WILDLIFE LAKE
SECTION 75W – WEIR & FLOOD OUTLET PIPE SUPPLEMENTARY REPORT

Prepared by Penrith Lakes Development Corporation |

6th December 2010

. Supplementary Environmental Assessment for section 75W application submitted on 2 December 2010. DATED 6th December 2010

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1.0 PURPOSE

Penrith Lakes Development Corporation Limited (PLDC) has prepared this Section 75W Application to address proposed changes to the configuration of the Wildlife Lake at the Penrith Lakes Scheme (Wildlife Lake) from that identified in the 1998 Structure Plan contained in Sydney Regional Environmental Plan 11 (SREP 11).

This Supplementary Environmental Assessment supplements the two Section 75W Applications lodged with the Department of Planning on 2 December 2010 for a Flood Weir and Flood Drainage Outlet Pipe in the north of the Penrith Lakes Scheme.

This Supplementary Environmental Assessment seeks to address the relevant considerations for the required amendments to the Structure Plan required to allow the modifications requested in the Section 75W Applications lodged on 2 December 2010. PLDC is requesting that the Minister as the consent authority exercises their discretion under clause 8(2)(a)(iii) of SREP 11 to grant approval to the development of the Wildlife Lake (Wildlife Lake weir and flood outlet pipe) which is generally in accordance with the Structure Plan.

The Structure Plan (contained within SREP 11) is a fundamental component of the planning controls for the Penrith Lakes Site (**Site**). The Structure Plan provides the basic details of lake shape. As part of a design review for the Site, PLDC has identified the need to amend the layout of the Wildlife Lake configuration from that layout contained in the current 1998 Structure Plan.

PLDC commissioned a suite of technical studies and strategies (see **Appendix A**) to assist the development of a design for the Wildlife Lake, focusing on flood mitigation and delivering cost effective and sustainable outcomes. The strategies and studies have been obtained from Sydney's leading experts in natural and cultural landscape design, terrestrial and aquatic ecology and engineering.

These technical studies and strategies are important underpinning studies formed on the basis of current industry thinking and standards to ensure that the detailed design of the Wildlife Lake meets the overall goals and objectives of the Penrith Lakes Scheme outlined in SREP 11 and 1984 Regional Environmental Study (**RES**).

The Wildlife Lake configuration as proposed, remains a key component of the Penrith Lakes Scheme and will provide a lake that can meet the schemes flood management, water quality, recreational and ecological values.

2.0 BACKGROUND

2.1 SREP 11 & STRUCTURE PLAN

SREP 11 is the main planning instrument that currently applies to the Site and provides for theimplementation of the Penrith Lakes Scheme. The Penrith Lakes Schemes is defined in Schedule 1 to SREP 11 to mean:

> *".....the creation of a regional recreational lake system as shown on the structure plan for the benefit of the public as a result of:*
>
> *(a) the staged optimum extraction of sand and gravel reserves,*
>
> *(b) the staged rehabilitation, reconstruction and landscaping of the land, and*
>
> *(c) the staged formation of a series of interconnected lakes,*
>
> *and includes the identification of land for possible future urban purposes as a result of the work referred to in paragraphs (a) and (b)."*

The aims and objectives of SREP 11 are:

> *"2 Aims, objectives etc*
>
> *(1) The aims and objectives of this plan are to permit the implementation of the Penrith Lakes Scheme.*
>
> *(2) Without limiting the generality of subclause (1), the particular aims of this plan are:*
>
> *(a) to provide a development control process establishing environmental and technical matters which must be taken into account in implementing the Penrith Lakes Scheme in order to protect the environment,*
>
> *(b) to identify and protect items of the environmental heritage,*
>
> *(c) to identify land which may be rezoned for urban purposes, and*
>
> *(d) to permit interim development in order to prevent the sterilization of land to which this plan applies during implementation of the Penrith Lakes Scheme."*

It establishes the development controls for the extractive activities, the management and control of water resources and the rehabilitation of the Site. SREP 11 includes a Structure Plan (Figure 1) which identifies the number, size and structure of the lakes, future urban areas, heritage items, open space, detention basins and the then proposed realignment of Castlereagh Road.

The Structure Plan (contained within SREP 11) is a fundamental component of the planning controls for the Site. The Structure Plan provides the basic details of lake shape. As part of the detailed design for the Wildlife Lake precinct, PLDC has identified the need to amend the layout of the Wildlife Lake configuration from the layout contained in the current 1998 Structure Plan.

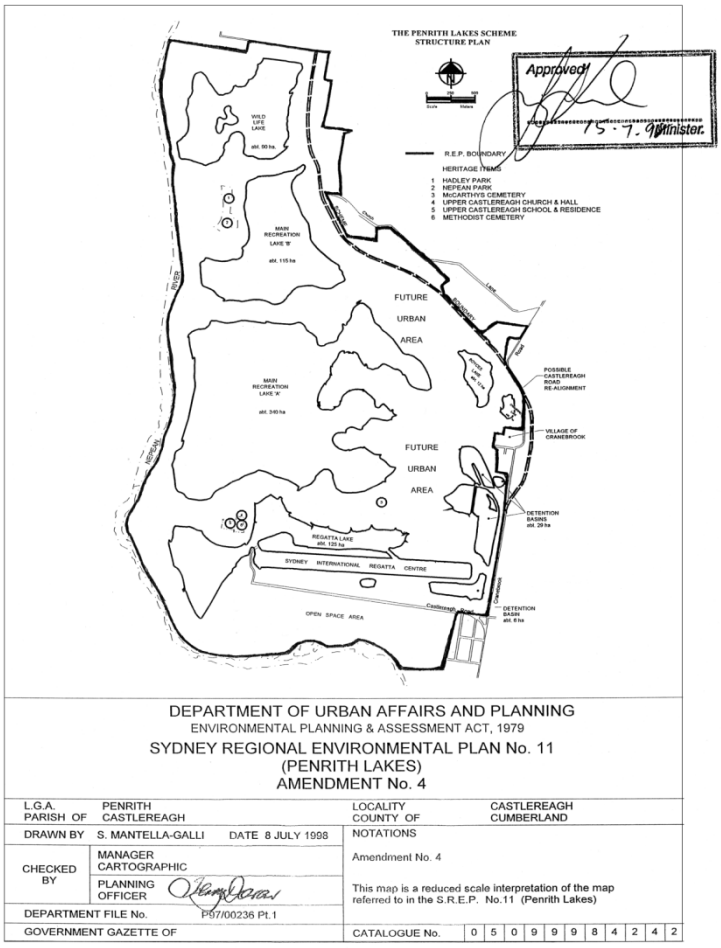

Figure 1

2.2 DA 4 CONSENT

DA 4 provides for the extraction of sand and gravel from the northern and western parts of the Site, including the area of the Wildlife Lake. The proposed development as described in the DA 4 consent is:

> *Development as described in the development application identified as DA 4 and its supporting papers for the purposes of implementing the Penrith Lakes Scheme as defined in Schedule 1 of Sydney Regional Environmental Plan No.11 Penrith Lakes Scheme...*

In approving DA 4, the consent authority would have formed the opinion that the proposed development in DA 4 was generally in accordance the Structure Plan.

2.3 PLANNING CONTEXT – LEGAL REFERENCES

SREP 11 is now deemed to be a State Environmental Planning Policy (**SEPP**). SREP 11 is the governing SEPP for the Penrith Lakes Scheme. As such, regard must be had to it when the Minister assesses any application for modification of existing development consents under section 75W of the Environmental Planning and Assessment Act, 1979 (NSW) (**EPA Act**).

Clause 8(2)(a)(iii) of SREP 11 requires the Minister as consent authority to approve development to which this clause applies unless it is *"(iii) not generally in accordance with the structure plan,....."*

SREP 11 contemplates that, from time to time, the Structure Plan would change. Express provision is made for this in clause 12 of SREP 11 which states:

"(1) The consent authority may from time to time amend the structure plan, but only in relation to:

(a) The size and shape of a lake or lakes, or

(b) The proposed route of the road to replace Castlereagh Road.

(2) The consent authority may only amend the structure plan in accordance with subclause (1)(a) if:

(a) The proposed size and shape of the lake or lakes is generally in accordance with the structure plan before its amendment, OR

(b) The consent authority is of the opinion that the proposed size and shape is in the public interest and will not significantly reduce the public enjoyment or use of the Penrith Lakes Scheme on completion.

(3) An amendment of the structure plan may not extend the land to which this plan applies."

The proposed variation to the size and shape of the Wildlife Lake clearly falls within the Minister's power as consent authority in clause 12(1)(a) of SREP 11.

PLDC takes the view that the Minister has power to approve the proposed amendment to the size and shape of the Wildlife Lake relying on clause 12(2)(a) and clause 8(2)(a)(iii) of SREP 11, that is that the proposed size and shape of the Wildlife Lake is generally in accordance with the Structure Plan before its amendment. In this regard, it is relevant to note that the Land and Environment Court has interpreted the term "generally in accordance" with plans on numerous occasions in the context of construing development consents. The Court has allowed some "latitude" where there is a deviation from approved plans and has not required a "pedantic approach" (see, for example, *Grace Bros Pty Ltd* v *Willoughby Municipal Council* (1980) 44 LGRA 400 at 406; *Katoomba Gospel Trust* v *Blue Mountains City Council* [1994] NSWLEC 107).

Further, PLDC submits that the exercise of the Minister's discretion to vary the size and shape of the Wildlife Lake should be made having regard to the overriding purpose of SREP 11, being to permit the implementation of the Penrith Lakes Scheme.

3.0 PROPOSED AMENDMENTS TO WILDLIFE LAKE OUTLINE

To support the proposed amendment to the Wildlife Lake configuration, PLDC commissioned a suite of technical studies and strategies (see **Appendix A**) to assist the development of a design for the Wildlife Lake, focusing on flood mitigation and delivering cost effective and sustainable outcomes. The strategies and studies have been obtained from Sydney's leading experts in natural and cultural landscape design, terrestrial and aquatic ecology and engineering.

These technical studies and strategies are important underpinning studies formed on the basis of current industry thinking and standards to ensure that the detailed design of the Wildlife Lake meets with the overall goals and objectives of the Penrith Lakes Scheme outlined in SREP 11 and 1984 RES.

To compare the two Wildlife Lake designs the main variations are shown in Figure 2 and explained below:

- The lake is approximately 20 ha larger (a total of 110ha);

  The increase in lake area assists with fill balance required to prevent the importation of fill to this area, as well as containing islands within this area.

- There are several additional islands;

  These islands provide a high variety of habitat value, foreshore wave protection and interpretation of historic land grant boundaries.

- The north western corner of the lake extends further north;

  This generally follows the Hunts Gully Floodway, which facilitates flooding ingress from the Nepean River and includes a weir into the Wildlife Lake.

- The western shore of the lake extends closer to the bank of the Nepean River;

  This area also contains the flood outlet pipe and has been chosen, as it will minimise disturbance to the environmental sensitive riverbank zone. This is also reflects the lack of fill material available in this zone.

- The south western corner of the lake extends closer to the Main Lake.

  The increase in lake area assists with fill balance required to prevent the importation of fill to this area.

- The south eastern corner of the lake extends closer to Castlereagh Road.

  The increase in lake area assists with fill balance required to prevent the importation of fill, as well as assisting in wildlife connectivity from the escarpment to the Wildlife Lake.

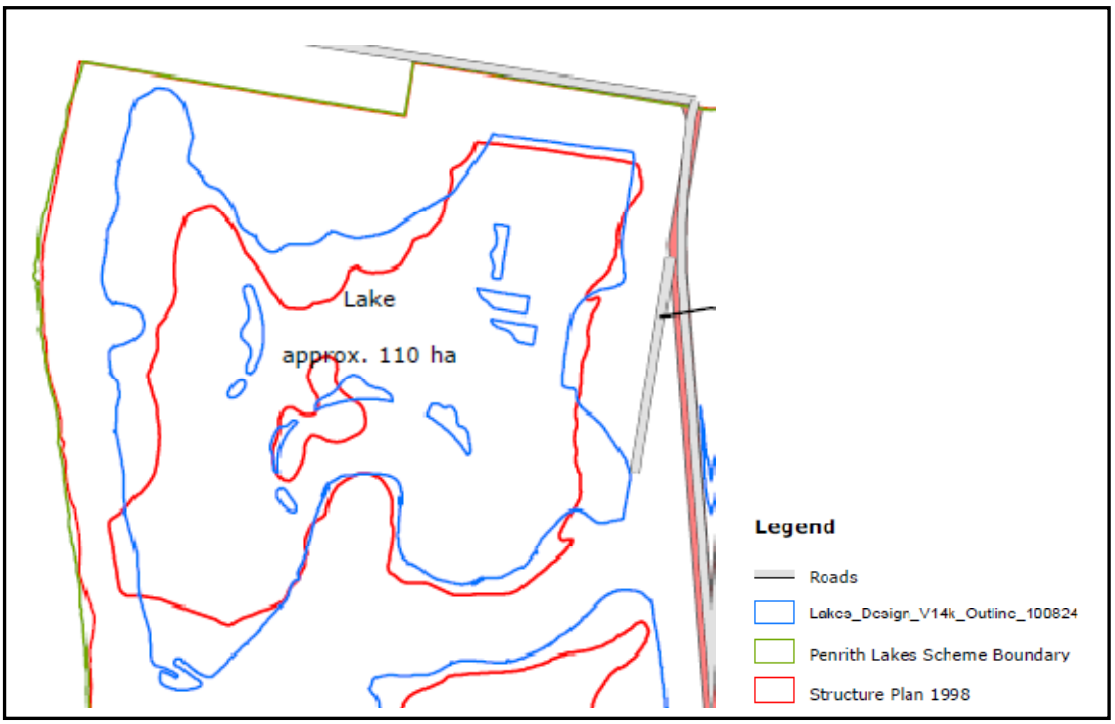

Figure 2

Whilst the Wildlife Lake shape proposed in the new Wildlife Lake configuration has increased in size and there are changes to the lake shoreline, the design of the Wildlife Lake is generally in accordance with the Structure Plan, particularly when considering the Wildlife Lake in the context of the broader Penrith Lakes Scheme. As detailed in this submission, the Wildlife Lake is designed to achieve a high ecological value, whilst also performing a key flood management function.

The overriding purpose of SREP11 as contained in Clause 2(1) is *"to permit the implementation of the Penrith Lakes Scheme."* Specifically, the proposed amendment to the Wildlife Lake configuration will continue to satisfy the objective as contained in Clause 2(2)(a) of affording protection to the environment.

In considering the aims and objectives of SREP 11 the proposed reconfigured Wildlife Lake design:

- is a key component of the lake system required to implement the Penrith Lakes Scheme;
- can meet the scheme flood management, water quality, recreational and ecological values; and fill balance with minimal disturbance to the sensitive riverbank
- is generally in accordance with the SREP 11 Structure Plan.

The proposed amendments for the Wildlife Lake are required to manage the fill balance within the Wildlife Lake precinct and to facilitate the construction of two key pieces of flood infrastructure; the flood outlet pipe and the Wildlife Lake weir, with minimal disturbances to the riverbank.

4.0 DETAILED ANALYSIS

4.1 WILDLIFE LAKE DESIGN PRINCIPLES

Background

To assist in the design development of the Wildlife Lake a detailed review of consents and major studies was undertaken. These studies include the Regional Environmental Study, the 1987 Deed of Agreement and the various reports and expert ecological reviews.

The Regional Environmental Study, completed for Department of Environment and Planning in 1984 anticipated that the Wildlife Lake could be a unique asset to the Penrith Lakes Scheme and may potentially offer scientific research, conservation and education land end use goals. The vegetation communities and associated ecologies were not well understood at the inception of the Penrith Lakes Scheme and the Wildlife Lake design allowed for research to be conducted.

The Wildlife Lake detailed in the 1984 RES had a maximum depth of 5.5m based on the geological model developed from bore hole data available at the time. The current lake depths range from 1 to 6m on average, however there is deeper locations due to previous quarrying activities. A 5.5m deep water body is considered a lake and cannot be considered an ephemeral wetland. The current design is consistent with both the RES and the 1987 Deed of Agreement in that a Wildlife Lake will be provided. The current design is consistent with both the RES and the SREP 11 Structure Plan in that a Wildlife Lake will be provided.

In a regional context the proposed habitats being developed through the Wildlife Lake and connecting corridors potentially re-establish an important ecological link between the Castlereagh escarpment, the Cumberland Plain and the Blue Mountains ecologies for the first time in nearly 200 hundred years. The establishment of the Wildlife Lake, will significantly enhance the overall biodiversity outcomes for Western Sydney adding areas of core conservation, wetlands and migratory bird zones to the Penrith Lakes Scheme's assets.

It has been PLDC's principal objective during the development of the design principles guiding the construction of landforms and lake foreshore to develop treatments which are cost effective, and ecologically sustainable. Information gained from 30 years of scientific monitoring programs run in conjunction with the CSIRO, UWS, UNSW, Sydney University and The Blue Mountains World Heritage Institute on Penrith Lakes Scheme lands and other regional targets have also formed the basis of the design principles and the rehabilitation processes.

Proposed Wildlife Lake Purpose

- The Wildlife Lake and its immediate surrounds should be primarily designed to optimise attractiveness to wildlife whilst also supporting flood management, water quality improvement and maintenance, providing suitable habitat and enabling research.
- The design of the Wildlife Lake and its immediate surrounds should communicate different layers of history associated with the Site through landscape features and interpretation.
- Design and development of the Wildlife Lake should embrace the concepts of integrated catchment management and sustainable water cycle management.

Wildlife Lake Character

- Design and layout of the Wildlife Lake should reflect the character of a natural lake with refuge islands, wetlands and a focus on wildlife habitat.
- The Wildlife Lake foreshore profiles should generally appear natural in gradient and planting types/communities.
- The design of some Wildlife Lake foreshore profiles should be influenced by the geometric nature of the former land grant boundaries and would be appropriate near Landers Inn. This would still promote natural ecological processes while integrating cultural heritage.
- The Wildlife Lake precinct topography should be constructed with natural resources from within the Penrith Lakes Scheme.
- The Wildlife Lake should be designed to be visually integrated within the context of the floodplain and river, including the use of trees of local provenance endemic to the original floodplain, and appropriate shrubs and grasses where possible.
- The current lake depths range from 1m to 6m on average, however, there may be deeper locations in areas yet to be quarried.

Rehabilitation Targets

- Create a fit-for-purpose landscape, striving for a high level of visual amenity.
- Address soil health, conservation and landform stability.
- Utilising on site resources as far as practical (neutral earthworks balance).
- Minimise establishment costs and ongoing maintenance costs.

4.2 KEY FLOODING CONSIDERATIONS

The current Wildlife Lake flood design is an improvement on flood mitigation over the flood scheme envisaged in the SEE of DA 4. The previous design allowed floodwaters to circumvent a natural constriction in the river by entering the Wildlife Lake through a weir (shown as Weir 7 in Figure 7 below) and exiting north through Hunts Gully. This resulted in increases in flood levels on properties outside of the Penrith Lakes Scheme.

The major benefit to the Scheme design from a protection of ecological and Aboriginal cultural heritage values is the removal of the majority of the proposed flood weirs that were to be constructed through the riverbank (2,000m to 640m) and involving significant earthworks and infrastructure development. The redesign will ensure that the sensitive riverbank zone is protected and may be established as a conservation zone. Significant modelling and studies have been conducted to integrate the conflicting conservation concerns for the riverbank and flood protection requirements.

Modelling of large floods in the Nepean River shows the expected flood sequence for the Wildlife Lake in Figure 6 and is summarised below.

Phase A

Floodwaters in the Nepean River rise until backwater enters the Wildlife Lake through the north western bay (Hunts Gully). This will occur in less than 10 yr ARI flood event. The water levels in the Wildlife Lake continue to rise as flood levels in the Nepean River rise.

Phase B

Floodwaters that have entered the Penrith Lakes Scheme further upstream fill the Main Lake in the Penrith Lakes Scheme and reach a level where overtopping from the Main Lake to the Wildlife Lake (Weir 6) occurs.

Phase C

As the flow over Weir 6 increases the water levels in the Wildlife Lake rise further and water flows out the north west. Flows from the Wildlife Lake also discharge across Smith Street from the north end of the Wildlife Lake.

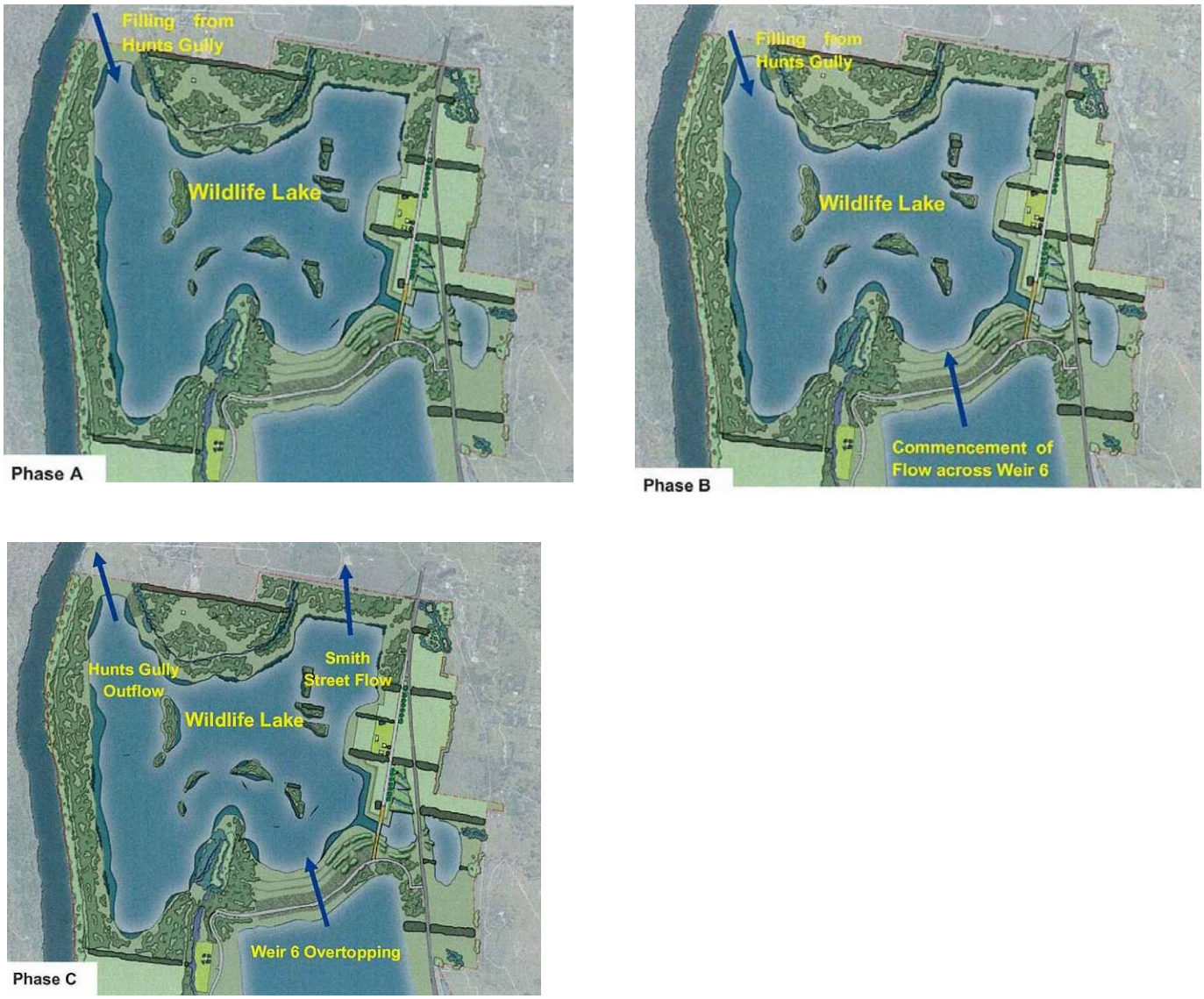

Figure 6: Flooding sequence for Wildlife Lake

To manage this flood behaviour the following key features are expected to be required;

North west bay inflow - Hunts Gully

Under the proposed design the ground levels north of the Wildlife Lake remains at existing (natural) levels allowing the Wildlife Lake to fill by backwater from the Nepean River during a flood event. A weir/spillway will be required for the transition from Hunts Gully into the Wildlife Lake.

Weir 6 (Wildlife Lake – Main Lake)

This weir controls the overtopping flows entering the Wildlife Lake from the Main Lake upstream. This weir is anticipated to be in a range 550m-640m long with a general crest height of 21m AHD. The exact dimensions and detailed design of this weir is subject to further design. The concept design is included for approval as submitted in the October Two Year Plans – Issue B.

Flood cell southern boundary (East and West or weir 6)

To contain the flows from the Main Lake overtopping at Weir 6, elevated landforms are required east and west of the weir to create a 'flood cell boundary'. To the east the landform is required to be generally a minimum of 23m AHD and to the west a minimum of 22.5m AHD. This requirement has been integrated into the landform design with gradual grades to transition from adjacent areas of lower elevation. These requirements have been included in the landform design, however is subject to finalisation of the flood scheme.

Smith Street

No weir or specific scour protection is required at this location where as there previously was.

The riverbank

To minimise overtopping and scour along the riverbank minimum heights are required to be 21.9m AHD in the north and south. These requirements have been included in the landform design were possible.

The current flood infrastructure design results in a significant improvement over the scheme detailed in the 1987 Deed and results in reductions in 100 year peak water levels in the order of 0.5 to 1m within Emu Plains.

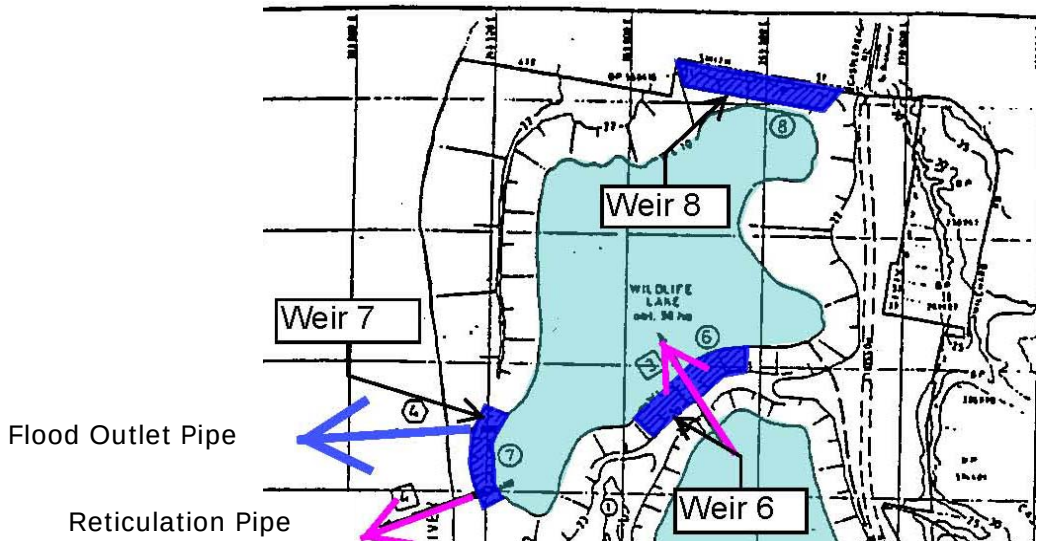

Figure 7 – Water Management Facilities as originally proposed in the 1987 Deed of Agreement

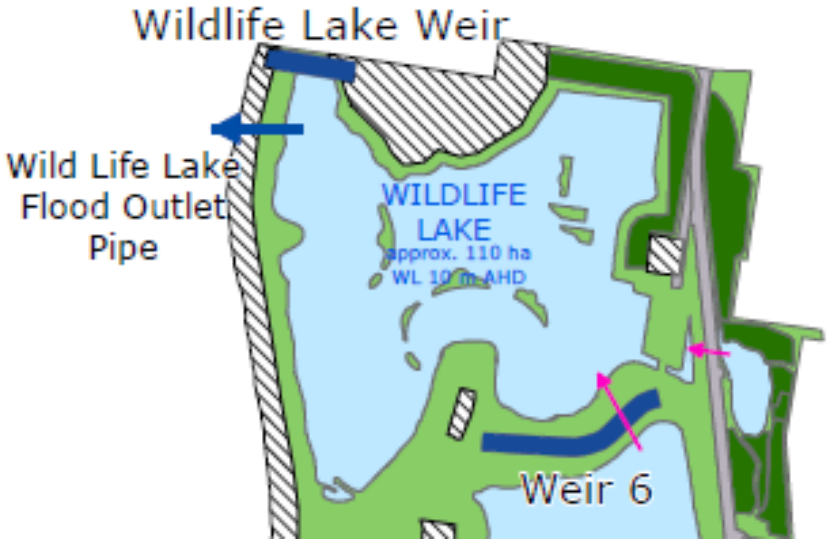

Figure 8 – Water Management Facilities as proposed today

In summary the flood infrastructure required for the current scheme results in less disturbance to the sensitive riverbank zone as well as reducing flood impacts off site by maintaining a natural constriction in the river that was removed in previous designs.

4.3 ECOLOGICAL & LANDSCAPE ACHIEVEMENTS THROUGH THE CURRENT DESIGN

The Wildlife Lake concept design is presented in detail in *Wildlife Lake Landscape Concept* (Cloustons 2010) (**Appendix**) and illustrated in the below:

Figure 11: Base Line concept plan

The key features of the concept design are:

- **Permanent wetland benches and bird refuges**, shallow areas where sedge lands and rush lands would be established. Located around the Wildlife Lake with different aspects, shelter and wave climates.
- **Emergent vegetation** along lake shores.
- **Shale Gravel Transition forest / Native grasslands.**
- **Submergent Macrophyte Zone.**
- **Alluvial Woodland - Cumberland Plain Open Woodlands**
- **Riparian Creek line planting** consisting of Cumberland Plain species along the creek line bordering the Smith Road area and other reinstated creek lines.

- **Native hedgerows** planted along lines of the old land grants, where possible being adequate in width to provide wildlife corridors.
- **Old Castlereagh Road Street trees** would be retained and reinstated where necessary along the Old Castlereagh Road alignment, adding to the cultural heritage interpretation of the old road.
- **Heritage gardens** within the heritage property of Landers Inn.
- **Grass terraces** near the southern weir, creating an area suitable for passive recreation.
- Major stands of existing vegetation are retained including:
  - Remnant *Angophora subvelutina* on the southern lake peninsula;
  - River corridor vegetation adjacent to the Nepean River;
  - Remnant stand of *Eucalyptus terreticornius* on the Smith Road Sandstone outcrop.
- **Emergent islands** serving several purposes:
  - Habitat and wildlife refuges for birds, fish and other aquatic animals;
  - Bird watching and other wildlife observations;
  - Interpretation of land grants where tree planting would reflect the old land grants on the north eastern islands.
- **Views** between key natural and historic assets are maintained across the Site, including:
  - From Landers Inn to Howells House;
  - From Howells House to Hadley Park;
  - From sandstone outcrop and existing stand of *Angophoras*;
  - From Landers Inn to existing stand of *Angophoras*.
- **Access and circulation** designed to protect proposed areas of core conservation while providing opportunities for visitor access and maintenance:
  - Opportunity for Great River Walk to follow the proposed weir to Old Castlereagh Road and Landers Inn (by others);
  - Existing maintenance tracks maintained.

4.4 CULTURAL HERITAGE CONSIDERATIONS

Cultural heritage landscape outcomes and integration with the built landform have been considered. These outcomes include the cultural heritage significance of the town of Castlereagh as documented in the RES:

- Townscape and landscape values;
- Settlement patterns;
- Demonstration of traditional ways of life; and
- Aboriginal cultural heritage.

The technical studies and strategy documents have investigated the integration of Old Castlereagh Road, Landers Inn conservation zone, the Angophora stand, the Nepean Riverbank and key Aboriginal cultural heritage matters with the overall design principles for the Wildlife Lake. The PLDC suite of strategies, and especially the Penrith Lakes Landscape Heritage Strategy (Cloustons Associates 2009) (see Appendix), also lists other important factors that have been taken into consideration in the planning phase of the Wildlife Lake.

The suite of studies form part of the consent related obligations which PLDC is systematically addressing in line with the consultation undertaken with the Heritage Branch. Completed documents include the Site wide Conservation Management Plan and Conservation Management Plan for Landers Inn.

4.5 PUBLIC INTEREST

The concept design of the Wildlife Lake undertaken by Cloustons (2010) considered the public interest by maintaining a lake system that potentially offers scientific research, conservation and education land end use goals. Importantly, the proposed size and shape of the lake continues to be in the public interest as the amendments will not reduce the public enjoyment or use of the Penrith Lakes Scheme on completion.

5.0 CONCLUSION

Whilst the Wildlife Lake shape proposed has increased in size and there are changes to the Wildlife Lake shoreline, it is PLDC's opinion the modified Wildlife Lake outline can be considered generally in accordance with the Structure Plan. In particular the Wildlife Lake configuration as proposed remains a key component of the Penrith Lakes Scheme and will provide an area that meets the Penrith Lakes Scheme's flood management, water quality, ecological values and public interest as summarised below:

Water Quality – The Wildlife Lake water quality is assigned "aesthetic value" in the 1987 Deed of Agreement, the design proposed for the Wildlife Lake will achieve this requirement through the establishment of extensive submergent and emergent vegetation combined with significant terrestrial vegetative communities.

Lake Depth – The Wildlife Lake detailed in the 1984 RES had a maximum depth of 5.5m, this was based on the geological model developed from bore hole data available at the time. The current lake depths range from 1 to 6m on average, however, there are deeper locations due to previous quarrying activities. A 5.5m deep water body is considered a lake and cannot be considered an ephemeral wetland. The current design is consistent with both the RES and the 1987 Deed of Agreement in that a Wildlife Lake will be provided.

Flood Management - The current Wildlife Lake design is an improvement on flood mitigation from the flood scheme envisaged in the 1987 Deed of Agreement. The previous design allowed floodwaters to circumvent a natural constriction in the river by entering the Wildlife Lake through a weir and exiting north through Hunts Gully, this resulted in increases in flood levels on properties outside of the Penrith Lakes Scheme.

The relocation of a weir from the riverbank zone to Hunts Gully removes the need to undertake earth works within the sensitive riverbank zone to construct the weir.

Ecological Values - The proposed ecologies being developed through Wildlife Lake and connecting corridors seek to re-establish important habitat and ecological link between the Castlereagh escarpment, the Cumberland Plain and the Blue Mountains ecologies for the first time in nearly 200 hundred years. The establishment of the Wildlife Lake will significantly enhance the overall biodiversity outcomes for Western Sydney.

The proposed variation to the size and shape of the Wildlife Lake clearly falls within the Minister's power in clause 12(1)(a) and clause 8(2)(a)(iii) of SREP 11. PLDC takes the view that the Minister as consent authority has power to approve the proposed amendment to the size and shape of the Wildlife Lake relying on clause 12(2)(a) and clause 8(2)(a)(iii) of SREP 11, that is that the proposed size and shape of the Wildlife Lake is generally in accordance with the Structure Plan before its amendment. Further, PLDC submits that the exercise of the Minister's discretion to vary the size and shape of the Wildlife Lake should be made having regard to the overriding purpose of SREP 11 in clause 2(1), being to permit the implementation of the Penrith Lakes Scheme and that the proposed size and shape is in the public interest and will not reduce the public enjoyment or use of the Penrith Lakes Scheme on completion.

6.0 APPENDIX – SUPPORTING STUDIES SUMMARY

These reports as listed below, provided assistance in developing the configuration of the Wildlife Lake:

Penrith Lakes Visual Management Strategy (Cloustons Associates 2009)

The Penrith Lakes Visual Management Strategy (**VMS**) addresses the visual aspects, Site lines and visual corridors within the Penrith Lakes Scheme. The document provides strategic guidance for the entire Penrith Lakes Scheme, reviews previous relevant studies and offers recommendations for general visual management across the site and any mitigation measures required in future development to ensure critical views are conserved.

From this document PLDC has incorporated into the Wildlife Lake plans:

- Key view and corridors between heritage assets; and
- Key views and corridors into and from the Penrith Lakes Scheme.

Penrith Lakes Landscape Heritage Strategy (Cloustons Associates 2009)

The Penrith Lakes Landscape Heritage Strategy (**LHS**) provides a linkage between items of cultural significance and the landscape surrounding them. It uses natural resources to interpret previous traditional land uses. The LHS identifies policies to conserve critical elements of cultural heritage for key heritage assets at the Site, and makes recommendations for these zones to be integrated into the wider landscape.

From this document PLDC has incorporated into the Wildlife Lake plans:

- Use of vegetative hedgerows to signify original land grant boundaries;
- Appropriate curtilages around archeological heritage zones;
- Recommendations on appropriate landscape species to interpret the original patchwork mosaics of the settlement era; and
- Focal view lines essential to landscape interpretation.

Castlereagh Natural Heritage and Biodiversity Strategy (TCM services 2009)

This gives an overview of key natural heritage and biodiversity principles, objectives and benchmarks for the Penrith Lakes Scheme development.

From this document PLDC has incorporated into the Wildlife Lake plans:

- A range of vegetation communities are identified; alluvial woodland, shale-sandstone transition forest (high sandstone influence), shale-gravel transition forest, and Castlereagh swamp woodland, coloniser native grass ground cover species;
- Benchmarks for overall design achievements;
- Core conservation, stepping stone and corridor principles; and
- Vegetation succession management principles.

Wildlife Lake Landscape Concept (Cloustons Associates 2010)

The Wildlife Lake Landscape Concept offers focused targets and Design Principles for the Wildlife Lake, and guidance to develop detailed designs for a portion of the Penrith Lakes Scheme.

From this document PLDC has incorporated in the Wildlife Lake plans:

- Design principles; and
- The concept design supporting the detailed design.

Ecological Considerations for the Development of the Wildlife Lake (TCM Services 2009)

This document provides a summary of the current information available for wetland and dry land vegetation communities to assist the detailed design, and once the landscape is complete to quantify, where possible, the achievements of the design.

From this document PLDC has incorporated into the Wildlife Lake plans:

- General principles for development of vegetation communities; and
- Specific requirements for establishments of habitats for key species.

Foreshore protection review – Penrith Lakes Wildlife Lake (Blacka M, J and Badenhop A M 2009)

The Foreshore Protection Review provides a technical assessment of the wave climate across the Wildlife Lake water body. Importantly the review incorporated consideration of a shallower loosely placed wave protection for wetland benches to increase the habitat value of the substrate and wave protection requirements for bird refuge sections, not previously included in the Penrith Lakes Scheme design. The result is eight wave protection types applied to the foreshore depending on wave climate and foreshore configuration.

From this document PLDC has incorporated into the Wildlife Lake plans:

- Recommended provision of wave protection on all open lake foreshores; and
- Extent and type of wave protection depending on wave climate and foreshore profile.

Interim Report, Penrith Lakes Scheme-Aquatic Plants Establishment Program & Aquatic Nursery Consultation (Australian Wetlands 2007) and Penrith Lakes Scheme: Aquatic Plant Establishment Monitoring Program Final Report, Australian Wetlands (REF D343)

This combination of reports detailed the research and development project undertaken at Duralia Lake (as detention basin in the south east of the Penrith Lakes Scheme) during 2007/2008. The project reviewed a variety of techniques available for aquatic plant establishment including identifying species most suited for each technique. In addition a trial implementation of planted moats is detailed and 12 months of monitoring results analysed.

From these documents PLDC has incorporated into the Wildlife Lake plans:

- A variety of establishment techniques for emergent macrophytes including the principles of constructed moats; and.
- Choice of species for initial plantings.

Annual Macrophyte Survey of Penrith Lakes for 2006, 2007 and 2008 (Biosis Research)

Annual Macrophyte Surveys of Penrith Lakes (2006-2008) provides annual mapping of emergent, floating and submerged macrophytes for key water bodies within the Penrith Lakes Scheme. Recreation lakes, detention basins and wetlands are included in the mapping program. The survey provides a recording of all species, densities and growth habits, comparison to previous years macrophyte communities, identification of exotic weeds and recommendations on future management of macrophytes.

From this document PLDC has incorporated into the Wildlife Lake plans:

- Focus on planting coloniser species; and
- Allow natural colonisation of species which have been demonstrated to effectively self colonise in the lakes.

Fish Community and Habitat Development Program, Penrith Lakes: Stage 2 (Beitzel M 2006)

The Fish Community and Habitat Development study considered the habitat requirements for the fish species desired within the Penrith Lakes system. Using data from annual fish surveys and literature reviews of available information on freshwater habitat, recommendations were made regarding materials, locations and density of vegetative and structural habitat in the Wildlife Lake.

From this document PLDC has incorporated into the Wildlife Lake plans:

- Location, size, shape and plant species for wetlands and deep water zones to provide small fish habitat; and
- Locations, type and size of structural habitat including sandstone rocks and timber configurations for general fish habitat.

Technical Specification-landform Construction for the Wildlife Lake. Coffey Geotechnics 2009 (GEOTLCOV24000DN-AArev6)

This technical specification provides detailed guidance on all matters relating to the landform engineering of the Wildlife Lake. PLDC has incorporated the full suite of technical specifications into the Wildlife Lake plans through referencing the specifications and cross sectional details.

Penrith Lakes Development Hydraulic Design for the Wildlife Lake (Cardno Lawson and Treloar 2009)

This outlines the numerical modelling used for the development of the flood protection system for the Penrith Lakes Scheme. Key hydraulic features such as flood

cell boundaries, flood weirs and flood flow paths are specified for the Wildlife Lake area. A flood impact assessment for the Wildlife Lake is also provided. A comparison to previous designs for this area is provided outlining differences and benefits of the changes.

From this document PLDC has incorporated into the Wildlife Lake plans:

- Removal of the large weir previously proposed from the Wildlife Lake to the river;
- Land formation to support overland flood flow paths in the north east and north west of the Wildlife Lake (scour protection and further details will be the subject of future detailed design and approval processes);
- Land formation to support a flood weir between the Wildlife Lake and the Main lake (scour protection and further details would be the subject of future detailed design and approval processes); and
- Land formation for the flood cell between Wildlife Lake and the Main Lake to manage flood flows in and out of the Wildlife Lake.