the ability to make informed decisions.

Limitations which have slowed Pittwater Council achieving best practice in stormwater management include:

- Limited financial resources (for both construction and ongoing maintenance)
- Pollution device maintenance and upgrade budget demand increasing as devices deteriorate over time
- Limited awareness of and resistance towards stormwater / WSUD integration by Council staff
- Minimal up to date local information on stormwater quality and its impacts
- Minimal monitoring of stormwater quality
- Low priority and awareness of stormwater impacts and opportunities across Council staff
- Reliance of ground water as substitution for potable water
- A uncommunicated clear directive by Council on the importance and direction of stormwater management within projects and operations

Greater stormwater funding will allow Council to:

- Protect and enhance the values of our local catchments and waterways
- Achieve *Pittwater 2025* strategies and objectives impacted by stormwater
- Achieve the aims of the Stormwater Management Strategy 2015 – 2019
- Contribute to regional and state water and environmental management plans and strategies
- Ensure compliance with relevant legislation and policies

Greater awareness and collaboration across Council staff will improve implementing stormwater and WSUD management principles within operations and projects.

Recommendations provided within this strategy have been developed to address these stormwater management limitations.

4.2 Developing Stormwater Management Strategy Recommendations

Recommendations of the *Stormwater Management Strategy 2015 – 2019* were developed by:

- Undertaking a review of Pittwater's Stormwater Management Program to identify priorities
- Incorporating opportunities and constraints identified during the internal consultation stage
- Aiming to achieve multiple outcomes
- Linking recommendations to relevant legislation and policies (refer to 2.7)
- Adhering to the 2025 Stormwater Management Vision (refer to 2.2)

The recommendations of *Stormwater Management Strategy 2015 – 2019* are across a broad range of areas including:

- Policy and procedure development
- Capacity and capability building of staff
- Data recording and management
- Studies and monitoring project/programs

Recommendations are over four years in line with the Council's *Delivery Program and Budget 2015 – 2019* timeline. This timeline was selected to:

- Ensure regular tracking and updating of stormwater management practices.
- Link and contribute to the strategic objectives of the *Delivery Program and Budget.*
- Improve budget and resource planning for stormwater management projects.

In addition to the recommendations provided for 2015 – 2019, the document also provides recommendations for 2020 – 2024. Recommendations for 2020 – 2024 are provided to allow additional time for planning, budgeting and to inform the development of the strategic objective of the 2020 – 2024 Delivery Plan and Budget. 2020 – 2024 recommendations can be implemented sooner if the opportunity arises to do so.

5 Stormwater Management Strategy Implementation

5.1 How will the strategy be implemented

All business units and staff are responsible for implementing, stormwater and WSUD management principles during the design, planning and delivery of their operations and projects.

The Catchment Management and Climate Change team will advocate, collaborate and provide technical advice to the business unit who is responsible for the implementation of a recommendation.

5.2 Review of progress

At the end of each financial year the *Stormwater Management Strategy 2015 – 2019* will be reviewed to identify the progress, outcomes and limitations of the recommendations provided within the strategy.

The review will also identify any new recommendations which should be added to the strategy.

The review will take into consideration the maintenance reports of stormwater control pollution devices, NSW OEH BeachWatch data, resident complaints and staff feedback.

6 Stormwater Strategy Recommendations

The following recommendations have been made to further drive improvement in stormwater for Pittwater Council.

6.1 Recommendations – Short term (2015 – 2019)

Recommendation	Details	Expected completion
1. Water quality KPI's	Establishment of water KPI's for positions involved in: management and or a projects which impact/involve any water resource (stormwater, rainwater, groundwater, greywater, freshwater, saltwater, recreational bodies of water, potable water, sewer mining, desalination etc.). KPI's are structured to drive and ensure: • monitoring of water quality • efficient and sustainable use of water resources • improved and maintained quality and quantities of stormwater • reduce sedimentation of waterways • reduce pollution, • WSUD is integrated within operations and projects **Desired outcomes:** Accountability for water management across the organisation. Greater integration of WSUD and sustainable water use principles in projects across the organisation.	30 December 2015
2. Council Water Management Group	Establishment and commencement of an internal water managers group, consisting of Managers from business units (Urban Infrastructure, Natural Environment and Education, Place Management, Reserves and Recreation, Planning and Assessment). Quarterly meetings to identify and address WSUD, stormwater quality & harvesting opportunities and issues. **Desired outcomes:** Establishment of regular knowledge sharing. Greater WSUD take up in Council projects.	30 December 2015
3. Water management program	Development of a register which captures projects (infrastructure and educational) relating to improving stormwater quality and quantities, harvesting and reuse. Projects in register are reviewed to identify level of success and or if further actions required to achieve aims of the	30 December 2015

register	project/action. **Desired outcomes:** Improved understanding of water management approach across Council. Ability to review success of projects to inform future actions. Track water management spending and integration of WSUD.	
4. Council's stormwater management directive	A signed, clear directive 'management statement' on stormwater management from the Council (General Manager and Directors) for Pittwater Council staff which informs and direct Council staff to integrate stormwater and WSUD management within project and resource planning. **Desired outcome:** Prioritisation by decision makers across Council to integrate stormwater management within their projects and business planning. Greater responsibility for stormwater management across the organisation.	30 February 2016
5. Stormwater education (Community)	Development of stormwater education plan short and long term objectives, to establish education aims, priorities and campaigns. Creation and promotion of community and business educational material on catchment and stormwater management. Sources of promotion: resources on Council website, community newsletters, materials provided to local schools and CEC. **Desired outcomes:** Greater community awareness and understanding of threats and impacts to water quality, aquatic habitats and catchments. Raised understanding and awareness of linkages between good catchment health and economic and social benefits. Linkages between stormwater education and Council projects.	20 February 2016
6. Stormwater education (Council staff)	Creation of an education and awareness campaign to build awareness of WSUD, stormwater quality threats, impacts of poor stormwater quality, catchment management and harvesting and reuse. **Desired outcomes:** Greater consideration and integration of water quality, WSUD and ruse principles within Council projects and operations. Greater soil erosion control and long term stormwater management.	30 March 2016
7. Water management awards	Development of annual awards which recognise, a business, household and sporting club which have implemented	30 June 2016

	Desired outcomes: Incentives for businesses, households and sporting clubs to harvest and treat stormwater to improve catchment and stormwater quality/health.	
8. Pollution Incident & Reporting Process	Development of step by step process for identifying, responding to and reporting stormwater pollution incidents affecting stormwater assets and waterways ensuring compliance of process with relevant legislation (e.g. *Protection of the Environment Operations Act, 1997*). **Desired outcomes:** Implemented stormwater pollution incident reporting process and system. Staff training and awareness program developed.	30 June 2016
9. DCP Water Management Control Review	Revision of DCP controls for stormwater, including; harvesting and reuse, quality, quantities, erosion and riparian corridors. **Desired outcomes:** Improvement of stormwater quality, increased water sensitive urban design within developments, greater role by Council in enforcing development controls.	30 June 2016
10. Water management induction (Council staff)	Development of a Council staff induction which covers management of water resources, catchments, water quality and quantities. **Desired outcomes:** Increase in knowledge of stormwater, catchment, WSUD and harvesting and reuse principles and opportunities. Greater awareness of support the CM&CC team can provide. Increase in WSUD principles being included in projects across Council.	30 June 2016
11. Stormwater pollution control device & drain audit	Completion of an audit including all types of stormwater pollution control devices (GPTS, pits, ponds, swales etc) and known stormwater drain hotspots within the Pittwater LGA. Pollution Device Audit identifies, type, model, dimensions, rectification works required, required cleaning/maintenance schedule (frequency) to ensure device operates efficiently, annual cleaning/maintenance budgets for each device, recommendations for additional sites, decommissioning and or upgrading of devices/sites and estimate. The audit also provides a value of each stormwater device and an overall value of the stormwater pollution control assets. The Stormwater Drain Audit identifies: known blockage hotspots, frequency of blockages, material and sources causing blockages, repair or upgrades required and maintenance schedule to mitigate drain blockages. **Desired outcomes:** An up to date list and complete list of; stormwater assets, value of stormwater treatment devices, required maintenance, required budgets to maintain current	30 June 2016

	assets. Assessment of risks and works required to ensure public safety of assets. Reduction in stormwater drain blockages in hotspot areas.	
12. Climate Change Risk and Impact Review on Stormwater Management	All infrastructure and pollution control devices (e.g. pipes, pits, GPTs etc.) are assessed and modelled against predicted climate change impacts/events to identify: Infrastructure and pollution control devices at risk from predicted impacts/events. Construction, upgrading, repositioning and decommissioning recommendations of infrastructure and pollution control devices to withstand future climate change impacts/events. **Desired outcomes:** Improved ability in assessing, planning, designing and funding stormwater infrastructure and pollution control devices.	30 June 2016
13. Water management standard	Creation and adoption of minimum standards for all new Council projects (infrastructure, building, roads, footpaths, carparks, skate parks etc.) to include WSUD principles and to assess opportunities to improve stormwater and catchment health within projects. Also includes, water quality standards (developed using *ANZECC Guidelines 2000*). **Desired outcomes:** Greater integration of WSUD in Council projects. Reduction in stormwater entering waterways. Reduction in stormwater pollution. Recharge of groundwater. Reduction in potable water use.	30 September 2016
14. Mullet Creek Study	Investigation of possible pollution sources, nutrient loads and identification of pollution types. Calculation of annual pollutant loads. Comparison of stormwater pollution against water quality guidelines. **Desired outcome:** Greater understanding of pollution within Mullet Creek. Development of community awareness program to reduce pollution entering creek.	30 September 2016
15. Estuary Rock Pool & Beach Stormwater Risks, Hazards and Impacts Review & Plan	Undertake a review of all estuary rock pools, assessing and identifying risks, hazards and impacts from stormwater on the amenity and water quality of estuary rock pools and beaches. Identification and priority of actions and or recommendations (including costs) which can mitigate and or remove risks, hazards and impacts of stormwater on estuary and ocean rock pools, beaches and its users. **Desired outcomes:** Reduced stormwater impacts and risks to recreational swimming sites	30 September 2016

	and its users. Identification of any stormwater diversion works to protect estuary beach amenity. Compliance with mandatory and best practice guidelines for recreational water quality.	
16. 12-month catchment water quality monitoring program	Development and completion of a 12-month catchment monitoring program. Top, middle and end of pipe/catchment drainage/creek tested twice a season (once during wet weather, once during dry weather). Establishes baseline water quality data set on catchment health. Test results compared to ANZECC Guidelines for fresh and marine water quality. **Desired outcomes:** Establish baseline dataset of water quality within natural creeks and health of catchments. Identifies actions to improve catchment health and water quality. Identifies possible pollution hot spots. Identify possible sewer leaks and illegal pipe connections.	30 June 2017
17. Water cost forecasting study	Completion of a study which identifies current total annual cost and volume of potable water used for non-drinking purposes (e.g. irrigation, toilet flushing, wash down, street cleaning) for all of Council's water using assets (e.g. buildings, carparks, sports fields, public toilets). Based on future impacts of climate change (e.g. heat events, drought, changed rainfall patterns), population growth, future asset projects, and increase water supply costs identify future financial costs of meeting these demands with potable water. **Desired outcomes:** Establishment of data / strengthen case to inform and drive WSUD and stormwater harvesting projects. Advocate action to save money in the future. Reduce potable water demand. Increase stormwater harvesting and reuse. Findings of study are to be used in the completion of the 'Water reuse feasibility study & strategy'.	30 April2017
18. Water reuse feasibility study & strategy	Completion of a feasibility study which identifies sites (e.g. business precincts, buildings, parks, road etc.), where use of town water can be replaced with use of harvested water from other sources (e.g. stormwater, rainwater, sewer mining and desalination) and where WSUD features can be placed to improve stormwater quality. Sites will be prioritised and estimated budgets for each project identified including any ongoing maintenance costs. **groundwater may only be considered if the source is sustainably extracted, salinity of the groundwater is not changed over time and the groundwater source is regularly recharged.*	30 June 2017

	Desired outcomes: Reduced use of potable water. Increased water security. Increase resilience to drought and effects of climate change. Improved stormwater quality. Reduced stormwater quantities entering waterways.	
19. Bilgola Creek GPT	Investigate feasibility of installing a GPT at Bilgola Creek, including triple bottom line assessment. Feasibility will also provide options for other treatment devices which better suit the site which improve stormwater quality. Budget for device and ongoing maintenance will be provided. **Desired outcomes:** Determination of whether a stormwater quality device is required at Bilgola Creek and what type of device is best suited if needed.	30 June 2018
20. Careel Creek Pollution Source Study	Investigate with Sydney Water to identify possible sources and types of pollutants impacting Careel Creek (near bridge overpass on Barrenjoey Road Avalon Beach). Compare test results against ANZECC Guidelines for Fresh and Marine Water Quality. Identify possible actions and to improve water quality of Careel Creek, including budgets and any ongoing maintenance costs for recommended actions/devices. **Desired outcomes:** Improved water quality. Reduced pressure on aquatic habitats of Careel Creek.	30 June 2018
21. Great Mackerel Beach Creek Study	Development and completion of a study identifying sources and causes of sedimentation and opportunities for improving water quality and aquatic habitat of the creek. Study identifies a list of actions which can be undertaken including estimated budgets for each action plus ongoing maintenance costs. **Desired outcomes:** Improved creek embankment stabilisation. Improved creek water quality. Reduced sedimentation rate of creek. Reduction in exotic flora species along creek.	30 June 2018
22. Pittwater Estuary Monitoring Program	Development of an Estuary Monitoring Program on water quality which meets the objectives of the NSW OEH *Guidelines for preparing Coastal Zone Management Plans* and the *NSW Natural Resources Monitoring, Evaluation and Reporting Program*. Program includes recreational swimming quality within the estuary. **Desired outcomes:** A completed and implemented Pittwater Estuary Monitoring Program.	30 June 2018
23. Sedimentation	Calculation of sedimentation rate/load each year for each catchment of the Pittwater LGA, and	30 June 2019

of waterways assessment.	an overall total. Sources of major sedimentation for each catchment and recommended devices to reduce sediments entering waterways. Budgets are provided for all recommendations including ongoing maintenance costs. **Desired outcomes:** Reduced sedimentation rates/loads. Improved protection of wetlands, aquatic habitats and waterways. Maintaining navigation routes for water vessels. Improved water quality.	
24. Landfill & Water Quality Monitoring	Identify and map historical landfill sites. Undertake 12 month monitoring program of waterways and groundwater surrounding landfill sites to identify possible leaching of pollutants from landfill sites into groundwater and surrounding waterways (creeks). Identifies remediation recommendations and budgets if pollution sources are found. **Desired outcomes:** Understanding of landfill sites with water sources, catchments and waterways. Actions if possible pollution sources identified.	30 June 2019
25. Water management video	Creation of series of 'water management' videos to educate on; local aquatic environments, threats to water quality and catchment health, WSUD/water harvesting and reuse opportunities and building resilience of water resources against the impacts of climate change. **Desired outcomes:** Greater connection of community and businesses with the local environment. Greater understanding of water quality issues. Greater update of water harvesting/WSUD principles within residential properties and businesses.	30 June 2019

6.2 Recommendations – Long term (2020 – 2025)

Although this plan focuses on recommendations for 2015 – 2019, the following recommendations are provided for additional planning of resources for their development, funding and implementation. They can be implemented sooner if possible.

Recommendation	Details	Expected completion
1. Water security levy	The creation of a water security levy where funds are used for the development, implementation and ongoing maintenance of devices which harvest, treat and reuse various water sources including stormwater, rainwater, sewer mining, groundwater and desalination. **Desired outcomes:** Greater, regular and dedicated funding for water management. Improved resilience of water resources against the impacts of climate change. Pittwater transitions into a water sensitive and sustainable city. Greater desirability as a place to live, visit and do business. Reduction of stormwater quantities entering waterways.	30 June 2020
2. Local water reserves	Establishment of harvesting centres which collect, treat and then direct stormwater into underground storage areas to create 'local water reserves'. These reserves can be used for irrigation, servicing business precincts and residential areas and Council operations which use water (e.g. street cleaning). Opportunity for harvested water to be sold. **Desired outcomes:** Local water storages to be used for various uses. Reduction of stormwater and pollutants entering waterways	30 June 2024
3. Natural waterways project	Identification of natural channels and drainage lines which have been cemented. Undertake feasibility of returning cemented channels back into naturally line channels. Preparation of works list, timeline and budget preparation. **Desired outcomes:** Increase in groundwater recharge for catchments. Natural filtration of pollutants to improve stormwater quality. Restore terrestrial and aquatic habitats.	30 June 2024

7 Appendix A: Pittwater 2025 stormwater related directions, strategies and objectives

7.1 Appendix A: Pittwater 2025 key directions, strategies and objectives which are impacted by stormwater management.

Key Direction	Strategy	Objective	Responsibility
Supporting & Connecting our Community	Building Communities	To be a community that appreciates and values our bush, beach and water	Community / Council
	Recreational Management Strategy	To champion the reduction of energy and water consumption in Council activities and buildings	Community / Council
Valuing & Caring for our Natural Environment	Beach & Coastal Management Strategy	To protect and maintain a healthy coast (beaches, dunes headlands and estuaries)	Community / Council
		To maintain the sustainability of beaches, headlands and estuaries	Community / Council
		To responsibly manage the risks associated with the coastal environment, including any exacerbated by global warming	Council / State
		To conserve and promote the iconic visual amenity of the Pittwater coastline	Community / Council
		To protect marine biodiversity	Community / Council / State
	Catchment Management Strategy	To achieve an integrated sustainable approach to water cycle management	State / Community / Council
		To sustainably manage water consumption though measures such as harvesting rainwater, recycling stormwater and reuse of waste water and treated effluent	Community / Council / State
		To manage catchments effectively to improve the health and biodiversity of eco-systems	Council / State
		To sustain environmental flows and water quality that support healthy ecosystems	Council / State
		To effectively manage stormwater and flooding including the impacts of climate change	Community / State

		To protect, enhance and conserve catchment zones, native aquatic vegetation and riparian corridors	Community / Council / State
		To reduce erosion and sedimentation in creeks, estuarine communities and watercourses	Community / Council / State
		To improve the water quality of creeks and other waterways	Community / Council / State
		To foster community participation in planning for a sustainable water future	Community / Council / State
		To promote and enhance vegetation's role in the water cycle	Council / State
	Flora & Fauna Management Strategy	To protect threatened species and habitats	Council / State
		To promote the economic and social value of Pittwater environment	Community / Council
		To promote vegetation's role in addressing the impacts of climate change and local micro-climates	Council / State
		To manage catchments, habitats, corridors and ecosystems effectively	Council / State
Enhancing our Working & Learning	Community Education & Learning Strategy	To encourage education programs that raise awareness of significant issues in the community	Council / State
		To increase community involvement and provide activities, education and opportunities in sustainability initiatives	Community / Council
		To maximise the use of community facilities for education and learning opportunities	Council / State
	Economic Development Strategy	To foster business opportunities through innovative technologies	Council / State
		To create expanded opportunities for business through a range of planning initiatives	Council
		To promote opportunities for sustainable tourism	Community / Council
		To promote sustainability principles within the Pittwater business community	Community / Council
Integrating our Built Environment	Land Use & Development Strategy	To establish land uses that respond to environmental, cultural, social and economic needs in a sustainable manner	Council / State
		To deliver a comprehensive suite of development controls that improve the liveability of the area	Council

		To protect environmentally sensitive areas and support the quality of beach, bush and water	Council / State
		To achieve landscapes dominated by vegetation including quality streetscapes	Community / Council
		To ensure development responds to hazards and climate change	Council / State
		To achieve a sense of place or character that reflects bush, beach and water	Community / Council
		To promote sustainability initiatives in land use development	Community / Council
	Town Village Strategy	To improve the streetscapes and recreational qualities of the centres	Council
		To promote sustainable development in Pittwater's town and village centres	Council
		To maximise recycling in our village centres	Council
		To connect our towns and villages with our natural environment	Council
Leading and Effective & Collaborative Council	Corporate Management Strategy	To continue to reduce Council's ecological footprint	Council
		To be a leader in sustainable management (social, economic, environmental, leadership)	Council
		To provide the community with a broad range of quality natural and built assets in a sustainable manner to meet the needs of the current and future generations	Council
		To sustainable and strategically manage the community's assets on a whole of life basis taking into account risks, community expectations and Quadruple Bottom Line (social, environmental & governance)	Council
		To create, acquire, maintain, enhance and manage assets in line with best practice, use of technology and innovation	Council

8 Appendix B: Catchments of Pittwater

This chapter provides an overview of the features of Pittwater's catchments, major creeks and beaches. The economic, ecological, social and cultural values of the Pittwater community of these areas are also identified.

8.1 Overview

The Pittwater catchment includes all areas within the Local Government Area (LGA) which drain into Pittwater estuary and or coastal areas (includes all coastal areas between Barrenjoey Head and Turimetta Head).

The Pittwater LGA contains six major creeks, including numerous stormwater outlets and watercourses which drain to Pittwater from mainly developed areas. A number of ephemeral creeks and permanent creeks drain to Pittwater from the Ku-ring-gai Chase National Park, situated on the western shores of Pittwater.

8.2 Subcatchments of Pittwater

Pittwater can be categorised by their physical features into four subcatchments, their features and locations are shown in Table 2.

Subcatchment	Features	Locations
Beach	Small and relatively steep catchments leading to an outlet on the beach. Existing pipes generally have very low longitudinal grades across the back beach area with little or no overland flow paths.	Warriewood, Mona Vale including Basin Beach, Bungan, Newport, Bilgola, Avalon, Whale, Palm and Barrenjoey.
East Pittwater	Small and relatively steep catchments leading to an outlet to Pittwater. Generally steep grades to waters edge with houses along foreshore and little space for control of stormwater discharges.	Scotland Island, Bayview (Winnererremy Bay), Church Point, Cahill Creek, Crystal Bay, Horseshoe Cove, Salt Pan Creek, Refuge Cove, Clareville, Careel Bay and Sand Point.
West Pittwater	Principally Ku-ring-gai Chase National Park consisting of small and relatively steep catchments leading to an outlet to Pittwater. Combination of outlet conditions with small extent of development in the lower areas, no sewer and large influxes of people in holiday periods (particularly summer and weekends).	Lovett/Elvina Bays, Towlers Bay, Coasters Retreat/The Basin and Great Mackerel Beach.
McCarrs Creek	Relatively steep larger catchment with National Park on northern side, non-urban/rural on the southern sides, and estuarine conditions in the lower creek.	Browns Bay, Cicada Glen Creek and Wirreandra Creek.

Table 2: Pittwater's subcatchment features and locations (Pittwater Stormwater Management Plan, 1999).

Figure 1: Pittwater LGA (pink boarder) and catchments (brown boarder).

8.3 Major Creeks

Descriptions of major creeks in Pittwater have been extracted from the Pittwater Stormwater Management Plan 1999.

8.3.1 Careel Creek

Careel Creek in Avalon receives water from a catchment that includes the Avalon valley, parts of Bilgola Plateau, Whale Beach and North Avalon areas.

The middle part of the creek takes the form of a concrete drain directing water from the commercial area of Avalon.

Below Barrenjoey Road there is a natural section where the creekline vegetation is dominated by *Casuarina glauca* with weed infestation. Grey and River Mangroves occur along the embankments where the tidal influence is present. At the mouth of Careel Creek there is a wetland.

8.3.2 Salt Pan Creek

Salt Pan Creek is located in Newport and has a small steep catchment area of residential development. It flows through Florence Park, where the creek is piped into Salt Pan Cove.

Its vegetation is typical of a rainforest gully of Cabbage Tree Palms on Narrabeen Shale surrounded by open forest of Spotted Gum. It is weed infested along its banks with privet and lantana.

8.3.3 Mona Vale Main Drain

Mona Vale Creek has been replaced by a concrete channel which drains the Mona Vale commercial and light industrial section as well as residential areas of Mona Vale into Winnererremy Bay.

Vegetation along the channel is mostly exotic grasses and in the tidal areas is dominated by *Casuarina glauca* and grey mangrove. The Winnererremy/Winji Jimmi Bay area has been altered due to dredging of the estuary and destruction of former wetlands with the dredge spoil which now forms Rowland Reserve. As a result the area is weed infested and has little remnant vegetation.

8.3.4 Cahill Creek

Cahill Creek is a natural creek that has its source and upper catchment in Ingeside and flows through Bayview into Winnererremy Bay. The creek flows through Bayview golf course and the presence of many water weeds in the creek and riparian zone are an indicator of nutrient enrichment.

The vegetation surrounding the creek is comprised of creekline rainforest species opening to Swamp Mahogany and coastal vegetation. Past infilling in the area has altered the creek's natural course.

8.3.5 McCarrs Creek and Cicada and Cicada Glen Creek

The catchment areas of both these creeks are largely undeveloped including parts of Ingleside as well as Ku-ring-gai Chase National Park, however parts of the catchments include some residential development at Church Point and Ingleside.

8.4 Pittwater Beaches

Descriptions of beaches in Pittwater have been extracted from the Pittwater Stormwater Management Plan 1999.

8.4.1 Palm Beach

Palm Beach is 2.3 kilometres, curving in an arc between Barrenjoey Head, the southern head of Broken Bay, to the sandstone rocks of Little Head in the south. Barrenjoey Headland is part of the Ku-ring-gai National Park and the rock platform is an intertidal protected area (IPA). The northern 600m of the beach remains in a relatively natural state with both vegetated and active dunes, the central 800m is a foreshore reserve and the southern third faces north east and is backed by residential development. The beach receives a range of wave height ranging from an average of less than 0.5m at the southern end to 1.5m in the north. These conditions produce a single sand bar which is always cut by rips along the half of the beach.

There are four stormwater drains which discharge onto the southern end of Palm Beach. The outlets cause erosion problems and could contribute to water pollution near the rock pools in storm events.

8.4.2 Whale Beach

Whale Beach is 600m long surrounded by two 40m high sandstone headlands backed by slopes rising 100m. The beach faces east and received waves averaging 1.6m resulting in a single attached bar with a rip at each headland and one or two others along the beach. Bluff erosion is evident on both headland areas.

Several stormwater outlets drain onto the beach with two at the southern end near the rock pools which may contribute to erosion and water pollution in storm events. There are two stormwater outlets in the centre of the beach.

8.4.3 Avalon Beach

Avalon Beach is approximately 500 metres long, facing south east, and bordered by 60 meter high sandstone cliffs and the rock platforms of Bilgola Head and Hole in the Wall. Immediately behind the beach is a fenced, high dune foredune. Originally, Avalon Beach had a large littoral rainforest backed by a freshwater swamp. The dune was destabilised and mined, the swap filled and channelled with the land being used as a camping ground until the 1960's.

The Avalon Dunes coastal vegetation is being actively restored by volunteers with the assistance of various grants fund.

There is a small stormwater outlet at the northern end of the beach.

8.4.4 Bilgola Beach

Bilgola Beach is 500 metres long, faces south east and is bordered by Bilgola Head to the north and the lower, shaley Newport Head and rocks to the south. The beach has single sand bar cut by two shifting beach rips and permanent rips against the rocks at each end.

There is a large stormwater drain in the middle of the beach which discharges across the beach berm to the ocean, with a steep catchment falling from Bilgola Plateau through a natural creek with significant Cabbage Tree Palm stands. Stormwater quality of this drain is unknown however complaints regarding beach pollution at Bilgola have been received. There are two smaller stormwater outlets at the northern end of the beach.

8.4.5 Newport Beach

Newport Beach is 1.3 kilometres long running from Newport Head in a gentle arc to Newport Reef, a 1 kilometre long sandstone reef which runs due east and it's the most significant reef in the Pittwater area with the adjoining rock platform being an IPA. The southern rock platform has a rock built into it.

Two stormwater drains discharge on to the beach with the largest drain to the south of the surf club forming the discharge from McMahons Creek. Both outlets contribute to dune erosion and beach pollution complaints have been received regarding the main stormwater drain.

8.4.6 Bungan Beach

Bungan Beach is 700 metres long running south-south east between Bungan and Mona Vale Headland. The beach is backed by partly vegetated dunes rising to steep cliffs up to 60 metres high. A number of natural depressions and water courses discharge across the beach dune system and berm, with three separate watercourses discharging across the beach berm from locations adjacent to the surf club building.

A single bar runs the length of the beach with two strong rips against rocks at either end and two or three shifting rips along the beach. Rock platforms at the northern and southern end of Bungan Beach are both IPA's.

A new sewer pumping station constructed and septic runoff/overflow is a water quality issue. This affects the water quality of the three stormwater drains. The drains discharge directly onto the beach and contribute to dune erosion.

8.4.7 Mona Vale and Basin Beaches

Basin Beach is a 300 metre semicircular beach in the lee of the northern Mona Vale Head (an IPA) and the extensive rock platforms and reefs to the south and centre. Mona Vale rock pool lies on the southern rock platform.

Mona Vale Beach runs south east for 1 kilometre between the rock platform that divides it from Basin Beach, to the food of the 30 metre high shale cliff that separates it from its southern neighbour Warriewood Beach to which it is periodically joined. There are two periodically exposed rock outcrops and stormwater outlet along the beach. Dune erosion and beach pollution are associated with this drain. Pollution

levels on Mona Vale Beach can be influenced by the sewage ocean outfall at Turimetta Head when southerly weather prevails.

8.4.8 Warriewood Beach

Warriewood Beach runs for 500 metres from the northern cliff face and rocks to the base of Turimetta Head which protects the beach from the south, causing it to curve around and face the east north east. A single attached bar runs to the north and is cut by a permanent rip that flows out over the southern rocks known as Pot Rock.

Stormwater drains exist at each end of the beach. Beach pollution is mostly associated with the sewage outfall which discharges directly off Turimetta Headland from the Warriewood Sewage Treatment Plant (STP).

8.4.9 Turimetta Beach

Turimetta Beach is a small 350 metre long beach between Turimetta and Narrabeen Headland backed by 20 to 30 metre high shale bluffs.

Beach pollution is associated with the ocean outfall discharging off Turimetta Head and bluff erosion is evident.

8.4.10 Beachwatch

The NSW Office of Environment and Heritage's (OEH) Beachwatch program monitors for faecal (enterococci) contamination at swimming locations of ocean and harbour beaches. The program provides information on the cleanliness of the water, allowing the individuals to make informed decisions on when and where to swim.

OEH publishes the results on the OEH website via:

- Daily pollution forecasts
- Weekly star ratings
- Annual State of the Beaches reports, and
- Data downloads.

OEH monitors ten ocean and ten estuarine swimming locations within the Pittwater LGA. Table 3 identifies locations tested by the Beachwatch program in the Pittwater LGA.

Ocean Beach Sites	Estuarine Beach Sites
Palm Beach, Whale Beach, Avalon Beach, Bilgola Beach, Newport Beach, Bungan Beach, Mona Vale Beach, Warriewood Beach, Turimetta Beach and North Narrabeen Beach	Barrenjoey Beach, Great Mackerel Beach, The Basin, Paradise Beach Baths, Clareville Beach, Taylors Point Baths, North Scotland Island, South Scotland Island, Elvina Bay and Bayview Baths.

Table 3: OEH Beachwatch monitoring sites.

Improvements in stormwater and wastewater management have contributed to cleaner beach water quality.

8.4.11 Ocean Beaches and stormwater

Pittwater Council's ocean coastline is approximately 18 kilometres long, extending from Barrenjoey Headland in the north to the Narrabeen Lagoon entrance in the south. The coastline is comprised of 8 distinct embayments and 10 surf beaches. Table 4 outlines developed from Pittwater's Stormwater Management Plan 1999, identifies stormwater infrastructure at Pittwater's surf beaches.

Surf Beach	Stormwater and pollution information
Palm Beach	There are five stormwater drains which discharge onto the southern end of Palm Beach. The outlets cause erosion problems and could contribute to water pollution near the rock pools in storm events.
Whale Beach	Several stormwater outlets drain onto the beach with two at the southern end near the rock pools which may contribute to erosion and water pollution in storm events. There are two stormwater outlets in the centre of the beach.
Avalon Beach	There is a small stormwater outlet at the northern end of the beach.
Bilgola Beach	There is a large stormwater drain in the middle of the beach which discharges across the beach berm to the ocean, with a steep catchment falling from Bilgola Plateau through a natural creek with significant Cabbage Tree Palm stands. Stormwater quality of this drain is unknown however complaints regarding beach pollution at Bilgola have been received. There are two smaller stormwater outlets at the northern end of the beach.
Newport Beach	Two stormwater drains discharge onto the beach with the largest drain to the south of the surf club forming the discharge from McMahons Creek. Both outlets contribute to dune erosion and beach pollution complaints have been received regarding the main stormwater drain.
Bungan Beach	Number of natural depressions and watercourses discharge across the beach dune system and berm, with three separate watercourses discharging across the beach berm from locations adjacent to the surf club building.
Mona Vale and Basin Beach	A rock platform divides Mona Vale and Basin beaches. Two periodically exposed rock outcrops and a stormwater outlet are present on Mona Vale beach. Dune erosion and beach pollution are associated with this drain. Pollution levels on Mona Vale Beach can be influenced by the sewage ocean outfall at Turimetta Head when southerly weather prevails.
Warriewood Beach	Stormwater drains exist at each end of the beach. Beach pollution is mostly associated with the sewage ocean outfall which discharges directly off Turimetta Headland from the Warriewood Sewage Treatment Plan (STP).
Turimetta Beach	Beach pollution is associated with the ocean outfall discharging of Turimetta Head and bluff erosion is evident.

Table 4: Pittwater's surf beaches and stormwater infrastructure (Pittwater Stormwater Management Plan, 1999).

8.4.12 Scotland Island and stormwater

With an area of 55 hectares, Scotland Island has over 300 houses across its shores and slopes. There are no town water or sewer treatment system connections to the mainland. Sewage disposal is predominantly by septic tank and soil absorption systems (Pittwater Stormwater Management Plan, 1999).

Thirty percent (30%) of the island has slopes greater than 20%, stream gradients are steep and flow is ephemeral. Stream responses to rainfall is rapid with minimal infiltration. There are 15 drainage subcatchments on the island, with no formal drainage system (Pittwater Stormwater Management Plan, 1999).

This combined, with the poor performance of a large number of the onsite sewage treatment and disposal systems results in significant loads of sediment, nutrients and bacteria being discharged to Pittwater in stormwater runoff (Pittwater Stormwater Management Plan, 1999). Stormwater runoff from private properties and overland flow during rainfall events cause erosion on Scotland Island.

8.5 Values

The *Stormwater Management Strategy 2015 – 2019* aims to protect and enhance the economic, ecological and social values of Pittwater's catchments including their receiving waters.

The values identified by the community during the development of the *Pittwater Stormwater Management Plan 1999* and *Pittwater 2025* both give high importance to protecting and enhancing our local catchments and waterways. The maintained high value of the local community for our catchments and waterways, identifies a priority for improving stormwater management within Council operations and projects.

Working towards becoming a water sensitive city will ensure that these values are protected and enhanced.

8.5.1 Pittwater Stormwater Management Plan 1999 Values

The community identified what they considered to be important economic, ecological, social and cultural values of catchments during the development of the Pittwater *Stormwater Management Plan 1999*. These values are listed below.

8.5.1.1 Economic values

Economic values of a catchment include:

- Stormwater reuse opportunities
- Economic values of receiving waters (e.g. swimming, surfing, fishing and tourism)
- Property value used for stormwater management (including value of land adjacent to stormwater treatment devices)
- Agriculture

8.5.1.2 Ecological values

Ecological values of a catchment include:

- Areas which play roles in maintaining healthy and functional ecosystems

- Area used by aquatic and terrestrial flora and fauna species and communities (including areas used as part of a life cycle and for migration)
- Areas which benefit the health, welfare and safety of the community

The ecological values of surrounding areas (e.g. waterways, receiving waters) that are outside the boundaries of the Pittwater LGA should also be included.

8.5.1.3 Social and cultural values

Social and cultural values of a catchment include:

- Public health and safety
- Recreational uses
- Visual amenity
- Historical and spiritual significance
- Scientific uses
- Educational uses

8.5.2 Pittwater 2025 values

During community consultation of Pittwater's Community Strategic Plan *Pittwater 2025*, it was asked that the community rank their importance of the Plan's five key directions. Results of the survey ranked highest priority (1) to lowest (5), of the key direction, being:

1. Supporting & Connecting our Community
2. Valuing & Caring for our Natural Environment
3. Enhancing our Working & Learning
4. Leading and Effective & Collaborative Council
5. Integrating our Built Environment

Under the second highest priority held by the Pittwater community, 'Valuing & Caring for our Natural Environment' the following areas are included:

- Preserving estuaries, beaches and coastal environments
- Effectively managing waste and pollution control
- Protecting catchments and waterways
- Protecting and enhancing vegetation
- Encouraging diversity of plan and animal species
- Addressing the impacts of climate change

Stormwater quality and quantities directly impact all areas included under the key direction 'Valuing & Caring for our Natural Environment'.

9 Appendix C: Water Quality and Quantity

This chapter provides information on factors which affect the quality and quantity of stormwater. Projected changes in climate and their impacts on stormwater are also provided.

9.1 Common urban stormwater pollutants, effects and sources

Table 5, modified from Environment Protection Authority (EPA) Victoria (2012), identifies:

- Common stormwater pollutants found in urban environments
- Effects from pollutants on: humans, plants, animals and environments
- Sources where these pollutants originate from.

Pollutant	Effects	Source
Sediment.	Reduces light penetration, decreasing plant growth which in turn reduces supply of food for organisms. Ability to clog and damage sensitive tissues e.g. gills of fish. Smother and suffocate organisms that live on or in the bed of lakes and streams, through forming thick deposits when suspended materials settle out of water. Reduce aquatic (fresh and marine environments) flora habitats.	Erosion of land surfaces (e.g. soil and rock). Pavement and vehicle wear. Building and construction sites. Spillage and illegal discharge. Organic matter (e.g. leaf litter, grass). Car washing. Weathering of buildings / infrastructure. Atmospheric deposition.
Nutrients	Increase in nutrients, stimulates growth of aquatic plants (especially exotic weed species). Leads to excessive growth of aquatic weeds and algae that choke waterways and result in intense fluctuations in	Organic matter. Fertilisers.

	daily dissolved oxygen. Some nutrients can create aquatic conditions which encourage the growth of bacteria and viruses. Trigger algal blooms in recreational swimming and fishing sites. Which can also affect humans who fish within these waters.	Sewer overflows and or septic tank leaks. Illegal sewer connections to stormwater infrastructure. Animal faeces (e.g. cat, dog, rabbit). Detergents (from vehicle, fleet washing). Atmospheric deposition. Spillage and illegal discharge. Golf courses.
Oxygen demanding substances.	Unpleasant odours. Oxygen being used up faster than it can be diffused into the water from the atmosphere or from aquatic plants. Resulting in drop in oxygen levels leading to the death of fish and other aquatic organisms.	Decay of organic matter. Atmospheric deposition. Over flow and or leaks of sewer / septic tanks. Illegal sewer connections to stormwater infrastructure. Animal faeces. Spillage and illegal discharge.
pH (acidity).	Increase damage (e.g. acidic burn) to tissues and or organs of aquatic plants and or animals.	Decay of organic matter. Spillage and illegal discharge. Erosion of roofing material. Atmospheric deposition.

Mirco-organisms.	Water containing very high numbers of bacteria and viruses can cause illness (e.g. hepatitis and gastroenteritis). Cause disease in terrestrial land animals which feed on species and or drink from water containing very high numbers of bacteria and or viruses. Poison humans who eat fish and or aquatic species caught in polluted waterways with very high numbers of bacteria and or viruses.	Sewer overflows and or septic tank leaks. Illegal sewer connections to stormwater infrastructure. Decay of organic matter.
Toxic organics.	Poison living organisms and or damage their life processes. Poison humans who eat fish and or aquatic species caught in polluted waterways. Cause disease in terrestrial land animals which feed on species and or drink from waterways.	Pesticides. Herbicides. Sewer overflows and or septic tank leaks. Illegal sewer connections to stormwater infrastructure.
Heavy metals.	Poison living organisms and or damage their life processes. Persist and damage the environment and or living organisms for a long time. Poison humans who eat fish and or aquatic species caught in polluted waterways. Cause disease in terrestrial land animals which feed on species and or drink from waterways.	Atmospheric deposition. Vehicle wear. Sewer overflows and or septic tank leaks. Illegal sewer connections to stormwater infrastructure. Weathering of buildings / infrastructure. Spillage and illegal discharge.
Gross pollutants (litter and debris).	Choke animals which eat this material. Visual pollution.	Pedestrians and vehicles. Waste collection systems.

	Blockage of poorly maintained stormwater drains and pollution control systems.	Leaf-fall from trees. Twigs and branches from plants. Lawn clippings. Spills and accidents. Takeaway food providers.
Surfactants (Oils, detergents and shampoos).	Extremely toxic to fish and aquatic life. Poison humans who eat fish and or aquatic species caught in polluted waterways.	Asphalt pavements. Spillages and illegal discharges. Leaks from vehicles. Car washing. Organic matter. Petroleum products. Inappropriate waste disposal (e.g. oil/paints in bins)
Increased water temperature.	Higher water temperatures are lethal to fish and aquatic organisms. Increased water temperatures stimulate growth of nuisance plants and algae. Higher temperatures combined with other effects can decrease levels of dissolved oxygen which threaten aquatic life.	Run-off from impervious surfaces (e.g. roads, roofs and footpaths). Removal of riparian vegetation increasing sun exposure of aquatic environments.

Table 5: Common stormwater pollutants, their effects and their sources. Table has been adapted from Environment Protection Authority (EPA) Victoria (2012).

9.2 Factors affecting quality and quantity of stormwater

The NSW OEH 2013, identifies the following which can affect quantity and quality of stormwater flows:

- Period since last rainfall event and the intensity of the rain,
- Catchment area's building density and land uses
- Level of vegetation cover
- Cleanliness of roads, streets and footpaths
- Maintenance regimes (e.g. street sweeping, garden/landscape irrigation, rubbish bin emptying)
- Local practices (e.g. pet control, use of chemicals)
- Building development works

Other factors include:

- Location, number and capacity of stormwater pollution control devices
- Monitoring and maintenance schedule of pollution control devices
- Level of knowledge of residents and businesses on how to minimise pollution of waterways and stormwater systems.

9.3 Common threats to stormwater quality and quantity

A threat is any activity or land use which has the potential to negatively impact:

- Stormwater quality
- Stormwater quantity
- Economic, ecological and or social values of a catchment and its receiving waters/environments.

9.4 Climate change impacts

"The natural, social and economic systems of New South Wales will all be affected by climate change" (DECCW, 2010).

Stormwater quality and quantities and the types, location and maintenance of pollution control devices used to manage stormwater will be directly impacted by climate change.

Stormwater pipes will be placed under greater pressure to withstand greater stormwater volumes, speeds and increased duration of flows due to changed frequency and increased intensity of rainfall and storm events.

Climate change risks and acceptable risk levels should be assessed during the consideration and design of stormwater infrastructure and pollution control devices, to identify long term feasibility of stormwater management investment.

Table 6 has been developed using impacts and projected changes in climate identified by the Australia Government and applied to stormwater management.

Impact	Projected change in climate	Impact on stormwater management	Management response
Temperature*	Maximum daily temperatures projected to increase by an average 1.5 – 3°C[#]. Winter and spring to have greatest temperature increase with 2 - 3°C[#]. Summer temperatures increase 1 - 2°C[#]. [#] Projected changes at 2050	Increase in demand of water resources during hot weather events (e.g. drinking, irrigation, swimming pools). Increase in potential for odour and pollutant breakdown under anaerobic conditions.	Implementing water resource harvesting and reuse systems to strengthen water security and resilience (e.g. stormwater harvesting). Selection of free draining (not wet sump) stormwater pollution control device.
Rainfall*	20 – 50%[#] increase in summer rainfall. 10 – 20% increase in spring rainfall. Winter rainfall to decrease 10 – 20%[#], with increased temperatures and evaporation. Evaporation is projected to increase by 10 – 20 %[#] during spring and summer. [#] Projected changes at 2050	Increase in removal / filtration demand and capacity of/on pollution control devices due to increased stormwater volumes and flow speeds due to greater rainfall. Increased rainfall leading to greater transportation of pollutants via erosion, overland flow and runoff. Irregular flushing of waterways due to rainfall changes result in clogging of treatment systems. Greater pressure on stormwater storage	Increase stormwater harvesting and reuse systems to reduce stormwater quantities. Increase capacity of stormwater pollution control device. Use of pollution control systems which slow stormwater flows to allow separation and sedimentation of pollutants. Quadruple bottom line feasibility assessment of stormwater pollution device.
Sea level rise*	A 0.4m increase by 2050 and 0.9m by 2100 on 1990 mean sea level.	Stormwater pollution control devices becoming submerged and or damaged by ocean/estuary/waterway processes and or	Removal / repositioning of stormwater pollution control device.

		levels.	Quadruple bottom line feasibility assessment of stormwater pollution devices.
Coastal erosion/ shoreline recession*	Combination of increased wave heights, sea level rise and storm events will cause increase shoreline/coastal erosion.	Stormwater pollution control devices (e.g. pits and GPTs) become exposed and impacted / damaged by weather events.	Removal / repositioning of stormwater pollution control device. Quadruple bottom line feasibility assessment of stormwater pollution devices.
Run-off**	In addition to the shift in seasonality of run-off patterns, there will be a substantial summer run-off increase of up to 20%[#], and significant reduction in winter run-off of up to 25%[#]. Minor autumn increases and moderate to significant decrease in spring run-off is also predicted. [#] Projected changes at 2050	Increased in concentration of pollutants entering stormwater and waterways through changed run-off patterns and intensities.	Removal / repositioning of stormwater pollution control device. Increase capacity of stormwater pollution control device. Quadruple bottom line feasibility assessment of stormwater pollution devices.
Flooding**	In lower coastal floodplains areas sea level rise will intensify catchment-driven flooding, bringing about increased flooding events, height and range. Changes in rainfall frequencies and intensities will also impact flooding events.	Stormwater pollution control devices becoming submerged and or damaged by flood processes and or levels.	Removal / repositioning of stormwater pollution control device. Ensure adequate flow bypass in the stormwater pollution control device design. Quadruple bottom line feasibility assessment of stormwater pollution devices.
Tidal inundation**	The increase in sea level rise will directly increase low, mid and high	Stormwater pollution control devices becoming submerged and or damaged by flood	Removal / repositioning of stormwater pollution control device.

	tidal heights. Greater areas of low-lying land surrounding coastal waterways will experience greater tidal inundation events.	processes and or levels.	Quadruple bottom line feasibility assessment of stormwater pollution devices.
Extreme storms**	Increased frequency of extreme storms.	Stormwater pollution treatment devices being either damaged or destroyed by storm processes. Increase in stormwater flows during stormwater events transporting higher pollutant loads, resulting in blockages and damage to treatment devices. Increase in upstream flooding of pollution control devices during storm events.	Repositioning of pollution control devices at high risk of storm damage. Ensure adequate flow bypass in the stormwater pollution control device design.

Source: *DECCW (2010a)
**DECCW(2010)

Table 6: Climate change impacts on stormwater management.

10 Appendix D: Improving stormwater quality

Improving stormwater quality can be achieved through various methods. This section explores how water quality is driven through: source control, development controls, maintaining riparian corridors, water management guidelines and WSUD treatments.

Information on how to evaluate, prioritise, treatment selection, opportunities and constraints of WSUD is provided.

10.1 Source control

"Source control involves minimising the generation of excessive runoff and / or pollution of stormwater at or near its source" (NSW EPA, 1998).

Stopping pollution entering stormwater systems is the most effective way in improving stormwater quality (NSW OEH, 2013a).

Environment Australia (2002), identify the main source control methods which can be implemented to reduce sources of stormwater pollution:

- Implementing WSUD principles within developments
- Reducing soil loss from building and land developments
- Consideration of suitability of sewer overflow points to reduce discharges into stormwater systems
- Reduce impervious surface areas
- Implement regular street sweeping and maintenance of stormwater pollution control devices
- Increase stormwater and rainwater detention, storage and reuse systems (e.g. rainwater tanks and stormwater harvesting systems)
- Education of community and businesses

10.1.1 Improving source control management

NSW OEH has produced resources below which can assist in source control management for stormwater.

10.1.1.1 Sediment and erosion management – unsealed roads

Council is to refer to the NSW Office of Environment and Heritage *Erosion and sediment control on unsealed roads – A field guide for erosion and sediment control maintenance practices*, for management of unsealed roads.

10.1.1.2 Managing urban stormwater – soils and construction

Council is to refer to the NSW OEH *Volume 1 – Blue Book*. This document provides guidance on the design, construction and measures for implementation to improve stormwater management during the construction phase of a development.

10.1.1.3 Resource guide for local councils: erosion and sediment control

Council is to refer to the NSW OEH *A Resource guide for local councils: Erosion and sediment control* during the design and planning of a project. This document

provides assistance on how to improve erosion and sediment control across operations.

10.1.2 Pittwater DCP 21

Development Control Plans (DCP) set the standards and controls that apply when carrying out development or building work within Pittwater. The DCP supports Pittwater Local Environmental Plan 2014 (LEP 2014), which regulates and guides planning decisions and controls development through the land zoning and development standards. A copy of Pittwater LEP 2014 can be accessed from Pittwater Council's website.

Pittwater 21 DCP assists in the management of rain and stormwater by providing specific controls and requirements.

Construction and maintenance costs of stormwater pollution control devices required to be installed by developments across the Pittwater LGA are the responsibility of the private property owner.

10.1.2.1 Warriewood Valley

Pittwater DCP 21 identifies the water management and creekline corridors' standards and controls which apply to all land within Warriewood Valley Release Area. The Warriewood Valley Urban Land Release Water Management Specification (2001) aims to set benchmarks and provide practical guidance for Applicants and Council for the management of water during and after the development of lands on a sector by sector basis within Warriewood Valley. It also encourages sustainable uses of water and appropriate design of subdivisions using water sensitive urban design.

10.1.2.2 Ingleside Precinct

Ingleside precinct planning commenced in July 2013 led by the Department of Planning and Environment in partnership with Pittwater Council and NSW UrbanGrowth.

The precinct planning process investigates the development potential of the Ingleside area for potential land release. The environment, economic viability, development types, community and infrastructure is assessed during the investigation.

The protection of natural water cycles including opportunities for water harvesting and reuse will be assessed and investigated as part of this process.

10.2 Riparian corridors

The NSW Office of Water (2015a) defines a riparian corridor as:

"a transition zone between the land, also known as the terrestrial environment, and the river or watercourse or aquatic environment. Riparian corridors perform a range of important environmental functions".

The NSW Office of Water (2015a) identifies the following environmental roles carried out by riparian corridors:

- Stabilise bed and bank reducing bank and channel erosion
- Trap sediment and various pollutants thereby protecting water quality

- Provide diverse habitats for terrestrial, riparian and aquatic flora and fauna
- Connect wildlife habitats
- Assist in carrying and directing flood flows
- Act as a barrier between developments and waterways
- Offer passive recreational uses

Maintaining riparian corridors is an effective way of ensuring that these roles are maintained to avoid negative impacts on water quality of stormwater and aquatic environments. Reducing riparian corridor areas diminishes the ability and capacity of these areas to maintain the environmental roles listed above.

The Pittwater DCP 21 sets out standards and controls required for activities which involve riparian areas.

Additionally the NSW Department of Primary Industries *Guidelines for riparian corridors on water front land* and the *Water Management Act 2000* provide guidance for developments in Pittwater.

10.3 National water quality strategies and guidelines

Monitoring and testing stormwater quality against standard provided in national strategies and guidelines provides a method to identify the current state of catchments, waterways and the performance of a stormwater pollution control device. The following strategy and guidelines should be referred to when undertaking stormwater monitoring.

10.3.1 National Water Quality Management Strategy (NWQMS)

The National Water Quality Management Strategy (NWQMS) is a joint national approach for driving improvement in water quality in both Australian and New Zealand waterways (DEC, 2015). The NWQMS aims to protect water resources through improving water quality, while also supporting those which depend on water (e.g. businesses, industry, environment and communities) for future development (DEC, 2015).

Two key elements of the NWQMS establishing water quality benchmarks are the:

- *Australian and New Zealand guidelines for fresh and marine water quality – 2000 (ANZECC Guidelines)*
- *Guidelines for managing risks in recreational water 2008*

10.3.2 Australian and New Zealand guidelines for fresh and marine water quality (ANZECC Guidelines 2000)

The Australian Government's Department of the Environment (DEC, 2015a), defines the core objective of the *ANZECC Guidelines 2000* is:

"to provide an authoritative guide for setting water quality objectives required to sustain, current, or likely future, environmental values (uses) for natural and semi-natural water resources in Australia and New Zealand".

The *ANZECC Guidelines 2000* provides a framework for management of water quality which is established on nationwide policies and principles.

The aims of Pittwater Council's *Stormwater Management Strategy 2015 – 2019*, align with the aims of the *ANZECC Guidelines 2000* which are, *"to achieve sustainable use of water resources by protecting and improving their quality while maintaining economic and social development"* (DEC, 2015a).

The *ANZECC Guidelines 2000* should be used when evaluating and managing water resources.

10.3.3 Guidelines for Managing Risks in Recreational Water 2008

The *Guidelines for Managing Risks in Recreational Water 2008* is a tool which has been developed to ensure recreational water environments are safely managed. The aim of the guidelines is to provide a national approach in ensuring quality of coastal, estuarine and fresh waters.

The aims of Pittwater Council's *Stormwater Management Strategy 2015* – 2019, align with the aims of the *Guidelines for Managing Risks in Recreational Water* 2008. It is recommended these guidelines be used for any investigations on the water quality of estuary and ocean recreational swimming sites.

10.4 Water Sensitive Urban Design (WSUD)

In 2004 the Council of Australian Governments (COAG) defined water sensitive urban design (WSUD) as, *"the integration of urban planning with the management, protection and conservation of the urban water cycle that ensures that urban water management is sensitive to natural hydrological and ecological processes"* (WSUD Sydney, 2014).

By developing urban environments with WSUD principles, landscapes can be created which minimise impacts to the natural water cycle.

10.4.1 WSUD key principles

CSIRO (2006) identifies key WSUD principles:

1. **Protect and enhance waterways:** Protection of waterways within urban environments so they continue to be valuable community assets, promoting liveability and provide for the ecosystems that rely on them.

2. **Integrate stormwater treatment into the landscape:** Management of stormwater within the landscape instead of allowing it draining into waterways. This allows volume, intensity and frequency of stormwater to be reduced thereby improving stormwater quality before it enters waterways.

3. **Reduce potable water demand:** Capturing, treatment and reuse of stormwater to replace (town) water use reduces the demand and consumption of potable water.

4. **Minimise development costs:** WSUD lowers drainage infrastructure costs through; reducing pipe sizes and replacing larger water systems with local solutions.

10.5 Where can WSUD be applied

WSUD systems are flexible allowing them to be different sizes and applied across different developments.

Examples (but not limited to) include, new and or existing:

- Roads (including, kerbs, median-strip, roundabouts)
- Drainage systems
- Residential areas / developments (including, single and multistorey dwellings)
- Commercial and industrial areas / developments
- Carparks
- Driveways
- Access routes (including, footpaths)

10.6 Management factors to evaluate for new stormwater devices

When new stormwater devices are to be installed the following factors should be evaluated before construction of any new device.

Factor	Detail
Priority assessment	Compare the site to other areas within the LGA to identify where device will have greatest benefit for the community and the environment.
Funding for design, planning & construction	Identify where the funding is available from for the construction of the device.
Funding for maintenance	Is there enough ongoing funding available to maintain the device to ensure it remains operational? Ensure ongoing funding is possible and or approved before the device is constructed.
Responsibility	Who in Council will be responsible for the construction and ongoing maintenance of the device. Have this agreement in writing.

Table 7: Factors to consider when evaluating new stormwater devices.

Treatments which are installed and not properly maintained waste resources and eventually end up costing more money to fix and or decommission.

See 8.3 for a case study on the feasibility assessment of a GPT.

10.6.1 Factors to help prioritise stormwater treatment locations

The following factors should be considered when determining priority of a stormwater treatment device:

Factor	Detail
Number of pollutants treated	Devices which can trap and remove more pollutants are preferred over those which only trap one type of pollutant.
Catchment area (pollution loads)	Catchments with a greater proportion of urbanised area compared to natural area (e.g. bushland) are of greater priority. Catchments with greater urban areas will have higher pollution loads due to greater altered

	environments, impermeable surfaces and populations.
Environmental health	Catchments whose receiving waters have greater environmental degradation (e.g. poor water quality, reduced aquatic habitat, reduction in biodiversity) are of greater priority
Human health	Recreational waters which pose greater risk to human health have greater priority
Agency support	If a proposed stormwater treatment device location impacts or is positioned within; land, environments and or infrastructure managed by another Government agency, Council must contact the agency to ensure support (including financial support) for the device construction and maintenance.
Community support	Does the device address any validated community concerns received by Council about impacts of stormwater on receiving waters and or aquatic environments within the catchment?

Table 8: Prioritising stormwater treatment locations

10.7 Selecting a WSUD approach

10.7.1 Outlet approach

Construction of a large single treatment, located at the end/exit point of a catchment.

Advantage:

- One location to maintain.

Disadvantage:

- Treatment system needs to handle huge volumes of water at a single location.
- Treatment system can be located far away from a pollutants source.

10.7.2 Distributed approach

Distributed approach involves construction of numerous smaller treatment systems established throughout a catchment.

Distribution of WSUD treatments across a catchment delivers the best results in reducing stormwater pollutants before reaching waterways.

Advantages:

- Lower cost to community,
- Increase in protection of waterway water quality (including protecting waterways downstream of a treatment),
- Target pollutant hotspots,
- Lower risk of overall treatment system failure (failure of a single treatment does not significantly impact overall waterway protection from multiple treatments),
- Greater opportunity for harvesting and reuse of stormwater,

- Different treatment systems can be used within a catchment to target different pollutants,
- Treatment systems can gradually be implemented,
- Greater pollutant removal efficiencies due to treatments being constructed in areas with lower flow and volumes.

Disadvantages:

- More sites to maintain.

10.8 Stormwater treatment train

Treatment trains are used to meet stormwater management / treatment of specific environments.

Treatment trains are commonly used in situations where treatment requires certain pollutants need to be removed to avoid impacting its operation / pollutant removal efficiencies.

Table 9 identifies train treatments and their functions

Treatment	Processes	Stormwater Pollutants	Common applications
Primary	Physical screening Rapid sedimentation	Gross pollutants Coarse sediment	Swales Litter traps Sediment ponds
Secondary	Sedimentation and filtration of fine particles	Fine sediment Attached pollutants	Swales Infiltration trenches Bio-retention systems Porous paving
Tertiary	Greater sedimentation and filtration Biological update Sediment absorption	Nutrients Dissolved heavy metals	Bio-retention Bio-infiltration Wetlands

Table 9: Treatment train treatments and functions Melbourne Water (2015).

10.9 Selecting a WSUD treatment

There are numerous WSUD systems which can be tailored to address specific purposes, pollutants and sites.

The following table outlines six steps developed by Melbourne Water (2015a), which can be used to select a suitable stormwater treatment.

Step	Things to consider
Determine objectives of treatment	What pollutant are you addressing? (e.g. sediment, litter, nutrients) What level does the pollutant occur at? What do you want to achieve from the treatment? (e.g. improve water quality, protection of aquatic biodiversity / habitat)
Understand the catchment	What are urban characteristics of the catchment? (e.g. developments, residential, commercial, roads, footpaths, roofs) What are the natural characteristics of the catchment? (e.g. bushland, parks, deciduous trees) Are their requirements from asset owners / land managers on the type of system to be used? Identify constraints and opportunities of physical characteristics of the catchment Water reuse opportunities (e.g. irrigation, fit-for-purpose water, groundwater recharge)
Short list treatments	Develop shortlist based on treatment objectives and catchment characteristics
Identify best treatment	Identify which treatment is going to serve Council best. Take into consideration: Maintenance Operability Pollution retention Capital and lifecycle costs Secondary benefits (e.g. alternative water supply) Land required
Identify responsibilities	Identify and agree who will manage the treatment system. Consider: Department who will manage system (including who pays for management) What is the maintenance schedule for the system How will the system be handed over
Detailed design	Develop design of treatment system using: Engineers Landscape architects Scientists/environment teams Operational staff

Table 10: Steps to follow when selecting and designing a stormwater treatment.

10.10 Opportunities and constraints for WSUD implementation

10.10.1 Location / site characteristics

Melbourne Water (2015a) identifies following characteristics should be considered when developing treatment systems:

- Topography: slope gradients,
- Soils and geography: acid sulphate soils, erosion risk, void spaces of soils/materials, bedrock depth,
- Groundwater: water table depth and geochemistry,
- Space: proximity of underground services (e.g. gas, electricity) and availability of open space,
- Environmental: presence of significant flora and fauna species / communities and heritage values.

10.10.2 Social considerations during WSUD design

When designing a treatment system, social issues should be taken into consideration, especially when new / innovative designs are to be used.

Consider the following during the planning stage of a treatment system:

- Occupational health and safety, procedures during construction and for maintenance staff, using appropriate signage and fencing of hazards to restrict public access,
- Accessibility of site for maintenance trucks
- Possible odour problems,
- Possible visual impacts,
- Possible noise pollution from system,
- Possible risks and injuries to human safety from unauthorised access to treatment system,
- Possible risk of causing contamination (e.g. algal blooms, poisoning),
- Possible attraction of pests and vermin (e.g. mosquitos, rats).

10.10.3 Social opportunities from WSUD treatments

Implementation of WSUD treatments can provide social opportunities, including:

- Improve visual amenity through; macrophyte plantings and treatment systems removing pollutants from waterways,
- Stormwater harvesting and reuse within public areas (e.g. toilet flushing, irrigation),
- Minimising flooding occurrences,
- Improve public amenities.

10.11 Types of WSUD treatments

The following types of WSUD treatments are commonly used to improve stormwater quality and reduce pollutants reaching waterways.

10.11.1 Gross pollutant traps (GPTs)

There are various GPT treatment designs; however all provide a filter to remove litter/rubbish, organic matter and sediments which are greater than 5mm in size. A litter rack is usually located downstream of a GPT (NSW OEH, 2011).

GPTs are most commonly used a primary treatment due to their ability to filter out larger pollutants.

NSW OEH (2011) has identified the advantages and limitations to GPTs, shown in table 11.

Advantages	Removal of coarse sediments before entering waterways or another stormwater treatment system. Concentrate removed pollutants in a single location, allowing for easy removal. Practical for catchments greater than 8 ha. Suitable for retrofitting. They are designed with bypass features.
Limitations	Fine sediments unable to be removed. Can cause upstream flooding if trash rack becomes blocked by debris. Visually unattractive. Odour and health risks to maintenance staff handling removed material. If trash rack in GPT is full, potential for debris to remobilise.

Table 11: GPTs advantages and limitations

10.11.2 Swales

Swales are open channels which collect stormwater, they can be grassed-lined, vegetated or landscaped.

Swales provide primary and secondary treatment of stormwater. Swales physically screen coarse and fine sediments and allow stormwater to infiltrate into soils. Infiltration and treatment can be increased by elevating the outlet slightly to aid in detention of water (Melbourne Water, 2015b).

NSW OEH (2011) has identified advantages and limitations to swales, shown in table 12.

Advantages	Runoff velocity can be reduced. Coarse particulates are removed. Cost effective. Visually attractive. Swales can pre-treat stormwater.
Limitations	More space required compared to area taken by kerb and guttering. Surface can be damaged by; cars parking, bike tracks and footprints. Swales require heavy vegetation before carrying runoff. Poor maintenance can lead to infestations of mosquitoes and weeds. Erosion can also occur. Difficult to maintain

Table 12: Swales advantages and limitations

10.11.3 Infiltration trenches

Infiltration trenches are excavations filled with a porous material. Trenches collect stormwater run-off while the porous material captures dissolved pollutants. Stormwater is then absorbed by surrounding soil (Melbourne Water, 2015c).

Infiltration trenches provide primary, secondary and tertiary treatment of stormwater. Pollutants retained within trenches include, gross pollutants, coarse sediments, removed nutrients and dissolved heavy metals (Melbourne Water, 2015c).

NSW OEH (2011) has identified advantages and limitations to infiltration trenches, shown in table 13.

Advantages	Suitable for areas with high permeable soil types. Recharges groundwater. Reduces run-off volumes and rates, thereby reducing downstream channel erosion.
Limitations	Requires large area of land. Reported high failure rates for treatment system. Possible groundwater contamination risk. Possible creation of mosquito breeding ground. May worsen flooding if basin becomes blocked. Hydraulic overload possible from catchment flows exceeding infiltration capacity. Hard to access for maintenance.

Table 13: Infiltration advantages and limitations.

10.11.4 Bio-retention systems

Bio-retention systems are also known as rain gardens. Bio-retention systems are vegetated filters that hold/pond stormwater, allowing the water to pass through different filtering mediums.

Bio-retention systems allow for primary, secondary and tertiary treatment of stormwater. Bio-retention systems provide, physical screening, rapid sedimentation, separation processes, biological uptake and breakdown of pollutants and nutrients and retain heavy metals and toxicants (Melbourne Water, 2015d).

Pollutants commonly left after treatment include; gross pollutants, coarse sediments, nutrients and heavy metals (Melbourne Water, 2015d).

Melbourne Water (2015d) has identified advantages and limitations to bio-retention systems, shown in table 14.

Advantages	Recharge groundwater (for unlined systems) High treatment levels compared to space required. Scalable system for use at property, street and regional levels.
Limitations	Systems can become clogged with sediments (if not properly maintained).

Table 14: Bio-retention advantages and limitations.

10.11.5 Constructed wetlands (artificial wetlands)

Constructed wetlands are man-made shallow and densely vegetated. Wetlands are a series of vegetated ponds, which constantly fill and drain. This process allow for filtering of stormwater via physical and biological processes. These systems provide a natural way to treat stormwater before entering waterways (Melbourne Water, 2015e).

Melbourne Water (2015e) notes wetlands require the following:

- **Inlet Zone:** Sediment pond for removal of coarse sediments.
- **Macrophyte Zone:** Main zone of the wetland characterised by being shallow, permanent ponds of water present and being densely planted with aquatic plant above and below water surface. Fine sediments/particles and dissolved pollutants are removed in this zone.
- **High flow bypass channel:** Diverts flood waters around to protect macorphyte zones.

NSW OEH (2011) has identified advantages and limitations to infiltration trenches, shown in table 15.

Advantages	Provide habitats for wildlife. Provide recreational areas for community. Sites can be used as an educational tool for the community. Visually appealing. Practical for catchments greater than 8 ha. Able to be implemented within existing urban areas.
Limitations	Cannot be used on steep terrain/slopes. A constant source of water is required to remain wet year round. Stream weir structures may require fishways to provide access for fish. Possibly contribute to groundwater pollution. Possible impacts on public safety from, physical, chemical or biological risks. Expensive to maintain.

Table 15: Constructed wetland advantages and limitations.

10.11.6 Rainwater tanks (stormwater harvesting)

Rainwater tanks (stormwater harvesting) store collected/harvested stormwater off impervious surfaces (e.g. roads, footpaths, roofs). Harvested water is then reused as an alternative water source to potable water (tap water).

Rainwater tanks provide primary and secondary treatment of stormwater, removing coarse and fine sediments. Treatment retains low level atmospheric and pollutants transported off impervious surfaces by run-off.

Melbourne Water (2015d) has identified advantages and limitations to rainwater tank harvesting systems, shown in table 16.

Advantages	Stores harvested water close to source. Reduce site run-off and minimise flood peaks.
Limitations	Tank water needs to be used to ensure enough storage is free for next rainfall event.

Table 16: Rainwater tank (stormwater harvesting) advantages and limitations.

10.11.7 Boom (litter boom)

A boom is a barrier which floats across the top of a channel. Booms contain a mesh skirt, which sits under the boom to assist in trapping buoyant pollutants. Booms can angled across a waterway's surface to direct floating pollutants into a collection point.

Booms provide primary treatment, retaining gross pollutants and litter. NSW OEH (2011) has identified advantages and limitations of booms, shown in table 17.

Advantages	Floating rubbish is removed. Appearance of waterways downstream from treatment are improved. Treatment can be moved after installation. Treatment can be used within existing drains and channels.
Limitations	Litter can pass under the boom and boom skirt during high water flow events (e.g. floods). Boom can be damaged from large gross pollutants (e.g. logs, large litter) or intense flow events (e.g. large storms). More susceptible to vandalism. Usually only accessible by boat. Buoyant pollutants only trapped.

Table 17: Boom advantages and disadvantages.

10.11.8 Litter/trash racks

Litter/trash racks are a barrier made from a series of metal bars or cage across a channel, which capture litter and large gross pollutants. Water is commonly diverted to pass through a litter rack. Litter racks provide primary treatment of stormwater.

NSW OEH (2011) has identified advantages and limitations of litter/trash racks, shown in table 18.

Advantages	Commonly used as part of a GPT treatment system. Litter is collected at a single location. Treatment can be used within existing drains and channels.
Limitations	May cause flooding upstream of treatment. If used in tidal areas, litter may be washed upstream. Treatment system can be unsightly. Racks can cause odours and health risks to maintenance staff. Sediments, nutrients, oil, grease and pathogens are not captured by racks. Costly to clear channels.

Table 18: Litter/trash rack advantages and limitations.

11 Appendix E: Case study – GPT feasibility assessment

The following case study is provided to identify the factors considered during the feasibility assessment of installing a stormwater pollution control device.

Figure 2 below highlights the subcatchment outlined in red which drains into Winji Jimmi Bay.

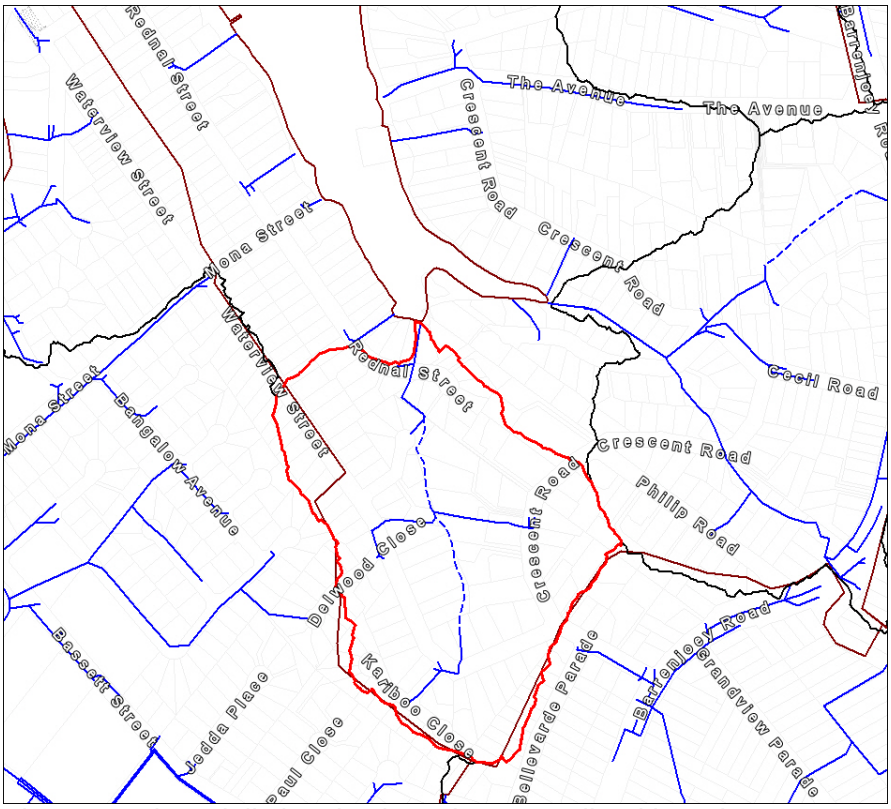

Figure 2: The Winji Jimmi subcatchment outlined in red.

Location	Rednal Street, Mona Vale
Subcatchment	Winji Jimmi
Subcatchment features	The catchment includes reserves (trees/bush), private property gardens, lawns, roads and footpaths. The stormwater system includes both natural (creek) and piped infrastructure.
Subcatchment area	0.3536km^2
Subcatchment pollution sources	Road and streetscapes (e.g. pedestrian and cars). Residential run off (e.g. sediments, organic matter, rubbish, garbage collection spills). Natural environment (e.g. leaves, sticks, branches, weeds, sediments).

Assessment	Notes
Stormwater treatment device	In-ground GPT.
Pollutants treated	Suspended sediments and large insoluble pollutants (e.g. organic matter and rubbish).
Access	The main drainage line for the catchment runs under private property and terminates into Winji Jimmy Bay.

	Due to land acquisition for construction and footprint of unit, best location is under Rednal Street between 68 and 69 Rednal Street. *Locations of underground services also need to be considered when selecting a position of a treatment device.*
Road works required	Yes. Excavation of the road required for construction of GPT and pipe connection works. Replacement of road required upon completion of GPT construction.
Earthworks required	Yes. Excavation and removal of sediment required for construction of GPT unit and associated pipe connection works. Disposal of unused excavated sediment required.
Pipe connection works	Yes. Excavation, construction and connection of pipes to main stormwater line required.
Construction issues / hazards	Short term road blockages and additional road traffic from construction team during installation. Security fencing / blocking around device during installation until completion. Reduction in off-street parking during construction. Ensuring no run-off from disturbed soil into stormwater system and waterway during construction / rainfall events.
Stormwater harvesting and reuse opportunities	No irrigation or building reuse opportunities.
Maintenance schedule	Removal of sediment via suction. Removal of insoluble pollution via basket removal (required crane).
Maintenance requirements	Sectioning off and blocking part of road during maintenance. Site/road safety plan for maintenance. Manual (e.g. hand) cleaning as required.
Maintenance issues / hazards	Car traffic hazards to maintenance workers. Parked cars creating access issues for maintenance trucks. Truck and or area sectioned off for GPT for maintenance, results in blocking access to private resident homes during cleaning. Risk of injury to maintenance staff from GPT basket and crane used during basket removal, cleaning and reinstallation. Risk of injury during suctioning and manual cleaning involved entering the treatment device.
Quadruple bottom line assessment	Quadruple bottom line assessment of the social, environmental, financial and governance factors to identify benefits and risks of the proposed stormwater treatment device. Consideration of the following factors when assessing a stormwater pollution device: Social: What benefits are gained by / risks to, the community / local residents from the installation of the GPT? Are any recreational and or business activities being impacted by current stormwater quality from the catchment? Environmental: What benefits and or risks are posed to the aquatic environments and species of Winji Jimmi Bay? What acid sulphate soil risks are involved in the project? What is the severity and priority of any environmental issues identified

	for the catchment? What are the climate change, flood and storm risks to the device and catchment? Financial: What financial contribution is required for the construction and ongoing maintenance. Are allocated funds for this project providing the greatest benefit for the community, environment and council. Is the device a good investment in the long term management for the catchment. Governance: Are there alternative management options to reduce any identified environmental impacts occurring to Winji Jimmi Bay. Does the project link to the objectives, outcomes, targets and vision of Council's long term strategic planning. Is the project supported by external agencies (e.g. NSW Office of Environment and Heritage, NSW Fisheries).
Modelling	Modelling of the catchment to identify any flooding risk issues caused by GPT construction.
Ownership	The authority which manages land across the Pittwater LGA varies. It can be owned by a single or multiple authorities. An authority could be: Pittwater Council, private resident or a State or Federal Agency (e.g. Department of Crown Lands or Sydney Water). Approval from the managing authority of the land is required for any works carried out on their land and or which involve infrastructure under their authority.
Endorsement / Approvals / Stakeholders	When assessing a stormwater pollution control device, Council engages, collaborates and seeks advice, endorsement and or approval (where required) on the project with relevant stakeholders. This is important to ensure the correct and agreeable management action is taken. Stakeholders can include but not be limited to: NSW Office of Environment and Heritage NSW Roads and Maritime NSW Environmental Protection Authority NSW Office of Water NSW Department of Primary Industries (Land and Fisheries) Sydney Water NSW National Parks and Wildlife Service
Construction cost*	$200,000 (A. Taylor, 2005).
Annual maintenance cost*	$20,000 (~10% of construction cost annually) (A. Taylor, 2005).
Decommissioning cost*	$32,000 (~16% of total acquisition cost).

*Construction, maintenance and life cycle costings will vary depending on unit, time of project and location. Prices are the average costs for construction and maintenance of an in-ground GPT. Average costs are based on review of Australian stormwater treatment projects and do not take into consideration inflation (A, Taylor, 2005).

Pittwater Council has hundreds of stormwater outlets which terminate into local waterways. Construction and maintenance costs are expensive, therefore it is essential that any proposed stormwater treatment device is assessed not only on a catchment level but also against the entire Local Government Area to determine its

overall benefit and priority. Installation of stormwater pollution control devices at the end of all stormwater outlets is not practical, financially viable or sustainable.

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