2012 WATER MANAGEMENT PLAN: STAGE 1

Prepared by

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Image: Sydney International Regatta Centre
1.0 INTRODUCTION

In partnership with the State Government of NSW (Government), Penrith Lakes Development Corporation (PLDC) is implementing the Penrith Lakes Scheme including the construction of major lakes, infrastructure and associated water bodies under the terms of the 1987 Deed of Agreement (Deed).

Scheme implementation is being undertaken over a 30 year period. During this time the Water Management Plan has been updated and modified on several occasions to reflect changed circumstances, changes in technology, ongoing monitoring results, water management studies and operational experience gained by PLDC through the management of the newly formed water bodies.

PLDC manages the emerging lakes of the Scheme throughout their various stages of development until final dedication. To facilitate the end objectives for the Scheme, PLDC is developing the 2012 Water Management Plan.

1.1 PURPOSE OF THIS REPORT
The main purpose of the 2012 Water Management Plan is to provide a contemporary, holistic response to water management across the Scheme. This is inclusive of flood management, water supply, water reticulation, water quality and lake operating levels for the Scheme and to enable it to function efficiently within the parameters established by the Deed and development consents.

The Plan will be the final Water Management Plan taking the Scheme through to final dedication currently estimated to be in 2017.

1.2 AGREED APPROVAL PROCESS
The 2012 Penrith Lakes Water Management Plan has been prepared to be generally in accordance with the 1998 Penrith Lakes Structure Plan as required under State Environmental Planning Policy (Penrith Lakes Scheme) 1989 and the Deed.

The 2012 Penrith Lakes Water Management Plan will be submitted to the Department of Planning and Infrastructure for approval in two (2) stages. Stage 1 outlines the infrastructure to be delivered and lake operating levels to be achieved for the completed Scheme.

Stage 2 sets out the strategy and operational procedures required to achieve the contracted water quality targets and water management obligations for interim and long term functioning of the Lakes system.

1.2.1 Stage 1 - Infrastructure and Lake Operating Levels
Stage 1 details the infrastructure works necessary to be implemented to complete the Scheme as well as establishing the optimum operating levels for each of the lakes and associated water bodies within the Scheme. These works complement the existing infrastructure constructed in earlier stages of the Scheme and complete a network of weirs, pipes and flowpaths that successfully manage all water movements. They are designed to meet the 100yr ARI flood event conditions.
Stage 1 of the Water Management Plan covers:

- Flooding Infrastructure
- Water Reticulation
- Water Balance
- Lake Operating Levels
- Water Supply Infrastructure

The Water Management Plan draws upon the most up to date studies and findings by expert consultants to ensure that it achieves a whole of site outcome in line with the objectives and requirements of the Deed and development consents.

Stage 1 will also include a draft Water Quality Strategy which outlines a process to guide PLDC in Government consultation/participation and the technical work necessary to complete Stage 2 of the Water Management Plan.

1.2.2 Stage 2 – Water Quality

Stage 2 details the biological and other ecosystem factors which have been taken into consideration to meet the Lake end use water quality criteria. It is concerned with issues related to water quality, aquatic biology, ecosystem development, stormwater management and ground water management.

Stage 2 will be covered in a separate document and will include:

- Water Quality Criteria
- Groundwater Management
- Stormwater Management
- Ecosystem Development
- Fisheries Management
- Lakes Operations Plan

Stage 2 of the Water Management Plan is to be lodged by 31 December 2012 (or as otherwise agreed) for the Director General’s consideration and ultimate approval.

1.3 STAGE ONE DOCUMENT STRUCTURE

The Water Management Plan Stage 1 consists of seven key sections which provide background to components of the Plan and conclusions and recommendations. It also includes a section relating to the Stage 2 process and contains a detailed reference and bibliography section which outlines historical reports and studies, as well as supporting documentation relevant to the development of the 2012 Water Management Plan.
Section 1 – Introduction.
Outlines the purpose of the 2012 Water Management Plan and how it is being prepared, summarises the background to the Scheme, and the approval process being followed up to final dedication.

Section 2 – The 2012 Scheme.
Discusses the Regional Environmental Study (RES) principles underpinning the Scheme design and the strategic approach that is being taken to deliver the Scheme.

Section 3 – Flood Protection.
Describes the infrastructure needed to protect the Scheme during 100 year flood ARI events and to minimise impacts both upstream and downstream of the Scheme. Flood protection works include river to lake weirs, lake to lake weirs and flood outlet pipes.

Section 4 – Water Reticulation System.
Describes the system of pipes, flow regulation devices, floodways and open channels that manage the movement of water from south to north though the Scheme.

Section 5 – Water Balance and Lake Operating Levels.
Describes the operational levels of the various lakes and the methods by which these are maintained.

Section 6 – Water Supply System.
Discusses the relocation of the Nepean river pump and pipeline to provide a suitable source of water to fill and maintain water levels within the Scheme.

Section 7 – Works and Approval Program.
Summarises a program of works and time frame for delivery of water infrastructure.

Section 8 – Conclusion and Recommendations.

Section 9 – Water Management Schedules.
Provides schedules for water management infrastructure, water quality criteria and lake operating levels.

Section 10 – Reference Documents.

Section 11 – Supporting Documentation & Appendices.
Outlines the stakeholder consultation undertaken; provides a copy of the Tracey Brunstrom Hammond (TBH) Works Program and copies of the Cardno reports covering flood infrastructure concept design, flood modelling calibration and water balance and operating levels. The Penrith Lakes draft Water Quality Strategy and draft Concept Masterplan 2012 are also attached.
1.4 PROJECT BACKGROUND

The Penrith Lakes Scheme was envisaged in the early 1970's and 1980's as a ground breaking rehabilitation project which had its genesis in a joint PLDC and Government working party. The outcomes from the working party was a Regional Environmental Study (RES) completed in 1984 by the Department of Environment and Planning. The key considerations for the RES were:

1. Securing the long term orderly extraction of sand and gravel for Sydney's building needs;

2. Providing significant social, community and environmental benefits for the residents of western Sydney by the creation of a major water-oriented recreation resource.

To give effect to the objectives of both parties as contained in the RES, the 1987 Deed of Agreement and a Sydney Regional Environmental Plan (SREP) were finalised to enable delivery of the Scheme and establish parameters for the Scheme's ultimate completion.

Today these documents and subsequent planning instruments together with the broad principles established by the RES remain relevant in the formulation of the 2012 Water Management Plan.

The Deed outlines the original intentions for overall water management within the Scheme by both the Government and PLDC consistent with the preferred Scheme articulated within the RES. The Deed acknowledges that the effect of those intentions was likely to alter over the course of the development and delivery of the Scheme. The 2012 Water Management Plan represents the culmination of these changes and establishes the blueprint for completion of the Scheme and achievement of the objectives of both PLDC and Government.

The Scheme was envisaged to be sequentially quarried, rehabilitated and dedicated in stages as covered by DA2, DA3 and DA4. To date the land and lakes forming the Sydney International Regatta Centre have been dedicated to Government.

As the Scheme is now nearing completion and significant works have occurred in each stage, PLDC proposes to commence dedication of large parcels of land and lakes with a program to have final dedication by the 2016/2017 financial year.
1.4.1 The Water Principles

Within the Deed, Schedule 7 – Water Principles outlines the original intentions of both the Government (on a long term basis) and PLDC (for the interim period until final dedication) for overall water management and provision of infrastructure within the Scheme. Since 1987 many additional studies, together with changes in technology, site management experience and the emergence of more efficient operational strategies has resulted in the development a contemporary water management plan.

Outside the “Water environment” section (chapter 8) of the RES, Schedule 7 of the Deed is the major guiding document for PLDC in the preparation of the 2012 Water Management Plan. Consequently the 2012 Water Management Plan will effectively update Appendix A of Schedule 7 contained within the Deed as reflected in Schedules 1 – 3 in this Plan.

PLDC is responsible for the preparation and implementation of procedures for the interim management of the lakes and associated water bodies until final dedication and for the preparation of a Completed Lakes Operations Plan to be provided to the Minister on final dedication.

The Completed Lakes Operations Plan will be developed progressively by reviewing and revising an Interim Lakes Operations Plan to reflect changed circumstances and improved knowledge gained by PLDC through the interim management stages. This Plan will be addressed in detail in Stage 2 of the Plan.

PLDC will also undertake all reasonable measures to achieve the water quality criteria appropriate to the end uses identified in the Water Principles or as otherwise agreed with Government.
Figure 1: Location of the Penrith Lakes Scheme
1.5 SITE CONTEXT
The Penrith Lakes Scheme is located within the Penrith LGA and is approximately 60km west of Sydney and approximately 2km north-west of Penrith. It is bound to the north by Smith Road, to the east by The Cranebrook Terrace and Castlereagh Rd and to the west and south by the Nepean River. The Scheme covers an area of approximately 1,935 hectares is located on the Nepean River floodplain with approximately 11kms of river frontage. The Scheme location within the greater Sydney region is shown in Figure 1.

1.6 SCHEME APPROVALS
The delivery of the Scheme is governed by State Environmental Planning Policy (Penrith Lakes) 1989 (formerly known as Sydney Regional Environmental Plan 11) and specific development approvals for the project. Works associated with the delivery of the Scheme have been primarily approved under four Development Applications.

Detailed rehabilitation works are approved though a ‘Two Year Plan’ process required by DA's 2, 3 and 4. Other approvals will be sought as State Significant Development or through Penrith City Council as appropriate.

The 2012 Water Management Plan will replace all previously adopted water management plans for the Penrith Lakes Scheme. Existing and superseded plans are:

- DA2 - Water Management Plan, 24 February 1987;
- DA3 – Stage 1 Water Management Plan, as outlined in Condition 25 of DA3; Section 4.6 of the Statement of Environmental Effects for DA3 Penrith Lakes Extraction and rehabilitation Programme – April 1994 – Approved 17 February 1995;
- DA3 – Stage 2 Water Management Plan, as outlined in Condition 25 of DA3; Section 4.6 of the Statement of Environmental Effects for DA3 Penrith Lakes Extraction and rehabilitation Programme – April 1994 – Approved 27 June 1995;

Of particular relevance to the future works required under the 2012 Water Management Plan is Development Application 4 (DA4), which was granted consent on 9 September 1998 by the Minister for Urban Affairs and Planning (ref P97/00237 Pt4).

Condition 27 of DA4 specifically approved Section 5.1 of the Statement of Environmental Effects for DA4 – Penrith Lakes Scheme November 1997 as the approved Water Management Plan for the Scheme subject to further studies and refinement. This Plan was subsequently amended by Modification Applications 4 and 5 which were granted consent on 6 May 2011. These modifications allow for the construction of a flood discharge pipe and weir within the Wildlife Lake in lieu of Weirs 7 and 8 and its associated flood / reticulation pipeline.
A further amendment, Modification 6 to DA4, was approved on 12 August 2012. This Modification contained Condition 27A of DA4 which reads as follows:

27A. By 31 March 2012, or as otherwise agreed by the Director-General, the Applicant shall review and update the existing Water Management Plan for the scheme to the satisfaction of the Director-General. The review and update of this plan must be prepared in consultation with OEH, DPI and Council; and cover the relevant aspects outlined in the Deed of Agreement for the Penrith Lakes Scheme, the proposed development in this consent, and the proposed development of the other development consents for the Penrith Lakes Scheme.

Following approval, the Applicant shall implement the updated plan to the satisfaction of the Director-General.

Note: Prior to approval of the revised Water Management Plan, the pre-existing Water Management Plan for the Penrith Lakes Scheme shall continue to apply to the development.

In consultation with the Department, it was subsequently agreed that the 31 March 2012 deadline date be extended to 29 June 2012 and further extended to 17 August 2012 for Stage 1 and 31 December 2012 for Stage 2.

Once approval of the 2012 Water Management Plan has been gained, Two Year Plan approval for the works needed to complete the Scheme will be sought from the Department of Planning & Infrastructure (DP&I) and where “building works” are involved Construction Certificate approvals will also be sought.
Image: Sydney International Regatta Centre
2.0 THE 2012 SCHEME

2.1 2012 WATER CONCEPT SCHEME BACKGROUND
The 2012 Water Management Plan is the culmination of many years of investigation, study, analysis and computer modelling. In recognising the dual goals of the Scheme, namely to supply the Sydney construction industry with sand and gravel, and to deliver a significant water-oriented recreational asset to the people of western Sydney in a cost-effective way, the RES identified a number of key principles to guide the overall design and delivery of the Scheme and these were incorporated in the Deed.

The 2012 Water Management Plan reflects these principles, the obligations under the Deed and the contemporary solutions for the effective management of water throughout the Scheme.

The RES recognised the significance of the river floodplain to the overall hydrology and health of the Nepean River. Considering the site location the RES states:

“The design of the lakes scheme should, as far as practicable, replicate the natural processes of lake formation usually associated with a river system meandering through a floodplain”

The RES also envisaged a Scheme that achieved diverse landform and landscaping outcomes based around the prior hydrology of the site. The 2012 Water Management Plan strives to achieve these goals and has adopted a design philosophy and approach which PLDC believes will do so.

These goals have been informed over a number of years by technical studies, detail strategies and other informing documents which are described in a work flow chart (refer to Figure 2: 2012 Water Management Plan Process Flow Chart).
Figure 2: 2012 Water Management Plan Process Flow Chart
2.2 SCHEME DESIGN PRINCIPLES

The 2012 Scheme has been designed to respect the hydrology of the Nepean River floodplain and to adopt a landscape context which reflects the natural processes and ecosystem as required in the RES. The extent to which this can be achieved will in large part be dictated by the primary objective of quarrying and its impact on the floodplain’s prior natural landscape and hydrology.

The rehabilitation of the floodplain into lakes and landforms following quarrying activities is driven by requirements of the Deed, subsequent development consents and other planning instruments such as the SEPP (Penrith Lakes) 1989 and Structure Plan while retaining the key principles established in the RES.

Among these is the need to deliver the Scheme within a cut-and-fill balance by either eliminating or minimising the importation or export of material. PLDC has largely been able to achieve this in delivering the completed Scheme.

The 2012 Scheme also strives to achieve diverse landforms and landscapes surrounding the series of interconnected lakes in order to deliver a fundamentally natural outcome. This has represented a significant challenge to PLDC over the years and the 2012 Water Management Plan does this as far as is practicable within the constraints outlined above.

2.3 SCHEME DELIVERY

To achieve the Scheme delivery PLDC has adopted the following approach in arriving at the 2012 Water Management Plan:

Landform and Lake Construction Principles

- Design and deliver a series of interconnected lakes flowing naturally from south to the north and discharging into the Nepean River in the north of the site in the same way that the floodplain operated prior to quarrying;
- Design the flow of water through the lakes by a gravity-fed system which as far as practicable replicates the natural path of water across the floodplain prior to quarrying (refer to Figure 3: Scheme Water Flow and Figure 4a & 4b: Gravity Flow Sections);
- Design a system that as far as practicable returns pre-quarry flows to the Nepean River;
- Create a number of associated water bodies and wetlands to optimise water quality and establish diverse ecosystems that will attract wildlife and plant species that may have flourished in a floodplain environment prior to European settlement;
- Design and deliver the lakes and landforms to accommodate the end uses prescribed in the Deed or as otherwise agreed to optimise the social and recreational objectives of the Scheme;
- Design and deliver a Scheme that not only respects but preserves as much of the Aboriginal, European and natural heritage values of the site as is practicable.
Figure 3: Scheme Water Flow (not to scale)
Landscape Principles

- Establish aquatic habitats within the lakes themselves to enable fish, macro-invertebrates and macrophytes to prosper and create a healthy ecosystem for the lakes and ultimately the Nepean River system;
- Design and deliver a terrestrial landscape that complements the aquatic ecosystems and assists in the treatment of water that enters the lakes from rainfall run-off;
- Design a series of detention basins, wetlands and water quality devices to manage the stormwater inflows from the external catchment before they enter the lakes system to optimise water quality and the opportunities for safe recreational uses by the public as envisaged in the RES and Deed;

Structural Infrastructure Principles

- Minimise the number of man-made structures to manage this water transfer and where possible build these structures from natural materials to more faithfully replicate a natural landscape (see Figure 5 Flood Water Flow 100yr ARI);
- Design and deliver a flood protection network which achieves an equivalent or improved flood impact on the Nepean River and surrounding areas in the 100yr ARI event;
- Design and deliver a flood protection network which equalises the water levels between the Nepean River and the Scheme in a 100yr ARI event and allows floodwaters to recede at a rate that minimises the risk of scouring and damage to the riverbank and Scheme landforms;
- Design and deliver a water supply system from the Nepean River to enable filling and topping up of the lakes for operational purposes as envisaged in the RES. (refer to Figure 5: Flood Water Flow 100yr ARI).

While there may at first glance appear to be a number of competing objectives, PLDC believes that 2012 Water Management Plan and Scheme very successfully achieves these objectives and optimises the targeted outcomes.

PLDC acknowledges that a recreational resource of this scale and complexity which will engender significant community interest will develop over a long period of time in much the same way as Centennial Park has done and Sydney Olympic Park is currently evolving.

Delivery by PLDC in accordance with the Deed and respecting the principles of the RES will provide a solid platform with innate flexibility that will enable the Scheme to successfully evolve over time in a way that meets the objectives of Government and the broader community. The 2012 Water Management Plan has been prepared with this in mind.
3.0 FLOOD PROTECTION

3.1 OBJECTIVE
The primary objective of the flood protection works is to fill the lakes with water during the early stages of a flood and should there be any overtopping of the river banks, then the water level in the lakes are designed to equalise with the water level in the river. This will minimise the area of bank that would be exposed to scouring flows. Control weirs interconnecting the lakes with the river and to each other are required to achieve this objective (Penrith Lakes Scheme - Regional Environmental Study 1984).

3.1.1 Strategic Framework – Flood Protection
In the following goals, objective and policy the abbreviation STS refers to items which PLDC have included in its master program.

GOAL:
Minimise potential of flood impacts within the Scheme both upstream and downstream of the Scheme with no adverse effect on flooding in the Nepean River.

Objective:
To construct Scheme landforms and structures that are cost-effective and achieve the primary goal of flood protection.

Policy:
Weirs and infrastructure to be designed with the capability to meet conditions of a 100yr ARI flood event.

Short Term Strategy (STS): Undertake extensive flood modelling to verify capabilities against the peak water levels for the 100 yr ARI as well as considering the 200 yr ARI and the peak water levels recorded from the 1978 and 1990 floods.

STS: Design infrastructure on a cost effective basis taking into consideration the long term maintenance and capital costs.

STS: Design the infrastructure to minimise flood impacts both upstream and downstream of the Scheme.

STS: Design infrastructure with minimal visual impact on the Scheme.

Policy:
Maintain the structural integrity of the banks between the Nepean River and Lakes within the Scheme.

STS: Conduct flood modelling to determine velocity and quantities of water overtopping weirs located along the river.

STS: Design weirs to cost-effectively cope with water velocity and quantity.

STS: Minimise the structures and intrusions on the riverbank to optimise stability and respect natural heritage and Aboriginal heritage areas.
Figure 5: Flood Water Flow 100yr ARI (not to scale)
Policy:
The Scheme to have capacity for flood storage, and to accept specific frequency flooding into individual lakes.

STS: Refine the flood protection concept plan as the lake design is refined.
STS: Model movement of flood waters in different flood events to determine specific lake capacities.

Policy:
Preclude urban development from lands below the 1:100 year flood level and protect other structures below that level.

STS: Conduct flood modelling to determine the limits of 1:100 year flood events.
STS: Design and construct flood mitigation works.

3.1.2 Performance Criteria
Performance criteria for flood overtopping and filling of the lakes has been developed having regard to principles outlined in the RES and Deed. The details of flood modelling for the Scheme are provided in the Cardno Infrastructure Concept Design Report (July 2012) at Appendix 1. The key performance criteria are as follows:

1:10 yr ARI Event
During the early part of the flood event, the Wildlife Lake starts to fill through Wildlife Lake weir in the north. Overtopping of Wildlife Lake weir will occur in events greater than a 10 year ARI. All other lakes will have controlled flows during these events.

Upstream catchment flows will enter the detention basins on the eastern side of the lake and be processed through a series of treatment ponds prior to entering the main lakes system.

1:25 yr ARI Event
Weir 3 starts to overtop in events greater than the 25 year ARI. During this event waters will commence the filling of Lake A. Once Lake A reaches the crest level of Weir 4 (RL15), Lake B will commence filling. Once the two lakes equalise, then Lake A and B behave as a singular lake. As the two Main Lakes fill, the Regatta Lake and Quarantine Lake will start to fill through the Regatta Lake flowpaths. Meanwhile, Wildlife Lake is still filling through the Wildlife Lake weir.

1:70 yr ARI Event
Once the Main Lakes have filled to the crest level of Weir 6 (RL20), it begins to overtop into the Wildlife Lake. Around this time, the overtopping of Weir 6 fills the Wildlife Lake such that it reverses the direction of flow through Wildlife Lake weir and water begins to flow from the lake into the Nepean River.

1:100 yr ARI Event
The peak water levels for 100 year ARI within the Lakes and surrounding areas are shown in Table 1. The water level differences to Pre-Quarry flood levels during the 100 year ARI show a reduction in peak levels in the order of -0.3 to -0.7m
Figure 6 is an example illustrating the potential durations which landform areas above operating level may be inundated following a 100 year ARI event.

Table 1: Peak Flood Levels (100 year ARI)

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<tr>
<th>LOCATION</th>
<th>100YR ARI PEAK WATER LEVEL</th>
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<tr>
<td>Quarantine Lake</td>
<td>22.4</td>
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<tr>
<td>Regatta Lake</td>
<td>22.4</td>
</tr>
<tr>
<td>Lake A</td>
<td>22.4</td>
</tr>
<tr>
<td>Lake B</td>
<td>22.4</td>
</tr>
<tr>
<td>Wildlife Lake</td>
<td>20.5</td>
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<tr>
<td>Waterside Green</td>
<td>22.19</td>
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<tr>
<td>Cranebrook Village</td>
<td>21.74</td>
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<tr>
<td>Penrith Industrial Area</td>
<td>25.88</td>
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<td>Emu Plains</td>
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3.1.2.1 Flood Recession

As the flood through the Nepean River recedes, overtopping of Weir 3 ceases. Following this, Weir 6 ceases overtopping and finally flows through Wildlife Lake weir cease.

After the flood has receded, the Lakes are still elevated above their normal operating levels. Flood outlet pipes located in the Wildlife Lake and combined Main Lakes allow the flood waters to drain to the Nepean River and allow the lakes to return to normal operating levels. The time taken for each lake to return to normal operating levels following the different flood events above the 1 in 10 ARI is shown in Table 2. The 10y ARI affects the Wildlife Lake only.
Table 2: Time Taken To Return To Operating Level

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<tr>
<td>Quarantine Lake</td>
<td>n/a</td>
<td>14 Days</td>
<td>29 Days</td>
</tr>
<tr>
<td>Regatta Lake</td>
<td>n/a</td>
<td>14 Days</td>
<td>29 Days</td>
</tr>
<tr>
<td>Lake A</td>
<td>n/a</td>
<td>14 Days</td>
<td>29 Days</td>
</tr>
<tr>
<td>Lake B</td>
<td>n/a</td>
<td>14 Days</td>
<td>29 Days</td>
</tr>
<tr>
<td>Wildlife Lake</td>
<td>15 Days</td>
<td>15 Days</td>
<td>15 Days</td>
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3.1.3 Priority Actions

The priority actions are:

- On approval of the Water Management Plan Stage 1 lodge Two Year Plans for minor variations to the design of Weir 6 (from RL 21 to RL 20) and/or flood cells around Nepean Park and Hadley Park as appropriate and once approval is obtained commence construction of the modified landforms by October 2012;

- On approval of the Water Management Plan carry out detail design of Weir 3 (including flood outlet pipes) and Weir 4, lodge a Two Year Plan for these structures and on approval commence construction of Weir 4 by December 2012;

- Call for tenders for Weir 3 in January 2013, let tender in April 2013, lodge a Construction Certificate application and commence construction by June 2013.

3.2 INFRASTRUCTURE DETAILS

3.2.1 Concept Design

The location of the Lakes Scheme on a floodplain requires the overall Scheme to be designed to adequately cope with flooding from local catchments and the Nepean River system. Local catchment flooding is managed through the Farrell’s Creek diversion works that have been approved and constructed.

Nepean River flooding of the Scheme was assessed in the RES process in 1983 and 1984. A concept plan was developed in 1983 which admitted floodwaters into the Scheme during the early stages of Nepean River flooding. The intended objective was to fill the lakes prior to over-bank flow to eliminate potential damage caused by scouring of the lakeside banks. This concept remains valid for the 2012 Water Management Plan.

In 2005 the Penrith Lakes Water Committee reviewed the Water Principles and the 1998 Water Management Plan. The Committee concluded that ‘The existing lakes have generally performed well under existing conditions, meeting Water Plan standards.’

In relation to flooding the Committee investigated the feasibility of increasing the weir heights to the 1 in 50 and 1 in 100 year flood levels as a way to reduce the number of inundations and the impact of the poor water quality of the Nepean River on the ecological values of the Lakes Scheme.
Advice obtained by PLDC was that ‘this is not a desirable option due to the increased potential for scouring under the higher head conditions involved. However, increasing the weir height in the Wildlife Lake to cater for a 1 in 10 year flood event may be feasible. Given the potential benefits, further advice should be sought on the cost effectiveness of raising the weirs in the Main Lakes’ (PLWC, 2005). This advice was accepted by PLDC and is incorporated in the Water Management Plan.

In 2008, a two dimensional computational model was developed by Cardno to enable better assessment of the impacts of the Scheme design upon the surrounding area and to produce the information which forms the basis of the current flood assessments. A lengthy calibration and verification process was undertaken with a physical model and other computer models for the Penrith area. Participating in the process were Manly Hydraulics Laboratory, Worley Parsons, WMAwater, OEH, and Penrith City Council (Cardno, 2010).

Studies and the extensive modelling carried by Cardno led to a number of changes to flood infrastructure and the reticulation network which provide significant benefits to the Scheme. In particular this process has resulted in a significant reduction in lake to river structures by relocating Weir 7 (RL10.9) from the riverbank to PLDC owned land in the north west corner of the Wildlife Lake and the capacity to rely solely on Weir 3 into Lake A.

The Calibration and Validation of the hydraulic model developed by Cardno was accepted by the Office of Environment and Heritage (formally DECCW) and Penrith City Council at a meeting in October 2009 as set out over:

- The SOBEK model as presented in Cardno’s calibration report is accepted as being calibrated to both the 1978 and 1990 floods.
- The SOBEK model has been validated against the physical ‘Alignment’ model for the 100yr ARI and the 200yr ARI design floods.
- The SOBEK model is accepted for the purpose of assessing the hydraulic impacts of works planned as part of the Penrith Lakes Scheme.

Subsequent investigations and modelling were undertaken by Cardno to develop an optimal flooding concept design for the Scheme given the requirements of the Deed and in particular DA4. This work included:

- Re-assessing interim flood plans.
- Updating data for the final design of flood protection structures.
- Re-assessing the potential flood risks during major flood events to identify practical solutions to address these risks.
- Ensuring Nepean River flooding is not adversely affected.
- Ensuring the lake water levels are high prior to over-bank flow occurring to prevent scouring.
- Ensuring that weirs located on the riverbank are approximately equivalent to:
  - Lake A – 1 in 25 years return period.
  - Wildlife Lake – 1 in 10 years return period.
WMAwater (WMAwater, 2010) undertook an independent peer review of the flood model and Scheme design and concluded the following:

- The SOBEK model has been calibrated and verified appropriately against available data from historical flood observations and physical modelling;
- Appropriate sensitivity modelling has been undertaken to determine the influence of varying key model inputs on the estimated flood behaviour;
- The model is fit-for-purpose in the investigation of flood impacts resulting from development approaches in the Penrith Lakes Development Area, and the development of a concept design for flood infrastructure at Penrith Lakes.

In relation to the flooding infrastructure proposed by Cardno, WMAwater concluded that:

> the general simplification of the scheme (fewer lakes, significantly less engineered weir structure between the river and lakes) is likely to result in less complex flow behaviour and reduced reliance on assumed design flood behaviour characteristics than the previous scheme, resulting in more robust flood mitigation performance; and the estimated impacts on flood risk at Cranebrook Village may require further analysis before being deemed acceptable by approving authorities and/or the affected community. The scheme has been optimised to produce a beneficial scenario for the 100yr ARI.

### 3.2.2 Impacts and Mitigating Measures

A comparison of the current design proposals with those of the ‘base case’, namely the pre-quarry situation indicates significantly improved outcomes for the 1 in 100 year flood event:

- A considerable reduction overall in the number of properties likely to have over-floor flooding
- A considerable reduction overall in the cost of flood damage
- Reduction in peak water levels at Emu Plains and Penrith
- Reduction in flood levels by up to 1.3 metres in Cranebrook Village
- Reduced peak flow velocities near Nepean Park.

As can be seen in Figure 7: Water Management Plan Flood Infrastructure and Reticulation other beneficial outcomes of the revised design include:

- Riverbank intrusions have been reduced and hence there will be less disturbance to the in situ riverbank.
- Potential impacts on both natural and Aboriginal heritage areas have been significantly minimised in the Hunts Gully Conservation Zone.
- Visual amenity within the Scheme and downstream of the Wildlife Lake weir has been improved.
## 3.2.3 Detailed Design and Further Studies

### 3.2.3.1 Detailed Design - Infrastructure

Table 3 below sets out the remaining flood protection infrastructure required to complete the Scheme as determined by the extensive flood modelling conducted by Cardno over the past 3 years. This is explained in detail in the Cardno Flood Infrastructure Concept Design Report (July 2012) which is provided in Appendix 1.

### Table 3: Flooding Infrastructure

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>DESCRIPTION</th>
<th>ADEQUATE CAPACITY</th>
<th>CONCEPTUAL DETAILS</th>
</tr>
</thead>
</table>
| Weir 3    | Weir 3 is the primary control for floodwaters entering the Lakes Scheme from the Nepean River | Peak flow of 1,740 m³/s | Weir Width 400 – 500m  
Weir Crest Height – 20.9 mAHD  
Scour Protection – Gabions / Reno Mattress |
| Weir 4    | Weir 4 is a low level broad embankment between Main Lakes A and B. The weir quickly overtops in flood events, allowing the two lakes to act as a single water body. | Peak flow of 1,650 m³/s | Weir Width 450 – 550m  
Weir Crest Height – 15.0 mAHD  
Scour Protection - Grass |
| Weir 6    | Weir 6 is the primary control for the spill of floodwaters from the Main Lakes into the Wildlife Lake. It controls the water levels within the Main Lakes, as well as Quarantine and Regatta Lakes. | Peak flow of 1,640 m³/s | Already constructed to:  
Weir Width: 440m  
Weir Crest Height: 21.0 mAHD  
Minor amendment recommended to achieve a crest height of 20m AHD.  
Weir Crest Height – 20.0 mAHD (for approval)  
Scour Protection - Grass |
| Wildlife Lake Weir | The Wildlife Lake Weir serves two purposes. It conveys inflows from the Nepean River during the early part of the flood, and outflows from the Lakes during the latter part of the flood. This weir was approved in Modification 5 of DA4. | Peak flow of 490 m³/s  
(stage 1)  
1,110 m³/s  
(stage 2) | Under Construction Contract:  
Stage 1:  
Central Weir Width: 65m  
Central Weir Crest Height: 16.0mAHD  
Stage 2:  
Total Weir Width: 150m  
Total Weir Crest Height: 18.5mAHD  
Scour Protection – Concrete / Grass |
| Regatta Flow Path | The Regatta Flow Path is a low level flow path between the Lake and Regatta Lake that convey floodwaters into the Regatta Lake. | Peak flow of 590 m³/s | Base Width: 25 - 75m  
Crest Height: 16.5 mAH |
The Eastern Lakes are a series of lakes to the east of the Main Lake. The majority of these lakes are disconnected from the Main Lake during a 100 year ARI flood by high ground levels. There are two flow paths which connect the Eastern Lakes with the Main Lakes: Main Lake to Duralia and Duralia to North Pond.

- **Duralia to Main Lake Flow path**: Peak flow of 0 m³/s, Base Width: 250 - 350m, Crest Height: 22 mAHD, Scour protection - Grass

- **Duralia to North Pond Flow path**: Peak flow of 60 m³/s, Base Width: 100 - 200m, Crest Height: 19.0 mAHD, Scour protection - Grass

- **Main Lake Flood Outlet Pipes**: Draw down rate <0.5m day, 2 x 1,350mm concrete pipe with appropriate energy dissipation and flood flaps installed

- **Wildlife Lake Flood Outlet Pipe**: Draw down rate <0.5m day, Under Construction Contract; 1 x 1,350mm concrete pipe with appropriate energy dissipation and flood flaps installed

- **Flood Cells**: Peak flow of 0 m³/s, Length: 5.7km (approximate), Crest Height Ranges from: 24.7 – 21.0 mAHD

*The conceptual details may vary slightly during the detailed design process.*

The proposed flooding infrastructure is shown in Schedule 1 of the Water Management Plan, along with concept design specifications. The exact location and dimensions of flooding infrastructure may change in the detailed design process although based on preliminary modelling undertaken by Cardno it is expected that they will remain generally consistent with those described in Schedule 1.

### 3.2.3.2 Further Studies

No further studies are proposed. PLDC has obtained comprehensive advice from a number of independent experts and consultants which, together with extensive physical and computer modelling, has formed the basis of the Scheme concept developed by Cardno and set out in their report at Appendix 1.
3.3 **RELEVANT EXISTING APPROVALS**

Existing approvals for flood infrastructure are contained in DA4. All weirs and flood outlet pipes remaining to be built are approved by DA4. The 2012 Water Management Plan alters the specification of these structures. On approval of the Plan, Two Year Plan approvals and Construction Certificates will be sought for construction of this infrastructure.

The necessary approvals for flood cells and flowpaths will be obtained through the Two Year Plan process under DAs 2, 3 and 4 as appropriate.

3.4 **APPROVALS REQUIRED**

3.4.1 **Water Plan Approval**

Approval of the 2012 Water Management Plan by the Director-General of the Department of Planning and Infrastructure is required.

3.4.2 **Two Year Plans and Construction Certificates**

Two Year Plan approvals and, in some instances Construction Certificate approvals, are required to deliver the flood infrastructure detailed in the 2012 Water Management Plan. Construction Certificates are not required in relation to Weirs 4 and 6 or to the Flood Cells as no works associated with the construction of these items fall within the definition of "building works" under the EP&A Act but are covered under rehabilitation works in DA4. Construction Certificates may be required for a sluice gate in Weir 4 and rip-rap or other edge treatments for flowpaths.

<table>
<thead>
<tr>
<th>PROPOSED ITEM</th>
<th>DESCRIPTION</th>
<th>TWO YEAR PLAN STATUS</th>
<th>CONSTRUCTION CERTIFICATE STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weir 3</td>
<td>400 - 500m long weir set to RL 20.9 between Lake A and the Nepean River.</td>
<td>Approval Required</td>
<td>CC Required</td>
</tr>
<tr>
<td>Weir 4</td>
<td>450-500m long weir set to RL 15 between Lake A and Lake B</td>
<td>Approval Required</td>
<td>Not Required</td>
</tr>
<tr>
<td>Weir 6</td>
<td>440m long weir set to RL 20.0 between Lake B and the Wildlife Lake.</td>
<td>Already constructed - Two Year Plan amendment to reduce crest height from RL 21 to RL 20 required</td>
<td>Not Required</td>
</tr>
<tr>
<td>Wildlife Lake Weir</td>
<td>Stage 1: 65m long weir set to RL 16.0 on the northern bank of the Wildlife Lake at Hunts Gully.</td>
<td>Approval Required</td>
<td>CC Required</td>
</tr>
<tr>
<td>Flood cells</td>
<td>There are a number of flood cells set to RLs 24.1, 23.9, 23.4, 23 and 21.9m as per Figure 6. Construction method is grass protected earth bund - They were not identified within the 1998 WMP.</td>
<td>Approval Required</td>
<td>Not Required</td>
</tr>
<tr>
<td>Weir 3 Flood Outlet Pipe</td>
<td>2 x 1350 mm concrete pipe located under Weir 3 to drain excess flood water from Lake A</td>
<td>Approval Required</td>
<td>CC Required</td>
</tr>
<tr>
<td>Wildlife Lake Flood Outlet Pipe</td>
<td>1350mm concrete pipe located in the Nepean River bank to drain excess flood water from the Wildlife Lake.</td>
<td>Approval Required</td>
<td>CC Required</td>
</tr>
</tbody>
</table>
Figure 7: Water Management Plan Flood Infrastructure and Reticulation (not to scale)

Note: lengths and heights shown here may vary, refer to Schedule 1 for approved dimensions
3.4.3 Controlled Activity Approvals and Licences
In certain instances, particularly in relation to works within the riverbank, separate permits, licences and controlled activity approvals associated with a range of legislation that is relevant to the site may be required. These separate legislative approvals will be identified and sought during the detailed design phase for each item of infrastructure and will cover, although not limited to the following operations and maintenance.

3.5 OPERATIONS AND MAINTENANCE
3.5.1 Operations and Maintenance Schedule
Operations and Maintenance Schedules will be developed during the detailed design phase of each item of infrastructure and delivered to Government (end owner) upon dedication. These Schedules will provide at least the following details:

- Design and Construction Warranties;
- Detailed Design, Construction and Works-as-executed drawings;
- Detailed operational procedures for each individual item of Infrastructure with specific relevance to the function/role it serves within the overall Flood Scheme Design and contained in the Completed Lakes Operations Plan;
- Detailed Maintenance Schedule for each individual infrastructure having regard to the applicable Design, Construction and Supply Insurances and Warranties
- Specification/s for each item of infrastructure.

3.5.2 Design and Construction Warranties
Where Infrastructure works involve “building works” that necessitate a Construction Certificate approval/s, PLDC will, where appropriate, arrange for Design and Construction warranties to be novated to the Government in accordance with existing industry practices. These Indemnities and Warranties will include those of the Principal Design Consultant (in the form of Professional Indemnity) Insurances, Principal Contractor Warranties and where relevant, Supply Warranties.

3.5.3 Inspections
The Operations and Maintenance Schedule will include details of regular inspections where these are required to ensure a proper maintenance regime is in place.
Image: Duralia Lake on the eastern boundary of the Penrith Lakes Scheme
4.0 WATER RETICULATION SYSTEM

4.1 OBJECTIVE
The primary objective of the water reticulation system is to maintain the optimum operating levels of the lakes in differing operational circumstances while preventing levels reaching a height which may result in damage to infrastructure. Pipelines, flowpaths and open channels large enough to move the water caught in each lake's catchment area in storm events are required to achieve this objective (Department of Planning 1984).

4.1.1 Strategic Framework

GOAL: To develop a reticulation system of pipes, flowpaths, sluice gates and open channels to manage the movement of water throughout the site for operating purposes and minimise the potential for localised flooding to damage lake infrastructure.

Objective: To provide lakes with the capacity to maintain desired operating levels and shed water collected during rain events that is excess to that required to maintain operating levels.

Policy: Infrastructure to be installed with the capacity to move water which falls in storm event.

Short Term Strategy (STS): Identify catchment areas that supply water to the Scheme.

STS: Conduct modelling to determine flowpaths, channel and/or pipe locations and specifications to efficiently move water by gravity through the Lakes' system in various storm events.

STS: Construct or install pipes, flowpaths, sluice gates and open channels in accordance with the Scheme design.

GOAL: Minimise adverse impacts on water quality within the Scheme.

Objective: To manage water that does not meet the water criteria standards through a system of detention basins, wetlands and water quality control ponds before entering the Main Lakes of the Scheme.

Policy: A network of water management structures to be constructed and operated in accordance with the 1987 Deed.

STS: Install and operate pipes, flow regulation devices, flowpaths and channels between water bodies so that sub-quality water can be retained in the detention system before being moved by gravity into the lakes system to maintain operating levels.
STS: Conduct ongoing water testing to assess the quality of water prior to opening the flow regulation devices.

STS: Provide the SIRC with operational use of the flow regulation device at the Final Basin during regattas and sporting events.

STS: Design and construct a series of wetlands south of Old Castlereagh Road and a Quarantine Lake to treat water supplied from the Nepean River to the Scheme through the Regatta Lakes.

4.1.2 Performance Criteria
The proposed performance criteria of the scheme are based on the above objectives and policies. Cardno has modelled the performance of the reticulation infrastructure and concludes that it is appropriate for maintaining operating levels in the lakes, minimising the impacts of stormwater inflow, achieving optimal protection of scheme assets and in assisting in maintaining water quality (Cardno, July 2012, Water Balance and Lake Operating Level Report).

4.1.3 Priority Actions
The priority actions are:
- On approval of the Water Management Plan Stage 1, lodge Two Year Plans for the construction of an open channel and sluice gate to Weir 4 by December 2012;
- Lodge Two Year Plans for flowpaths between Duralia Lake and Lake A, between Duralia Lake and North Pond, between Lake A and SIRC Warm-up Lake and for the southern wetlands by December 2012 and;
- Obtain S75W approval for use of Lewis Lagoon as a water quality control pond to protect the Wildlife Lake;
- Finalise the State Significant Development (SSD) application for the Nepean Pump and Pipeline by December 2012,
- Complete the reticulation pipe between Lake B and the Wildlife Lake;
- Document procedures for the interim operations of the Final Basin flow regulation device.

4.2 INFRASTRUCTURE DETAILS
4.2.1 Concept Design
Reticulation pipelines allow water to pass from lake to lake, from south to north, through a gravity system when individual lakes reach operating level. Water excess to overall Scheme requirements can be discharged at any time to the Nepean River through the Wildlife Lake flood outlet pipe or, in significant storm events, through the two flood outlet pipes in Lake A, all of which are designed for dual purposes.

The flowpaths are designed to manage water flows after significant storm or flood events to mitigate damage to landforms and lake infrastructure. They will be incorporated in the
Scheme landform design as natural features. Open channels and wetlands will be designed to move water through landscaped and vegetated areas to provide treatment for water quality and topping up of the lakes to achieve or maintain operating levels.

Many of these works have been completed under DAs 2 and 3 and corresponding Two Year Plans. The new works proposed in the 2012 Water Management Plan complement these works in a whole of site system.

A system of pipes, flow regulation devices, flowpaths and open channels manages the movement of water throughout the Scheme. Much of the external catchment runoff enters the Scheme through the already constructed Eastern Lakes - a series of small lakes and treatment ponds and basins (Duralia Lake, North Pond, Middle Basin, Final Basin) that lie to the east of Lake A.

Their operating levels vary between 15mAHD and 18mAHD. Two flow paths will be constructed to connect the Eastern Lakes with Lake A (from Duralia) and to connect Duralia to North Pond during flood events greater than the 100yr ARI. The Eastern Lakes also supply the Regatta Lake and flow from these is controlled by a flow regulation device between the Regatta Lakes and Final Basin.

At the northeastern end of the Scheme external catchment runoff flows into Lewis Lagoon and from there into the Wildlife Lake across a floodway west of new Castlereagh Road. Lewis Lagoon has been constructed and operates as a water quality control pond for water entering the Wildlife Lake.

The flows from lake to lake, to achieve desired operating levels and to allow excess water to return to the Nepean River, are mainly by gravity but include flow regulation devices such as sluice gates for operational flexibility. As far as practicable the reticulation system replicates the natural flow of water across the floodplain to the river as recommended in the RES.

The reticulation system is shown in Figure 7 Water Management Plan Flood Infrastructure and Reticulation.

**4.2.2 Impacts and Mitigating Measures**

The reticulation system has been designed following extensive modelling by Cardno. It is based on a gravity flow system that is initially fed from the eastern catchment through a detention system and in the south from the Nepean River by the water supply system discussed in Section 6 of the Stage 1 Plan.

The system design comprises primarily open channel and overland flowpaths. This achieves a natural landscape, more in keeping with a parkland setting, and minimises recurrent maintenance and costly replacements generally associated with metal, PVC or concrete structures such as pipes. The flow regulation devices are designed for easy access for maintenance and operational purposes.
### Detailed Design and Further Studies

#### Detailed Design - Infrastructure Proposed for Scheme

The reticulation system proposed for the Scheme is shown in Table 5. The pipeline and pumping system to supply the Scheme is considered further in Section 6, Water Supply System.

Table 5: Infrastructure and Reticulation Works – Complete and to be constructed

<table>
<thead>
<tr>
<th>REFERENCE+</th>
<th>ITEM DESCRIPTION</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>750 – 1100 mm² Pipeline from Nepean River Pump – to carry a flow of 1.0 m³/s</td>
<td>To be constructed</td>
</tr>
<tr>
<td>2</td>
<td>1200 mm diameter pipeline to SIRC</td>
<td>Complete</td>
</tr>
<tr>
<td>3</td>
<td>1500 mm diameter pipeline SIRC to Lake A</td>
<td>Complete</td>
</tr>
<tr>
<td>4</td>
<td>2 x 1350 mm² pipeline Main Lakes to Nepean River (for reticulation and flood</td>
<td>To be constructed</td>
</tr>
<tr>
<td></td>
<td>water draw down)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>900 mm diameter pipeline Lake B to Wildlife Lake</td>
<td>Complete</td>
</tr>
<tr>
<td>6</td>
<td>1 x 1350 mm pipeline Wildlife Lake to Nepean River (for reticulation and flood</td>
<td>To be constructed</td>
</tr>
<tr>
<td></td>
<td>water draw down)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5 x 3m x 0.9m culverts Lewis Lagoon to Wildlife Lake</td>
<td>Complete</td>
</tr>
<tr>
<td>8</td>
<td>900 mm diameter pipeline Cranebrook Lake to Duralia Lake</td>
<td>Complete</td>
</tr>
<tr>
<td>9</td>
<td>900 mm diameter pipeline Duralia Lake to North Pond</td>
<td>Complete</td>
</tr>
<tr>
<td>10</td>
<td>2 x 900 mm pipes connecting West and North Ponds</td>
<td>Complete</td>
</tr>
<tr>
<td>11</td>
<td>Overflow weir 20m crest width on Farrell’s Creek</td>
<td>Complete</td>
</tr>
<tr>
<td>12</td>
<td>1200 mm pipe plus a weir connecting North Pond and Middle Basin</td>
<td>Complete</td>
</tr>
<tr>
<td>13</td>
<td>3m x 1.8m culvert connecting Middle and Final Basins</td>
<td>Complete</td>
</tr>
<tr>
<td>14</td>
<td>3m x 1.8m culvert connecting Final Basin and SIRC</td>
<td>Complete</td>
</tr>
<tr>
<td>15</td>
<td>Pump to deliver 1.0 m³/s Nepean River to Scheme</td>
<td>To be constructed</td>
</tr>
<tr>
<td>16</td>
<td>Sluice gate to control flows between Lake B and Wildlife Lake</td>
<td>Complete</td>
</tr>
<tr>
<td>17</td>
<td>Sluice gate to control flows between Duralia Lake and North Pond</td>
<td>Complete</td>
</tr>
<tr>
<td>18</td>
<td>Sluice gate to control flows between Final Basin and SIRC</td>
<td>Complete</td>
</tr>
<tr>
<td>19</td>
<td>Channel to convey reticulation water from Lake A to Lake B</td>
<td>To be constructed</td>
</tr>
<tr>
<td>20</td>
<td>Sluice gate to control flows between Lake A and Lake B</td>
<td>To be constructed</td>
</tr>
</tbody>
</table>

+ Reference number locations are illustrated on Figure 7
4.2.3.2 Further Studies
No further studies are required.

4.3 RELEVANT EXISTING APPROVALS
Existing approvals for all items to be constructed are under DA4. Further approvals required are set out in Section 4.4 below.

The Nepean Pump and Pipeline will require approval as a State Significant Development and is discussed in Section 6 of this plan.

4.4 APPROVALS REQUIRED
4.4.1 Water Plan Approval
Approval of the 2012 Water Management Plan by the Director-General of the Department of Planning and Infrastructure is required.

4.4.2 Two Year Plans and Construction Certificates
Table 4 items to be constructed which require Two Year Plan approval. The Nepean Pump and Pipeline requires development consent under the SSD provisions of the EP&A Act and a Construction Certificate.

4.4.3 Controlled Activity Approvals and Licences
In certain instances, particularly in relation to works within the riverbank, separate permits, licences and controlled activity approvals associated with a range of legislation that is relevant to the site may be required.

These separate approvals will be identified and sought during the detailed design phase for each item of infrastructure.

4.5 OPERATIONS & MAINTENANCE
4.5.1 Operations and Maintenance Schedule
Operations and Maintenance Schedules will be developed during the detailed design phase of each item of infrastructure and delivered to Government (end owner) upon dedication. These schedules will provide at least the following details:
• Specification/s for each item of infrastructure;
• Design and Construction Warranties;
• Detailed Design, Construction and Works-as-executed drawings;
• Detailed operational procedures for each individual item of Infrastructure with specific relevance to the function/role it serves within the overall Flood Scheme Designs and contained in the Completed Lakes Operations Plan;
• Detailed Maintenance schedule for each individual infrastructure having regard to the applicable Design, Construction and Supply Insurances and Warranties.
4.5.2 Design and Construction Warranties
Where Infrastructure works involve “building works” that necessitate Construction Certificate approval/s, PLDC will, where appropriate, arrange for Design and Construction warranties to be novated to the Government in accordance with existing industry practices.

These Indemnities and Warranties will include those of the Principal Design Consultant (in the form of Professional Indemnity) Insurances, Principal Contractor Warranties and where relevant, Supply Warranties.

4.5.3 Inspections
The Operations and Maintenance Schedule will include details of regular inspections where these are required to ensure a proper maintenance regime is in place.
Image: Duralia Lake on the eastern boundary of the Penrith Lakes Scheme
5.0 WATER BALANCE AND LAKE OPERATING LEVELS

5.1 OBJECTIVE
The primary objective of the proposed water balance and lake operating levels is to provide the Scheme with the capacity to move water through the Scheme from south to north to maintain water bodies at their desired operational levels and discharging excess water to the Nepean River through the Wildlife Lake in the north.

5.1.1 Strategic Framework

GOAL:
To identify the sources of water available to the Scheme and investigate a water balance that could be achieved under various climatic and operating conditions.

Objective:
To identify the quantities of water available as input to the Scheme and determine the water balance for an average year.

Policy:
Scheme water inputs (groundwater, stormwater, rain and river) and outputs (quarry production requirements in the short term and evaporation and seepage in the long term) to be identified.

Short Term Strategy (STS): Water allocation to be calculated for each water body.

STS: Overall scheme water requirements to be calculated.

STS: Adopt a hierarchy of lakes for operational/management purposes.

GOAL:
To maintain desired Lake Operational levels within the Scheme under a variety of different operational circumstances.

Objective:
To provide the capability of the lakes to achieve their designated end uses and ecological values through maintaining an operational level particularly during extended periods of low rainfall.

Policy:
Infrastructure and gravitational systems to be designed with the capability to move water from non recreational/storage water bodies to recreational water bodies.

Long Term Strategy (LTS): Water bodies to be designed and constructed to be used as a water supply source for the recreational lakes.

LTS: The operational capacity of the Nepean Pump and Pipeline to be determined, to optimise the opportunity to maintain lake operating levels within acceptable tolerances for their desired end use.
### Table 6 - Summary of Lake Details

<table>
<thead>
<tr>
<th>LAKE</th>
<th>SIZE (HA)</th>
<th>AVERAGE DEPTH (M)</th>
<th>OPERATING LEVEL (M AHD)</th>
<th>VOLUME AT OPERATING LEVEL (GL)</th>
<th>TIME TO RETURN TO OPERATIONAL LEVEL (POST 100YR ARI) (DAYS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Lakes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife Lake</td>
<td>110</td>
<td>4-5</td>
<td>10</td>
<td>3.9</td>
<td>15</td>
</tr>
<tr>
<td>Lake B</td>
<td>121</td>
<td>6-7</td>
<td>13.5</td>
<td>7.3</td>
<td>29+</td>
</tr>
<tr>
<td>Lake A</td>
<td>318</td>
<td>5-6</td>
<td>14</td>
<td>17.8</td>
<td>29</td>
</tr>
<tr>
<td>Quarantine Lake</td>
<td>42</td>
<td>6-7</td>
<td>15</td>
<td>2.4</td>
<td>29</td>
</tr>
<tr>
<td>Regatta Lake</td>
<td>80</td>
<td>5-6</td>
<td>15</td>
<td>4.2</td>
<td>29</td>
</tr>
<tr>
<td><strong>Treatment Lakes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duralia Lake</td>
<td>13</td>
<td>10-11</td>
<td>18</td>
<td>0.9</td>
<td>35++</td>
</tr>
<tr>
<td>Cranebrook Lake</td>
<td>3</td>
<td>10-11</td>
<td>18</td>
<td>0.13</td>
<td>35++</td>
</tr>
<tr>
<td><strong>Detention Basins</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lewis Lagoon</td>
<td>3</td>
<td>5</td>
<td>14</td>
<td>0.08</td>
<td>15</td>
</tr>
<tr>
<td>North Pond</td>
<td>7</td>
<td>4</td>
<td>16.5</td>
<td>0.17</td>
<td>35++</td>
</tr>
<tr>
<td>Stilling Basin</td>
<td>0.6</td>
<td>2.5</td>
<td>17.7</td>
<td>0.01</td>
<td>35++</td>
</tr>
<tr>
<td>West Pond (Pioneer Pond)</td>
<td>5</td>
<td>1-2</td>
<td>17</td>
<td>0.04</td>
<td>35++</td>
</tr>
<tr>
<td>Middle Basin</td>
<td>13</td>
<td>4-5</td>
<td>16.0</td>
<td>0.5</td>
<td>35++</td>
</tr>
<tr>
<td>Final Basin</td>
<td>7</td>
<td>3-4</td>
<td>15.5</td>
<td>0.07</td>
<td>35++</td>
</tr>
<tr>
<td><strong>Lake Totals</strong></td>
<td>723</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WETLANDS</strong></td>
<td></td>
<td>OPERATING RANGE (M AHD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern Wetlands*</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duralia Wetlands</td>
<td>3.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cranebrook Wetlands</td>
<td>2.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Chain of Ponds</td>
<td>3.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The Southern Wetlands have not been designed at this stage. The details shown in this table are estimates only and will change following the conceptual design that is being undertaken as part of the SSD application for the Nepean River Pump and Pipeline.

+ Drawdown time is to 0.5m above operational level except for Lake B where it is to 1m above operational level. Increased tolerances are to assist future managers in maintaining water volumes.

++ These drawdown times have been assumed. In reality they are controlled by sluice gates and the draw down will be governed by lake operators.
5.1.2 Performance Criteria
Performance criteria for the proposed water balance relate to the operating levels of the lakes and other water bodies within the Scheme as shown in Table 6. Capacity and licensing conditions of the Nepean River and Pipeline is discussed in Section 6.

5.1.3 Priority Actions
The priority actions are:
1. Determine appropriate lake operating levels and respective tolerances for desired end uses and protection of aquatic ecosystems and to guide the operation of the Nepean Pump and Pipeline and flow regulation devices;
2. Determine a hierarchy of lakes to optimise recreational usage and determine management priorities particularly during prolonged periods of dry weather when operation of the Nepean Pump and Pipeline may be significantly constrained;
3. Consider locating a beach or beaches in the SIRC where operating levels and water quality have a much higher capability of achieving acceptable quality and operational levels for more than 90% of the time than the Main Lakes;
4. Design and construct the Quarantine Lake and associated Southern Wetlands to allow for pumped river water to be treated to a standard to enable lakes to be filled upon completion and topped up as required for long term operations.

5.2 INFRASTRUCTURE DETAILS
5.2.1 Concept Design
The earliest Water Management Plan for the Scheme was presented in the Regional Environmental Study. It was based on the knowledge of management of other water bodies and various studies, including the investigation of potential water sources for the Scheme. It was determined that the Nepean River was the most suitable source of water for the Scheme.

The possibility of using Farrells Creek stormwater as a possible water source for the Scheme was identified in the early 1990s. Predictive studies on lake performance using stormwater as a source in conjunction with Nepean River water were carried out. Stormwater was assessed as being viable provided there were adjustments to facilities and infrastructure where appropriate, and it was approved in the Water Plan for DA3. Diversion works were constructed and have been in operation since June 1995.

The deep excavation of the quarrying operations results in groundwater seepage into the quarry pits, and they also accumulate water following rain. The pits have to be ‘dewatered’ for quarrying to continue. Studies were conducted to dispose of water extracted from quarry operations areas in a manner that would:

- Have no significant impact on the Nepean River system;
- Have regard to water management in lakes during the development phase;
- Meet the water requirements of the crushing plants; and
- Meet the needs of quarry and rehabilitation works.
An overall dewatering management plan was developed. The Penrith Lakes Interim Lakes Operations Plan details the rules regarding dewatering of the site and is regularly updated to reflect changes as they occur. Under the plan the dewatering of all quarry pits is contained within the Scheme and all dewatering is in strict accordance with the prevailing Environmental Protection Licences (EPL).

In 2006 Water Research Laboratory (WRL) carried out some initial computer modelling of water balance for the Scheme. It focussed on assessing various pumping regimes and trigger levels for commencement of pumping from the Nepean River, and compared water quality in the Nepean River with that of the Lakes Scheme and local catchment inflows.

WRL reviewed environmental flow aspects and the return of flows from the Lakes Scheme. The findings formed the basis of the water extraction license approved in 2007. They provided the ‘pumping rules’ for the Scheme, setting River flow rates for beginning and ceasing extraction and the rate at which water could be extracted.

Since the WRL studies were undertaken there have been changes to the design of the Lakes Scheme and environmental flows for the Nepean River have been set.

Cardno established a hydrological model (MUSIC) and a hydraulic model (SOBEK) to model the behaviour of the Lakes Scheme under various scenarios. Their work updates the WRL analysis and provides current information on the water balance of the Scheme.

The infrastructure to address the water balance challenges for the Scheme is outlined in Sections 3 and 4 of the Plan.

5.2.2 Impacts and Mitigating Measures

The major impacts on water balance and lake operating levels will principally be climatic and environmental particularly given the ability to top up the Scheme with water extracted from the Nepean River. This is discussed further in Section 6 of the Water Management Plan.

5.2.3 Detailed Design and Further Studies

5.2.3.1 Detailed Design – Water Balance

Cardno has conducted detailed modelling of the Scheme’s water balance and the analyses are provided in the Water Balance and Lake Operating Levels Report (July 2012) at Appendix 2.

The results of Cardno’s modelling indicate the following:

- Operating levels: The lakes are generally within their target operating levels. Target levels within the Regatta Lake are met less often (modelling suggests 80% of the time) but operations over the past 14 years have clearly demonstrated higher reliability because of the increased storage in the Eastern Lakes. The 2012 Water Management Plan requires connection to the Quarantine Lake to achieve the desired reliability. On this basis modelling shows operating levels in the Regatta Lakes are achieved in excess of 90% of the time.
• Pumping requirements from the Nepean River: The modelling suggests that while 16.4GL/year can be pumped from the Nepean River under current approved license conditions, only 2.5GL is required on average to top up water in the lakes if groundwater inflows are excluded. When groundwater flows are included at the estimated volume of 3GL/yr then modelling suggests zero net extraction from the Nepean River is required in an average year.

• Filling of the Lakes: Pumping from the Nepean River will be required initially to fill the Lakes to their operating levels. Based on the current PLDC water extraction licensing conditions the modelling suggests that on average the Lakes will take about 2.9 years to fill, but during dry periods filling could take more than 8 years. In wet periods filling could take around 1 year.

• Flood drainage: Following a significant flood event, the Lakes will be above their normal operating levels, constrained by the flood weirs. Two sets of flood drainage pipes are proposed to drain the Lakes to the River, one from Lake A and the other from the Wildlife Lake. The time estimated for the Lakes to draw down to 0.5 metres above their optimal operating levels following a 1 in 100 year flood event, while complying with the Deed requirement of not more than 0.5m per day, is estimated for Lake A at approximately 29 days and for Wildlife Lake approximately 15 days. Draw down following lesser flooding events will take considerable less time.

5.2.3.2 Further Studies
No further studies are required.

5.3 RELEVANT EXISTING APPROVALS
No approvals are relevant.

5.4 APPROVALS REQUIRED
No approvals are required other than approval of the 2012 Water Management Plan by the Director-General of the Department of Planning and Infrastructure.
5.5 OPERATIONS AND MAINTENANCE

5.5.1 Construction Warranties
None required.

5.5.2 Operations and Maintenance Schedule
The Interim Lakes Operations Plan will be updated progressively to ensure that water management practices continue to:

- Meet the needs of the quarry processing plants (until cessation of processing operations),
- Meet the quarry operations until cessation,
- Design to the water quality targets set out in Schedule 7 of the Deed as amended subsequently,
- Monitor water quality within the SIRC lakes and work with SIRC on its operational requirements; and
- Guide future aquatic ecosystem development and long term management.

A Completed Lakes Operation Plan (LOP) will be developed which guides the day to day operational and environmental management of water for the lakes, their ecosystems and landforms on final dedication.
Image: Penrith Weir upstream of the Scheme, eastern bank
6.0 WATER SUPPLY SYSTEM

6.1 OBJECTIVE
The primary objective of the water supply system is to supply water from the Nepean River for initial filling of the lakes and to supplement rain, stormwater and groundwater to maintain the desired operating levels of the lakes.

6.1.1 Strategic Framework

GOAL:
Provide a permanent supply of water to the Lakes Scheme.

Objective:
To pump water from the Nepean River when water inflow from other natural sources is insufficient to maintain the desired operating levels and environmental requirements in the lakes.

Policy:
Pump facilities and pipeline to be located, designed and constructed to meet water balance targets for the Scheme in the most cost effective manner.

   Long Term Strategy (LTS): Extract water at a flowrate of no greater than 1.0 cubic metre/sec.

Policy:
Obtain a Water Extraction Licence to meet the operational and environmental needs of the Scheme.

   LTS: Extract water only when flowrate of water exceeds the minimum level for commencement of pumping as required under the water extraction licence.
   LTS: Cease extraction if flowrate of water is reduced to the limit set by the water extraction licence.
   LTS: Extract water only to fill up and maintain lake water levels within operating limits and to maintain a healthy aquatic ecosystem.

6.1.2 Performance Criteria
The proposed performance criteria for water supply of the Scheme are based on the above objective and strategies and to meet licence requirements when pumping is necessary.

6.1.3 Priority Actions
The priority actions are:
1. Obtain Development Consent for the location, construction and operation of the Nepean River pump and pipeline with a capacity of 1.0 cubic metre per second under the SSD provisions of the EP&A Act; and
2. Obtain a Construction Certificate to construct the facility; and
3. In conjunction with OPL, seek a Water Extraction Licence that will meet the needs for initial filling of the Scheme and for long term operations.
6.2 INFRASTRUCTURE DETAILS

6.2.1 Concept Design

After extensive research and analysis the RES concluded that the most suitable source of water to supplement natural sources of water to the Scheme was the Nepean River. It also indicated that given the impacts of the Penrith STP the most suitable location for a pump facility was above the Penrith weir, however alternative locations might be suitable if the Penrith STP issues were resolved.

In 2007 a licence was issued to PLDC under the Water Act 1912 to divert water from the Nepean River (Schedule 7 of Water Principles) from upstream of the Penrith Weir, and the infrastructure of a pump and pipeline was approved under Part 3A of the EP&A Act. This approval was sought as a suitable alternative water supply option was not available. The DIPNR Water Committee in 2005 commented that:

“The only reliable alternative lake water supply in the longer term for Penrith Lakes and Water side Green developments is the use of treated effluent for the Penrith STP which is situated nearby.

This alternative would necessitate upgrading the STP to a level where water quality is appropriate to the lakes. The treated effluent could be further polished in wetlands located in the area currently occupied by the existing tailings ponds located on the southern boundary of the site. This area could be developed as parkland incorporating the treatment wetlands but the area will not be available until the completion of the quarrying operations.”

The Water Committee also recommended that should the Penrith STP issue be resolved that an alternative location closer to the Quarantine Lake should be investigated.

At the time the Corporation lodged the Part 3A Application for the Nepean River Pump and Pipeline in June 2006, the water quality from the STP was not suitable to be pumped into the Penrith Lakes Scheme and therefore the Part 3A Application to construct the pump upstream of Penrith Weir was submitted.

Since then there have been a number of changes that have occurred and these have led to a reconsideration of the location of the water extraction site.

The 2006 NSW Metropolitan Water Plan committed to the release of new variable environmental flows from the water supply dams and weirs in the upper Nepean River. These flows began in July 2010. The variable environmental flows on the Nepean River are to be protected and hence the operational rules for pumping may require reassessment.

At the end of 2010, the St Marys Water Recycling Plant was completed and now returns a very high quality recycled water into the Nepean River via Boundary Creek. The quality of this water has been assessed as appropriate for the Scheme and hence the relocation of the infrastructure was investigated as recommended by the DIPNR Water Committee.
In 2011 AECOM carried out the investigation into the most suitable location for the Nepean River Pump and Pipeline from environmental, and capital and operating cost perspectives. The AECOM report is the main supporting study accompanying the new development application for relocation of the infrastructure.

The study has concluded that the new location will access water of a suitable quality, will result in less expensive operating costs over the long term, and as it is situated on land owned by PLDC, will avoid the compulsory acquisition of privately owned land. The pipeline will link to a wetland treatment train approximately 3kms in length feeding into the Quarantine Lake to improve the quality of water before it enters the Regatta Lakes.

The use of recycled water from the Penrith/St Mary’s STP and the relocation of the Pump and Pipeline (refer to Figure 8: Proposed Nepean Pump and Pipeline Location) give effect to the recommendations of the DIPNR Water Committee (2005).

The AECOM report and other related studies by Cardno indicate that the amendments proposed are complementary to the proposed flooding infrastructure set out in Section 3, and the water reticulation system outlined in Section 4 of the Plan and the works that have already been delivered.
6.2.2 Impacts and Mitigating Measures

The Water Supply System plays a significant role in the long term operations of the Scheme and is an integral component of the reticulation system for the management of the Scheme’s overall water balance and protection of the aquatic ecosystem. The conditions of the Water Extraction Licence will be critical to developing operating plans for the Scheme covering a variety of climatic conditions.

The quality of water in the Nepean River is likely to be of a standard suitable for use in the lakes. Pumping of water from the river has the potential to introduce unwanted species of weed and aquatic life and therefore design and operation of this system will need to take these impacts into consideration.

To mitigate these impacts PLDC has designed a “treatment train” of interconnected wetlands (the Southern Wetlands) of approximately 3kms for the water pumped from the Nepean River to pass through before entering the Quarantine Lake. Similarly the Quarantine Lake design will need to be carefully considered to enhance the water polishing process commenced through the wetlands system. The modelling completed by J Wyndham Prince (JWP) indicates that the water entering the Regatta Lake will be of superior quality than that currently entering from the Eastern Lakes and will be of a primary contact standard prior to entering the Quarantine Lake. The JWP report is at Appendix 6.

Regular monitoring of flowrate limits and water quality will be included in the completed Lakes Operations Plan to guide effective management of this system so that the Scheme is both protected and supported in its long term operational stage.

6.2.3 Detailed Design and Further Studies

6.2.3.1 Detailed Design - Infrastructure proposed

Studies undertaken for the Nepean River Pump and Pipeline have indicated that two axial flow line shaft driven pumps with fishtail intake strainers is suitable to deliver the 1.0 m3/s required to maintain the lakes. Figure 9 shows the current concept design.
6.2.3.2 Further Studies
No further studies are required for the Water Supply system other than to address the Director-General’s Requirements in respect of the Development Application under the SSD provisions of the EP&A Act.

6.3 RELEVANT EXISTING APPROVALS
PLDC was issued a licence (Licence No 10SL047922) to extract water from the river under Section 12 of the Water Act 1912 for a period of 5 years in 2010. This licence allows PLDC to pump water from the Nepean River for recreation purposes until 17th April 2015. Condition 10A of the licence stipulates that the extraction point is to be upstream of the weir and as such PLDC will seek to have it transferred to the new location or a fresh licence issued.

Development approval for the construction and operation of a pump and pipeline to extract water from the Nepean River to facilitate the initial filling and long-term water supply of the Penrith Lakes Scheme was given under section 75B(1)(a) of the Environmental Planning and Assessment Act 1979 on 4 June 2007. This approval has now expired.
6.4 APPROVALS REQUIRED

6.4.1 Water Plan Approval
The new location requires approval of the 2012 Water Management Plan.

4.4.2 Major Project Approval - EPA Act 1979
Approval to construct and operate the Nepean Pump and Pipeline is required as a State Significant Development under State Environmental Planning Policy (State and Regional Development) 2011. This process is well advanced and will involve detailed consultation with the Water agencies and other stakeholders now likely to take place in August/September 2012.

6.4.2 Water Licence
Approval for a variation to Condition 10A of the current licence or issue of a fresh licence is required to allow water to be extracted from the new location.

6.4.3 Two Year Plan and Construction Certificates
Two Year Plan approval and Construction Certificate approval will be sought for this infrastructure.

6.4.4 Controlled Activity Approvals and Licences
In certain instances, particularly in relation to works within the riverbank, separate permits, licences and controlled activity approvals associated with a range of legislation that is relevant to the site may be required. These separate approvals, if required, will be identified and sought during the detailed design phase for each item of infrastructure, operations and maintenance.

6.5 OPERATIONS AND MAINTENANCE SCHEDULE
Operations and Maintenance Schedules will be developed during the detailed design phase of each item of infrastructure and delivered to Government (end owner) upon dedication. These schedules will provide at least the following details:

- Specification/s for each item of infrastructure;
- Design and Construction Warranties;
- Detailed Design, Construction and Works-as-executed drawings;
- Detailed operational procedures for each individual item of infrastructure with specific relevance to the function/role it serves within the overall Water Balance and Lake Operating Levels, Flood Scheme Design and contained in the Completed Lakes Operations Plan;
- Detailed Maintenance Schedule for each individual infrastructure having regard to the applicable Design, Construction and Supply Insurances and Warranties.
6.5.1 Design and Construction Warranties
Where infrastructure works involve “building works” that necessitate Construction Certificate approval/s, PLDC will, where appropriate, arrange for Design and Construction warranties to be novated to the Corporation in accordance with existing industry practices.

These Indemnities and Warranties will include those of the Principal Design Consultant (in the form of Professional Indemnity) Insurances, Principal Contractor Warranties and where relevant, Supply Warranties.

6.5.2 Inspections
The Operations and Maintenance Schedule will include details of regular inspections where these are required to ensure a proper maintenance regime is in place.
Image: Constructed wetlands across the Scheme
7.0 WORKS AND APPROVALS PROGRAM

The works programmed by PLDC have been affected by a number of factors including lack of approvals. The currently revised program of works has been prepared by Tracey Brunstrom Hammond (TBH) to reflect the current circumstances impacting on delivery including extending the mining program to accommodate these delays and rescheduling of works to reflect a more achievable time frame for approvals and construction times.

This program is shown in Appendix 7.

The main features of this Program are:

1. Quarry operations extended to 31 December 2014;
2. Rehabilitation works including construction of all flood, reticulation and water supply infrastructure by 30 September 2014; and
3. Completion of the Quarantine Lake and commencement of lake filling from the Nepean River Pump and Pipeline by June 2015.

This Program is indicative and based upon the best information available to PLDC as July 2012 and could change depending on a number of factors.
Image: Water quality has improved encouraging the natural return of native birdlife to the constructed wetlands across the Scheme.
8.0 CONCLUSION AND RECOMMENDATIONS

8.1 CONCLUSION
The Scheme is being implemented under the Deed, SEPP (Penrith Lakes) 1989, development consents and other relevant approvals. The 2012 Water Management Plan is being submitted to the Director-General of the Department of Planning and Infrastructure under Condition 27A of DA4.

The Plan will be submitted in two (2) stages. The first will focus on the infrastructure to be provided to successfully manage the flow of water into and out of the Scheme in all conditions including in a 100yr ARI event and to establish optimal lake operating levels to support the end uses envisaged under the Deed.

The second stage will focus on water quality criteria and the operational requirements for the short and long term management of the quality of water before and after it enters the lakes to achieve the recreational and environmental objectives of the Scheme. While connected, Stage 1 can be approved and implemented separately to Stage 2. Stage 2 will be submitted to the Director-General for approval by 31 December 2012.

The 2012 Water Management Plan has been prepared by PLDC with the assistance of external experts following many years of study, analysis and modelling to provide a contemporary strategy for the completion of the Penrith Lakes Scheme. It has also been the subject of extensive consultation with Government agencies, Penrith City Council and other stakeholders to ensure the Water Management Plan will deliver a successful outcome for both the short and long term objectives of PLDC and the New South Wales Government as the parties to the Deed.

Following approval of the Water Management Plan it is proposed to seek modifications to DA2, DA3 and DA4 to refer to the Water Management Plan to ensure consistency across the Scheme.

The 2012 Water Management Plan:

1. Provides a robust and cost-effective structural solution to manage flows during flood events as well as the day to day management of water throughout the Scheme,
2. Optimises the flood, reticulation and water supply infrastructure to meet long term operational requirements,
3. Provides management options for a range of climatic conditions from prolonged dry periods through to wet periods,
4. Establishes a hierarchy of lakes which optimises the recreational and end usage outcomes for patrons of Penrith Lakes,
5. Delivers the best opportunity to achieve desired water quality targets in the individual lakes,
6. Minimises ongoing maintenance and operations costs,
7. Minimises disturbance to the riverbank zone thereby preserving the natural stability of the riverbank,
8. Minimises intrusions into sensitive Aboriginal, European and natural heritage areas,
9. Optimises the use of landscaped and aesthetically pleasing structures in keeping with a recreational and parkland setting, and
10. Optimises flexibility for recreational uses of the Scheme.

The 2012 Water Management Plan details the infrastructure and associated works necessary to complete the Scheme, sets operating levels and water quality targets for each of the lakes and establishes a format and process for the preparation of a Completed Lakes Operations Plan. The specifics are included in three (3) schedules contained in the Plan. Schedule 1 of the Plan details the flood, water supply and reticulation infrastructure required to meet the objectives set out in the Deed and deliver a completed Scheme that successfully performs in a variety of climatic situations.

Schedule 2 of the Plan contains the draft Water Quality Strategy which will form the basis of Stage 2 of the 2012 Water Management Plan. It also commits to the update of the Interim and preparation of the Completed Lakes Operations Plan. It also commits to a process and timetable to submit Stage 2 of the Plan to the Director-General of Planning and Infrastructure by 31 December for approval.

Schedule 3 of the Plan sets lake operating levels suitable to achieve desired flexibility for recreational uses, water storage capability and the environmental management of the Scheme for long term operations.

Stage 2 will also provide for the necessary licensing for the interim and long term operational needs of the Scheme. It is proposed to pursue the licensing in conjunction with OPL to ensure that the end owner’s requirements are appropriately addressed in this process.

The 2012 Water Management Plan contains the relevant technical and analytical reports prepared by independent experts that have led to the design decisions PLDC have made.
8.2 RECOMMENDATION
It is recommended that the Director-General of the Department of Planning and Infrastructure approves this 2012 Water Management Plan and the specific works and targets contained in:

- Schedule 1 – Water Management Infrastructure;
- Schedule 2 – Draft Water Quality Strategy includes consultation process and timetable for submission to the Director General of Department of Planning and Infrastructure for approval; and
- Schedule 3 – Lakes Operating Levels.

It is also recommended that the Director General approves the submission of Stage 2 of the Water Management Plan as contained in Schedule 2 for approval by 31 December 2012.
Figure 10: Water Supply and Reticulation Works to be Completed
9.0 WATER MANAGEMENT SCHEDULES

SCHEDULE 1: WATER MANAGEMENT INFRASTRUCTURE
The Water Management Infrastructure is to be constructed by PLDC. Figure 10 shows the water supply and reticulation which is to be completed by PLDC.

Table 7: Water Supply & Reticulation Works to be completed

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>ITEM DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>750 – 1100 mm(^1) Pipeline from Nepean River Pump – to carry a flow of 1.0 m(^3)/s</td>
</tr>
<tr>
<td>4</td>
<td>2 x 1350 mm(^2) pipeline Main Lakes to Nepean River (for reticulation and flood water draw down)</td>
</tr>
<tr>
<td>6</td>
<td>1 x 1350 mm pipeline Wildlife Lake to Nepean River (for reticulation and flood water draw down)</td>
</tr>
<tr>
<td>15</td>
<td>Pump to deliver 1.0 m(^3)/s Nepean River to Scheme</td>
</tr>
<tr>
<td>19</td>
<td>Channel to convey reticulation water from Lake A to Lake B</td>
</tr>
<tr>
<td>20</td>
<td>Sluice gate to control flows between Lake A and Lake B</td>
</tr>
</tbody>
</table>

\(^1\) Sizing to be determined in final design following approval for revised location.

\(^2\) Final size to be determined following detailed design process.
Figure 11: Completed Water Supply and Reticulation Works
9.0 WATER MANAGEMENT SCHEDULES

Figure 11: Completed Water Supply and Reticulation Works shows the water supply and reticulation works already completed by PLDC.

Table 8: Completed Water Supply and Reticulation Works

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>ITEM DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1200 mm diameter pipeline to SIRC</td>
</tr>
<tr>
<td>3</td>
<td>1500 mm diameter pipeline SIRC to Lake A</td>
</tr>
<tr>
<td>5</td>
<td>900 mm diameter pipeline Lake B to Wildlife Lake</td>
</tr>
<tr>
<td>7</td>
<td>5 x 3m x 0.9m culverts Lewis Lagoon to Wildlife Lake</td>
</tr>
<tr>
<td>8</td>
<td>900 mm diameter pipeline Cranebrook Lake to Duralia Lake</td>
</tr>
<tr>
<td>9</td>
<td>900 mm diameter pipeline Duralia Lake to North Pond</td>
</tr>
<tr>
<td>10</td>
<td>2 x 900 mm pipes connecting West Pond and North Pond</td>
</tr>
<tr>
<td>11</td>
<td>Overflow weir 20m crest width on Farrell’s Creek</td>
</tr>
<tr>
<td>12</td>
<td>1200 mm pipe plus a weir connecting North Pond and Middle Basin</td>
</tr>
<tr>
<td>13</td>
<td>3m x 1.8m culvert connecting Middle and Final Basins</td>
</tr>
<tr>
<td>14</td>
<td>3m x 1.8m culvert connecting Final Basin and SIRC</td>
</tr>
<tr>
<td>16</td>
<td>Sluice gate to control flows between Lake B and Wildlife Lake</td>
</tr>
<tr>
<td>17</td>
<td>Sluice gate to control flows between Duralia Lake and North Pond</td>
</tr>
<tr>
<td>18</td>
<td>Sluice gate to control flows between Final Basin and SIRC</td>
</tr>
</tbody>
</table>
Figure 12: Flood Protection Works to be Completed
### 9.0 WATER MANAGEMENT SCHEDULES

Figure 12 Flood Protection Works to be Completed shows the flood protection works to be completed by PLDC.

<table>
<thead>
<tr>
<th>REFERENCE</th>
<th>DESCRIPTION</th>
<th>ADEQUATE CAPACITY</th>
<th>CONCEPTUAL DETAILS</th>
</tr>
</thead>
</table>
| Weir 3    | Weir 3 is the primary control for floodwaters entering the Lakes Scheme from the Nepean River | Peak flow of 1,740 \text{ m}^3/\text{s} | Weir Width 400 – 500m  
Weir Crest Height ~ 20.9 mAHD  
Scour Protection – Gabions / Reno Mattress |
| Weir 4    | Weir 4 is a low level broad embankment between Main Lakes A and B. The weir quickly overtops in flood events, allowing the two lakes to act as a single water body. | Peak flow of 1,650 \text{ m}^3/\text{s} | Weir Width 450 – 550m  
Weir Crest Height ~ 15.0 mAHD  
Scour Protection – Grass |
| Weir 6    | Weir 6 is the primary control for the spill of floodwaters from the Main Lakes into the Wildlife Lake. It controls the water levels within the Main Lakes, as well as Quarantine and Regatta Lakes. | Peak flow of 1,640 \text{ m}^3/\text{s} | Already constructed to:  
Weir Width: 440m  
Weir Crest Height: 21.0 mAHD  
Minor amendment recommended to achieve a crest height of 20m AHD.  
Weir Crest Height: 20.0 mAHD (for approval)  
Scour Protection - Grass |
| Wildlife Lake Weir | The Wildlife Lake Weir serves two purposes. It conveys inflows from the Nepean River during the early part of the flood, and outflows from the Lakes during the latter part of the flood. This weir was approved in Modification 5 of DA4. | Peak flow of 490 \text{ m}^3/\text{s} (Stage 1)  
1,110 \text{ m}^3/\text{s} (Stage 2) | Under Construction Contract:  
Stage 1:  
Central Weir Width: 65m  
Central Weir Crest Height: 16.0mAHD  
Stage 2:  
Total Weir Width: 150m  
Total Weir Crest Height: 18.5mAHD  
Scour Protection – Concrete / Grass |
| Regatta Flow Path | The Regatta Flow Path is a low level flow path between the Lake A and Regatta Lake that convey floodwaters into the Regatta Lake. | Peak flow of 590 \text{ m}^3/\text{s} | Base Width: 25 - 75m  
Crest Height: 16.5 mAHD  
Flowpath Length: ~ 225 m  
Scour Protection - Grass |
## Reference Description

### Adequate Capacity

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
<th>Adequate Capacity</th>
<th>Conceptual Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duralia to Main Lake Flow path</strong>&lt;br&gt;The Eastern Lakes are a series of lakes to the east of the Main Lake. The majority of these lakes are disconnected from the Main Lake during a 100 year ARI flood by high ground levels. There are two flow paths which connect the Eastern Lakes with the Main Lakes: Main Lake to Duralia and Duralia to North Pond.</td>
<td>Peak flow of 0 m³/s</td>
<td>Base Width: 250 - 350m&lt;br&gt;Crest Height: 22 mAHD&lt;br&gt;Scour protection - Grass</td>
<td></td>
</tr>
<tr>
<td><strong>Duralia to North Pond Flow path</strong>&lt;br&gt;There are two flow paths which connect the Eastern Lakes with the Main Lakes: Main Lake to Duralia and Duralia to North Pond.</td>
<td>Peak flow of 60 m³/s</td>
<td>Base Width: 100 - 200m&lt;br&gt;Crest Height: 19.0 mAHD&lt;br&gt;Scour protection - Grass</td>
<td></td>
</tr>
<tr>
<td><strong>Main Lake Flood Outlet Pipes</strong>&lt;br&gt;These pipes are provided to return the Lakes Scheme to normal operational levels following a significant flood event.</td>
<td>Draw down rate &lt;0.5m day</td>
<td>2 x 1,350mm concrete pipe with appropriate energy dissipation and flood flaps installed</td>
<td></td>
</tr>
<tr>
<td><strong>Wildlife Lake Flood Outlet Pipe</strong>&lt;br&gt;This pipe is provided to return the Lakes Scheme to normal operational levels following a significant flood event. As per Modification 4 of DA4.</td>
<td>Draw down rate &lt;0.5m day</td>
<td>Under Construction Contract; 1 x 1,350mm concrete pipe with appropriate energy dissipation and flood flaps installed</td>
<td></td>
</tr>
<tr>
<td><strong>Flood Cells</strong>&lt;br&gt;The Riverbank flood cell prevents the inflow of floodwaters into the Lakes Scheme until the lake levels are close to the Nepean River levels. This protects the integrity of the riverbank.</td>
<td>Peak flow of 0 m³/s</td>
<td>Length: 5.7km (approximate)&lt;br&gt;Crest Height Ranges from: 24.7 – 21.0 mAHD</td>
<td></td>
</tr>
</tbody>
</table>

*The conceptual details may vary slightly during the detailed design process.*
Figure 13: Water Operating Levels

Nepean River
Wildlife Lake
approx. 110 ha
OWL 10m AHD

Lake A
approx. 318 ha
OWL 14m AHD

Warm-up Lake
approx. 121 ha
OWL 13.5m AHD

Lake B
approx. 80 ha
OWL 15m AHD

Duralia
approx. 78 ha
OWL 18m AHD

Final Basin
OWL 15.5m AHD

North Pond
OWL 16.5m AHD

Cranebrook Lake
OWL 18m AHD

SIRC Regatta Lake
approx. 55.3 ha
OWL range 26.0 - 20.0m AHD

Lewis Lagoon
OWL 14.0m AHD

Wilchard Road Wetlands
The Poplars

Southern Wetlands
approx. 55.3 ha
OWL range 26.0 - 20.0m AHD

Sail Basin
OWL 17.7m AHD

West Pond Wetlands
OWL 17.0m AHD

Middle Basin
OWL 16.0m AHD

Quarantine Lake
approx. 42 ha
OWL 15m AHD

The Escarpment Lagoons

Boat Ramp
Boat Ramp

9.0 WATER MANAGEMENT SCHEDULES

SCHEDULE 2: WATER QUALITY CRITERIA
Schedule 2 – Draft Water Quality Strategy is provided at Appendix 4. The submission is to be lodged by 31 December 2012.

SCHEDULE 3: LAKES OPERATING LEVELS
Table 10 below shows the lakes and Wetlands water operating levels and is further illustrated in Figure 13: Water Operating Levels.

Table 10 - Water Operating Levels

<table>
<thead>
<tr>
<th>LAKE</th>
<th>OPERATING LEVEL (M AHD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Lakes</strong></td>
<td></td>
</tr>
<tr>
<td>Wildlife Lake</td>
<td>10</td>
</tr>
<tr>
<td>Lake B</td>
<td>13.5</td>
</tr>
<tr>
<td>Lake A</td>
<td>14</td>
</tr>
<tr>
<td>Quarantine Lake</td>
<td>15</td>
</tr>
<tr>
<td>Regatta Lake</td>
<td>15</td>
</tr>
<tr>
<td><strong>Treatment Lakes</strong></td>
<td></td>
</tr>
<tr>
<td>Duralia Lake</td>
<td>18</td>
</tr>
<tr>
<td>Cranebrook Lake</td>
<td>18</td>
</tr>
<tr>
<td><strong>Detention Basins</strong></td>
<td></td>
</tr>
<tr>
<td>Lewis Lagoon</td>
<td>14</td>
</tr>
<tr>
<td>North Pond</td>
<td>16.5</td>
</tr>
<tr>
<td>Stilling Basin</td>
<td>17.7</td>
</tr>
<tr>
<td>West Pond Wetlands</td>
<td>17</td>
</tr>
<tr>
<td>Middle Basin</td>
<td>16.0</td>
</tr>
<tr>
<td>Final Basin</td>
<td>15.5</td>
</tr>
<tr>
<td>Southern Wetlands</td>
<td>26 - 20</td>
</tr>
</tbody>
</table>
10.0 REFERENCE DOCUMENTS

10.1 REFERENCED DOCUMENTS
The following documents have been used in the development of the 2012 Water Management Plan.

Department of Planning (1984) Regional Environmental Study
Department of Planning (1987) Deed of Agreement
Department of Planning (1989) Deed of Agreement
Patterson Britton (2005) Castlereagh Road Relocation Flood Study
Patterson Britton (2007) Waterside South Precinct (Ver 2) Flood Impacts
Cardno (2010) Flood Infrastructure Concept Design
Cardno (2010) Two Lakes Alternative Flood Analysis
Cardno (2010) Penrith Lakes Flood Model Calibration and Verification
Cardno (2011) Assessment of Wildlife Lake Weir
Cardno (2011) Flood Infrastructure Concept Design (Rev 4)
Cardno (2012) Letter on Proposed Flood Infrastructure and Scheme Design
AECOM Report (2011) Nepean River Pump and Pipeline
PLDC (2012) Strategic Framework
11.0 SUPPORTING DOCUMENTATION AND APPENDICES

11.1 STAKEHOLDER CONSULTATION
PLDC completed a consultation process which is reflected in the flowchart below. Ongoing consultation between PLDC and OPL and Department of Planning and Infrastructure continued up to submission of the Plan.

11.1.1 Consultation Flowchart

**STAGE 1: NOTIFICATION OF WATER MANAGEMENT PLAN AND REGISTRATION OF INTEREST**

- List of stakeholders compiled and who may have an interest in the Water Plan, and hold knowledge relevant to determining issues of concern from reasonable sources of information, which includes writing to:
  - DP&I, DT&I and OEH
  - Penrith City Council.

PLDC writes to the people whose names were provided by the above organisations to notify them of the proposed plan and opportunity to be involved in consultation.

Interested parties confirmed attendance at Concept presentation.

PLDC records the names of people who have registered an interest in being involved in consultation and make this record available upon request.

Consultation meetings between stakeholders and PLDC on the 12th and 14th of March 2012

*Figure 14: Consultation process Stage 1.*

The notification includes the consent condition 27A:

By 31 March 2012 or as otherwise agreed by the Director-General, the Applicant shall review and update the existing Water Management Plan for the Scheme to the satisfaction of the Director-General. The review and update of this plan must be prepared in consultation with OEH, DPI and Council; and cover the relevant aspects outlined in the Deed of Agreement for the Penrith Lakes Scheme, the proposed development in this consent, and the proposed development of the other development consents for the Penrith Lakes Scheme.

Following approval, the Applicant shall implement the updated plan to the satisfaction of the Director-General.

Note: Prior to approval of the revised Water Management Plan, the pre-existing Water Management Plan for the Penrith Lakes Scheme shall continue to apply to the development.
**STAGE 2: PRESENTATION OF INFORMATION ABOUT THE WATER MANAGEMENT PLAN**

PLDC provides proposed WMP information to registered parties (8th May 2012).

PLDC provides an opportunity for registered parties to visit the site.

PLDC records that information on the proposed WMP has been received by the agencies. PLDC records any written comments it receives from agencies prior to the proposed consultation meetings (where applicable).

Consultation meetings between stakeholders and PLDC on the 12th and 14th of March 2012

*Figure 15: Consultation process Stage 2.*

**STAGE 3: GATHERING INFORMATION ABOUT PROPOSED WATER MANAGEMENT PLAN**

Second consultation meetings with respective stakeholders on the 16th and 17th May 2012.

Registered parties have two weeks after the consultation meetings to provide written comment (being 30th/31st May 2012).

PLDC presents proposed WMP to the meetings and seeks comment/feedback from registered parties to identify issues for consideration.

PLDC considers input provided from registered parties and finalises methodology for implementation. PLDC documents how the input has been considered.

PLDC seeks follow up input from registered parties.

*Figure 16: Consultation process Stage 3.*
11.1.2 Registered Stakeholders
The stakeholders that have been included in the consultation process to date are:
• Department of Sport and Recreation (Office of Penrith Lakes)
• Department of Planning and Infrastructure
• Office of Environment and Heritage
• Department of Finance and Services (NSW Public Works)
• Department of Primary Industry (Office of Hawkesbury Nepean, NSW Office of Water)
• Penrith City Council
• Office of Communities (SIRC)

11.1.3 Issues Raised
Issues raised in the consultation process together with responses are contained in Consultation Issues Log at Appendix 8

11.1.4 Consultation Pack
The PLDC presentation material and Consultation Pack were issued to all stakeholders in March and May 2012 and for further reference should be read in conjunction with the 2012 Water Management Plan.
APPENDICES

APPENDIX 1 - CARDNO FLOOD INFRASTRUCTURE CONCEPT DESIGN REPORT AUGUST 2012

APPENDIX 2 - CARDNO WATER BALANCE AND LAKE OPERATING LEVELS REPORT AUGUST 2012

APPENDIX 3 - CARDNO FLOOD MODELLING CALIBRATION REPORT

APPENDIX 4 - DRAFT WATER QUALITY STRATEGY

APPENDIX 5 - PENRITH LAKES DRAFT CONCEPT MASTERPLAN 2012

APPENDIX 6 – JWP SOUTHERN WETLANDS MODEL

APPENDIX 7 - TBH WORKS PROGRAM

APPENDIX 8 – CONSULTATION ISSUES LOG