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**STORMWATER PLANNING IN CANBERRA, AUSTRALIA**

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**ABSTRACT**

Since its inception the ACT Government has been committed to a high level of planning and the formulation of policies and guidelines to guide both new development and redevelopment in Canberra. These Policies and guidelines which provide the context for development are outlined.

The lower Molonglo Valley, downstream of Scrivener Dam, and the East Lake area in the Jerrabomberra Creek catchment are both identified as areas of possible future urban development in Canberra, Australia.

In 2006 a Stormwater Management Strategy for the lower Molonglo Valley was released. It identifies values, sets objectives and assesses water quantity and quality management issues, flood flow management and dam safety issues. A wide range of options for the ACT Government to meet its regional and catchment-wide stormwater quality targets were also assessed.

Future development in the East Lake area in Canberra is envisaged to become a showcase of sustainability in Australia. Among many other aspects, the continuing health and functionality of waterways is a key characteristic of proposed sustainable development in the East Lake area.

The various stormwater studies that have been undertaken to assess the impacts of planned urban development in the Lower Molonglo Valley and the East Lake areas and the approaches that have been adopted to manage these impacts are outlined and discussed.

It is concluded that the stormwater planning for the Molonglo valley and Jerrabomberra Creek catchment demonstrate the ACT Governments commitment to sustainable development. It is also concluded that stormwater planning is a key part of a comprehensive and integrated approach to any future urban development of new growth areas in Canberra.

**1. INTRODUCTION**

As Canberra expands and grows, the water cycle undergoes a transformation from its natural regime. This transformation poses a significant risk to our environment as a result of (ACTPLA, 2007):

- a growing demand for mains water that requires an increased abstraction of water from either our existing water supply catchments or from new catchments;
- increasing volumes of wastewater that require treatment prior to discharge into the Murrumbidgee River;
- increases in the rate and volume of stormwater runoff which can erode our waterways and destroy ecological habitats; and
- increased mobilisation of pollutants such as nutrients, sediment and litter into local waterways, ponds and lakes.

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The costs of these impacts are not limited to the environment. They include significant social and economic costs as well. Some of these costs include:

- loss of amenity in our public places - our waterways and lakes become unattractive and can be closed to recreational use due to potential health risks; and
- loss of biodiversity - changed flow regimes and water quality in our creeks can no longer support species we value in our environment.

As a consequence the ACT Government is committed to a high level of planning and the formulation of policies and guidelines to guide both new development and redevelopment in Canberra.

## **2. PLANNING AND REGULATORY FRAMEWORK**

The following Government plans and strategies are relevant to the stormwater planning and management in the ACT.

### **2.1 The National Capital Plan**

Planning within the Territory is guided by the Commonwealth, through the National Capital Plan administered by the National Capital Authority, as well as the ACT Government and its planning authority. The National Capital Plan provides a general policy framework for land use and planning in the Territory, and more specifically guides the planning, design and development of areas of the Territory that have been identified as having national capital significance (Designated Areas).

Any significant departure from the National Capital Plan requires the Commonwealth's agreement to amend the National Capital Plan. Assessment of any such amendment would include consideration of matters of national significance.

### **2.2 The Territory Plan**

The Territory Plan is the key statutory planning document in the ACT, providing the policy framework for the administration of planning in the ACT. The purpose of the Territory Plan is to manage land use change and development in a manner consistent with strategic directions set by the ACT Government, Legislative Assembly and the community. It must not be inconsistent with the National Capital Plan. The Territory Plan includes broad principles and policies that guide development, through land use specific objectives and policies.

### **2.3 Canberra Spatial Plan**

The Canberra Spatial Plan, released on 5 March 2004 presents the ACT Government's preferred direction for accommodating Canberra's future growth over the next 30 years. It identifies a number of regions as potential greenfield development areas. In the case of the lower Molonglo Valley the Spatial Plan proposals for urban development are currently inconsistent with the National Capital Plan provisions and with the metropolitan structure plan for Canberra that it contains. For the Spatial Plan to be given effect, a Variation to the Territory Plan and an Amendment to the National Capital Plan are required to enable urban development to occur in the Molonglo Valley.

## **2.4 Development Planning**

Prior to any development occurring in a region, extensive planning, engineering and environmental studies are undertaken together with an environmental impact assessment, Variation to the Territory Plan and Amendment to the National Capital Plan. Major trunk infrastructure construction needs to be identified, incorporated and funded through the Government's and the ACTEW Corporation's capital works programs.

The ACT Planning & Land Authority (ACTPLA) is primarily responsible for delivering planning outcomes. The Land Development Agency (LDA) undertakes detailed design and construction and releases land for private enterprise land development. The NCA and ACT Government agencies are consulted widely during the planning phase.

## **2.5 Broadacre Studies**

Planning studies are undertaken within Broadacre areas within Development Planning areas to determine appropriate future land uses and options for urban development.

## **2.6 Environmental Flow Guidelines**

The 2006 Environmental Flow Guidelines are a disallowable instrument under the *ACT Water Resources Act 1998* that set out the environmental flow requirements needed to maintain aquatic ecosystems. The Guidelines have been developed using the most up to date scientific information available, and will be used with the Water Resource Management Plan *Think Water Act Water* to manage ACT water resources. The Environmental Flow Guidelines apply to all rivers and streams in the ACT. The 2006 Environmental Flow Guidelines replace the 1999 Environmental Flow Guidelines.

## **2.7 ACT Aquatic Species and Riparian Zone Conservation Strategy, Action Plan 29**

The strategy reflects government policy to protect and manage the rivers and riparian areas in the ACT that support threatened species and ecological communities. It outlines objectives and strategies and specific actions related to vegetation, riparian fauna and fish, crayfish and macro invertebrates. A central purpose of the Strategy is to inform decision-making with regard to conservation of threatened species, land use planning, and the development and management of land in the ACT.

## **2.8 Think water, Act water**

The ACT Government is committed to the sustainable use and management of ACT water resources and intends to implement best practice water management strategies. *Think water, act water, a strategy for sustainable water resource management in the ACT* was released on 28 April 2004. The strategy provides long-term guidance for the management of ACT water resources.

The strategy sets out six objectives:

- Provide a long-term reliable source of water for the ACT and region;
- Increase the efficiency of water usage;
- Promote the development and implementation of an integrated regional approach to ACT/NSW cross border water supply and management;
- Protect the water quality in ACT rivers, lakes and aquifers, to maintain and enhance environmental, amenity, recreational and designated use values and to protect the health of people in the ACT and down river;

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- Facilitate the incorporation of water sensitive urban design (WSUD) principles into urban, commercial and industrial development; and
- Promote and provide for community involvement and partnership in the management of the ACT Water Resources Strategy.

Development of new areas for urban use must do their part in contributing to the achievement of these objectives and targets.

## **2.9 WaterWays Water Sensitive Urban Design General Code**

The purpose of the water sensitive urban design (WSUD) guidelines is to provide a methodology for the implementation of WSUD in the ACT to assist in achieving the specific targets set out in *Think water, Act water strategy*. These guidelines apply to:

- Development of new residential neighbourhoods and estates;
- Redevelopment or in-fill development within the existing built environment; and
- Community, commercial and industrial developments.

The Guidelines provide mandatory targets for mains water use reduction and for stormwater quality and quantity management. These targets must be met for all new developments and redevelopments. The Guidelines describe a broad range of measures that can be utilised to achieve these targets and identify a number of assessment tools that can be used to demonstrate that the targets are being met. They also provide a range of acceptable solutions to assist with meeting the targets on less complex developments.

## **2.10 Rainwater Tank Guidelines**

The Rainwater Tank Guidelines was prepared in partnership between ActewAGL, Environment ACT and the ACT Planning and Land Authority (ACTPLA) and provides guidance on the installation of rainwater tanks in residential properties.

## **2.11 Design Standard for Urban Infrastructure - Stormwater**

The underlying objectives of the stormwater design policies and standards are to:

- provide safety for the public
- minimise and control nuisance flooding and to provide for the safe passage of less frequent flood events
- stabilise the landform and control erosion
- protect property from flooding
- enhance the urban landscape
- optimise the land available for urbanisation
- minimise the environmental impact of urban runoff on water quality
- provide opportunities to enhance the environment through the provision of water sensitive stormwater design

The standards cover all aspects of urban infrastructure including hydrology, road drainage, pipelines, sumps, manholes, engineered waterways, cutoff drains, retarding basins, gross Pollutant Traps, ponds and wetlands.

### **3. STORMWATER PLANNING IN THE MOLONGLO VALLEY**

The lower Molonglo Valley comprises the sub-catchments of the Molonglo River reach between Scrivener Dam and the confluence with the Murrumbidgee River including the existing urbanised catchments of Yarralumla Creek (Woden Valley) and Weston Creek. New development areas for urban (predominantly residential) and peri-urban uses are shown in **Figure 1**.

The Territory Plan was varied in December 2008 (Variation No. 281 Molonglo and North Weston) to enable urban development in parts of the Molonglo Valley and North Weston. This variation also introduced a Structure Plan for Molonglo and North Weston, and concept plans for the first suburbs of Coombs, Wright and North Weston, into the Territory Plan.

The Molonglo urban area is intended to accommodate a significant proportion of the future population growth of Canberra in a socially, environmentally and economically sustainable manner. The projected population for Molonglo at the time of the commencement of Variation 281 was 55,000 people.

Development of Molonglo Stage 1 is currently underway following the incorporation of the Coombs and Wright Precinct Code into the Territory Plan through a technical amendment in January 2010.

In August 2006 a Stormwater Management Strategy for the lower Molonglo Valley was completed. The primary objectives of the study were to identify values and set objectives and to assess water quality management issues, flood flow management, dam safety, selected environmental issues, recreational opportunities and to identify urban design objectives (Phillips & Paynter, 2008).

The strategy was supported by a Ponds and Lakes Options Study that assessed a wide range of options to meet the regional and catchment-wide stormwater quality targets as well as other urban design and environmental objectives. This study also included the consideration of opportunities within the existing urban areas of Weston Creek and Woden Valley.

Subsequently an Urban Water Management Study was completed in January 2007.

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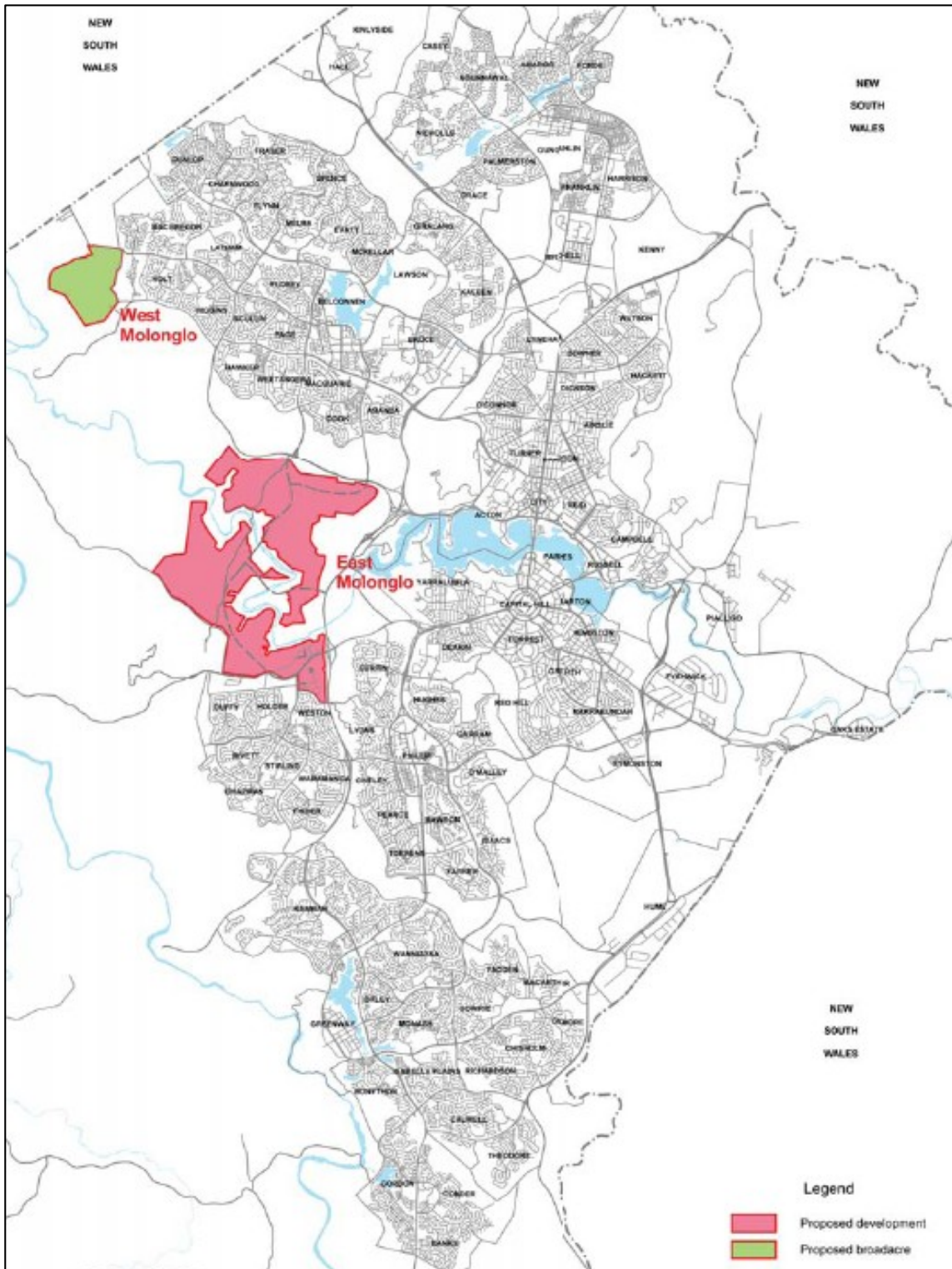


Figure 1 Molonglo development Areas

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### 3.1 Flood Management and Drainage

#### *Flood Planning Level*

It was recommended that the 100 year ARI flood level plus a 0.5 m freeboard allowance be adopted as the flood planning level for the lower Molonglo River and its tributary watercourses early in the planning.

The flood planning level for minor watercourses and engineered waterways within the proposed urban development areas would be the 100 year ARI flood level plus a 0.3 m freeboard in accordance with ACT Government guidelines. In the interim however, hazard rating issues associated with Scrivener Dam upstream of the development area mean that development is likely to be excluded from the areas subject to inundation under a dam break scenario during a PMF. It has been proposed that the viability of adopting multiple flood planning levels be explored further later in the planning process.

#### *Flow Management Strategy*

The recommended retardation strategy for urbanised sub-catchments draining to the Molonglo River is to reduce scour potential and required waterway reserve widths by providing flood storage in consolidated regional water quality control ponds at sub-catchments outlets and 'dry' basins at key locations scattered through the sub-catchment. The analyses undertaken indicated that retardation of flows discharged to the Molonglo River from Yarralumla Creek and Weston Creek is not necessary as discharges from these creeks do not affect the magnitude of peak flows in the Molonglo River.

#### *Drainage Strategy*

The urban drainage system should be designed generally in accordance with the ACT Design Standards for Urban Infrastructure and planning codes under the Territory Plan including the WaterWays WSJD General Code. Stormwater will drain to the tributary creek system and then to the Molonglo River (East Molonglo) or the Murrumbidgee River (West Molonglo). These tributary creeks will become important open space corridors for managing stormwater, enhancing wildlife habitat and movement, cycle and pedestrian paths, recreational activities and for major trunk utility services, and should be left in their natural state as far as practical or, if degraded, restored.

### 3.2 Water Quality Management

Three approaches were identified for the provision of regional stormwater treatment measures for the Molonglo Valley (Cardno Young, 2006)). These approaches were (refer Table 1):

**Table 1 Summary of Pond Option Strategies**

Regional Pond Strategy	Planned Molonglo Development Area		Existing Development	
	West	East	Weston Creek	Yarralumla Creek
Distributed Ponds	▲	▲	△	△
Consolidated Ponds	▲	▲	△	△
Lake or Regional Ponds		▲	▲	▲

▲ Possible Option

△ Option not considered in the strategy

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- *Distributed regional ponds or wetlands* – these ponds or wetlands would be located in all major drainage lines that receive runoff from planned urban development. Around 11 and 41 sites were identified for the planned West and East Molonglo development areas respectively (refer Figure 2);
- *Consolidated regional ponds or wetlands* – through the installation of diversion pipes or channels runoff from several subcatchments could be diverted to a lesser number of ponds or wetlands. It was estimated that are around 6 and 14 sites for the planned West and East Molonglo development areas respectively.
- *One or more (on-line) lakes* – one or more lakes located on the Molonglo River at or downstream of Coppins Crossing could treat outflows from Scrivener Dam, most runoff from the East Molonglo development area and runoff from the Weston Creek and Yarralumla Creek catchments.

Alternatively a lake on the Molonglo River could be supported by regional ponds located in the downstream reaches of Weston Creek and possibly Yarralumla Creeks depending on the timing of construction of a major lake and the feasibility of constructing ponds within these existing urbanised catchments.

*Stormwater Quality Objectives*

As stated in the WaterWays WSUD General Code (ACTPLA, 2007), the objectives for stormwater quality management would be achieved by the combination of works undertaken by the ACT Government, through its capital works program, and by Government and the private sector through works undertaken in new developments and redevelopments. These targets are shown in Table 2. They refer to reduction in pollutant export compared to an urban catchment with no water quality management controls.

**Table 2 Draft Targets for Stormwater Management (after ACTPLA, 2007)**

	<b>Developer/ Builder</b>	<b>ACT Government</b>	<b>Resulting Catchment-Wide</b>
Reduction in average annual TSS export	60%	60%	85%
Reduction in average annual TP export	45%	45%	70%
Reduction in average annual TN export	40%	33%	60%

*Stormwater Quality Objectives for Distributed and Consolidated Ponds*

Based on developers achieving the required reductions in SS, TN and TP export within urban areas the interim pollutant reduction targets for ACT government regional measures including ponds and lakes equated to 60%, 45% and 55% reductions in SS, TN and TP exports respectively. These targets were adopted for the initial conceptual sizing of distributed and/or consolidated regional ponds. Subsequently the adjusted regional targets given in Table 2 were adopted and would apply to subsequent detailed sizing of measures.

*Stormwater Quality Objectives for Lakes and Regional Ponds*

Lake Burley Griffin provides considerable water quality treatment and applying the pollutant reduction targets for ACT government regional measures to outflows from Scrivener Dam is hence not appropriate. Instead the adopted water quality objectives for a lake located on the Molonglo River downstream of Scrivener Dam with or without regional ponds on Yarralumla Creek and Weston Creek was “no increase in SS, TN and TP pollutant exports above the adopted benchmark condition”.



After discussion with stakeholders it was agreed that the benchmark condition was not existing conditions (with untreated runoff from the Yarralumla Creek and Weston Creek catchments) but rather the benchmark would be based on the following conditions:

- Existing outflows from Lake Burley Griffin including the existing quality of outflows;
- The quality of runoff from the urbanised Yarralumla Creek and Weston Creek catchments and runoff from the existing pasture in the Molonglo East catchment estimated using MUSIC; and
- The conceptual installation of regional ponds downstream of the urban areas in the Yarralumla Creek and Weston Creek catchments to meet the ACT Government's pollutant reduction targets (but not including the developer/builder targets).

The adopted benchmark average annual SS, TN and TP exports were rounded to 7,130 tonnes/yr (30% improvement on existing conditions), 261 tonnes/yr (7.8% improvement) and 17.8 tonnes/yr (11% improvement) respectively. While these improvements appear modest, they are significant considering that the lower Molonglo Valley subcatchments are only 4.3% of the total Molonglo River catchment to the development area.

#### *Lakes and Regional Ponds*

One or more lakes could be located on the Molonglo River at or downstream of Coppins Crossing and could treat runoff from the East Molonglo development area and the urbanised Weston Creek and Yarralumla Creek catchments. In 2006 four potential dam sites were identified for one or more regional ponds located on the Molonglo River as follows (refer Figure 2). Possible dam sites on Yarralumla Creek and Weston Creek were also identified by ACTPLA. The concept sizes of ponds located on the Molonglo River, Weston Creek and Yarralumla Creek adopted for the eight scenarios that were investigated are summarised in Table 3.

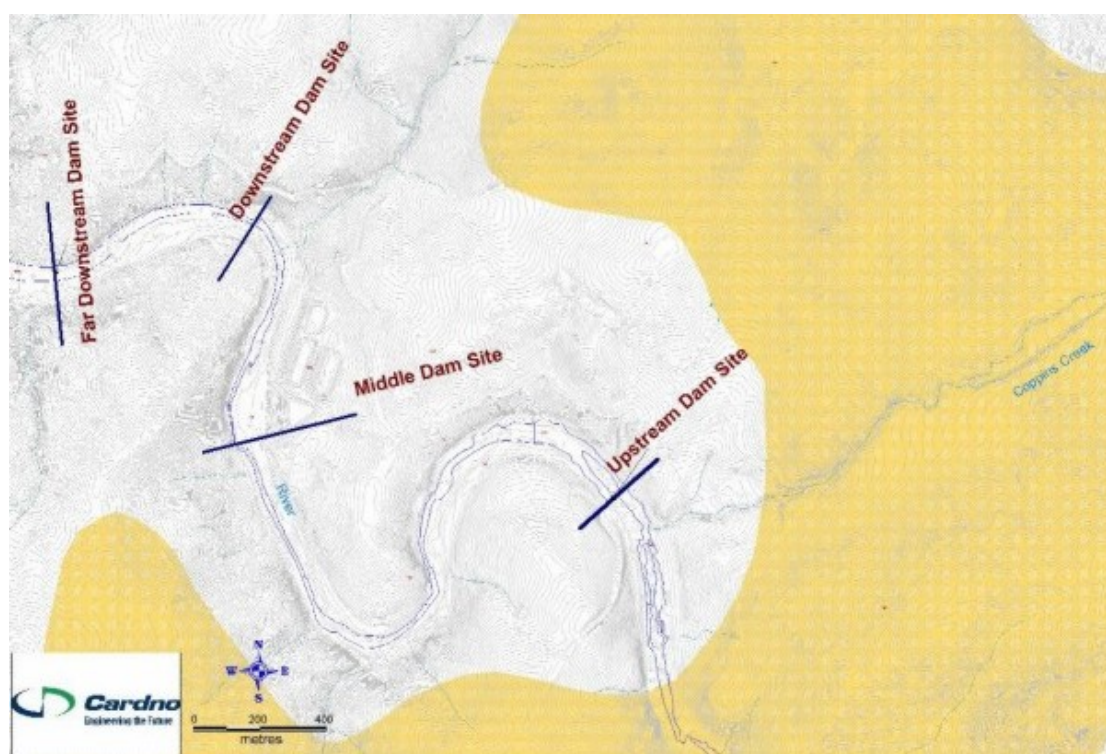


Figure 2 Concept Dam Sites on the Molonglo River

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**Table 3 Concept Sizes for Ponds and Lakes**

Scenario	Pond or Lake Volume (ML)			Molonglo River Dam Location
	Yarralumla Ck	Weston Ck	Molonglo River	
0	0	0	15,800	Far Downstream Site
1	0	0	16,000	Downstream Site
2	480	288	2,800	Downstream Site
3	150	422	6,300	Downstream Site
4	150	278	7,300	Downstream Site
5	480	288	2,800	Coppins Crossing
6	150	422	6,300	Coppins Crossing
7	150	278	7,300	Coppins Crossing

*Regional Pond and Lake Schemes*

Based on the technical assessment of pond options for the Molonglo Valley and an initial qualitative assessment of their economic, environmental and social aspects, three schemes were formulated by ACTPLA and its consultants for a triple bottom line assessment that is being undertaken in 2010. These schemes are summarised in Table 4.

Other studies are being undertaken to further investigate the schemes MV1 and MV2 and in particular issues of potential concern raised by stakeholders and the community regarding a new large lake located on the Molonglo River

**Table 4 Summary of Regional Pond and Lake Schemes for the Molonglo Valley**

Scheme	MV1	MV2	MV3
West Molonglo	Consolidated regional ponds		
East Molonglo	A 16,000 ML lake located at the Far Downstream site	A 6,300 ML lake at Coppins Crossing + consolidated regional ponds downstream of Coppins Crossing	Consolidated regional ponds only
Yarralumla Creek	No Pond	A 150 ML pond located downstream of the Cotter Road	150 ML pond downstream of the Cotter Rd + 330 ML of ponds in the upstream catchment
Weston Creek	A 280 ML pond located downstream of the Cotter Road	A 280 ML pond located downstream of the Cotter Road	A 280 ML pond located downstream of the Cotter Road

*Other Related Studies*

The Molonglo Valley Urban Water Management Strategy was completed in January 2007. This investigation looked into 18 urban water supply options ranging from conventional water supply systems (business as usual) to stormwater harvesting, sewer mining, reuse from the nearby Canberra sewage treatment plant (LMWQCC) and on-site supply options including rainwater tanks and greywater use.

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Options were discussed with agencies and the water supply authority to arrive at a preferred solution combining conventional supply and wastewater systems, stormwater harvesting from a central lake and widespread application of water sensitive urban design options at the block and neighbourhood scales.

The Molonglo Lake EIS Scoping Study was completed in July 2007. It identified the range of likely issues to be included within an EIS for a proposed lake. Legislative and approval requirements and processes are discussed and the broad range of scope items were grouped under 'People', 'Place' and 'Prosperity' headings for the current situation, during construction, long term operation and the beneficial impacts.

The Lake Molonglo Water Quality Study was completed in August 2007. This study focussed on the likely in-lake water quality issues and performance based on a comparison of other urban lakes in the ACT and a one dimensional hydrodynamic analysis of the proposed water body. It was concluded that any proposed lake would stratify during periods of the year as for all other lakes in the ACT but that this would not necessarily create water quality issues in surface waters. Destratification options would be available to prevent this if required.

The North Weston Pond Feasibility Study was completed in September 2007. The construction of a 280 ML pond on the Weston drain was identified in the 2006 study as one element of the stormwater management strategy for lower Molonglo Valley. It is to be implemented ahead of new residential development. The pond is in a challenging location which was once a sewage treatment plant. Contaminated land remediation and protection of a major sewer (2000 mm diameter) are required as part of the project.

An Environmental Flow Release Scheme for the Lower Molonglo River Reach was completed in 2008. This two part study looked into the ecological condition and ecological values of the lower Molonglo River reach (Stage 1) followed by a recommended environmental flow release scheme (Stage 2).

While the existing ecological values have been severely compromised over decades of human impacts including the construction of Scrivener Dam, values still exist and can be reinstated with a purposeful environmental flow release scheme.

A water balance study for Lake Molonglo (both lake options) was undertaken in 2009 to analyse a number of different lake management scenarios. Three key flow scenarios were assessed in the water balance analysis (Phillips et al, 2009):

- (i) The first scenario assumes flow releases generally in accordance with the 2006 ACT Environmental Flow Guidelines (maintenance of 80th percentile flow in each month under pre-urban conditions),
- (ii) The second scenario assumes an low flow regime that preserves releases up to the 80th percentile of historical flows in the Molonglo River since the construction of Scrivener Dam (not contained in the 2006 ACT Environmental Flow Guidelines), and
- (iii) The third scenario assumes the environmental flow releases as identified in the Environmental Flows study completed in April 2008 comprising:
  - Base flows / low flows
  - Maintenance flows for riffles, pools and channels
  - Special purpose flows

Detailed water balance models for each lake option were assembled and run to assess the impact of each lake and of the three flow release scenarios.

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A preliminary analysis of dam site options was also completed. Preliminary engineering and geotechnical constraints and opportunities were investigated for three possible dam sites along the Molonglo River based on site observations and a desk top analysis.

A Lower Molonglo River Riparian Rehabilitation Strategy has also assessed the opportunities to re-establish species, assemblages, ecosystems processes and functional ecosystems within the Molonglo River corridor from Scrivener Dam to the confluence with the Murrumbidgee River.

#### **4. STORMWATER PLANNING IN THE JERRABOMBERRA CREEK CATCHMENT**

In September 2007, ACTPLA released the East Lake Urban Renewal Draft Planning Report for public consultation. The report identifies potential outcomes for the future development of the area.

The draft planning report also proposes a draft Structure Plan for East Lake which defines areas of mixed use, residential, commercial, education facilities and open space, on which further investigations will take place. The draft Structure Plan also indicates the potential for a pond and rehabilitation of Jerrabomberra Creek. As the pond shown on this plan is indicative only, further concepts for a pond in East Lake have been developed in-house by ACTPLA.

The East Lake Draft Planning Report identifies the potential for the East Lake precinct to be a demonstration project. This site is identified to potentially provide for a leading example of new development sustainability for other urban development projects.

The Jerrabomberra Wetlands Nature Reserve is located to the north and east of the proposed East Lake urban renewal area. The wetlands are one of 13 ACT wetlands included in A Directory of Important Wetlands in Australia, Australian Nature Conservation Agency (1996). The Jerrabomberra Wetlands are also of international importance as they provide reliable habitat for a number of migratory birds protected under international agreements.

Management of the Jerrabomberra Wetlands is currently guided by the Jerrabomberra Wetlands Plan of Management (1994). A revised plan, Jerrabomberra Wetlands Nature Reserve Draft Management Plan (2006), has been prepared for the reserve. The 1994 Plan of Management still has effect until a revised plan is approved, which is likely to be within the timeline of this project.

A lake at Symonston, previously called "Lake Jerrabomberra", was the subject of proposals for an Olympic standard rowing facility as well as other potential aquatic events. The 1997 lake proposal was incorporated in the Southern Broadacre Planning Study (2005) which examined the development potential of Symonston and the Jerrabomberra Valley. This Study identified that there was a minimum need for a water quality pond to be installed immediately south of Hindmarsh Drive and noted the opportunity for this to be a substantial recreational water body and potential water bird habitat. The Southern Broadacre Planning Study included an outline plan which depicted a lake on Jerrabomberra Creek, with an edge road, and provision for recreation cycling facilities, connecting to a cycle path network to the north and south of the area. Although the need for a rowing course for the Olympics is no longer apparent, the opportunity remains to combine the water quality function of a pond or lake with recreational uses and landscape objectives.

A major retardation basin on Jerrabomberra Creek was provided during the construction of the Hindmarsh Drive extension, with the new road forming the embankment for this basin and a possible future pond or lake. The Southern Broadacre Planning Study noted that any future pond or lake would need to be sized to achieve containment of pollutants from existing and proposed developments.

In 2010, Cardno completed a study to investigate pond and lake options along Jerrabomberra Creek to support the intent of the East Lake Draft Planning Report to provide opportunities for urban renewal, land release, recreation and the implementation of design and management measures protecting the Jerrabomberra Wetlands environment. The study also investigated the feasibility of a lake or pond(s) on Jerrabomberra Creek upstream of Hindmarsh Drive within Symonston.

#### **4.1 Study Catchment**

Jerrabomberra Creek begins in the headwaters of the catchment, approximately 30 km upstream from East Lake (see Figure 3). It flows in a natural channel downstream, crossing into the ACT east of Hume, beneath the railway before flowing into an existing retardation basin south of Hindmarsh Drive, then through a series of road and railway bridges and open vegetated channels prior to entering a sedimentation basin before discharging into the Jerrabomberra Wetlands and Lake Burley Griffin.

#### **4.2 Water Quality**

Pond and wetland concept options were investigated for future development conditions within the East Lake precinct, generally in the location of the sedimentation basin, as well as on Jerrabomberra Creek immediately upstream of Hindmarsh Drive, herein referred to as Symonston. All concept options presented have been analysed quantitatively using the MUSC software package with respect to their ability to capture pollutants in stormwater runoff and meet the required ACT stormwater treatment targets. The options were then assessed further by scoring against a multi-criteria framework.

The pond and wetland options investigated for East Lake were:

- Option 1a:** An on-line pond receiving all flows from Jerrabomberra Creek (ACTPLA preliminary option)
- Option 2a:** An off-line pond receiving only low flows from Jerrabomberra Creek (ACTPLA preliminary option)
- Option 2b:** An off-line wetland receiving only low flows from Jerrabomberra Creek
- Option 3a:** An off-line wetland receiving flows from Fyshwick (16.9 ha) and a pumped diversion from the sedimentation basin
- Option 3b:** An off-line wetland receiving flows from Fyshwick (109 ha)

Additional sites for WSUD measures were also investigated in the East Lake area.

The pond and wetland options investigated for Symonston were:

- Option 1:** An on-line lake immediately south of Hindmarsh Drive
- Option 2:** Multiple off-line ponds located upstream on tributaries discharging to Jerrabomberra Creek

The potential impact of a lake at Symonston (Option 1) on the average annual runoff from the catchment and on downstream environmental flows under current conditions (Case 1), future conditions (Case 2) and future conditions with climate change (Case 3) was assessed.

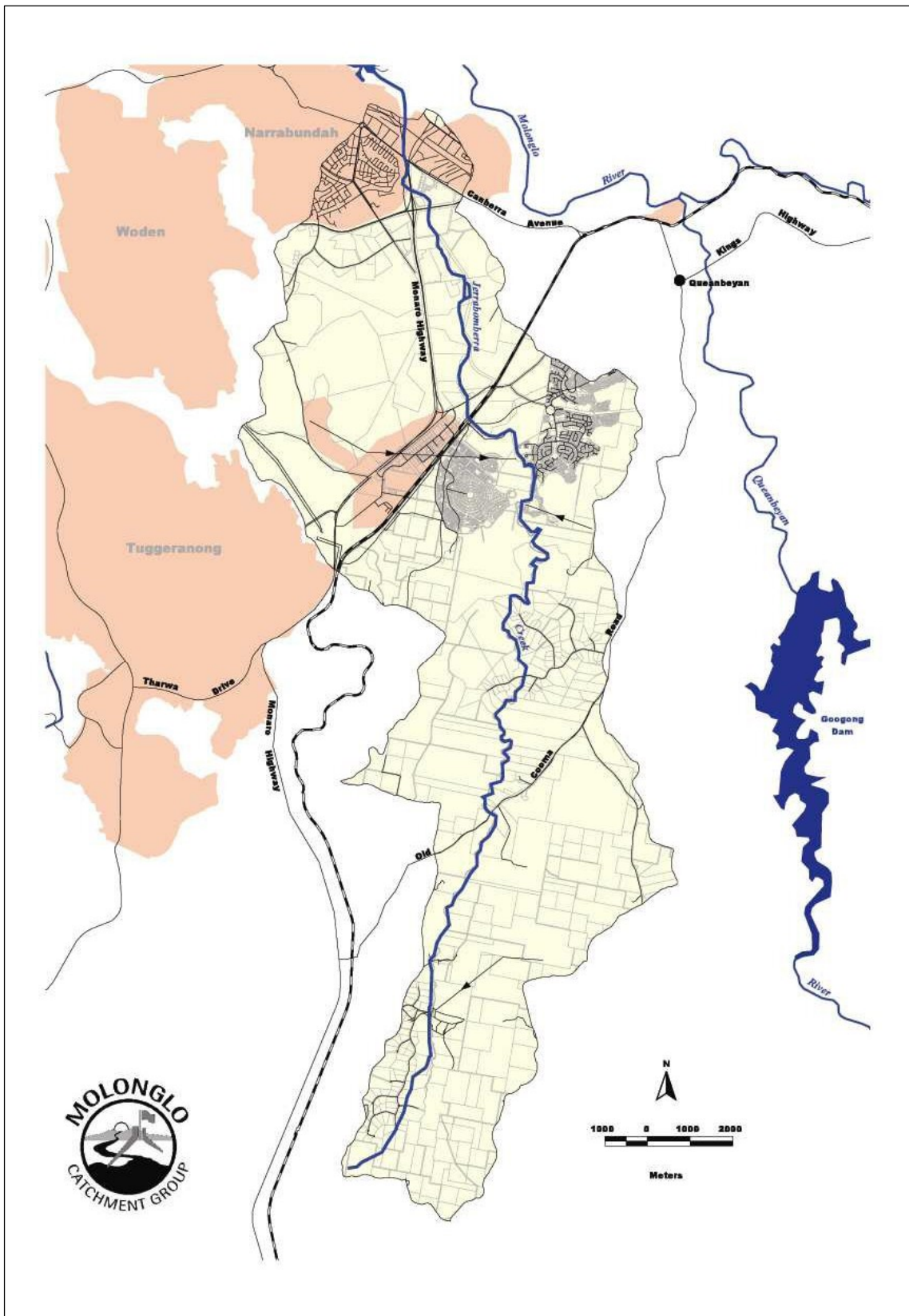


Figure 3 Jerrabomberra Creek Catchment

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Separate water balance models were assembled for a 3.67 GL lake at Symonston. For each of these cases a scenario based on a bypass limit that varies from month to month was also assessed. These cases were Cases 1B, 2B and 3B.

The estimated maximum drawdown of the lake water level (in the absence of any irrigation demands) under each scenario is summarised as follows:

Case	1	1B	2	2B	3	3B
Max Lake Drawdown (m)	0.48	0.79	0.01	0.09	0.15	0.23

The average annual runoff from the catchment upstream of Station 410721 was also determined for each case as summarised as follows

Scenario	Ave Annual Runoff (ML/yr)	Current Benchmark	Future Benchmark
Current (without Lake)	10,182		
Current (with Lake)	9,539	-6%	
Current under Climate Change	6,077	-40%	
Future (without Lake)	16,460	62%	
Future (with Lake)	15,793	55%	-7%
Future under Climate Change	11,363	12%	-50%
Future (with Lake) under Climate Change	10,702	5%	-57%

It was concluded that a lake at Symonston would:

- reduce the average annual streamflow downstream of Hindmarsh Drive by around 6% under current conditions;
- still provide an average annual streamflow downstream of Hindmarsh Drive that increases by around 55% under future conditions (due to urban development);
- still provide an average annual streamflow downstream of Hindmarsh Drive that increases by around 5% under future conditions and under climate change.

The assessment of the impact of a lake at Symonston on environmental flows under current conditions and future conditions on a month by month basis was also undertaken. It was concluded that under both current and future conditions that a 3.67 GL lake at Symonston would almost eliminate environmental flows downstream of Hindmarsh Drive because low inflows into the lake would be lost to the atmosphere through evaporation. Immediately downstream of the lake the only environmental flows would be seepage flows from the dam. Hence a bypass scheme or an environmental flow release scheme would need to be implemented to overcome the impact of any on-line lake at Symonston on downstream environmental flows.

It is fully expected that treatment of local stormwater using off-line regional facilities (option 2) will yield considerable savings in landtake by avoiding the need to treat runoff from the substantial (>5,000 ha) rural catchment upstream of Lanyon Drive with a single lake or wetland. These regional ponds or wetlands should be located at specific sites selected along strategic positions on minor tributaries to Jerrabomberra Creek before discharging into Jerrabomberra Creek.

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It was not considered practical to position a regional pond at every tributary and, therefore, to limit the number of ponds, some of the watercourses will need low flow diversions to direct low flows to the pond sites. A biofilter would also be required in the northern section, near Hindmarsh Drive, as the local topography will not allow for a pond. The regional ponds range in area from 0.9 ha to 8.3 ha (with a combined area of 25.2 ha) and treat runoff from local catchments as large as 390 ha.

#### **4.3 Flooding**

Flooding in Jerrabomberra Creek in a 100 year ARI and PMF under both existing and proposed future development conditions were modelled using the **xpswmm** software package. The assembled **xpswmm** models were calibrated to flows estimated from streamflow records at two former gauging stations in the catchment.

The flood modelling indicates that, except for some minor flooding of blocks along Mildura Street in Fyshwick and at the Causeway in Kingston, peak 100 year ARI flows are contained within the corridor of Jerrabomberra Creek. This is largely due to the construction of a large retardation basin upstream of Hindmarsh Drive which reduces flows downstream to approximately half those prior to the basin's construction.

100 year ARI flood levels in the Hindmarsh Drive basin will rise by 0.16 m under future development conditions, however peak flows and flood levels downstream will essentially be the same as existing conditions due to the large flow attenuation afforded by the retarding basin. The flood level in the basin does however place some restrictions on the extent of proposed development along the creek corridor in Symonston. Modelling has also shown that land earmarked for development on the eastern side of Jerrabomberra Creek between Canberra Avenue and the railway bridge and at the proposed sustainability demonstration project site downstream is subject to inundation in a 100 year ARI event.

## **5. CONCLUSIONS**

As Canberra expands and grows, the water cycle undergoes a transformation from its natural regime. This transformation poses a significant risk to our environment. As a consequence the ACT Government is committed to a high level of planning and the formulation of policies and guidelines to guide both new development and redevelopment in Canberra.

It is concluded that the stormwater planning for the Molonglo valley and Jerrabomberra Creek catchment demonstrate this commitment. It is also concluded that stormwater planning is a key part of a comprehensive and integrated approach to any future urban development of new growth areas in Canberra.

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