Cardno
Shaping the Future

Wildlife Lake Flood Outlet Pipe

Environmental Assessment

LJ2869/R2684v3

Prepared for Penrith Lakes Development Corporation

29 November 2010

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Declaration

This Environmental Assessment (EA) assesses the potential environmental impacts associated with the construction of a proposed flood outlet pipe connecting Wildlife Lake to the Nepean River. This EA has been prepared to support a Section 75W Modification request to a previously approved Development Application (DA4) for the proposed pipe and is based on information available from secondary sources and also specialist studies specifically conducted on heritage, ecological and hydraulic aspects of this proposal.

This EA has been prepared with regard to Section 79C of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and has taken into consideration the range of matters of relevance to the proposed works that are the subject of the accompanying DA modification request.

Based on the information available and presented in this EA, it is concluded that by adopting and implementing the mitigation measures listed in this report there will be no significant environmental impacts from the proposal. It is concluded that the proposed flood outlet pipe is necessary for the implementation of the Penrith Lakes Scheme and is suitable and in the public interest.

Certified by:

Kester Boardman

Manager – Environment and Sustainability

For Cardno (NSW/ACT) Pty Ltd

Executive Summary

The Penrith area has been a major source of supply of medium to coarse grained sand and crushed river gravel for the Sydney construction industry since the 1880s and today provides most of Sydney's requirements for these materials. The ongoing quarrying operations and future rehabilitation of the site has become known as the 'Penrith Lakes Scheme'.

As part of the rehabilitation of the Penrith Lakes Scheme it is proposed that a series of lakes and parklands will be developed on completion of quarrying at the site (**Figure E1**). The rehabilitation works require a carefully controlled hydraulic link between the proposed lakes and the Nepean River, primarily to allow floodwaters entering the lakes to return to the River. This Environmental Assessment (EA) is concerned with the construction of a pipe connecting the proposed Wildlife Lake to the Nepean River.

A set of flood discharge pipes was previously approved for the scheme under DA4. However, PLDC now seeks to modify the configuration and location of the pipes to allow better hydraulic functionality of the Penrith Lakes Scheme and to minimise environmental impacts associated with the pipe outlet location.

A number of possible pipe designs and locations were considered, and this EA has assisted in the process of determining the preferred design and location of the pipe by considering how potential impacts of the pipe can be minimised. The preferred routes and discharge locations of the pipe discussed in this EA were determined by consideration of a number of factors including topography, terrestrial and aquatic ecology, heritage constraints and constructability. The assessment found the following to be the preferred location and design configuration:

- 1 x 1350mm diameter pipe to be location at the Wildlife Lake North site,
- Total estimated construction cost of $900,000.

The preferred location is identified in **Figures E1 and E2**, and details of the site selection process can be found in **Section 2.4**.

This EA identifies the environmental constraints and potential environmental impacts associated with the pipe construction and recommends mitigation measures to prevent or minimise the identified potential impacts.

Environmental constraints and impacts considered in this EA include:

- Terrestrial Ecology;
- Aquatic Ecology;
- Hydrology;
- Aboriginal and Non-Aboriginal Heritage;
- Soils, Sediments and Erosion;
- Contaminated Land;
- Air Quality, Climate and Dust;
- Hazards and Risks;
- Landscape and Visual Impact;
- Land Use Impacts;

- Noise and Vibration Impacts;
- Social and Health Values;
- Traffic Impacts/Access and Accessibility;
- Utilities and Infrastructure;
- Waste Materials and Management; and
- Water Quality Impacts.

The key issues identified in the EA related to the adaption of the design to retain existing significant trees and the management of potential erosion associated with both the construction and operation phases. Specifically:

- Vegetation across the preferred work site was predominantly represented by exotic riparian vegetation, dominating all growth forms including the graminoid, herbs, shrub and tree layers. In general, the riparian vegetation was considered to be of very low ecological value and in very poor condition due to the long history of anthropological land use disturbances leading to a high degree of weed infestation. However, a few scattered local and non-local native trees were recorded within the study area which are of some conservation value (Figures 4.5-4.8 in **Appendix A**). In particular *Casuarina cunninghamiana* and *Acacia implexa* were seen to be the dominant tree species at the site. The design was modified to minimise the disturbance on these species.
- An assessment of the discharges and velocities occurring at the outlet of the pipe identified the need for energy dissipation. This analysis demonstrated that without energy dissipation there is the potential for a scour hole to form at the outlet. Measures will be required to prevent scouring at the pipe outlet. Detailed consideration of potential scour protection works was undertaken as part of the design report (Cardno, 2010a). Based on a consideration of the advantages and disadvantages of the alternative outlets it was recommended that a baffle dissipator be provided at the river side outlet of the proposed pipe. The structure presented in the design report (Cardno, 2010a) report is based on the USBR Type VI dissipator.

The key environmental issues and considerations are shown on **Figure E2**.

After consideration of all of the environmental issues, this EA concludes that the installation of the proposed pipe is unlikely to have any long term significant negative environmental impacts provided that the management measures outlined in this EA and summarised in **Sections 6 and 7** are effectively implemented by incorporation into a suitable Construction Environmental Management Plan.

This EA also recognises that the installation of the pipe is an important and necessary component of a larger scheme to create lakes at the site of the existing quarry. Completion of the Penrith Lakes Scheme is expected to significantly improve ecological, visual, and amenity value of the area, and consequently the installation of the pipe is expected to facilitate an overall improvement of the area following the cessation of quarrying activities.

Figure E1: Proposed Penrith Lakes Scheme (Provided by PLDC, November 2010).

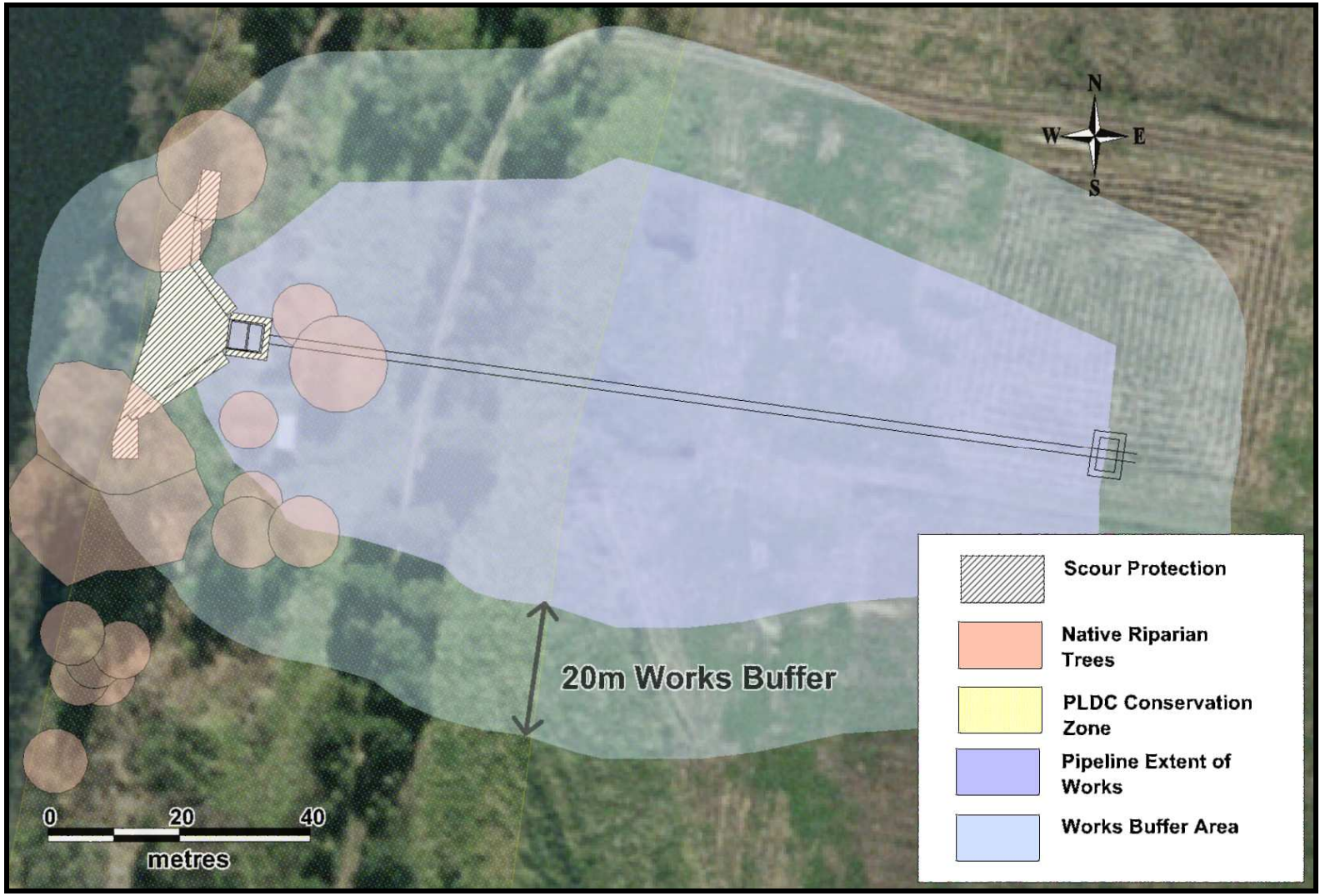

Figure E2: Wildlife Lake Proposed Pipe and Significant Environmental Issues

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Glossary

AHIP	Aboriginal Heritage Impact Permit
ASSMAC	Acid Sulfate Soil Management Advisory Committee
CEMP	Construction Environmental Management Plan
DECC	Department of Environment and Climate Change (now DECCW)
DECCW	Department of Environment, Climate Change and Water
DEWHA	Department of the Environment, Water, Heritage and the Arts
DoP	Department of Planning
DPI	Department of Primary Industries
DWE	Department of Water & Energy
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act 1979
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
EPA	Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
GDA	Geocentric Datum of Australia
GMR	Greater Metropolitan Region
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan

LGA	Local Government Area
LPMA	Land and Property Management Authority
NPW Act	National Parks and Wildlife Act 1974
NPWS	National Parks and Wildlife Service
NRA	National Registration Authority for Agriculture and Veterinary Chemicals
NSW	New South Wales
PCC	Penrith City Council
PoEO Act	Protection of Environment Operations Act 1997
RCE	Riparian, Channel and Environmental Inventory
REF	Review of Environmental Factors
REP	Regional Environmental Plan
RFEF	River-Flat Eucalypt Forest on Coastal Floodplains
RTA	Roads and Traffic Authority of New South Wales
SEPP	State Environmental Planning Policy
SEPP (Major Development)	State Environmental Planning Policy (Major Development) 2005
SIS	Species Impact Statement
TSC Act	Threatened Species Conservation Act 1995
WARR Act	Waste Avoidance and Resource Recovery Act 2001

1 Introduction

1.1 Introduction

Cardno (NSW/ACT) Pty Ltd has been engaged by Penrith Lakes Development Corporation to prepare an Environmental Assessment (EA) as part of a Section 75W Application under the *Environmental Planning and Assessment Act 1979* for the proposed construction of a flood outlet pipe from the proposed Wildlife Weir at Penrith Lakes, Castlereagh NSW. The pipe would form part of the overall proposed Penrith Lakes Scheme.

1.2 Objectives and Outline of the Proposal

The Penrith Lakes Development Corporation (PLDC) seeks approval to modify the existing development consent (Development Application 4 - continued sand and gravel extraction and the restoration of the area by construction of a lake system) to include a flood outlet pipe to connect the already approved Wildlife Lake to the Nepean River. It should be noted that DA4 already includes a set of flood outlet pipes within the approved works. However, PLDC seeks to modify the size, number and location of the pipes to provide better hydraulic operation of the lakes system in the event of a flood in the Nepean River.

The flood outlet pipes were proposed to ensure the sustainability of the proposed lakes within the Penrith Lakes site during and after flood events in the Nepean River.

During normal weather conditions these lakes will be largely isolated from the Nepean River only receiving flows from the surrounding catchment areas with additional top up water from an alternate water source if required. However, during large flood events the Nepean River will overtop flood weirs resulting in floodwaters entering the Lakes Scheme. This occurs in events greater than a 10 year ARI for the Wildlife Lake. Following a large flood event, the lake will remain elevated above its normal operating levels (by up to 6 metres in the Wildlife Lake). PLDC propose the construction of a flood drainage pipe to connect the lake with the Nepean River and allow the lake to return to normal operating levels following a large flood event.

The pipe would incorporate a floodgate on the Nepean River end to stop any ingress of waters from the Nepean River into the Lakes unless the banks are overtopped and dissipation devices at the end of the pipe to dissipate the energy of the flow being discharged into the Nepean River.

The construction of the pipe would involve:

- Excavation of the riverbank between the lakes and the river;
- Laying of the pipe;
- Construction of the dissipation devices;
- Backfilling of the excavated area; and,
- Revegetation and rehabilitation of the disturbed area.

1.3 Background to the Development of the Penrith Lakes Scheme

The Penrith area has been a major source of supply of medium to coarse grained sand and crushed river gravel for the Sydney construction industry since the 1880s and today provides most of Sydney's requirements for these materials.

Initially, excavation of sand and gravel was from deposits in the Nepean River; however, as these reserves were depleted during the late 1950s attention was turned to the reserves under the Penrith-Castlereagh floodplain. Development consents to quarry parts of the floodplain to the northwest of Penrith were subsequently obtained by four quarrying companies.

In the late 1960s, the piecemeal manner in which the quarrying operations were being undertaken and the restriction this placed on the rehabilitation of the quarried areas were causing concern. At the request of the Penrith City Council, the State Planning Authority (now the Department of Planning) examined the concepts for coordinating the extraction of the sand and gravel resources and restoration of the quarried areas. As a result, the Penrith Lakes Scheme Working Party was established, comprising representatives of five State Government Departments, the Penrith City Council and the quarrying companies. Its aim was to examine the feasibility of a program of orderly and economical extraction and comprehensive rehabilitation with a view to creating a regional water-oriented recreation resource in the former quarry areas.

This concept became known as the 'Penrith Lakes Scheme'. The regional context of the Penrith Lakes Scheme as a whole is shown in **Figure 1.1**.

Figure 1.1: Regional context of the Penrith Lakes Scheme (Source: Google Earth).

As part of the rehabilitation of the Penrith Lakes Scheme a series of lakes and parklands have been proposed; Main Lake A, Main Lake B and Wildlife Lake. There are also a number of key flood management structures in the scheme which control the inflow and outflow of floodwaters from the Nepean River into the lakes, as well as the flows between the lakes themselves. This flood infrastructure allows for the controlled filling of the Lakes Scheme under a Nepean River flood and minimises any adverse impacts on flood levels on surrounding properties. The concept plan of the Penrith Lakes Scheme is shown in **Figure 1.2.**

The combination of this flood infrastructure and the proposed Lakes results in a significant flooding benefit to the Penrith and Emu Plains communities. Reductions in flood levels in the 100 year ARI event are up to nearly 1 metre on Emu Plains, and the reduction in flood damages in a 100 year ARI event is estimated to be in the order of $3.5M.

The flooding behaviour of the proposed scheme is detailed in the **Section 3.1**. A more detailed discussion on the flooding behaviour is provided in the associated Penrith Lakes Flood Infrastructure Report (Cardno, 2010b). This EA focuses on the construction and operation of a flood outlet pipe from Wildlife Lake within this broader flood infrastructure system.

Figure 1.2: Proposed Penrith Lakes Scheme (PLDC, November 2010)

1.4 Purpose of the EA

The purpose of this EA is to describe the proposal, to assess and document the likely impacts of the proposal on the environment, and to detail mitigation measures to be implemented in order to minimise any environmental impacts due to the proposed works.

Under the *Environmental Planning and Assessment Act 1979* (EP&A Act) there is a duty for the consent authority (in this case the Minister) to consider the likely impacts of that development, including environmental impacts on both the natural and built environments. This EA has been prepared in accordance with Schedule 2 of the EP&A Regulation 2000 to allow the Minister to take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the proposal.

Following submission of this report, the Minister, as the determining authority, can consider:

- Whether the proposed works are likely to have any impacts on the environment that have not been considered in the EA that may require further assessment, or for which additional mitigation strategies should be developed;
- Any possible impacts on threatened species as defined by the Threatened Species Conservation Act 1995 (TSC Act);
- Any potential impacts on any Aboriginal or non-Aboriginal heritage items as defined by the National Parks and Wildlife Act 1974 (NPW Act) and Heritage Act 1977; and
- The potential for the proposal to impact on any matter of national environmental significance or Commonwealth land that would require referral to the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) for a decision by the Commonwealth Minister for the Environment, Heritage and the Arts on whether assessment and approval is required under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The Minister would then determine if the proposal should proceed and set relevant conditions.

1.5 Structure of the Document

The structure of this EA is as follows:

Section 1 Provides the objectives of the application and history and development of the Penrith Lakes Scheme.

Section 2 Describes the planning context for the Scheme including planning consents and conditions.

Section 3 Discusses the need for the modification to DA4 (Wildlife Lake Flood outlet Pipe) in the context of ensuring the sustainability of the rehabilitation works comprising the Penrith Lakes Scheme.

Consequences of not proceeding with the proposal are also discussed.

Section 4 Describes the proposal in terms of its extent, design and its relationship to the overall Penrith Lakes Scheme. The details associated with cost and timing are also provided.

Section 5 Describes the existing environment, the potential impacts and benefits associated with the proposal and any mitigation measures to be adopted to manage potential environmental impacts.

Section 6 Provides an overview of the environmental management plans that need to be prepared prior to construction and monitoring requirements.

Section 7 Provides a summary of the environmental safeguards and management measures to be undertaken during construction and operational phases of the proposal. Provides a conclusion on the likely impacts of the proposal if all recommended measures are implemented.

Section 8 Qualifications

Section 9 References

2 Planning Context

2.1 Background

The Environmental Planning and Assessment Act 1979 and Regulations (2000) provide for the making of environmental planning instruments for the proper management, development and conservation of the State's natural and man-made resources.

The extensive deposits of sand and gravel occurring in the floodplain of the Nepean River, north of Penrith have been recognised by the State Government as a resource of regional significance to supply the future demands for construction materials in the Sydney Region. As a result, the resource has been identified in a number of planning instruments with the objective of providing a development control process to establish environmental and technical matters which must be taken into account in implementing the Penrith Lakes Scheme in order to protect the environment. Key planning documents produced in relation to the Scheme since 1981 are listed in **Table 2.1**.

Table 2.1: Penrith Lakes Scheme Planning Documents

Date	Document / Report	Result
April 1981	Development Application (DA1)	Consent granted in July 1982 for interim extraction while preferred Scheme in preparation.
October 1986	Sydney Regional Environmental Plan 9 – Extractive Industry	Indentified Penrith Lakes as a priority for extraction.
November 1986	Sydney Regional Environmental Plan 11 – Penrith Lakes Scheme	Legal framework for implementation of Scheme.
November 1986	Development Application (DA2)	Consent granted in February 1987 for extraction of DA2 area in accordance with SREP11.
May 1989	Amendment no. 2 to SREP11	Amendment extended SREP boundary and made provision to incorporate international standard rowing course into the Scheme.
August 1989	Development Application (Rowing Lake)	Consent granted November 1989 to modify DA2 and extract additional lands to construct the rowing course.
January 1994	Amendment No. 3 to SREP11, the structure plan.	Amendment to incorporate results of flood and drainage studies. Approved November 1994.
April 1994	Development Application (DA3)	Consent granted in June 1995 for extraction of DA3 area in accordance with SREP11.
September 1997	Amendment No. 4 to SREP11, the structure plan.	Proposed amendment to incorporate implications arising from geological review.
November 1997	Development Application (DA4)	Consent granted in September 1998 for continuation of sand and gravel extraction from DA4 area in accordance with SREP11.

2.2 Modification to Development Application 4

As mentioned above, Development Application 4 (DA4) was approved in 1998 for continuation of sand and gravel extraction from the DA4 area of about 737 hectares in order to ensure the continued supply of sand and gravel to the building and construction industry and to meet the commitments for the completion of the Penrith Lakes Scheme.

Detailed water management investigations were undertaken as part of DA4 and reported in the accompanying EA (Enviro-Managers, 1997) to determine the infrastructure required to provide adequate quantities of quality water within the lakes scheme. This included flood infrastructure. PLDC is now proposing to modify the flood infrastructure reported in the previous EA (Enviro-Managers, 1997), specifically, the location and size of the flood discharge pipes from Wildlife Lake.

The flood discharge pipes from Wildlife Lake currently included in DA4 are described in two conflicting ways:

- 2 x 900mm diameter 150m long pipes; and
- 1 x 1500mm diameter pipe (no length indicated).

The pipes are indicated to be discharging from the South-West portion of Wildlife Lake into the Nepean River. The EA (Enviro-Managers, 1997) estimated that works would be completed by 2007/2008.

This EA has been prepared in order to evaluate the proposed modification to the proposed pipe design such that it consists of a single 1350mm diameter pipe approximately 130m in length. It is proposed that the pipe shall discharge from the North-Western portion of Wildlife Lake. The updated design details have been based on detailed hydraulic investigations (Cardno, 2010B) and environmental constraints analysis (Cardno, 2010A).

2.3 Legislative Requirements

2.3.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) aims to encourage the proper management, development and conservation of natural and artificial resources to ultimately promote the environment and the economic and social welfare of the community. In addition to this, it seeks to promote the sharing of responsibility between state and local government and facilitate public involvement in the planning and assessment process.

The proposed development requires consent and an associated assessment by the applicant under the EP&A Act. The consent authority for the proposed works is The Minister. The existing approval requires PLDC to obtain the necessary statutory approvals and therefore the relevant approval authorities are DECCW (for Aboriginal heritage matters under the *National Parks and Wildlife Act 1974* and waterfront land matters under the *Water Management Act 2000*) and I&I NSW (for excavation within a waterway matters and obstruction to fish passage matters under the *Fisheries Management Act 1994* (FM Act)).

The proposed development does not constitute ‘designated development’ as defined in Schedule 3 of the *Environmental Planning and Assessment Regulation 2000*.

2.3.2 Pollution Control Legislation

The Protection of Environment Operations Act 1997 (PoEO Act) is administered by DECCW and ultimately aims to protect, enhance and restore the quality of the environment in NSW, to reduce risk to human health and promote mechanisms that minimise environmental degradation through a strong set of provisions and offences.

The Pesticides Control Act 1999 states that pesticides must be registered by the National Registration Authority for Agriculture and Veterinary Chemicals (NRA). The NRA therefore regulates the sale of pesticides, whilst the EPA (DECCW) enforces proper use of pesticides after the point of sale to minimise the impacts on health, the environment and trade. Permits for "off label" use may be obtained under the existing legislation, however Penalty and Clean-up notices will be issued for the improper use and/or management of pesticides.

The Environmentally Hazardous Chemicals Act 1985 governs the use and disposal of potentially hazardous chemicals and waste material. Any use and/or removal of hazardous chemicals and materials defined under this Act require licensing and must be appropriately declared.

Given the comparatively minor nature of the proposed works, which do not fall within the description of a "scheduled activity" under the PoEO Act, a licence is not required. However, liability for pollution events is not waived just because a licence is not required and pollution mitigation measures (e.g. for water quality and sediment and erosion control) must be implemented to mitigate impacts. It is considered unlikely that the proposed works would trigger either the Pesticides Control Act 1999 or the Environmentally Hazardous Chemicals Act 1985.

2.3.3 Terrestrial Ecology Legislation

The Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) is Commonwealth legislation requiring that approval is obtained from the Minister for any environmentally significant actions on Commonwealth Land, or actions that are likely to have a significant impact on nationally threatened species, populations and endangered ecological communities, Ramsar wetlands and other nationally significant issues. This EA considers these environmentally significant issues in relation to the proposed site in **Section 5.1**. It has been determined that there would be no significant impact as a result of the proposed works and a referral to the Department of the Environment, Water, Heritage and the Arts (DEWHA) is not required.

The Environmental Planning and Assessment Act 1979 (EP&A Act) requires that the impact that any proposed activity may have upon threatened species, populations or ecological communities and their habitats must be assessed. Lists of threatened species, populations and ecological communities are contained in Schedules 1 and 2 of the Threatened Species Conservation Act 1995 (TSC Act). These matters are considered in **Section 5.1** of this EA.

The Noxious Weeds Act 1993 was implemented to regulate the impacts and spread of weeds within NSW. The Act governs the control of weeds which requires declaration as a noxious weed, classification and removal. Land which is privately occupied requires implementation of appropriate noxious weed controls under Part 4 of the Noxious Weeds Act 1993. Penalties apply if the occupier fails to comply. It is not anticipated that the restrictions of the Noxious Weeds Act 1993 would be triggered under the proposed works.

Clearing of native vegetation or protected regrowth normally requires approval under the Native Vegetation Act 2003. However, under Section 5 of the Act lands within the Penrith LGA are excluded from the operation of the Act.

2.3.4 Aquatic Ecology Legislation

Approval under the Fisheries Management Act 1994 from the Department of Primary Industries (DPI) (NSW Fisheries) is required for any dredging or reclamation works or works that may obstruct free passage of fish. The proposed works would involved dredging and construction works within the Nepean River waterway and riparian corridor and as such would require approval.

2.3.5 Water Legislation

The Water Management Act 2000 replaces the repealed Rivers and Foreshores Improvement Act 1948, and regulates construction activities in close proximity to waterways. Principles set out in the Act generally aim to preserve and or restore water sources, floodplains, and water dependant ecosystems (including groundwater and wetlands). The Act also encompasses the protection of habitats, animals and plants which benefit from water or are potentially affected by managed activities.

A controlled activity approval is required from the Department of Water & Energy (DWE) for the proposed flood outlet pipe.

2.3.6 Heritage Legislation

Heritage within NSW can be generally described under two categories: Aboriginal heritage and non-Aboriginal heritage. The Heritage Act 1977 applies to deposits, objects or material evidence within NSW which is following an assessment of significance and relates to non-Aboriginal settlement. Under the Heritage Act 1977, it is an offence to harm relics protected by Interim Heritage Orders, the State Heritage Register or environmental planning instruments.

The National Parks and Wildlife Act 1974 (NPW Act), administered by DECCW, is the primary legislation for the protection of Aboriginal cultural heritage in NSW. Part 6 of the NPW Act provides specific protection for Aboriginal objects and places.

An existing Aboriginal Heritage Impact Permit has been issued by DECCW for the PLDC site. An application for amendment of the existing permit to incorporate the proposed flood outlet pipe construction works has been submitted to DECCW.

2.3.7 Geology and Soil Legislation

The Soil Conservation Act 1938 is associated with the preservation of soils and prevention of erosion within a parcel of land. The appointment of a conservation commissioner is primarily to control and protect proclaimed works, notified catchment areas, rivers, lakes, dams, creeks, lagoons and marshes from the effects of soil erosion, land degradation, siltation and sedimentation. Notice may be issued if the commissioner is of the opinion that the land holder has done or is likely to do something that will ultimately lead to land degradation.

The Contaminated Land Management Act 1997 outlines the assessment criteria and management of contaminated land which poses a significant risk to human health or the environment. Under the Act, a person or persons (or a public authority) will be held responsible as an outcome of land contamination. DECCW is responsible for declaring the land as 'contaminated' and will give notice to end the declaration, once satisfied that the land poses no further risk.

It is not anticipated that either of these Acts would be triggered during the proposed works, as discussed in **Section 2.6**

2.3.8 Waste and Hazards Legislation

The Waste Avoidance and Resource Recovery Act 2001 (WARR Act) repeals and replaces the Waste Minimisation and Management Act 1995. No permits are required under the Act, though the responsibilities of land occupiers are clearly defined with regards to waste production, waste management and natural resource usage. The Act makes reference to 'waste strategies' including minimisation and disposal along with efficient use and disposal of natural resources.

2.4 Environmental Planning Instruments

2.4.1 Regional Environmental Plans (REPs)

Sydney Regional Environmental Plan 9 – Extractive Industry

This aim of this plan are to facilitate the development of extractive resources in proximity to the population of the Sydney Metropolitan Area.

The sand and gravel resources of the Penrith Lakes Scheme were considered resources of regional significance under SREP 9(1) and at the time of gazettal of the REP9 in 1995, were of such significant as to be considered under a separate State Regional Environment Plan, SREP 11.

Sydney Regional Environmental Plan 11 – Penrith Lakes Scheme.

The aims and objectives of this plan are to permit the implementation of the Penrith Lakes Scheme. In particular, the aims of this plan are:

- 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,
- to identify and protect items of the environmental heritage,
- to identify land which may be rezoned for urban purposes, and
- to permit interim development in order to prevent the sterilization of land to which this plan applies during implementation of the Penrith Lakes Scheme.

Clause 8(3) of SREP11 requires that a consent authority shall not consent to the carrying out of development for the purposes of implementing the Penrith Lakes Scheme unless the Applicant has submitted an Environmental Assessment of the proposed development addressing the matters specified in Schedule 2 of SREP11. The matters specific in Schedule 2 of the SREP are provided below, with the relevant section of this EA where the matter has been addressed.

Matters to be Included in EA	**Section of EA Addressing Matter**
(a) justification of the proposed development in the context of Sydney Regional Environmental Plan No 11—Penrith Lakes Scheme,	Section 3
(b) a full description of the proposed development,	Section 4
(c) a statement of the objectives of the proposed development,	Section 3.2
(d) a full description of the existing environment likely to be affected by the proposed development if carried out,	Section 5
(e) identification and analysis of the likely environmental interactions between the proposed development and the environment,	Section 5
(f) analysis of the likely environmental impacts or consequences of carrying out the proposed development (including implications for use and conservation of energy),	Section 5
(g) justification of the proposed development in terms of environmental, economic and social considerations,	Section 3
(h) measures to be taken in conjunction with the proposed development to protect the environment and an assessment of the likely effectiveness of those measures,	Throughout Section 5 and Summarised in Sections 6 and 7.
(i) energy requirements of the proposed development,	Machinery to be run on fuel. No electricity requirements.
(j) any feasible alternatives to the carrying out of the proposed development and the reasons for choosing the latter, and	Sections 3.3 and Section 3.4
(k) the consequences of not carrying out the proposed development.	Section 3.3.1
2 In addition to the matters listed in clause 1, particular regard must be given to the following matters:	
(a) relationship and extent of the proposed development to the completed scheme,	Section 4.2
(b) where appropriate, the integration of the proposed development with development previously carried out,	As previously provided for in DA4 and 2 Year Plans.
(c) the sequence of extraction and rehabilitation where the proposed development is for or includes an extractive industry,	As previously provided for in DA4 and 2 Year Plans.

Matters to be Included in EA	**Section of EA Addressing Matter**
(d) unless the land is to be dedicated to the Crown, the proposed control and management of the land,	Ultimately the land will become Crown Land, until such time, the land remains under the control and management of PLDC
(e) the management and control of water resources including:	
(i) the source of water in order to fill any lake (including the quality and quantity of water from that source),	N/A
(ii) water reticulation systems from the Nepean River to any lake, from lake to lake and from any lake to the Nepean River,	N/A
(iii) the water quality of any lake (including the aquatic ecosystem),	N/A
(iv) water treatment facilities,	N/A
(v) water depth of any lake,	N/A
(vi) flood control,	Section 3.1
(vii) storm water control,	Section 5.5 and 5.6.11
(viii) the effect that development would have upon the quantity and quality of the existing groundwater as well as the level of the existing groundwater table,	Section 5.6.1
(ix) lake usage,	N/A
(x) staged development of the lakes and their usage during staged development,	N/A
(xi) the need to monitor the water quality of the lakes having regard to their intended use, and	N/A
(xii) the effect upon the Hawkesbury/Nepean River system,	Sections 5.2, 5.3 and 5.6.11
(f) the rehabilitation and reconstruction of the land including:	
(i) landscape design,	Section 5.6.4 and Design report & drawings.
(ii) the structural stability and soil compaction of landforms (including, where appropriate, the land shown on the structure plan as future urban),	Section 5.5
(iii) the stability and impermeability of the Nepean River embankment,	Section 5.5
(iv) soil conservation, and	As previously provided for in DA4 and 2 Year Plans.
(v) revegetation,	Sections 5.1 and 5.6.4 and Design report & drawings.
(g) any effect upon a locality, place or building not listed in Schedule 3 having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations,	Section 5.4
(h) measures to be taken to conserve and preserve items of environmental heritage listed in Schedule 3 including, where appropriate, a conservation plan, and	Section 5.4 (and summarised in Section 7.1)
(i) access to, the supply of water from any existing service to, and the supply of and access to municipal and utility services to, land to which this plan applies other than that part of that land the subject of the application.	N/A

The development in this application is generally in accordance with the structure plan within the meaning of clause 8(2)(a)(iii) of SREP 11. The development is consistent with all of the matters listed in clause 8(4) of SREP 11.

The proposed works are permissible with consent under this Plan.

Sydney Regional Environmental Plan 20 – Hawkesbury-Nepean River

The aim of this plan is to protect the environment of the Hawkesbury-Nepean River system by ensuring that the impacts of future land uses are considered in a regional context.

2.4.2 State Environmental Planning Policies (SEPPs)

State Environmental Planning Policy 19 – Bushland in Urban Areas

The general aim of this Policy is to protect and preserve bushland within the urban areas because of:

- its value to the community as part of the natural heritage,
- its aesthetic value, and
- its value as a recreational, educational and scientific resource.

Bushland areas within the Penrith LGA are identified as part of this SEPP.

2.4.3 Local Environmental Plans (LEPs)

Local Environment Plans (LEPs) provide a statutory framework under the EP&A Act and ensure that local needs and interests are taken into account when planning for development. The proposed works are subject to the following LEPs:

- Penrith Local Environmental Plan 1991 (Environmental Heritage Conservation);
- Penrith Local Environmental Plan 1998 (Urban Land); and
- Penrith Local Environmental Plan 1998 (Lakes Environs).

It is noted that the Draft Penrith Local Environmental Plan 2008 does not apply to the Penrith Lakes site.

2.4.4 Development Control Plans (DCPs)

Development Control Plans (DCPs) provide specific, comprehensive guidelines for certain types of development within LGAs. Whilst the current development proposal is not being assessed by Council (rather by the Minister), the following plans have still been considered in this environmental assessment:

- Penrith Development Control Plan 2006; and
- DRAFT Penrith Development Control Plan 2008.

2.5 PLDC Consents, Agreements and Commitments

It is noted that a series of agreements have been formed between PLDC, the NSW State Government and Local Government which will inform the management of the environment on site. Further, PLDC has established on-going commitments consistent with these agreements to comply with requirements and improve the regional environment. These include the following.

Penrith Lakes Scheme 1980: The Department of Planning and Environment undertook a study of the proposed extraction and rehabilitation works to be undertaken by PLDC. This study recommended the establishment of a large lakes area (both wildlife and recreational) as the preferred rehabilitation option for the Scheme.

Deed of Agreement 1987: A formal deed of agreement to implement the Penrith Lakes Scheme was reached between PLDC and the NSW Government. The deed set out processes to be adopted by both parties to both fulfill quarry resource requirements as well as the lake establishment plan.

Penrith Lakes Scheme DA No.4: Development Application consent was granted for PLDC to undertake the extraction of sand and gravel from the northern and western parts of the Penrith Lakes scheme. The proposed works described in this Environmental Assessment occur in close proximity to these approved quarry works and are seen to be consistent with requirements of the development consent.

PLDC Conservation Zones: PLDC established a series of "conservation zones" (**Figure 2.1**). These have no legal standing and encompass land considered unsuitable for quarrying for a variety of reasons including:

- Environmental Values;
- Heritage Values;
- Social Values; and
- Quarrying Value.

The proposed works will occur within both quarried land and declared 'conservation' zones. It is recognised that potential impacts within land previously quarried is likely to be significantly less than that on unquarried lands.

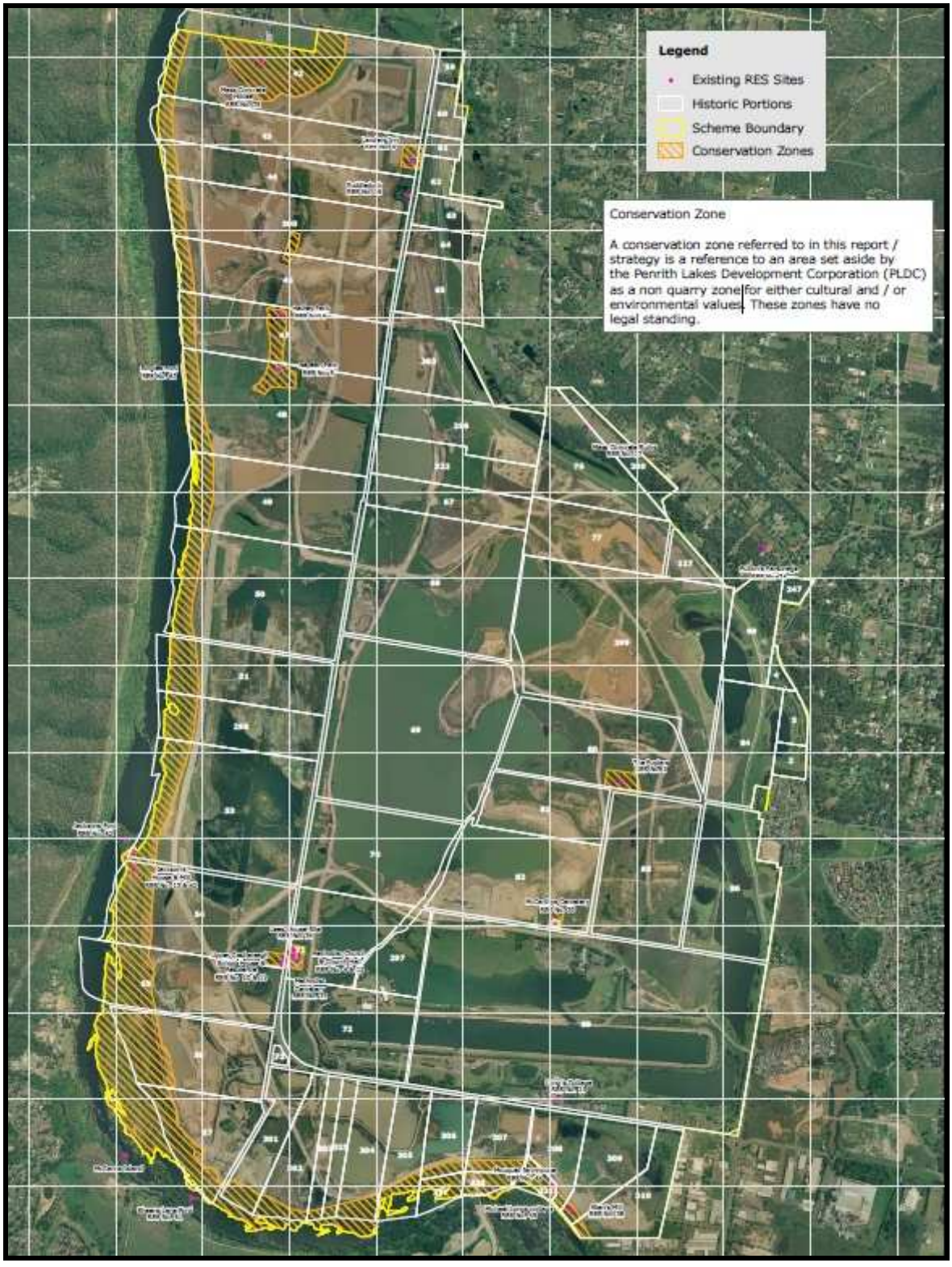

Figure 2.1: PLDC Applied Conservation Zones (source: PLDC)

2.6 Permits, Licences and Approvals

Table 2.2 lists the full range of permits, licences and approvals associated with the range of legislation that is relevant to the site.

Table 2.2 Relevant Permits, Licences and Approvals

Legislation	Authority	Relevance to the Project	Approval / Licence Other Requirements
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	DEWHA Commonwealth	Approval from DEWHA if any significant impacts are expected on items of NES or significant impacts on Commonwealth Land.	The ecological investigations undertaken as part of this EA did not identify any potential impacts on items of NES.
Environmental Planning and Assessment Act 1979 (EP&A Act)	The Minister for Planning	Approval from government to encourage proper management of natural and artificial resources to promote the environment and the economic and social welfare of the community.	Consent required from The Minister under Section 75W of the Act.
Contaminated Land Management Act 1997	DECCW	Any contaminated land, which presents 'a significant risk of harm'.	Report to DECCW if contaminated land identified. None identified in the Stage 1 assessment undertaken as part of this EA and outlined in **Section 5.6.1**.
Fisheries Management Act 1994 (FM Act)	I&I NSW (Fisheries)	Permit required for dredging, reclamation, removal of aquatic vegetation or obstructing fish passage.	A Section 201 Permit would be required to undertake excavation works within the Nepean Rover riparian corridor.
Heritage Act 1977	NSW Heritage Office (DoP)	Non-Aboriginal historic artefacts and / or sites if found.	No approvals or licences required (subject to discovery of items during construction works)
National Parks and Wildlife Act 1974	DECCW	Disturbance or destruction of any Aboriginal sites and isolated finds.	No approvals or licences required (subject to discovery of items during construction works)
		Removal of any protected native species.	No permits or approvals required.
Noxious Weeds Act 1993	I&I NSW / Penrith City Council	Removal and disposal of noxious weeds.	No permits or approval required but responsibility for removal and proper disposal.
Pesticides Act 1999	DECC	Pesticides, if used.	Labelling requirements for pesticides to be adhered to. Certificates for use of restricted pesticides.
Protection of the Environment	DECCW	Noise, Air and Water Pollution and Waste Management for scheduled activities or activities	The activity is not a scheduled activity and therefore no licence is

Legislation	Authority	Relevance to the Project	Approval / Licence Other Requirements
Operations Act 1997 (PoEO Act)		that may cause water pollution.	required.
Soil Conservation Act 1938	DECCW	Alteration of land that may lead to increased erosion hazard and follow on effects within catchment water bodies.	No Permit required. Commissioner may issue notice if works are considered to induce significant erosion effects. Erosion control practices are to be maintained in accordance with the Act.
Threatened Species Conservation Act 1995 (TSC Act)	DECCW	Threatened species of flora and fauna, endangered ecological communities or critical habitat.	No approvals or licences identified.
Waste Avoidance and Resource Recovery Act 2001 (WARR Act)	DECCW	The Proposal would use resources and generate waste, and as such needs to consider the Resource Management Hierarchy in the Act.	No approvals or licences required.
Water Management Act 2000	NSW Office of Water (DECCW)	Any works taking place in, on or under waterfront land (at present defined as 40m inland from the highest bank of the river) require a Controlled Activity Approval (CAA). Water extraction from waterways for activities such as dust suppression during construction. Construction of temporary earthworks or structure across a floodplain.	The works will be located within the waterway and within 40m from the highest bank of the Nepean River. Therefore a CAA (under Section 91) is required and will need to be obtained from NSW Office of Water. The works are considered to be flood works and as such approval is required under Section 90. Water for dust suppression will not be sourced from the creek therefore no Access Licence to extract water from a water source is required.

3 Justification and Alternatives for the Proposal

3.1 Strategic Need for the Proposal

The strategic need for the proposal lies within the need for the wider rehabilitation works proposed at Penrith Lakes. The rehabilitation of the quarry site is required to ensure the ongoing sustainability of the site for future generations. The proposed pipe is critical to the ongoing sustainability of the lakes after large flood events in the Nepean River. This is explained in more detail in the following sections.

3.1.1 Lake Filling – Flood Behaviour of Lakes Scheme

3.1.1.1 Stage 1 – Filling through Hunts Gully

During the early part of the flood event, the Wildlife Lake starts to fill through Hunts Gully (having backed up from the flooded Nepean River) in the north (**Figure 3.1**). The crest level of Wildlife Lake weir at Hunts Gully is 16m AHD, while the operating level of the Wildlife Lake is 10m AHD. This will occur in events greater than a 10 year ARI.

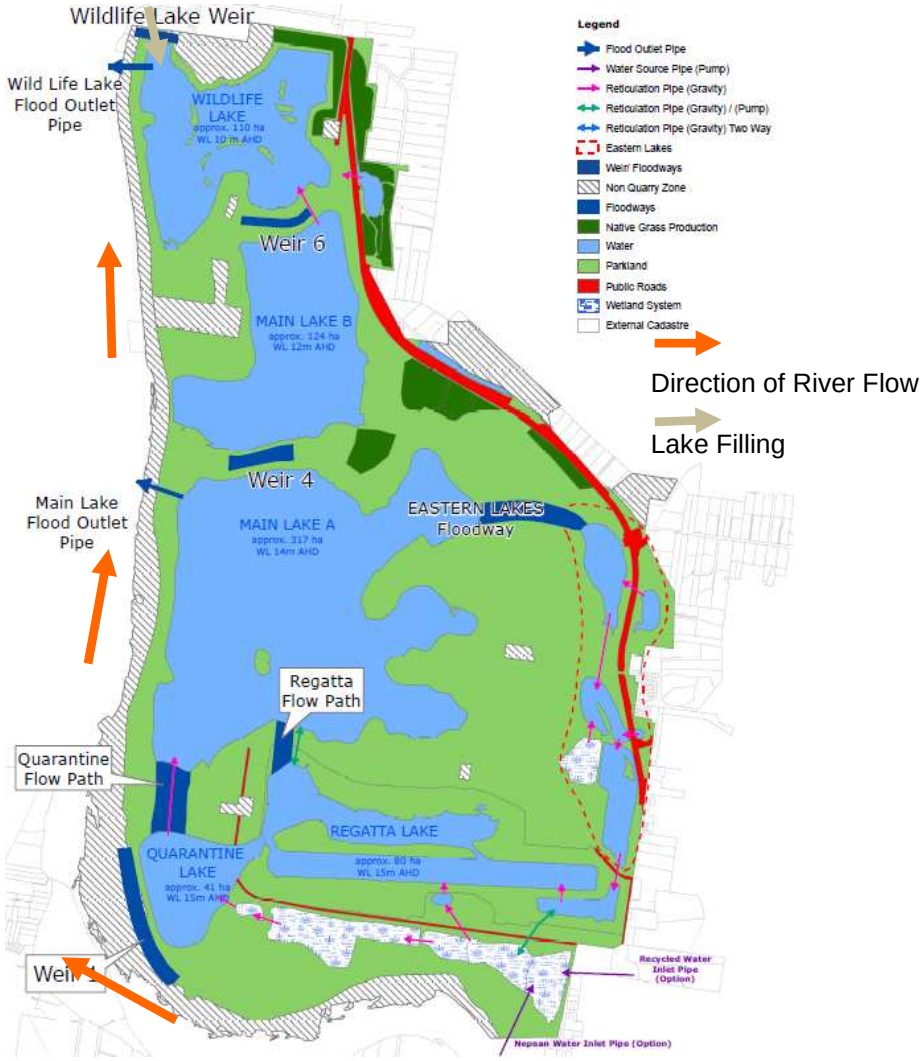

Figure 3.1: Stage 1 - Flooding Behaviour

3.1.1.2 Stage 2 – Filling through Hunts Gully & Across Weir 1

In the second stage, Weir 1, at a level of 21.6m AHD, starts to overtop (only in events greater than a 25 year ARI). This commences the filling of Quarantine Lake and Main Lake; meanwhile Wildlife Lake continues to fill through Hunts Gully **(Figure 3.2**).

Figure 3.2: Stage 2 - Flooding Behaviour

3.1.1.3 Stage 3 – Overtopping of Weir 4

Shortly after Main Lake A starts to fill, the low level Weir 4 overtops and starts to fill Main Lake B.

3.1.1.4 Stage 4 – Overtopping of Weir 6

Weir 6, at a level of 21m AHD, represents the major control for Main Lakes A and B. Once Main Lakes A and B have filled from 14m AHD (operating level) to 21m AHD, Main Lake B begins to overtop into the Wildlife Lake. Around this time, the direction of flow through the weir at Hunts Gully is reversed (**Figure 3.3**).

Figure 3.3: Stage 4 - Flooding Behaviour

3.1.1.5 Stage 5 – Post Flood

As the flood through the River recedes, the overtopping of Weir 1 stops, then Weir 6 stops overtopping and finally inflow from Wildlife Lake weir ceases.

After the flood has receded, however, the lakes are elevated above their normal operating levels. For Main Lakes A and B, the post-flood level is 21m AHD (the crest level of Weir 6). For the Wildlife Lake, the post-flood level is 16m AHD (the crest level of Wildlife Lake weir).

Flood drainage pipes are provided to draw-down the post-flood levels within the lakes back to normal operating conditions. For Main Lake A, this represents a drawdown of approximately 7 metres of water, for Main Lake B it represents approximately 9 metres of water while for the Wildlife Lake this represents a drawdown of approximately 6 metres of water. Flood water will be discharged from the proposed flood outlet pipes to the Nepean River (**Figure 3.4**).

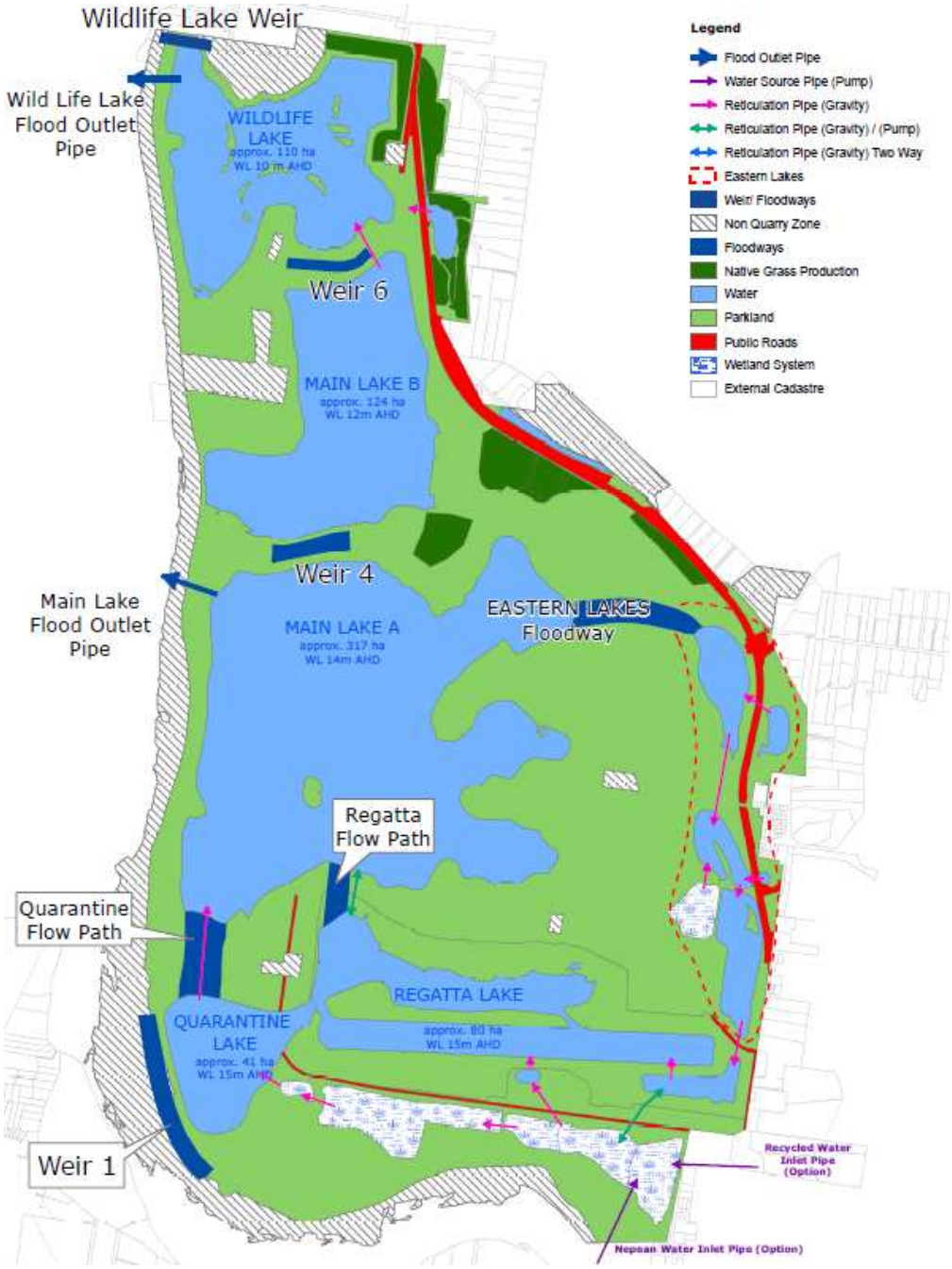

Figure 3.4: Stage 5 - Post Flood Behaviour

3.2 Proposal Objectives

The discharge pipe has been proposed to ensure the sustainability of the proposed Wildlife Lake within the Penrith Lakes site after large flood events in the Nepean River.

During a large flood event, floodwaters will enter the Lakes Scheme via the Main Weir (Weir 1) for the Main Lake (in events greater than a 25 year ARI) and Wildlife Lake Weir for the Wildlife Lake (in events greater than a 10 year ARI).

Without the proposed pipe, the lakes would remain elevated above normal operating levels following a large flood event (by up to 6 metres in the Wildlife Lake). The flood waters would remain in the lake system until it is lost via evaporation or infiltration, which could take months or years. During this time, the riparian vegetation and habitat of Wildlife Lake, established as part of the rehabilitation works, would be submerged for extended periods affecting its vitality and health, potentially to the extent of vegetation death. To reduce the potential impacts on the vegetation and to return Wildlife Lake to its normal operating level, the pipe has been proposed to allow the flood water stored in the lake to discharge back into the Nepean River in a controlled manner following a flood event.

Under normal flow conditions flows from the surrounding catchments will pass into the lake system (comprised of three major lakes: Wildlife Lake (WL), Main Lake A (MLA) and Main Lake B (MLB) and a number of smaller lakes (e.g. Quarantine Lake, Regatta Lake)**Error! Reference source not found.** and eventually into the Nepean River via the proposed pipe. It is noted that this flow will be relatively small in comparison to a large flood event, and represents a secondary function of the pipe.

The pipe has been sized on the basis that the lake water levels should return to normal operating levels within approximately two weeks.

Dissipation devices are proposed at the outlet of the pipe to dissipate the energy associated with the discharge from the pipe and prevent erosion.

3.3 Alternatives and Options Considered

The following alternatives and options were considered in the development of this proposal.

3.3.1 Do Nothing Approach

This option would involve not constructing the pipe. This would result in prolonged periods of inundation of the land surrounding Wildlife Lake after a flood event. This is expected to lead to a substantial loss of riparian and semi-aquatic vegetation which would be incapable of withstanding extended periods of inundation. Therefore, this option is not considered favourable.

3.3.2 Alternative Pipe Locations

A number of potential routes and locations for the pipe were considered along the length of the western boundaries of Wildlife Lake. The disturbed nature of the quarried areas provides flexibility in regard to the pipe origin and route within the proposed lake area. However, the discharge points into the Nepean River were found to be more constrained.

The final two proposed routes and discharge locations considered in **Section 3.4** were determined based on factors including:

- **Topography:** the topography at many locations is too steep to enable the pipe to be installed with minimum impact, i.e. in steep sections significant stabilisation would have been required during construction and after completion to manage bank erosion. The nature of the post completion stabilisation works required (e.g. terracing, clay fill or reinforcing) would likely have lead to ongoing erosion issues on the banks adjacent to the stabilisation works.
- **Constructability:** The selected location needs to allow not only for the installation of the pipe but also for the construction of the associated dissipation devices. Some locations do not provided adequate space on the lower bank to incorporate the dissipation devices.
- **Riparian Vegetation Impacts:** Vegetation surveys were undertaken at a number of potential sites. The impacts on riparian vegetation were considered in the identification of appropriate sites, with particular emphasis being placed on the possible presence of any threatened species or endangered ecological communities.
- **Heritage Constraints:** Cultural Heritage (Aboriginal and non-Aboriginal) surveys were undertaken at a number of potential sites. The presence or absence of significant heritage items was considered in the identification of appropriate sites.

Further details of the specific factors considered in selection of the preferred options are provided in **Section 3.4**.

3.4 Preferred Options

Two possible pipe discharge locations were considered for the Wildlife Lake outlet. These sites are:

- Wildlife Lake North (WLN); and
- Wildlife Lake South (WLS).

These locations are shown in **Figure 3.5.**

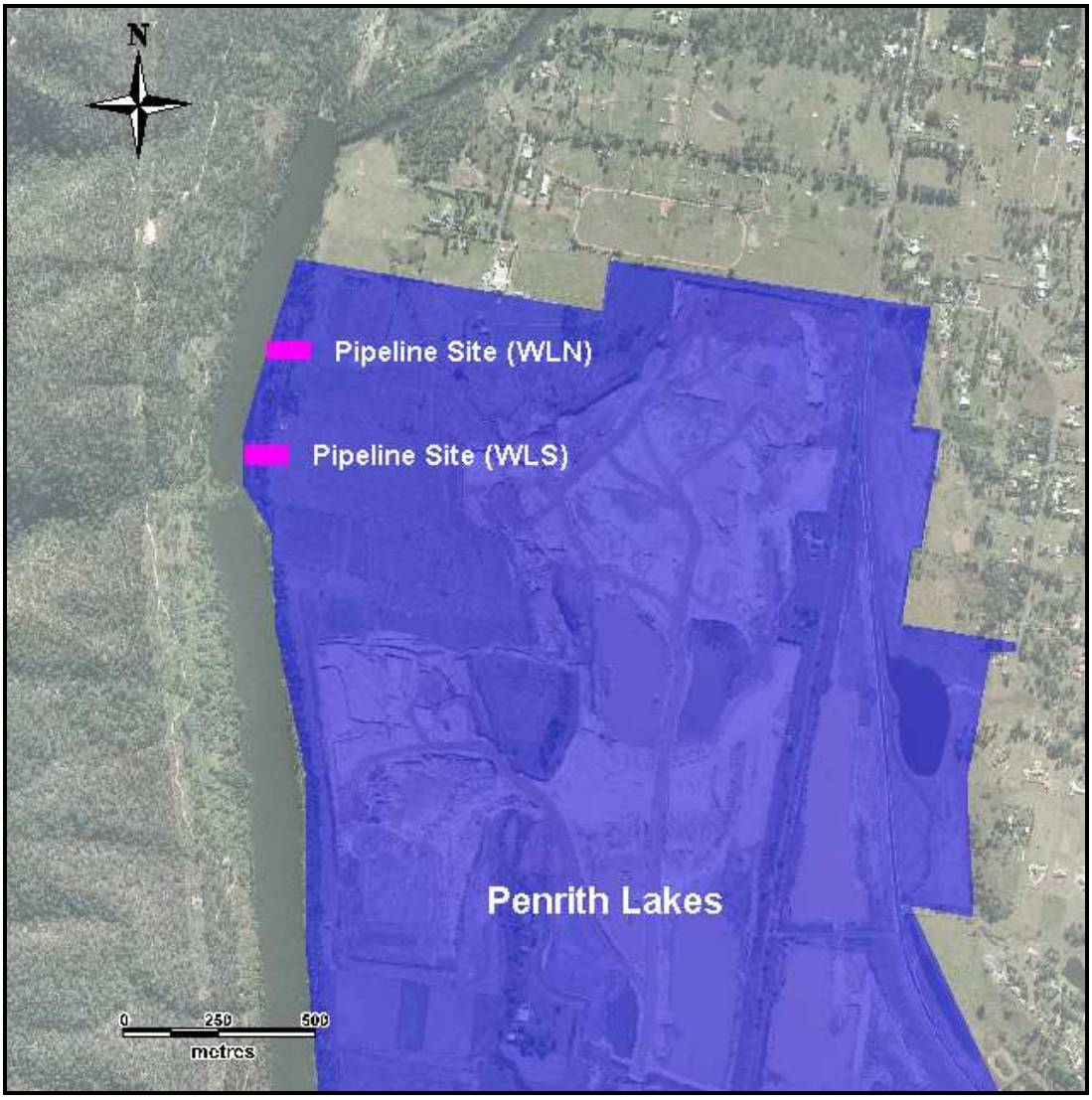

Figure 3.5: Possible pipe locations considered

In order to determine the preferred discharge locations from these two possible locations, a number of design, construction and operational factors were then considered to select a single pipe discharge location from Wildlife Lake. These factors included:

- The length of the pipe required;
- The riverbank cross section at the outlet locations;
- Environmental constraints;
- Heritage constraints;
- Local hydraulic conditions;
- Site access; and,
- Geotechnical constraints.

As a result of the investigations, Wildlife Lake North (WLN) was selected as the preferred location. The pipe design and proposed works at this location is the subject of this EA.

A detailed discussion on the selection of this site is considered further in Section 8 of the design report (Cardno, 2010a) which can be found in Section 4 of this application for development consent modification. **Table 3.1** provides a brief summary of the works associated with the proposed pipe route.

Table 3.1: Preferred Option Design Components

Design Component	Details
Number of Pipes	1
Diameter of Pipe	1350
Length of Pipe (per pipe)	135
Type of Dissipation Devices	USBR Type VI Dissipator
Length of Trench# (metres)	60
Approx. Top Width of Trench (metres)	40
Approx. Volume of Excavation Material (m^3)#	15,000
Approximate area of works (m^2)	1,500

It is noted that only a portion of the riverbank is to be excavated. The remaining length of pipe is to be placed within areas that will or have been placed as a part of the Lakes Scheme.

4 Description of the Proposal

4.1 Location and Site Description

The study area is located within the Middle Nepean – Hawkesbury and Blue Mountains catchments, Sydney Bio-region. The Penrith Lakes Scheme is located within the Penrith LGA and is approximately 60km west of Sydney and approximately 2km north-west of Penrith (**Figure 1.1**). It is bound to the north by Smith Road, to the east by Cranebrook Terrace, and to the west and south by the Nepean River. It is approximately 1,935 ha. The proposed works are located on the eastern bank of the Nepean River (i.e. the western portion of the Penrith Lakes Scheme site). The proposed works involve the construction of a pipe providing an outlet from the Lakes Scheme (specifically Wildlife Lake) to the Nepean River.

The majority of pipe length will occur within land that currently is or was disturbed and actively quarried. However, the western end of the pipe will extend through the existing Nepean River riparian corridor, eventually discharging into the river itself.

This EA provides an assessment of the proposed works location. The location of the proposed discharge work area is shown in **Figure 3.5** and an aerial view of the site is provided in **Figure 4.1**.

Figure 4.1: Aerial imagery of potential pipe termination sites.

4.2 Relationship to the Overall Scheme

The overall Scheme design as defined in SREP 11 Structure Plan represents the broad framework for the implementation of the Scheme through to its completion. The main features of the Scheme are large main lakes (comprising of Main Lake A and Main Lake B) intended for a variety of recreational activities complemented by several small lakes which will provide for both recreational and conservation activities. When fully implemented, the Scheme will include both land-based recreation and potential future urban areas. An immediate benefit of the Scheme has been the completion of the Olympic rowing/canoeing course. This precinct has been available for public use since 1995.

An orderly sequence of extraction and rehabilitation is required to achieve the progressive construction of the lakes and landforms. Factors such as access, stockpiling, affordability and environmental management have been considered in the development of the

sequence of works. The proposed flood discharge pipe from Wildlife Lake would form a component of Development Application 4 (DA4), which comprises of the fourth stage of the Scheme's development.

As discussed in **Section 3.1** the proposed discharge pipe is an integral part of the wider rehabilitation works proposed at Penrith Lakes. The rehabilitation of the quarry site is required to ensure the ongoing sustainability of the site for future generations. The proposed flood discharge pipe is critical to the ongoing sustainability of the lakes after large flood events in the Nepean River.

4.3 Design Parameters

The following summarises the key design parameters. Design drawings of the proposed pipe are provided in Section 5 of the Major Project application.

4.3.1 Pipe Details

The design of the pipe includes an outlet from Wildlife Lake to the Nepean River. A target 2 week drawdown period for the 100 year ARI was adopted, representing the period of time in which the lakes are 0.5 metres above normal operating levels in a flood event. The pipe details for each of the lakes are provided in **Table 4.1**.

Table 4.1 Pipe Details

Pipe Details	
Pipe Diameter	1350 mm
Number of Pipes	1
Length of Pipe	135 m
Crest Level of Inlet Structure	10 m AHD
Invert of Inlet Structure	7.79 m AHD
Invert of Pipe Outlet	6.5 m AHD
Drawdown period	14.3 days

4.3.2 Energy Dissipation

The recommended energy dissipation device for the pipe is a USBR Type VI. Other alternatives are also available and these were considered in the Concept Design Report (Cardno, 2010a); Section 4 of the application).

The following provide the key dimensions of the dissipator for the pipe:

- Width of dissipator = 5.0 m
- Length of dissipator = 6.7 m
- Height of dissipator = 3.9 m
- Height of baffle = 2.75 m
- Thickness of baffle = 300 mm

Rock rip rap covering an area of approximately 130m^2 using hard sandstone boulders having a median equivalent spherical diameter of 600mm will be required in front of the dissipator.

4.3.3 Inlet Structure

The design of the inlet is effectively a drop inlet structure. The overall structure would be 5 metres wide.

There are a number of inlet configurations that could prevent the blockage of the inlet. While the design discussed in the Design Report (Cardno, 2010a and Section 4 of this application) shows a hooded style outlet, grates could also be incorporated. Grates have been adopted for the detailed design.

4.4 Cost

A preliminary estimate of the cost of the proposed works is $900,000.

4.5 Timing

Based on the designs it is estimated that the proposed construction works will take 3 – 6 months to complete.

5 Environmental Impact Assessment

This section presents an environmental assessment undertaken in order to identify the environmental constraints and potential environmental impacts associated with the construction of a flood outlet pipe at Wildlife Lake. This section of the EA also identifies site-specific mitigation measures which are recommended to avoid or minimise any identified potential impacts.

The section is divided into sections to describe each of the environmental aspect assessed in this EA. Significant environmental factors considered in this section include:

- Terrestrial Ecological Impacts;
- Riparian and Aquatic Ecological Impacts;
- Hydrological Impacts;
- Aboriginal and Non-Aboriginal Heritage; and
- Soils, Sediments and Erosion.

A range of impacts of relatively lesser significance were also assessed. These aspects include:

- Contaminated Land;
- Air Quality, Climate and Dust;
- Hazards and Risks;
- Landscape and Visual Impact;
- Land Use Impacts;
- Noise and Vibration Impacts;
- Social and Health Values;
- Traffic Impacts/Access and Accessibility;
- Utilities and Infrastructure;
- Waste Materials and Management; and
- Water Quality Impacts.

5.1 Terrestrial Ecology

5.1.1 Aims and Assessment Methodology

The proposed installation of a pipe at the Penrith Lakes Scheme is primarily designed to ensure that following flood events, the water levels within Wildlife Lake revert to normal operating levels in a reasonable amount of time so that riparian vegetation along the banks adjacent to the lakes within the Penrith Lakes Scheme are not significantly submerged for extended periods of time.

A pipe discharge point into the Nepean River has been proposed for Wildlife Lake (**Figure 3.5**, **Figure 4.1**). A terrestrial ecology field survey was conducted at this site (and others) over two days by Cardno (2010d) (**Appendix A**) in conjunction with Eco-Logical to determine conservation and ecological values, and enable site specific assessment of potential impacts on the existing riparian flora and fauna. Possible mitigation measures were also discussed. Given the highly disturbed nature of previously quarried area through which the pipe will pass, the terrestrial ecology assessment largely focused on the location of the pipe outlet.

Desk Top Assessment

An initial desktop review of flora and fauna records (particularly threatened species) was conducted for the general Penrith Local Government area using the NPWS Wildlife Atlas (2000), EBPC Act Databases (1999) and Threatened Species Conservation Act (1995) listings. A review of historical flora and fauna reports specifically from within the Penrith Lakes Scheme area was also conducted (Mission Australia 2002; Abel Ecology 2007; Eco Logical 2009).

Field Survey

A field survey was conducted by Cardno / Eco-Logical on 17 and 18 February 2010. This involved recording information on the composition of the vegetation community at the proposed site.

The survey included:

- Meandering vegetation transects to allow for identification of all plant species encountered;
- A rough estimate of their plant species densities and crown cover;
- Where possible, qualitative assessment of condition, dominance, and habitat value;
- The area extending approximately 50 to 75 m on either side of the proposed works areas (approximately 500 m² for each site).

During the survey threatened flora and fauna identified during the desk top assessment were targeted. In particular:

- Threatened flora species which have been historically known to occur in the area and species typical of the River-flat Eucalypt community were targeted. The locations of mature riparian trees were recorded and mapped.
- Survey effort also focused on detecting and assessing the presence of suitable habitat areas and resources for fauna species, with particular emphasis on those species of formally recognised conservation significance that have been previously recorded, or are considered likely to occur, in the locality of the site.

Findings and recommendations of the terrestrial ecology study report (**Appendix A**) were considered when determining the preferred pipe route.

5.1.2 Ecological Legislative Requirements

This study and report was undertaken with reference to the requirements of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act 1979), the NSW Threatened Species Conservation Act 1995 (TSC Act 1995), the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999) and the Noxious Weeds Act (1993).

5.1.3 Existing Environment

Flora

Vegetation across the study site was predominantly represented by exotic riparian vegetation, dominating all growth forms including the graminoid, herbs, shrub and tree layers. In general, the riparian vegetation were considered to be of very low ecological value and in very poor condition due to the long history of anthropological land use disturbances leading to a high degree of weed infestation. However, a few scattered local and non-local native trees were recorded within the site which are of some conservation value (**Appendix A**). In particular *Casuarina cunninghamiana* and *Acacia implexa* were seen to be the dominant tree species at the site.

A total of 46 flora species belonging to 23 families were recorded at the WLN site. A comprehensive list of all plant species recorded, including estimates of their densities and cover at the site, and their biological attributes, such as growth forms, conservation significance (based on EPBC Act 1999, TSC Act 1995) and their weed control category (based on Noxious Weeds Act 1993) is provided in **Appendix A**. Of the 46 recorded species, 33 species were non-native weed species and four were recorded as declared weeds under the Noxious Weed Act (1993) (**Table 5.1**). Weed species dominating the groundcover include many graminoid species such as *Pennisetum clandestinum* (Kikuyu grass), *Bromus catharticus (*Prairie Grass), *Eharta erecta*, *Eragrostis curvula* (African Lovegrass), *Digitaria ciliaris* (Summer Grass) and *Paspalum dilatatum*. Dominant weedy shrubs include *Cestrum parqui*, *Ricinus comunis*, and *Solanum mauritianum*. Only 13 species belonging to five families were recorded to be native (**Table 5.2**).

Table 5.1: Declared weed species and their control categories listed under the Noxious Weeds Act (1993) at Wildlife Lake North (WLN).

Noxious Weed Species	WLN		Control Category	
	P	D	C	
*Cestrum parqui**	*1*	*2*	*2*	*3*
*Lantana camara**	*1*	*2*	*3*	*5*
*Ligustrum sinense**	*1*	*2*	*2*	*4*
*Ludwigia peruviana**	*1*	*2*	*2*	*3*
Total	***4***			

P = Presence (1 = present), D = Density (Rough estimates - 1 = 1 individual, 2=2-20 individuals, 3 = 21-100 individuals, 4 = over 100 individuals), C = Crown Cover (Rough estimates - 1 = 1-5%, 2 = 5-25%, 3 = 26-75%, 4 = 76-100%).

Table 5.2. List of native plant species recorded at Wildlife Lake North (WLN)

		WL N			Vegetation Attributes		Conservation
Species	**Family**	**P**	**D**	**C**	**Common Name**	**Growth form**	**Value**
Acacia decurrens	Fabaceae	1	2	2	Black Wattle	Tree	
Acacia implexa	Fabaceae	1	2	2	Hickory Wattle	Tree	
Angophora floribunda	Myrtaceae	1	1	2	Rough Barked Apple	Tree	Riverflat Eucalypt
Calochlaena dubia	Dicksoniaceae	1	2	2	Soft Bracken Fern	Shrub	
Casuarina cunninghamiana	Casuarinaceae	1	2	3	River Oak, River Sheoak	Tree	Riverflat Eucalypt
Commelina cyanea	Commelinaceae	1	2	2	Scurvy weed	Graminoid	Riverflat Eucalypt
Cynodon dactylon	Poaceae	1	3	2	Couch, Bermudagrass	Graminoid	
Eucalyptus amplifolia	Myrtaceae	1	1	2	Cabbage Gum	Tree	Riverflat Eucalypt
Eucalyptus baueriana	Myrtaceae	1	1	2	Blue Box	Tree	Riverflat Eucalypt
Eucalyptus terticornis	Myrtaceae	1	1	2	Forest Red Gum	Tree	Riverflat Eucalypt
Microlaena stipoides	Poaceae	1	4	2	Weeping grass	Graminoid	Riverflat Eucalypt
Oplismenus aemulus	Poaceae	1	2	2	Basket Grass	Graminoid	Riverflat Eucalypt
Phragmites australis	Poaceae	1	2	2		Herb	
	TOTALS	**13**					

P = Presence (1 = present), D = Density (Rough estimates - 1 = 1 individual, 2=2-20 individuals, 3 = 21-100 individuals, 4 = over 100 individuals), C = Crown Cover (Rough estimates - 1 = 1-5%, 2 = 5-25%, 3 = 26-75%, 4 = 76-100%).

Threatened flora database searches (EPBC Act 1992, TSC Act 1995, NSW Wildlife Atlas 1999) revealed 13 species which were historically recorded within the Penrith LGA (**Table 5.3**). No threatened flora species were recorded within the WLN site and it was considered that such species would be highly unlikely to occur given the degraded nature of the sites.

Table 5.3. Threatened flora species recorded within the Penrith LGA

Species Name	Common Name	Status *
Allocasuarina glareicola		E1
Leucopoon fletcheri subsp. fletcheri		E1
Hibbertia puberula		E1
Dillwynia tenuifolia		V
Pultenaea parviflora		E1
Acacia bynoeana	Bynoe's Wattle	E1
Micromyrtus minutiflora		E1
Pterostylis saxicola		E1
Grevillea juniperina subsp. *juniperina*	Juniper-leaved Grevillea	V
Personoia hirsuta	Hairy Geebung	E1
Persoonia nutans	Nodding Geebung	E1
Pimelea spicata	Spiked Rice-flower	E1
Allocasuarina glareicola		E1

E1 = Endangered species list under Schedule 1 of the TSC Act 1995
V = Vulnerable species listed under Schedule 2 of the TSC Act 1995

Endangered Ecological Communities

Background searches using the databases of the EPBC Act (1999), NSW Wildlife Atlas (1999), TSC Act (1995), and reports by Abel Ecology (2007) and Eco Logical Australia (2009) have recorded the presence of River-Flat Eucalypt Forest on Coastal Floodplains (REFCF), an endangered ecological community (EEC) under the TSC Act, in the area.

During the field survey, only a very minor component (eight species) of the REFCF community was recorded at the WLN site (**Table 5.4**). Of these several species sightings represented single juvenile trees planted as part of quarry environmental management programs. All REFCF species generally represented low density and cover values within the site (**Table 5.4**). The establishment of REFCF was considered to be constrained by the dominance of the weed species present, constituting 72% of species at WLN.

In light of field survey findings, it is considered that the existing vegetation within WLN is only very broadly analogous to an intact River-flat Eucalypt community (**Appendix A**) and that it is not sufficiently representative of an EEC to provide conservation value.

The flora values associated with the WLN site are not considered to be of sufficient magnitude to warrant prohibition of the proposed works.

Table 5.4. River-flat Eucalypt Forest species (based on EEC listing of species in the TSC Act 1995) recorded within the Wildlife Lake North (WLN) site.

Species	WLN				Vegetation Attributes	
	Family	P	D	C	Common Name	Growth Form
Angophora floribunda	Myrtaceae	1	1	2	Rough Barked Apple	Tree
Casuarina cunninghamiana	Casuarinaceae	1	2	3	River Oak, River Sheoak	Tree
Commelina cyanea	Commelinaceae	1	2	2	Scurvy weed	Graminoid
Eucalyptus amplifolia	Myrtaceae	1	1	2	Cabbage Gum	Tree
Eucalyptus baueriana	Myrtaceae	1	1	2	Blue Box	Tree
Eucalyptus terticornis	Myrtaceae	1	1	2	Forest Red Gum	Tree
Microlaena stipoides	Poaceae	1	4	2	Weeping grass	Graminoid
Oplismenus aemulus	Poaceae	1	2	2	Basket Grass	Graminoid
	Total Riverflat sp	**8**				
	Total Native sp.	**13**				
	Total Weed sp.	**33**				
	Total sp	**46**				

P = Presence (1 = present), D = Density (Rough estimates - 1 = 1 individual, 2=2-20 individuals, 3 = 21-100 individuals, 4 = over 100 individuals), C = Crown Cover (Rough estimates - 1 = 1-5%, 2 = 5-25%, 3 = 26-75%, 4 = 76-100%).

Fauna

A threatened species fauna search using the NSW Wildlife Atlas (2000), EBPC Act Database (1999) and Threatened Species Conservation Act (1995) listings was conducted for the general Penrith LGA. A total of 26 fauna species were recorded and are listed in **Table 5.5**. Due to the very small disturbance area anticipated for the proposed works (a maximum of 500 m²), and the fact that the existing site is highly degraded and lacks contiguous native vegetative cover, the proposed work site provides limited fauna habitat suitable for utilisation by native fauna species. The abundance of feral animals as indicated in previous reports (Mission Australia 2002; Abel Ecology 2007) is of significant concern, since the increase in predation pressure on native animals may cause local extinction of many native species within the remaining riparian strip.

Table 5.5. Threatened Fauna species recorded within the Penrith LGA.

Order	Species name	Common name	Status
Amphibia	*Litoria aurea*	Green and Golden Bell Frog	E1
	Pseudophryne australis	Red-crowned Toadlet	V
	Heleioporus australiacus	Giant Burrowing Frog	V
Aves	*Xanthomyza phrygia*	Regent Honeyeater	E1
	Lathamus discolor	Swift Parrot	V
	Rostratula australis	Australian Painted Snipe	V
	Petroica rodinogaster	Pink Robin	V
	Lophoictinia isura	Square-tailed Kite	V
	Stictonetta naevosa	Freckled Duck	V
	Callocephalon fimbriatum	Gang-gang Cockatoo	V
	Petroica rodinogaster	Pink Robin	V
	Glossopsitta pusilla	Little Lorikeet	V
	Neophema pulchella	Turquoise Parrot	V
	Ninox strenua	Powerful Owl	V
Gastropoda	*Meridolum corneovirens*	Cumberland Plain Land Snail	E1
Insecta	*Petalura gigantea*	Giant Dragonfly	E1
Mammalia	*Dasyurus maculatus*	Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll	E1
	Chalinolobus dwyeri	Large-eared Pied Bat, Large Pied Bat	V
	Potorous tridactylus	Long-nosed Potoroo	V
	Pteropus poliocephalus	Grey-headed Flying-fox	V
	Petaurus norfolcensis	Squirrel Glider	V
	Phascolarctos cinereus	Koala	V
	Pteropus poliocephalus	Grey-headed Flying-fox	V
	Miniopterus schreibersii	Eastern Bentwing-bat	V
	Myotis macropus	Southern Myotis	V
Reptilia	*Hoplocephalus bungaroides*	Broad-headed Snake	V

E1 – Endangered, V - Vulnerable

Fauna species recorded on site during the ecological survey are listed in **Table 5.6**. None of the species are currently listed as endangered or vulnerable under the TSC Act (1995) or EBPC Act (1999). No arboreal or terrestrial mammals were sighted in the area. It is

considered unlikely that many arboreal mammals permanently inhabit the riparian corridor due to the lack of *Eucalyptus* trees containing potential hollow bearing habitat. River Oaks (*Casuarina cunninghamiana*) and *Acer* species may provide some small shelter sites in the form of branch forks or fissures within the bark, but it would not offer the quality of habitat provided by mature Eucalypt species.

Table 5.6. Fauna species recorded during the ecological survey at Penrith Lakes (17 and 18 February 2010).

Order	Species name	Common name
Aves	*Anhinga melanogaster*	Darter
	Gymnorhina tibicen	Australian Magpie
	Dacelo novaeguineae	Laughing Kookaburra
	Haliaeetus leucogaster	White Bellied Sea Eagle
	Hirundo neoxena	Welcome Swallow
	Fulica atra	Eurasian Coot
	Falco peregrines	Peregrine Falcon
	Pelecanus conspicillatus	Australian Pelican
Reptilia	*Physignathus lesuerii* *Varanus varius*	Easter Water Dragon Lace Monitor
	Pseudechis porphyriacus	Red Bellied Black Snake

Three species of Microbats were historically recorded further south of the study sites (Abel Ecology 2007). This included the Large Bentwing Bat (*Miniopterus schriebersii*), Eastern Freetail Bat (*Mormopterus norfolkensis*), and the Large-Footed Myotis (*Myotis adversus*). These are all listed as Schedule 2, Vulnerable under the NSW Threatened Species Act 1995, however, due to the lack of *Eucalyptus* species it is unlikely the proposed works site provides suitable habitat for these species. No caves or large rocks were observed within the study site, or within the general riparian corridor. It is most likely that bats occupy the caves and the Eucalypt forest species on the other side of the Nepean River in the Blue Mountains.

Targeted field survey to determine the potential presence of Koalas (*Phascolarctos cinereus*) did not identify any evidence of habitat utilisation (i.e. scratches, scats). It is also noted that none of the few eucalypt species present on site represent Koala feed trees. It is possible Koalas may utilise the riparian corridors to access preferred habitat areas. However, the lack of eucalypt species, lack of sightings and no indicators of utilisation suggest this to be unlikely. Only one historic sighting of a koala in the southern section of Penrith Lakes Scheme has been recorded.

It is recognised that the site's most important ecological feature is the fact that it forms part of a habitat corridor which provides linkages with other flora and fauna corridors in the local and regional area further north and south of the study sites. Some mammals may also be able to cross the Nepean River at the narrow areas and partial land bridges which occur to the north and south of the quarry. However, it is considered the study site's greatest connectivity value will be established upon completion of the proposed Wildlife Lake as part of the Penrith Lakes Scheme.

5.1.4 Potential Impacts

Flora

Primary temporary impacts of the proposed works includes:

- Loss of vegetation;
- Smothering by construction dust; and
- Altered erosion and sediment regimes changing the flora habitat values (i.e. Salix *spp*. and Casuarina *spp*. are good at maintaining bank stability).

Only a very small fraction of the riparian strip between the quarried area of the Penrith Lakes Scheme and the Nepean River will require clearance during the proposed works (at most 500 m²). Further, due to the relatively sparse occurrence of mature (native) trees in the area, the number of mature trees lost during pipe installation is low. There are a small number of trees to be removed from the quarry boundary and adjacent to an established vehicle track; however none of the trees to be removed (**Figures 5.1**) were identified as being highly significant in the terrestrial ecology assessment undertaken (**Appendix A**).

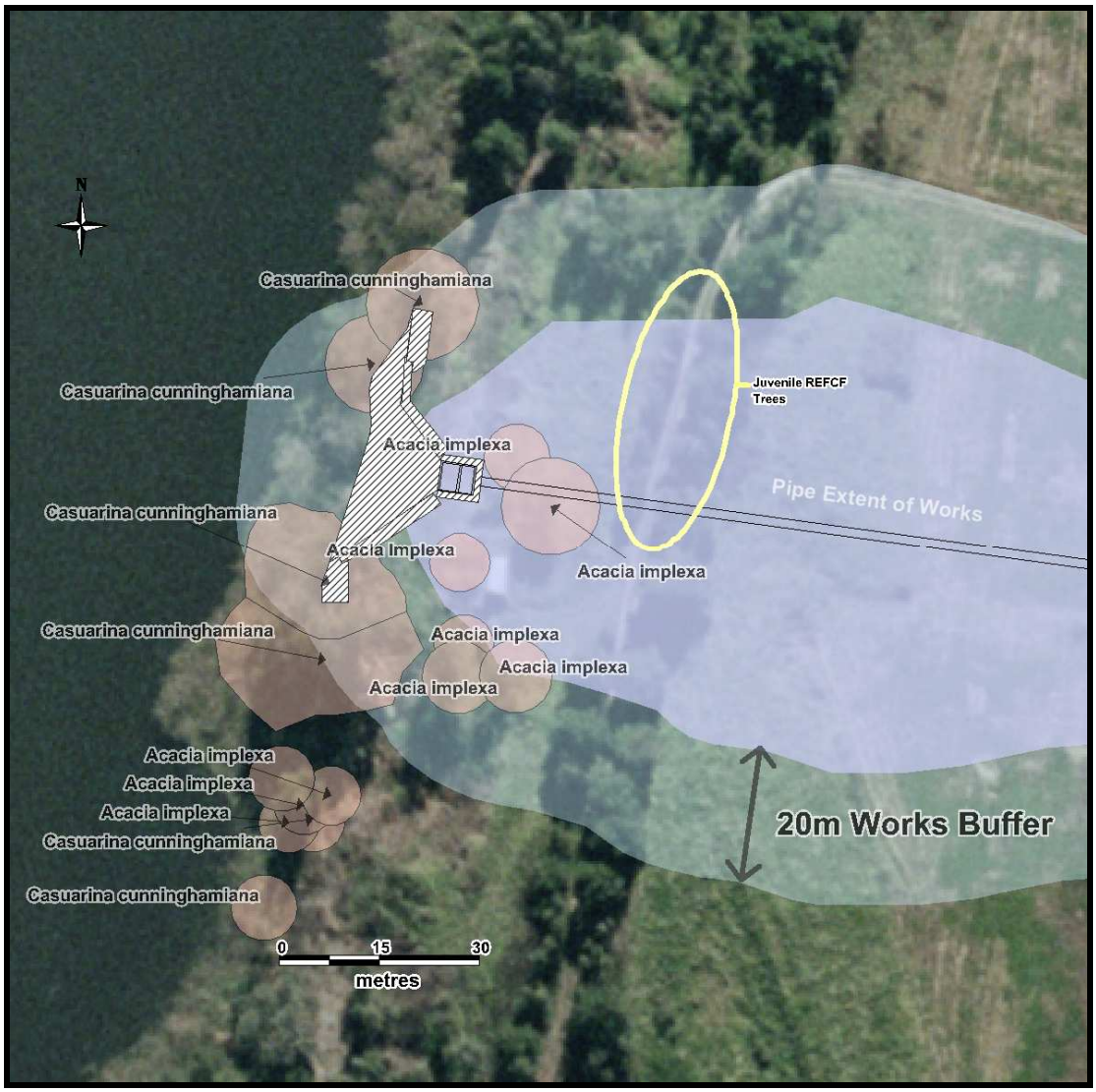

Figure 5.1: Wildlife Lake North: Extent of Works with Mature Riparian Trees

No threatened plant species were recorded in this assessment and threatened species historically recorded in the Penrith LGA were considered very unlikely to occur amongst the highly degraded, weed infested habitat that was observed within all the vegetative layers. Due to the high levels of degradation it was considered that the likelihood of any threatened species being present in the soil stored seed bank is negligible.

A very minor component of an endangered ecological community, the Riverflat Eucalypt community (listed under Schedule 3 of the TSC Act 1995) was detected. The species present comprised only a very small proportion (less than 5%) of the total species of a typical Riverflat Eucalypt species, and included none of the characteristic tree species in mature form. It is considered that the community present is only very broadly analogous to the REFCF EEC. It was also predicted that the pervasive nature of the weed community will continue to suppress the survival of any remaining REFCF in the future. Subsequently, it is considered that the proposed works will not have any significant negative impact upon REFCF within WLN or the wider area. It is noted that a small stand of planted juvenile trees containing REFCF component species will be affected as part of the WLN works. However, it is anticipated that these individuals would be able to be replaced during the post construction rehabilitation phase.

The removal of weeds and rehabilitation plans may allow for the re-establishment of REFCF in the area. In its current form, the site is significantly degraded such that the loss of vegetation resulting from the proposed pipe works will not significantly impact any native flora species within the site.

Overall, there was found to be no significant impact on any threatened species, their habitats, populations or endangered ecological communities as a result of the proposal. As such a Species Impact Statement is not required. Referral to the Federal Minister for the Environment is not deemed to be required in relation to the obligations and objectives of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, as there would be no significant impact on any 'Matters of National Environmental Significance'.

Fauna

No threatened fauna species were recorded as directly inhabiting the site. No evidence of nests, hollows, native fauna burrows, native fauna scats, or markings recorded within the immediate vicinity of the proposed works. Most native fauna that were sighted were recorded on the boundaries of the proposed works area, and were mostly highly mobile birds capable of dispersing rapidly (**Table 5.6**). The Red-Bellied Black Snake (*Pseudechis porphyricus*), Lace Monitor (*Varanus varius*) and the Eastern Water Dragon (*Physignathus lesueurii*) were the only on-ground fauna recorded along the edges of the proposed works site. These species are capable of dispersing into adjacent habitat during construction events. Historical sightings of pigs (*Sus scrofa domesticus*), cats (*Felis silvestris catus*) and foxes (*Vulpes vulpes*) in the riparian corridor suggest an increase in predation pressure may have stunted populations of native fauna along the riverbank strip. Furthermore, the riparian bush is in poor condition and is generally characterised as having limited habitat value for native fauna dependant on native flora (and fauna) for food resources and protection. As a result, it is expected that the riparian corridor only functions as transient

habitat (rather than permanent habitat) for ground dwelling species attempting to access habitat to the north and south of the proposed work site.

It is expected that during the proposed works, temporary trenches and fences will limit the movement of ground dwelling fauna crossing the works area. However, it is anticipated that the maximum duration of works would be three months, after which rehabilitation of the soil profile and revegetation of native flora species is planned. Scheduling of the construction works would limit the extent to which animal movement would be limited (i.e. construct progressively to retain gaps along the pipe route to allow animal movement). More mobile and larger ground dwelling species would also be capable of migrating short distances through reedy shallow waters if required.

Noise and vibration disturbance to fauna provided by the proposed works is not considered likely to exceed disturbance levels currently incurred by quarry operations.

Potential impacts on fauna species that may occur as a result of the proposed works include:

- death or injury of individual animals during construction work which will involve the operation of machinery, clearance of vegetation, and the excavation/filling of trenches;
- loss of fauna habitat resources including roosting / nesting sites or food sources due to vegetation clearance;
- interference with movement patterns via the creation of exposed areas or installation of barriers (i.e. fences or trenches)which may interfere with the movement of fauna along the eastern bank of the Nepean River; and
- disturbance associated with construction noise and vibration.

As a result of the short duration of the proposed works, and the general low numbers of native fauna utilizing the area, it is expected that the proposed works would not have a significant impact on the survival of native fauna, and would not disrupt migrating patterns for most mobile fauna species.

5.1.5 Proposed Mitigation Measures

Table 5.7 provides a list of recommended mitigation measures to be implemented to minimise ecological impact. Application of these mitigation measures will ensure there will be no significant impact on native flora and fauna communities within the final adopted sites. Where appropriate, these measures should be included within a Construction Environmental Management Plan.

Table 5.7: Mitigation measures

Mitigation Number	Development Stage	Description of measure
M1	Design	All mature (native) trees should be retained where possible.
M2	Design	In regards to the pipe, site selection has considered the relative ecological value of the sites as a factor in decision making.
M3	Design	Mark the extent of vegetation to be cleared on all technical drawings and mark in the field.
M4	Design & Construction	Between excavation and filling, a temporary construction trench would limit the movement of ground dwelling native fauna travelling north and south along the riparian strip. To minimise impact, work should be scheduled to minimise duration of the works, and to minimise the length of open trench at any time.
M5	Construction	The locations of native trees at the selected development sites should be made known to construction contractors. All construction machinery should keep a sufficient distance from the trees (i.e. outside the canopy drip line) to limit root damage. Protective marking or fencing of trees to be retained should be considered.
M6	Construction	During the vegetation clearing stage it is recommended a qualified animal handler be present to ensure that any native fauna that may be temporarily occupying the area, is relocated in a safe manner.
M7	Construction	Limit stockpiling of materials on site and actively manage stockpiles to minimise dust under high wind scenarios, and minimise weed establishment.
M8	Construction	Construction contractors must be made aware of protected species which may be encountered during works (e.g. Green and Golden Bell Frog (*L.aurea*), Cumberland Land Snail (*M.corneovirens*)). Should any such species be encountered works shall cease until approval is provided by DECCW.
M9	Construction	Establish a Fauna log recording any significant species observed on site during construction. Works shall cease until the animal moves from the area or a qualified animal handler can remove it from the site.
M10	Construction	Prohibit works from exceeding the approved disturbance width and enforce boundaries.
M11	Construction	Logs from felled native trees should be returned post-construction to provide suitable habitat for ground-dwelling fauna in preference to being sent off site for disposal. Wherever possible, the cleared understorey vegetation should be utilised post-construction as a source of mulch for the revegetation programme.
M12	Construction & Operation	A weed management plan must be employed to limit colonisation of the disturbed areas by weeds. Where possible this should include weed removal of the surrounding areas. This is considered to be important in the context of the broader Penrith Lakes Scheme.
M13	Construction & Operation	Rehabilitation works following installation, should aim to reinstate a stable landform that supports a native plant community which resembles the original forest, the Riverflat Eucalypt community.

5.2 Aquatic Ecology

A desk and field based review of the aquatic ecology and potential impacts of the proposed works was undertaken by Cardno Ecology Lab (2010) (**Appendix B**).

5.2.1 Assessment Methodology

Background information on the possible occurrence of (aquatic) threatened species, populations and ecological communities in the general study area was reviewed using the following legislation and relevant database searches:

- Threatened Species Conservation Act 1995 (TSC Act 1995);
- Fisheries Management Act 1994 (FM Act 1994);
- Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999);
- NSW Government BioNet Database;
- Commonwealth Department of Environment, Water, Heritage and Arts (DEWHA);
- NSW Department of Environment, Climate Change and Water (DECCW);
- Industry and Investment NSW (I&NSW); and
- Cardno Ecology Lab specialist library.

Field sampling was conducted by Cardno Ecology Lab on the 17 and 18 February 2010 at the sites. In addition, two reference sites were selected to enable comparison of the site with some baseline data – one upstream (Southern Reference) and one downstream (Northern Reference) from the proposed works area (**Appendix B**). Assessments of the biological attributes within the site are tabulated using the methodology described in **Table 5.8**.

Table 5.8: Methodology used for sampling aquatic habitat, surface water quality, macrophyte, aquatic macroinvertebrate and fish assemblages for each site.

Biological Attributes	Sampling Methodology
Aquatic Habitat	The 'Riparian, Channel and Environmental Inventory' (RCE) method was used to describe the adjacent land and condition of riverbanks. This method creates an RCE score developed by Chessman et al. (1997) - see Appendix 1 in Aquatic Ecology survey. The RCE score takes into account the following habitat features: geomorphological characteristics of waterways, types of land use along the waterway, riparian vegetation and instream vegetation, and substratum type (e.g., rock, sand, gravel, alluvial substrata)
Water Quality	Measured physical and chemical properties using a Yeo-Kal 611 probe, which included electrical conductivity (ms/cm and µs/cm); salinity (ppt); temperature (0C); turbidity (ntu); dissolved oxygen (mg Litre-1 and % saturation); pH; and ORP (oxidation reduction potential: mV). Alkalinity (mg CaCO3 Litre-1) was measured in situ using hand-held titration cells from CHEMetrics
Macrophyte	Presence of instream macrophytes were recorded
Macroinvertebrates	Samples were collected over a total length of 10 m of edge habitat usually in 1-2 m sections. Dip nets with a mesh size of 250µm were used to collect invertebrates - the dip net was first used to disturb animals by agitating bottom sediments and suspending invertebrates into the water column. The net was then swept through this cloud of material to collect suspended invertebrates and surface dwelling animals.

Biological Attributes	Sampling Methodology
Fish	Electrofishing and bait traps were used to sample fish. The technique involves discharging an electric pulse into the water which stuns fish, allowing them to be easily netted, counted, identified and released. Electrofishing was done in edge habitat beneath overhanging banks and vegetation and within macrophyte beds located away from the bank. One staff member used the electrofisher, whilst a second handled a dip net and was primarily responsible for capture of stunned fish. Five traps were deployed in shallow water habitats such as bare substratum and amongst macrophytes. Traps were baited with approximately 70 ml of a mixture of chicken pellets and sardines and were left overnight for approximately 18 hours.

5.2.2 Existing Environment

Background Information

Relevant database searches and ecological reports of aquatic flora and fauna species recorded in the Nepean River and Penrith Lakes Scheme are tabulated in Table 1 of the Aquatic Ecology report in **Appendix B**.

Twenty seven fish species were identified as potentially inhabiting or having historically inhabited the wider region of the study sites. Of these, 24 are native species and three are exotic species; goldfish (*Carassius auratus*), carp and mosquito fish, the latter two are declared Class 3 noxious species under the FM Act. Two of the identified native species are listed as threatened. These are:

- Macquarie perch (*Macquaria australasica*); and
- Australian grayling (*Prototroctes maraena*).

The Macquarie perch and the Australian grayling are also listed under the EPBC Act as endangered and vulnerable, respectively.

Three species of freshwater mussels are seen to be present in the Hawkesbury – Nepean River system; *Hyridella depressa*, *Hyridella australis* and *Velesunio ambiguous*.

Tall knotweed (Alternanthera philoxeroides) and two invasive species Alligator weed (Alternanthera philoxeroides) and Salvinia (*Salvinia molesta*) also potentially occurring in the area

Surveys within and around Penrith Lakes from 1998 – 2009 have identified a total of 11 fish species (**Appendix B**). Australian bass (*Macquaria novemaculeata*) and carp were the most abundant large fish, whilst mosquito fish were the most abundant small fish (I&I NSW 2009). A stocking program from 1996 to 2005 introduced 129,000 bass into the Penrith Lakes.

The macroinvertebrate fauna of Penrith Lakes is dominated by species from *Trichoptera* (Caddisflies), *Odonata* (Dragonflies and Damselflies), *Diptera* (True Flies) and to a lesser extent *Hemiptera* (True Bugs) and *Coleoptera* (Beetles) (I&I NSW 2009). Freshwater shrimp and prawns have also been frequently observed (I&I NSW 2009).

Field assessment

In general, the aquatic communities recorded during the survey in the site and the two additional reference sites were very similar. When present, the riverbank vegetation was

generally dominated by *Salix spp.* (Willows), Cumbungi, Common Reed, Alligator weed and other weed species. At all sites, conductivity and pH were within ANZECC threshold limits, whereas turbidity values were low. In contrast, dissolved oxygen was considerably lower than ANZECC threshold limits. The species richness of aquatic macroinvertebrate communities ranged from 13 to 28 species, and all sites generally represented pollutant tolerant taxa, such as *Chironomidae* (true flies), *Coenagrionidae* (damselfly), *Atyidae* (freshwater shrimp) and *Baetidae* (mayfly). The most abundant fish species at all sites include the small flathead gudgeon and the introduced mosquito fish. No threatened species were recorded at any of the sites sampled. **Table 5.9** lists the water quality conditions and the qualitative species composition of riverbank vegetation, macroinvertebrates, and fish species, at each site.

Table 5.9: Biological attributes, such as riparian vegetation, water quality, macroinvertebrate composition and fish species assemblages at the proposed site and the southern reference site and the northern reference site.

	Biological Attributes			
Sites	**Riverbank vegetation**	**Water quality**	**Macroinvertebrates**	**Fish**
Southern Reference site	Moderate RCE Score. Continuously dominated by introduced species such as Willow Tree (*Salix* spp) and groundcover (*Tradescantia albiflora*). Other spp in water include Common reed, Common rush, and Alligator Weed, Ribbonweed, Azolla spp., Duckweed and Salvinia spp.	Conductivity and pH were within ANZECC threshold limits. Turbidity values were marginally lower while dissolved oxygen was considerably lower than ANZECC threshold limits.	24 *spp* were recorded with an average signal score of 3.7, indicating a severely polluted site. *Chironomidae* (true flies), *Coenagrionidae* (damselfly), *Atyidae* (freshwater shrimp) and the introduced *Physidae* (water snail). The more pollution-sensitive *Leptoceridae* (caddisfly) were also relatively abundant	Five species of fish were recorded: longfinned eel, flathead gudgeon, striped gudgeon, empire gudgeon and the introduced mosquito fish
Wildlife Lake North	Moderate RCE score. *Casuarina cunninghamiana* and *Salix* sp.	Conductivity and pH were within the ANZECC threshold limits.Turbidity values were marginally lower while dissolved oxygen was considerably lower than ANZECC threshold limits.	13 spp were recorded with an average signal score of 4.3 indicating severe pollution. Common taxa: *Chironomidae* (true flies), *Coenagrionidae* (damselfly) and introduced *Physidae* (water snail)The more pollution-sensitive *Leptoceridae* (caddisfly) were abundant	Two species of fish were recorded: Flathead gudgeon and the introduced mosquito fish
Northern Reference site	Low RCE Score. Common plants include Cumbungi, marsh clubrush (*Bolboschoenus fluviatilis*), Alligator Weed, Dense waterweed and Ribbonweed	Conductivity and pH were within the ANZECC threshold limits.Turbidity values were marginally lower while dissolved oxygen was considerably lower than ANZECC threshold limits.	13 spp were recorded with an average signal score of 4.3 indicating severe pollution. Common taxa: *Chironomidae* (true flies), *Coenagrionidae* (damselfly) and introduced *Physidae* (water snail). The more pollution-sensitive *Leptoceridae* (caddisfly) were abundant	Five species of fish were recorded: Australian bass, flathead gudgeon, dwarf flathead gudgeon and the introduced mosquito fish

5.2.3 Potential Impacts

Potential environmental impacts on the aquatic ecology as a result of the proposed works would mostly be confined to the construction and operational phase of the project. Impacts include sediment mobilisation, pollution, thermal pollution, invasive species, water quality, removal of large woody debris, and reduction in bank stability.

Sediment mobilisation

Sediment mobilisation can occur as a result of the earthworks, run-off over disturbed land and erosive scour from flood discharge. Compaction in works areas may reduce infiltration of surface waters and also contribute to sediment load in run-off. In addition, airborne dust may enter local waters. Sedimentation can result in:

- Mortality and decreased growth. Suspended particles can clog respiratory gills and/or feeding apparatus of fish and macroinvertebrates;
- Degradation of habitat. Siltations can infill deep water refugia and interstitial spaces in the stream bed and smother aquatic macrophytes beds and spawning grounds; and
- Reduced water quality. Increased light attenuation could decrease primary productivity and nutrients.

Increased sedimentation and habitat degradation is considered a threat to Macquarie perch, Australian grayling, Sydney hawk dragonfly, Adam's emerald dragonfly and protected aquatic habitat, such as gravel beds.

Pollution

The construction and operation of the proposal has the potential to mobilise contaminants into aquatic habitat within the study area. Possible pollutant sources include:

- Pollutants associated with heavy vehicles used on site during construction, such as aromatic hydrocarbons (lubricating oils and fuels) and heavy metals (e.g. copper in brake linings, and zinc and cadmium in tyres);
- Pollutants associated with materials used in construction. There is a diverse array of materials used in construction (e.g., cementatious materials, cement admixtures and aggregates).; and
- Pollutants bound to disturbed sediments may be mobilised into aquatic habitat.

Thermal pollution

There is potential on thermal pollution as a result of the pipe drawing water from different thermal layers of Penrith lakes where temperatures may be stratified (i.e. deeper waters may be cooler than surface waters). Changes to temperature can reduce biodiversity by exceeding the thermal tolerance limits of aquatic biota or reduce population viability via reduced rates of growth or reproductive output. However, it is noted that discharges will be limited to discrete events following flooding and that pipe layout design is such that pipe lake inlet will only draw from the upper layers and discharge into the surface waters of the Nepean River, reducing the risk of thermal pollution.

Invasive species

Seven species of introduced macrophytes and three species of introduced fish (with an additional three native species outside their natural distribution) were identified from the Nepean River, including the noxious pests: alligator weed, salvinia, carp and mosquitofish.

There are currently no invasive aquatic species within Penrith Lakes that are not already present within the adjacent reach of the Nepean River. However, there is potential for populations of invasive species to increase as a result of the crossover.

Water Quality

The proposed lakes within the Penrith Lakes Scheme may stratify with the cold deoxygenating water layers occupying the bottom of the lake. The basins could also become sinks for sediment, organic carbon and pollutants flowing in from the catchment. Algal blooms may develop during the summer months. There is potential for this low quality water to be transferred in to the Nepean River. However, the proposed pipe designs will only draw water from the upper/flood condition levels, reducing the risk of low DO water being pumped into the Nepean River. It is also noted that pipe flow will only occur during or shortly after flood events when water quality and temperature regimes are already altered. Measures to rectify the potential problems in the Penrith Lakes should be undertaken as part of water quality management in the lakes.

Bank Stability

The proposed works have the potential to degrade the Nepean River banks by removing the bank verge vegetation adjacent the riverbank. Subsequently, this can lead to erosion, slumping and increased sedimentation issues.

Removal of large, woody debris

Submerged woody debris was common along the pool reach of the Nepean River adjacent to the study site. However, the potential temporary loss of snags due to the proposed works would not have a significant impact on aquatic ecology.

5.2.4 Proposed Mitigation Measures

To minimise the potential impacts of the proposed works on the aquatic ecology of the area, it is suggested that a Construction Environmental Management Plan (CEMP) is developed incorporating the following mitigation measures:

Sediment mobilisation

The following measures should be incorporated into an Erosion and Sediment Control Plan (ESCP):

- Erosion and sediment controls, such as: bunding, silt fences/curtains, sediment basins/ponds and drains. These measures should be able to operate effectively during high rainfall events;
- If coffer dams are used for works within the wetted width of the Nepean River channel, the coffer dam should be designed so that it has minimal impacts on geomorphology and hydrology of the Nepean River and should be surrounded by a sediment curtain;

- Clean water should be diverted around disturbed areas;
- Runoff from disturbed areas should be diverted into erosion and sediment controls;
- The area and duration of exposed unconsolidated soils should be minimised;
- Revegetation and rehabilitation of disturbed areas should take place as quickly as possible. Erosion and sediment control measures should be in place to treat run-off from these areas until adequate cover is established;
- Restricting work within disturbed areas during rainfall; and
- Fish passage should be considered where silt fences/curtains may be positioned across waterways. A permit may be required for works that require temporary blockage of fish passage.

Pollution

Management plans should include regular inspections of work practices, and provision of training to staff in the correct handling, storage, transport and disposal of hazardous substances. Construction staff shall be aware of the potential pollution risks associated with riparian work sites. The risk of flood events during construction and potential associated pollution risks should be monitored and planned for at all times.

Thermal pollution

It is planned that the drawdown points of the pipe would be close to the surface of the lakes where temperatures are similar to that flowing in the Nepean River. As a result, the transfer of the cold, deoxygenating waters into the Nepean River would not occur.

Invasive species

An eradication/control programs should be developed by PLDC to keep Penrith Lakes free of large populations of invasive aquatic species.

Water Quality

Regular water quality monitoring should be maintained to identify potential problems that might result from discharging water from Penrith Lakes into the Nepean River (e.g. algal concentrations, nutrient levels, dissolved oxygen, pH).

Bank Stability

Plans to maintain and strengthen the riverbank stability should be considered in the detailed design (e.g. minimize clearing). This is discussed in more detail in **Section 5.5.3**.

Removal of large, woody debris

Where large woody debris is encountered, lopping should be considered the first management response. Any large woody debris removed during works should be replaced back in the river following completion of construction works.

5.3 Hydrological Impacts

5.3.1 Assessment Methodology

Background

The proposed flood drainage pipe is an integral part of the overall Penrith Lakes Scheme. The overall Lakes Scheme has been assessed in detail utilising a complex 2D hydraulic model and is discussed in detail in Section 6 of the Application (Cardno, 2010B).

The proposed Penrith Lakes Scheme will result in significant benefits to both Emu Plains and Penrith, with significant reductions in flood levels in large flood events (up to nearly 1 metre in Emu Plains in a 100 year ARI event). It is estimated that the proposed Lakes Scheme will result in a reduction in flood damages in the 100 year ARI event of approximately $3.5M.

Assessment

A two-dimensional (2D) hydraulic model was established to analyse the flood behaviour for the study area using SOBEK 1D/2D. Details of the setup and calibration of this model can be found in Section 7 of the Application.

A one-dimensional (1D) hydraulic model was established to analyse the behaviour of the flood drainage system and to determine the drawdown period following a large flood event.

The following reports have been prepared by Cardno in undertaking this design:

- Cardno (2010). *Penrith Lakes Flood Model – Calibration & Verification*, prepared for Penrith Lakes Development Corporation, Version 7, May. (Section 7 of the Application).
- Cardno (2010). *Penrith Lakes Scheme – Flood Infrastructure Concept Design*, prepared for Penrith Lakes Development Corporation, Version 2, May. (Section 6 of the Application).
- Cardno (2010). *Two Lake Scheme Alternative Flood Analysis,* prepared for Penrith Lakes Development Corporation, November 2010. (Section 6 of the Application). *Prepared as an addendum to Lakes Scheme – Flood Infrastructure Concept Design*.
- Cardno (2010). *Penrith Lakes Scheme – Concept Flood Drainage Design*, prepared for Penrith Lakes Development Corporation, Version 2, May. (Section 4 of the Application).
- Cardno (2010). *Two Lake Scheme Alternative Flood Drainage Assessment,* prepared for Penrith Lakes Development Corporation, November. (Section 4 of the Application). *Prepared as an addendum to Lakes Scheme – Flood Infrastructure Concept Design*.

5.3.2 Existing Environment

A detailed description of the flooding behaviour in the area, both prior to the quarry and after the construction of the Lakes Scheme, is provided in Section 6 of the Application.

5.3.3 Potential Impacts

The design of the proposed drainage pipe has been undertaken to ensure a minimal impact on the hydraulics of the Nepean River. The main influence to the Nepean River will be through two components:

- The proposed dissipative structure; and,
- The reinstatement of the riverbank.

The proposed dissipative structure, which is a box style dissipator, would be located adjacent to the waterway area of the Nepean River. To minimise its impact on the River hydraulics, this structure will be partially buried into the riverbank (refer Section 5 of the Application). As such, it is not expected that this structure will have a significant impact on the river hydraulics.

It is recommended in the proposed design (Sections 4 and 5 of the Application) that the bank be reinstated in a similar geometry to its current form. A steepening of the bank may result in a decrease in overall cross sectional area of the river, and hence impact on the overall hydraulics. However, this is expected to be unlikely to occur given the current grades of the riverbank.

It should also be noted that the proposed Lakes Scheme will result in a reduction in peak flood levels in the vicinity of the outlet in the order of 0.5 metres in a 100 year ARI event. Therefore, any minor changes to the river hydraulics in the vicinity of the outlet are unlikely to adversely affect the peak flood levels.

5.3.4 Proposed Mitigation Measures

It is expected that there will be minimal impacts as a result of the proposed pipe outlet. However, the following mitigation measures are proposed:

Following detailed design, any changes to river cross section or obstruction as a result of the dissipative structure should be reviewed in light of the potential impacts on peak flood levels by a suitably qualified hydrologist.

5.4 Aboriginal and Non-Aboriginal Heritage

5.4.1 Aboriginal Heritage: Existing Condition

The Penrith Lakes Scheme has been in operation for approximately 20 years. Archaeological surveys, monitoring and assessment have been and continue to be undertaken in respect of the Scheme.

The majority of the archaeological surveys, monitoring and assessments have been conducted by Dr Jim Kohen on behalf of the Penrith Lakes Development Corporation, and were summarised by Kohen in 1997. The archaeological work is ongoing.

Archaeological assessments conducted by Kohen as part of the Penrith Lakes Regional Environmental Study (Dept. of Environment and Planning, 1984) identified 31 sites within and around the Penrith Lakes Scheme. Since that time many additional sites have been identified. **Table 5.10** summarises the sites identified prior to Kohen's work and sites identified by Kohen in the area.

Table 5.10: Aboriginal Heritage Sites Located in and Around the Study Area

AHIMS No.	Site Name	Site Type
45-5-0054	Shaws Creek K1 Hawkesbury Lookout	Rock engraving and shelter with deposit
45-5-0056	Upper Castlereagh	Axe grinding groove
45-5-0206	Shaws Creek K1	Axe grinding groove and shelter with deposit
45-1-0219	Penrith Lakes 39	Open camp site
45-5-0278	Shaws Creek K1	Open camp site
45-5-0279	Shaws Creek K2	Open camp site
45-5-0280	Castlereagh South	Axe grinding groove and open camp site
45-5-0281	Cranebrook Creek 1	Contact, Mission, open camps site

AHIMS No.	Site Name	Site Type
45-5-0282	Upper Castlereagh	Open camp site
45-5-0284	Castlereagh 2	Open camp site
45-5-0314	Penrith Lakes 28	Open camp site
45-5-0315	Penrith Lakes 1	Open camp site
45-5-0316	Penrith Lakes 2	Open camp site
45-5-0317	Penrith Lakes 3	Open camp site
45-5-0318	Penrith Lakes 4	Open camp site
45-5-0319	Penrith Lakes 5	Open camp site
45-5-0320	Penrith Lakes 6	Open camp site
45-5-0321	Penrith Lakes 7	Open camp site
45-5-0322	Penrith Lakes 8	Open camp site
	Penrith Lakes 9	Isolated Find
45-5-0323	Penrith Lakes 10	Open camp site
45-5-0324	Penrith Lakes 11	Open camp site
45-5-0325	Penrith Lakes 12	Open camp site
	Penrith Lakes 13	Isolated Find
45-5-0326	Penrith Lakes 15	Open camp site
45-5-0327	Penrith Lakes 16	Open camp site
45-5-0328	Penrith Lakes 17	Open camp site
45-5-0329	Penrith Lakes 18	Open camp site
45-5-0330	Penrith Lakes 19	Open camp site
45-5-0331	Penrith Lakes 20	Open camp site
45-5-0332	Penrith Lakes 21	Open camp site
45-5-0333	Penrith Lakes 23	Open camp site
45-5-0334	Penrith Lakes 24	Open camp site
	Penrith Lakes 25	Artefacts and axe-grinding grooves
45-5-0335	Penrith Lakes 26	Open camp site
	Penrith Lakes 28	Open camp site
45-5-0366	Emu Plains 4	Open camp site
45-5-0371	Fire Trail 1	Open camp site
45-5-0372	Black Falls 1-6	Open camp site
	Shaws Creek K1	Rock shelter
45-5-0518	Shaws Creek K2 area, Springwood	Open camp site
45-5-0520	Castlereagh South 1, Springwood	Axe grinding groove; open camp site
45-5-0530	Upper Castlereagh 1, Penrith	Open camp site
45-5-0589	Penrith Lakes 29	Open camp site
45-5-0590	Penrith Lakes 30	Open camp site
45-5-0591	Penrith Lakes 31	Open camp site
45-5-0592	Penrith Lakes 32	Open camp site
45-5-0593	Penrith Lakes 33	Open camp site
	Penrith Lakes 34	Open camp site
	Penrith Lakes 44	Open camp site
	Penrith Lakes 45	Open camp site

AHIMS No.	Site Name	Site Type
	Penrith Lakes 46	Open camp site
	Castlereagh 1	Open camp site
45-5-2414	Penrith Lakeside Village L1	Open camp site
45-5-2416	Penrith Lakeside Village	Open camp site
	VC/1 (Vincent Creek 1) This site was recorded in 2004 as an extension of PL33	Scarred tree and artefact scatter (6 artefacts)
	Camenzuli 1	Open artefact scatter
	PL47	Open artefact scatter
	PL48	Open artefact scatter
	PL49	Open artefact scatter
	PL50	Open artefact scatter
	PL51	Open artefact scatter
	PL52	Open artefact scatter
	Cranebrook Escarpment (CE) 1 & 2	Open artefact scatter

Kohen (1997) noted that sites that occur within the Penrith Lakes area are particularly likely to occur adjacent to the rivers and creeks. Kohen (1997) also identified that all artefacts located within the Penrith Lakes area are significantly younger than 40,000 years old and the vast majority are less than 4,000 years old.

Additional surveys and excavations were undertaken by Comber (2006 & 2007) which confirm the previous analysis that sites would be more likely to be located adjacent to the River and to creeks. They also confirmed the significance of the archaeological resource at Penrith Lakes.

No records of aboriginal items occurring within the proposed works site have been identified in previous studies, or are recorded within the DECCW AHIMS registry.

The study site is an area which has previously been disturbed through agricultural activities (e.g. installation of a pump), historic river quarrying, and river slumping. Sites such as scarred trees or middens may have existed within the area. However, previous disturbance would likely have ensured such sites no longer exist.

5.4.2 Aboriginal Heritage: Potential Impacts

As there were no Aboriginal objects or places recorded within the works area, it is highly unlikely that the works will have any impact upon items of indigenous significance. However, given the abundance of aboriginal items located elsewhere within the Penrith Lakes Scheme it is acknowledged that excavation works may uncover new items.

5.4.3 Aboriginal Heritage: Proposed Mitigation Measures

Due to the level of disturbance at the site it is not anticipated that any sub-surface deposits will be located within the study area. Therefore, there are no objections on Aboriginal archaeological grounds, to the proposed works at the site. It is not considered necessary to conduct any further monitoring or subsurface testing.

An existing Aboriginal Heritage Impact Permit (AHIP: 2595) currently exists for the majority of the DA4 area. This permit is currently subject to an amendment application submitted to the Department of Environment, Climate Change and Water (DECCW) to include the study site.

Mitigation measures (**Table 5.11**) will be applied in accordance with the permit requirements.

Table 5.11: Aboriginal Heritage Mitigation Measures

Development Stage	Description of measure
Construction	Subject to approval of amendment to the existing AHIP (ref: 2595), all works will be undertaken in accordance with the mitigation and management measures outlined as part of the AHIP and PLDC heritage conservation plans.

5.4.4 Non-Aboriginal Heritage: Existing Environment

A Non-Aboriginal archaeological and cultural heritage assessment of the proposed pipe discharge site was conducted by Godden Mackay Logan (GML) Consultants (**Appendix C**). The assessment was undertaken in accordance with the principle of *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance 1999*, is consistent with NSW Heritage Manual (NSW Heritage Office, 1996) and incorporated:

- Data Review: A review of existing relevant information including a search of local, state, and national heritage registers;
- Field Survey: Site archaeological survey involving identification of any Non-Aboriginal objects, sites, or places within either of the proposed sites; and
- Heritage Impact Assessment: An assessment of the potential impacts from the proposed works upon any heritage items identified by the data review and field survey.

The Castlereagh Plains have a significant place in the non-Aboriginal settlement and development of Sydney Basin. Starting from around 1800 the PLDC area has been utilised for either agricultural or quarrying purposes. Numerous small scale agricultural land holdings and quarries were established to source the raw materials for the rapid growth of Sydney and Parramatta. In particular, quarrying (both directly from the Nepean River and the gravel/sand soils of the PLDC areas) expanded during the first half of the 20th century to meet construction needs (e.g. Yarramundi Quarry). The Penrith Lakes Development Corporation has managed the operation of quarries within the area since 1979.

Given this history it is considered highly likely that non-aboriginal heritage items may occur within or surrounding the proposed works locations. It should also be noted that more recent events of cultural significance (e.g. hosting of events as part of the Sydney 2000 Olympics) have occurred in the proximity of the site which should be taken into account.

Searches of relevant local, state and national databases indicate a number of heritage listed items within the general PLDC area, including:

- Upper Castlereagh School and Residence;
- Hadley Park;
- Nepean Park;
- McCarthy's Cemetery;

- Upper Castlereagh Methodist Church and Hall;
- Upper Castlereagh Methodist Cemetery;
- Ruin of stone stables associated with Landers Inn;
- "Puddledock" slab cottage;
- Church Lane Farmhouse, garden and natural vegetation;
- Ruins of pise house;
- The site of Fulton's Church School;
- McCarthy's Farm, tree and archaeological remains;
- "The Poplars" slab cottage, pise house and garden;
- Upper Castlereagh war memorial;
- The Castlereagh Area (comprising floodplain, Upper Castlereagh and the township of Castlereagh); and
- Castlereagh Road upper room chapel, hall and cemetery.

None of these sites are located within 500m of the proposed work site location.

In order to help preserve these items, as well as other items considered of cultural or environmental value PLDC has established its own "conservation zones" to assist in the protection of these items (**Figure 2.1**). The proposed works will occur within the riverbank voluntary conservations zones.

The history associated with the proposed works area (lot and DP: 1 / 63308 and 421 / 1130185) is not well documented. Located on the border between land grants issued to D. Kennedy and R. Smith in 1803 (Karskens, 2007) it is considered likely a mixture of agricultural and quarrying activities were conducted within these lots.

Field survey undertaken at the study site identified only one item of interest, a small timber walkway, with cut steps lined with timber proceeding down the bank to the Nepean River. It is likely that these features relate to a pump servicing local farms in the early 20th century. These features are not considered to be of heritage significance.

Previous studies have indicated the presence of a historical winch to the north of WLN, but its precise location was unable to be determined during site inspections.

5.4.5 Non-Aboriginal Heritage: Potential Impacts

It is considered that the proposed works at the proposed pipe outlet locations will not impact upon any items of heritage significance. The wooden steps and race observed at the site is not listed a heritage item and would not be considered of significance. No other items relating to non-aboriginal settlement of the area were observed at the proposed works site.

Given the known utilisation of the area it is recognised that the proposed works may uncover currently unknown heritage items.

5.4.6 Non-Aboriginal Heritage: Proposed Mitigation Measures

No items of significance were identified at the sites. Should any archaeological remains be discovered within either of the worksites during construction, works should cease and an

archaeologist be called in to assess the finds. In addition the local Aboriginal land council, Heritage Council of NSW and DECCW shall be notified of the find.

All contractors and subcontracts should be made aware of the sites' potential archaeological significance and the appropriate response actions in the event of discovery.

5.5 Soils, Sediment and Erosion

5.5.1 Existing Environment

The region surrounding the study site is primarily based upon fluvial sediments typical of the Nepean and Hawkesbury rivers. The soils are a mixture of yellow podzolic soils, and brown earths interspersed with clay loams and sands. Such soils typically represent moderate erosion hazards and tend to promote flooding due to the dispersible and impermeable subsoils (Hazelton et al. 1989).

It is considered unlikely that any acid sulfate soils occur in the area (Land and Water Conservation, 1997).

Coffey Geotechnical undertook an initial site investigation to assess the ground conditions in the vicinity of the proposed pipe. The full investigation report is contained in Appendix A of the design report (Cardno, 2010a); however in summary the investigations found the following:

- The soils encountered generally comprise topsoil overlying 1.3m of Silt.
- Underlying the silt was approximately 3.5m of very dense, sandy gravel with many cobbles (Primary Raw Feed or PRF).
- The RL at the ground surface was 8.8mAHD and the top of the PRF was at RL7.3mAHD.
- The PRF became wet from approximately RL6.6mAHD.
- Sandstone bedrock was encountered at RL3.8mAHD.

5.5.2 Potential Impacts

The river bank at the outlet location is steep, typically in the order of 50% (1 Vertical: 2 Horizontal). Re-compaction of the bank at the same slope after trenching to lay the discharge pipe will present difficulties in stabilizing the surface. If the backfilled trench is finished at a flatter slope is will leave a "gully" that may act as a point of concentrated runoff and/or a discontinuity in the bank alignment that under high river flood conditions may cause eddying and scouring of adjacent sections of the bank.

It is noted that there is a risk of flooding during the construction works. **Table 5.12** provides the peak flood levels for different recurrence intervals in the vicinity of the preferred outlet location. The Nepean River bed level is at approximately 3 mAHD and the river bank is up to 20 mAHD at some locations within the study area, as such there would be a significant are of exposed bank during construction which would be at risk of erosion should a flood event occur.

Table 5.12 Peak Flood Levels (m AHD)[1]

Location	10 year ARI	20 year ARI	50 year ARI	100 year ARI
Wildlife Lake North	16.1	18.0	19.5	20.8

[1] These results are based on the base case scenario, as defined in the calibration report (Cardno, 2010c).

An assessment of the discharges and velocities occurring at the outlet of the pipe identified the need for energy dissipation. This analysis demonstrated that without energy dissipation there is the potential for a scour hole to form at the Wildlife Lake in the order of 23 – 35 metres in length and 10 – 15 metres in width per pipe ignoring overlapping widths. Details of the scour calculations for the pipe without dissipation measures are provided in Appendix C of the design report (Cardno, 2010a).

If a scour-hole in the riverbank is allowed to form, the result would be the deliberate adding of sediment to the river which is against government policy (*In-stream Works*, February 2008) and the *Water Management Act 2000*. In addition to the sediment released from the scour-hole, a period of river instability may be initiated that could result in the further enlargement of the scour hole and possible undermining of the river bank.

5.5.3 Proposed Mitigation Measures

The potential problems of post construction bank stability may be minimised by gentle contouring of the river bank adjacent to the backfilled trench and/or the employment of a soil confinement mat laid over the final surface plus the use of reinforced earth techniques. This will need to be investigated further in the detailed design phase.

It may be appropriate to stage the construction within the riverbank to limit the flood risk. This should be addressed during both the detailed design and the construction phase of the project. It is recommended that a Flood Emergency Response Plan be prepared for the construction phase of the work. This report may include a flood warning system, which could utilise the water level gauge at the Penrith Weir.

Measures will be required to prevent scouring at the pipe outlet. Detailed consideration of potential scour protection works was undertaken as part of the design report (Cardno, 2010a). Based on a consideration of the advantages and disadvantages and cost of the alternative outlets it was recommended that a baffle dissipator be provided at the river side outlet for the proposed pipe. The structures presented in the design report (Cardno, 2010a) report are based on the USBR Type VI dissipator.

5.6 Minor Impacts

5.6.1 Contaminated Land

Assessment Methodology

A Phase 1 (non-intrusive) Contaminated Land Assessment was undertaken for the proposed pipe development site. The potential for contamination to be present at the site was assessed by undertaking a review of available historical information, site inspection and interviews with on-site environmental staff.

The proposed works cover several land parcels as listed in **Table 5.13**.

Table 5.13: Land Parcels affected by the proposed works

Work Site	Lot and DP (Lot/DP)
WLN	1 / 63308
	421 / 1130185

Historical information obtained for the purpose of the Phase 1 assessment included title deeds, aerial photography, contamination regulatory notices, and a search of groundwater bore usage. Council records obtained under the Freedom of Information Act and WorkCover historic records on the storage of Dangerous Goods were not accessed. Given the findings of the Non-Aboriginal Heritage assessment (**Section 5.4.5**) it is not anticipated that these documents would identify significant sources of historic contamination within these sites.

The site inspection and interviews were conducted over two days and involved guided walk-over by site employees during which time detailed observations of existing landforms and any evidence of contamination or potential indicators/sources were made.

Existing Environment

The results of the historic searches describing the present contamination risk across the four work sites are summarized in **Table 5.14**.

Table 5.14: Historic Use and Risk of Contamination

Search	Land Use	Likelihood of Existing Contamination
Historic and Current Title Deeds	A search of historic title deeds provided under the NSW LMPA General Register of Deeds indicates there has been a long history of agricultural practices in the broader area since 1803. Early agriculture predominantly consisted of wheat and maize. Mills were established along the river site to grind wheat and corn. A fruit and dairy industry developed from 1850 – 1950. Quarrying in the area occurred from the 1890's (using wet extraction at first). Quarrying gradually expanded eventually booming in the 1960's.	Low: The agricultural practices and quarrying practices are considered unlikely to have contaminated the work sites included in this assessment due to their proximity to the river, and the nature of the open-cut quarrying works undertaken.
Aerial Photography	Historic aerial photography (1978, 1985, 2006, 2007) demonstrates the progressive replacement of agricultural lands with quarrying. The aerials demonstrate that existing fence lines are largely unchanged to those described in the 1803 agricultural land grants.	Low: No potential contaminating structures were identified from aerial photography.
DECCW Contaminated Land Register	A search of the DECCW Contaminated Land Register identified only seven sites of contaminated land within the Penrith LGA. None of these sites occurred within 5km of the proposed work sites.	Low: Given the extent of existing quarry works and distance between the proposed sites and the identified contaminated areas it is unlikely any contamination from offsite would have migrated to the work sites.
Groundwater Bore Usage	A groundwater bore search of the DECCW groundwater database was conducted. 112 current and historic groundwater bores identified within a1 km radius of the quarry site. This represents a significant number of bores.	Low: A high presence of functional bores indicates the presence of existing Contamination is unlikely.

These historic database searches indicate the likelihood of existing contamination from historic sources being present on site is low.

Staff interviews and anecdotal evidence suggests that discarded materials may be present on site. In particular it is understood that PLDC have previously encountered and removed materials including old asbestos pipes and old farming tips.

At the site, inspection showed evidence of at least partial historic clearing (most likely during agricultural phases) and relatively little further disturbance. Examination of soil profiles where naturally visible did not indicate any evidence of contamination. Similarly neither the extant terrestrial vegetation nor the adjacent aquatic vegetation suggested the presence of any subsurface contamination.

Given the known land-uses of the area any existing contamination would have to have come from migration from external sources (i.e. the quarry) or minor local contamination events (i.e. chemical spills or localised tipping). Given the results of the historic database searches it is considered that the most likely contaminants that may be found on site include:

- Asbestos;
- Petroleum Hydrocarbons; and
- Polycyclic aromatic hydrocarbons.

During the site inspections quantities of scattered debris were discovered on site. Consultation with staff indicates that this is most likely a result of river debris deposited during flood events. Debris largely consisted of plastics and non-degradable disposable items and clothing; it is unlikely these items would lead to contamination of the site. **Section 5.4** indicates that it is likely that some objects relating to the original agricultural settlement of the area may be found within the study site. Any subsequent contamination from such sources is likely to be highly localised. It is considered unlikely that this debris would lead to significant contamination events.

Based on the identified site history a Phase 2 (intrusive) Contaminated Land Assessment is not considered necessary as part of the proposed works.

Potential Impacts

It is considered unlikely that any significant contaminants exist with the site and therefore it is unlikely that the proposed works will disturb any existing contamination. Riparian flood debris was found to be present, however, there is no evidence that these materials have led to gross soil or groundwater pollution. It should be noted that disturbance of debris (e.g. wire and plastic) may lead to the injury or death of wildlife.

The nature of the proposed works is such that the risk of contamination events occurring as a result of installation or operation of the pipe is low. Potential sources of future contamination identified include:

- Petrol and oil spills associated with construction materials;
- Construction run-off and pollutants (i.e. concrete);
- Fertilisers and pesticides utilised during weed control and site rehabilitation; and
- Migration of contaminants from off-site (i.e. from the quarry).

Given the proximity of the sites the Nepean River it is important to ensure no contaminants pass into the river system.

Mitigation Measures

In order to ensure any potential impacts are minimized during construction and operation a Construction Environmental Management Plan (CEMP) should be developed, which incorporates a Spill Management Plan and all construction staff should be made aware of their responsibilities and the procedures to be followed under a spill event. In particular it is recommended that:

- All refuelling is undertaken in appropriate and designated areas;
- No construction equipment is stored within the riparian zone;
- The site works manager shall consider the potential for flooding events during construction;
- Application of fertilizers and pesticides shall not occur during rain events;
- No fuel or oil should be stored within the construction zone;
- An appropriate spill kit should be maintained at each of the work sites.

Should any contaminants be encountered during construction earthworks, works shall halt until a further contamination assessment has been undertaken.

Debris found on site should be removed and disposed of appropriately prior to the onset of works.

5.6.2 Air Quality and Dust

Existing Environment

The Penrith LGA represents a diverse mix of low to high residential land as well as light to heavy industrial and commercial uses. A search of the National Pollutant Inventory Emission Report (2008) indentifies that Fabricated Metal Product manufacturing and other basic manufacturing processes are the greatest contributors to air pollution within the Penrith LGA.

It is noted that the regional air quality within Penrith is strongly influenced by air quality and emissions associated with the wider Sydney basin in addition to local emissions. The 2007-2008 Penrith City Council Annual Report indicates air quality within the LGA to be of a reasonably high standard, with some evidence of a reduction in the frequency of air quality criteria exceedance over the past 6 years. Under RAQI guidelines 7 exceedances were observed in 2008 (PCC, 2008).

Locally, the air quality is influenced by pollutants and dust emissions associated with the operation of the Penrith Lakes quarry. The quarry maintains strict air quality and dust management systems in accordance with DECCW requirements.

Potential Impacts

Minor emissions likely to be produced as a result of the proposed works include:

- Dust as a result of earthworks; and
- Exhaust emissions associated with construction vehicles and machinery.

No emissions are expected to be associated with the proposed works following construction.

Given the scale and nature of the proposed works in comparison to those of the quarry it is considered unlikely that the works will significantly affect ambient local air quality levels.

There are no sensitive receivers within 500m of the proposed work location.

Mitigation measures

In order to ensure any potential impacts are minimised a site Construction Environmental Management Plan (CEMP) should be developed which specifies appropriate mitigation measures. These will be in accordance with the Penrith Lakes quarry dust environmental management plans where appropriate. As a minimum it is recommended that:

- Scheduled regular visual inspections of weather conditions and dust levels are conducted in accordance with the site CEMP;
- Work is to cease during periods of very strong winds (above 40km/hr) unless dust can be suppressed by water carts;
- Dust suppression techniques should be regularly applied to any exposed surfaces and stockpiled materials;
- The work shall be scheduled so to minimise duration of construction activity and time to revegetation establishment; and
- Regular servicing of construction equipment and vehicles shall be undertaken to minimise exhaust emissions.

5.6.3 Hazards and Risks

Several potential hazards will occur as a result of the proposed pipe works. However, most hazards would only be realised during the construction phase while long term hazards are expected to be insignificant, as the pipe is planned to be installed underground. The types of hazardous risks, a description, and possible mitigation measures are tabulated in **Table 5.15.**

Table 5.15. Risks and Mitigation Measures

Hazard Risk	Description	Control/ Mitigation measure
Vehicle movements	Construction workers have to enter the quarry to access the proposed sites. The quarry sites are currently active, and as a result, pose several hazards to the pipe construction workers who are required to manoeuvre different types of heavy machinery (Excavators, Trucks, Bobcats, etc.). This will alter traffic volumes within the quarry site and potentially increase hazardous risks to the quarry workers	A quarry induction is essential for all construction workers. In addition, all workers required to drive into the active quarry should undergo a driving induction test organised by PDLC so they become familiar with all quarry roads or be escorted into and out of the quarry by qualified personnel, be made aware of roads not clearly defined, learn how to operate UHF radios. Current road maps of the quarry site should be provided if possible. Quarry site workers should also be made aware of changed traffic conditions as a result of the proposed works
Changing roads	Roads within the quarrying site are not clearly defined and have the potential to mislead construction workers	All contractors required to drive through the quarry should be informed of any unclear roads through driving permits or are to be escorted.
Treefelling	Felling of trees may pose a hazard to construction workers on site	All treefelling activity must be undertaken by suitably qualified and competent personnel.
Topography	Movement of heavy machinery in relatively steep terrain along the riverbank poses hazards	Contractors should not drive beyond their vehicle limits.
Slumping	Digging of deep trenches has potential for slumping at the verges, especially if heavy machinery travels alongside the trenches	All workers operating heavy machinery should maintain a sufficient distance from the verge. Adequate signage and bunding to be installed at the top of the high face to prevent vehicles coming too close to the trench.
Falls	Contractors working close to the edges of the trench have the risk of falling in	All workers should keep sufficient distance away from the verge. Adequate signage (e.g., warning/caution tapes) is required.
Bushfires	The narrow strips of riparian vegetation increases the chances of bushfire risk, especially as the groundcover is covered by dense grasses indicating high fuel loads	All workers should be made aware of the possibility of bushfires, and an appropriate evacuation programme should be planned prior to the commencement of works. Smoking should be restricted to designated areas, where the potential for fires is highly unlikely.
Animal attack	Presence of venomous snakes, spiders and feral fauna such as pigs pose a threat to construction workers	It is essential that all contractors have access to a First Aid Kit and at least one worker on site has passed the quarry driving induction and has access to a vehicle in the case of emergencies. It is preferred that all workers on site have attended an up-to-date First Aid training course. All workers will be able to contact their supervisor and PLDC in case of emergency.

Hazard Risk	Description	Control/ Mitigation measure
Intense rain	Intense rainfall may accelerate slumping effects on the trench and the general riverbank, or make driving conditions dangerous	Limit works if conditions become hazardous.
Drowning / Entrapment	The pipe/ dissipation structure may pose a risk of workers falling in during construction or for individuals becoming entrapped/drowned during operation.	Adequate signage will need to be provided alerting the public to the presence of the pipe and prohibiting public access.

5.6.4 Landscape and Visual Impact;

Existing Environment

The proposed works will occur in a riparian strip of vegetation bounded to the west by the Nepean River, and to the east by the quarry. Riparian vegetation extends north and south of the proposed sites. There is a single residence located approximately one kilometre north-east of the site. Continuous residential property occurs to the east of the quarry site, and is approximately a minimum of two kilometres away from the proposed work sites.

Potential Impacts

The location of the site limits public access to the proposed works area, and only the few recreational users (e.g., small water vessels, fishing, kayakers) of the Nepean River would be visually exposed to the proposed site, while travelling along the river. Consequently, the proposed works would not have significant impacts on the visual amenity of the area.

In the wider context, the associated quarry site is physically of a much larger scale than the proposed works and the disturbance from the quarry represents a much more significant visual impact. In the long term, installation of the pipe is required to allow the sustainable function of the proposed Lakes Scheme which will have a high visual and aesthetic value. In addition, the rehabilitation of native species typical of an intact native forest will potentially improve the visual appearance of the works area in comparison to the current vegetation which is highly degraded by weed infestation.

Localised and short-term visual impacts as a result of the proposed works include:

- The removal of trees and groundcover vegetation;
- Presence of deep trenches;
- Fencing and signage during the construction process;
- Presence of heavy vehicles and equipment on site;
- Rubbish and waste material; and
- Discharging ends of the pipe and dissipation structures on the Nepean Riverbank (long term).

Mitigation Measures

The approximate duration of construction is likely to be between three to six months, after which rehabilitation with overburden material blending with natural contours and revegetating with native flora species is proposed. In the long term, the main body of the pipe would only be present underground and the end of the pipe and associated dissipation

structures would be the only visible structures. Dissipation structures would be visible at the outlet of the pipe.

Any rubbish or waste material as a result of the proposed works should be removed and disposed of correctly, as frequently as possible. After completion of works, all machinery, fencing, and unnecessary signage is expected to be removed from the site as soon as practicable.

5.6.5 Land Use Impacts

Current land uses surrounding the proposed works area include quarrying and agriculture practices towards the east, and potential hikers in the Blue Mountains Nature Reserve across the River to the West. The proposed site exists in a remaining riparian strip of vegetation aligning the riverbank. The proposed work site is expected to disturb a maximum area of 500m². The pipe will be installed underground and trenches will be refilled with soil and contoured to blend with the surrounding riverbank slope. Revegetation will follow to represent species composition which resembles the original pre-disturbance community type.

In the long term, no significant land use impacts are expected and the works will not affect any neighbouring land uses. The sites are not currently publically accessible by land and as such will not impact upon any potential land uses in the short term.

5.6.6 Noise and Vibration Impacts

Existing Environment

The proposed works area exists within a narrow riparian strip of vegetation, bounded to the west by the Nepean River and to the east by the quarry. Existing background noise and vibration sources include heavy machinery operating within the active quarry. The noise levels were observed to be low to medium during site inspections.

There are no sensitive receivers within 500m of the proposed work sites.

Potential Impacts

The proposed works would result in some intermittent noise and vibration. Sources of noise during the construction phase would be in the form of excavators, graders, bobcats and other heavy vehicles used to clear vegetation, dig trenches, align and install the pipe and dissipation structures. However, it is important to note that the noise and vibration from the proposed works are not considered to be significant compared with the existing background noise and vibration levels from the quarry. In addition, noise and vibration impacts as a result of the proposed works are only expected to be present for the short term during the construction phase.

The most sensitive noise and vibration receptors are the quarry workers followed by the residence located approximately one kilometre north-east of the site, and the occasional, infrequent recreational user of the Nepean River. These receptors are already exposed to background noise levels associated with the active quarry site. Residents to the east of Castlereagh Road are unlikely to be affected since they are approximately two kilometres away from the proposed work site. As a result, the additional noise impact arising from the proposed works is expected to be negligible to all receptors.

Mitigation measures

Although the likely impacts associated with noise and vibration from the proposed works is considered to be negligible, it is still recommended that noise mitigation measures should be included in a Construction Environmental Management Plan (CEMP). Mitigation measures should consider:

- Limiting the proposed works to the approved working hours of the quarry; and
- Maintain all equipment used on site to standards maintained within the quarry.

5.6.7 Social and Health Values;

The proposed works would not have significant negative impacts on social and health values of the area, especially considering that there is no public access to the proposed site from the land. On completion of the works, the only visible remains of the works will be the outlet of the pipe since the pipe will be overlayed with soil and blended to adjacent riverbank contours.

However, in the long term, the works are expected to lead to an improvement of social and health values by enabling the creation and operation of the lakes and open space as part of the Penrith Lakes Scheme. This will provide improved recreational opportunities for residents residing in Western Sydney.

5.6.8 Traffic Impacts/Access and Accessibility;

Existing Environment

Castlereagh Road is the largest arterial road near the proposed works, and is predominantly a north-south route serving the suburbs of Penrith, Cranebrook, Castlereagh, and through to Richmond. The existing road network is displayed in **Figure 5.2**. Old Castlereagh Road has been discontinued north of the International Regatta Centre.

Access to the proposed work sites would involve travel within the quarry using the quarry's network of unsealed roads.

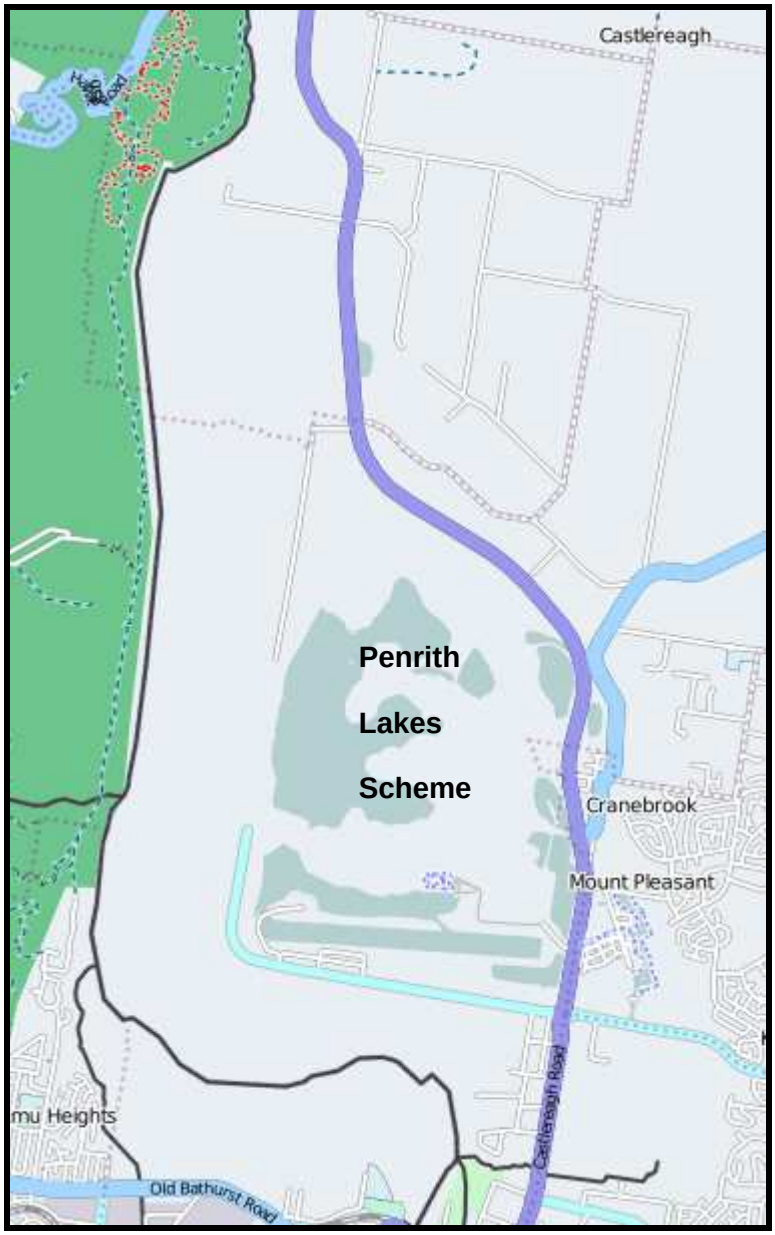

Figure 5.2. Existing road network surrounding the proposed works site (Google Maps, 2010)

Potential Impacts

A range of vehicle types would be required for the proposed works, including excavators, trucks, dump trucks, bobcats etc. Local traffic network volumes may marginally increase along major roads (Castlereagh Rd, Old Castlereagh Rd) to provide contractor access. This impact would be restricted to the construction phase period. It is noted that the local road network is currently regularly used by heavy vehicles accessing the quarry site, and that junctions and access routes are suitable for heavy traffic and large vehicles.

Within the active quarry site, there will be minor changes in internal traffic volumes resulting from construction workers entering the quarry premises to access the proposed sites.

Mitigation measures

On site vehicle traffic will be required to comply with the existing traffic rules of the site which includes:

- Site driver training;
- Minimum vehicle requirements;
- Radio network; and
- Sign in/sign out procedures.

The quarry maintains its own strict traffic management plan and procedures. The vehicle movements associated with the proposed works would be considered part of quarry activities and subject to their requirements.

5.6.9 Utilities and Infrastructure

Site inspections and consultation with PLDC has confirmed that no significant utilities are present at the proposed work sites. A fence surrounding the premises of the quarry does exist, and a small portion would need to be removed to accommodate the trench and for access of heavy vehicle machinery on to the riverbank. It is expected that the fence will be reconstructed following completion of the works. A Utilities Management Plan which includes the accurate locations of utilities in the general area is to be prepared by the contractor and should be incorporated in a CEMP. It is expected the contractor will have responsibility for inspecting the site to locate the presence of any utilities nearby.

5.6.10 Waste Materials and Management

Prior to the commencement of works, a Waste Management Plan should be developed as part of a CEMP. The plan should specify suitable locations and appropriate disposal methods for excess soil or rock material, where the material cannot be re-used. It is expected quarry waste management procedures will be appropriate for use during the proposed works. Coordination with the quarry will be required to manage overburden / fill storage and provision. Any other forms of rubbish and waste material present on site are required to be disposed of in the correct manner, as frequently as possible.

An Erosion and Sediment Control plan should be developed as part of the CEMP, and should take into account methods to prevent erosion of stockpiled material. It is not expected that the digging of trenches would generate substantial amounts of excess material, since the dug-out soil material would be ultimately required to refill and compact the trenches. It is expected that the clear-felled logs of native trees would not be disposed and returned post-filling to provide suitable habitat for ground-dwelling fauna. The cleared understorey vegetation can be returned post-filling as a source of mulch for the revegetation programme.

5.6.11 Water Quality Impacts

Existing Environment

Limited public data is available in regards to water quality in the Nepean River adjacent to Penrith Lakes. However, the Aquatic Ecology Assessment (Appendix B) reports water quality conditions at a number of sites along Nepean River. Conductivity and pH were within the ANZECC threshold limits (Table 3, Appendix 3 in Appendix B) for the protection

of lowland rivers of southeast Australia. Turbidity levels were marginally less than the lower ANZECC threshold limits. The dissolved oxygen was considerably lower than recommended levels.

Short-Term Impacts

The installation of the pipe and dissipation structures on the riverbank will involve digging trenches, and works may extend a short distance into the Nepean River. There is expected to be a short term reduction in the surrounding water quality of the river as a result of the disrupted sediments, creating an increase in turbidity levels and an alteration of sedimentation processes occurring within the water column. However, it is anticipated that disturbance will be limited to only a very minor section of the Nepean River, and the increase in turbidity levels is not expected to extend considerable distances. In addition, the slow flow/ movement of water observed during site inspections will limit the extent of sediment movement along the river.

Increased turbidity levels would impact aquatic vegetation and fauna by reducing sunlight penetration for aquatic vegetation and water quality conditions for aquatic fauna. In addition, nutrients which have accumulated over extended periods of time may eventually be released as a result of the disturbance process. However, these impacts are expected to be minimal as riverbank activities are only expected to occur within a small section of the river, and the construction phase is limited to an approximate period of three to six months.

There is the possibility for the accidental spill of chemicals and fuels into the river as a result of the movement of machinery required to carry out the proposed works. There may also be disturbance of contaminated soils or acid sulphate soils, but this is considered extremely unlikely (**Section 5.5.2**).

Long Term Impacts

Physical and chemical characteristics of the proposed lakes within the Penrith Lakes Scheme may differ at times from those of the Nepean River (e.g. there may be algal blooms within the lakes). There is a possibility of lake waters discharging into the Nepean River during either a flood related discharge or a lake catchment flow discharge, and impacts from these distinct events are expected to differ. However, in general it is considered likely that the water quality within the actively managed lake scheme would be higher than that of the Nepean River.

Flooding event discharges from the pipe will be of similar water quality to water within the Nepean River during a flood as the water being discharged will primarily be that which originally came from the Nepean River, overtopping the PLDC site weirs into the lake scheme. River flood and associated discharge events may occur between 10 and 20 year intervals. At these times, turbidity and sediment loads may be elevated above operation catchment discharges. It is noted however that during flood events the dissipation structures will reduce the speed of waters discharging from the pipe out into the Nepean River reducing scour and associated turbidity. It is also noted that turbidity levels in the River during large flood events will be naturally high and the impacts of discharges from the Penrith Lakes scheme are expected to be negligible in comparison.

The operational catchment discharges will be more frequent although at lower volumes and lower outlet velocities. These discharges not will be non-sediment laden as the pipe will

draw water from the top of the lake water profile. Discharges associated with operational catchment flow are also unlikely to lead to nutrient or temperature pollution due to the positioning of the pipe inlets at the top of the water column. However, there is potential for algal populations to spread from the lakes to the river if not appropriately controlled within the Lakes. Control of algal growth will require management as part of the operational Penrith Lakes Scheme management plans.

Mitigation Measures

Several mitigation measures may reduce the possible impacts of the proposed activities on the water quality of Nepean River. A Water Quality Management Plan should be prepared by the contractor to reduce potential disturbance effects on water quality. As a minimum this should include the following mitigation measures:

Short Term

- Minimise the use of heavy vehicle machinery near the edges of the riverbank/ within waters;
- Observe and measure water turbidity levels while conducting the proposed activities along the riverbank/ within waters. Install a sediment boom if required;
- Any temporary stockpiling of soil during construction should be carefully located further away from the riverbank edges, and in an area that would not be exposed to strong winds;
- Activities required to operate closer to the riverbank should be minimised as much as possible and should limit the number of days required for works near the river;
- Prior to vehicles entering the river/riverbank edge, vehicles should be washed down, and petrol and oil tanks should be sealed firmly to prevent oil, chemical or tank spills;
- Cautious driving procedures should be practiced with regards to the steep conditions of the riverbank and the possible chances of collisions; and
- Employment of appropriate sediment and erosion control measures.

Long Term

- Regular monitoring of the water quality condition in Penrith Lakes Scheme is required to ensure that that water quality conditions are not significantly different from that of the Nepean River, especially during periods of high water levels;
- If any visual evidence of algal growth occurs within the immediate vicinity of the inlet/outlet an aquatic ecologist shall evaluate the extent of algal growth and recommend appropriate management strategies as soon as possible; and
- Continued employment of appropriate sediment and erosion control measures.

6 Environmental Management

6.1 Environmental Management Plans

In accordance with relevant legislation and the requirements of this EA, the following sub-plans would need to be created and implemented during the proposed works as constituents of the Construction Environmental Management Plan (CEMP):

- Fauna Management Sub-Plan
- Aquatic Flora and Fauna Management Sub-Plan
- Dust Management Sub-Plan
- Hazards Management Sub-Plan
- Contamination Management Sub-Plan;
- Erosion and Sediment Control Sub-Plan (ESCSP);
- Environmental Health and Safety Sub-Plan;
- Vegetation Management Sub-Plan;
- Waste Management Sub-Plan;
- Water Quality Management Sub-Plan;
- Aboriginal Heritage Management Sub-Plan; and
- Non-Aboriginal Heritage Sub-Plan.

6.2 Monitoring

Monitoring will be undertaken as part of the overall approved works for the Penrith Lakes Scheme in accordance with the tests recording and reporting requirements outlined in conditions 65 – 68 inclusive of the Approval for Development Application 4 (NSW Department of Urban Affairs and Planning, 1998, ref: P97/00237).

7 Conclusions

7.1 Summary of Environmental Safeguard and Management Measures

Environmental safeguards relating to each of the aspects considered in this EA are summarised in **Table 7.1**

Table 7.1: Summary of proposed Environmental Safeguards

Environmental Parameter(s)	Environmental Safeguards and Management Measures
Terrestrial Flora and Fauna	• All mature (native) trees should be retained where possible. • Site selection for discharge locations has considered the relative ecological value of the sites as a factor in decision making. • During construction works, movement of ground dwelling native fauna travelling along the riparian strip will be restricted. To minimise impact, work should be scheduled to minimise duration of the works, and to minimise the length of open trench at any time. • The location of native, mature trees at the selected development site should be made known to construction contractors. All construction machinery should keep a sufficient distance from trees (i.e. outside the canopy drip line) to limit root damage. Protective marking of trees should be considered. • During the vegetation clearing stage, it is recommended a qualified animal handler be present to ensure that any native fauna that may be occupying the area is relocated in a safe manner. • Establish a Fauna log recording any significant species observed on site during construction. Where fauna is observed, works shall cease until the animal moves from the area or a qualified animal handler can remove it from the site. • Logs from felled native trees should be returned post-construction to provide suitable habitat for ground-dwelling fauna in preference to being sent off site for disposal. • Wherever possible, the cleared understorey vegetation should be utilised post-construction as a source of mulch for the revegetation programme. • A weed management plan must be employed to limit colonisation of the disturbed areas by weeds. Where possible, this should include weed removal of the surrounding areas. This is considered to be important in the context of the broader Penrith Lakes Scheme. • A Vegetation Management Plan should be prepared to assist rehabilitation and restoration works following pipe installation. This should aim to reinstate a stable landform that supports a native plant community which resembles the pre-disturbed, original forest (the Riverflat Eucalypt community).

Environmental Parameter(s)	Environmental Safeguards and Management Measures
Aquatic Flora and Fauna	The following measures would need to be incorporated in the CEMP: **Sediment Mobilisation**: • Erosion and sediment controls measures such as bunding, silt fences/curtains, sediment basins/ponds and drains. These measures should be able to operate effectively during high rainfall events. • If coffer dams are used for works within the wetted width of the Nepean River channel, the coffer dam should be designed so that it has minimal impacts on geomorphology and hydrology of the Nepean River and should be surrounded by a sediment curtain. • Clean water should be diverted around disturbed areas. • Runoff from disturbed areas should be diverted into erosion and sediment controls. • The area and duration of exposed unconsolidated soils should be minimised. • Revegetation and restoration of disturbed areas should take place as quickly as possible. Erosion and sediment control measures should be in place to treat run-off from these areas until adequate cover is established. • Fish passage should be considered where silt fences/curtains may be positioned across waterways. A permit may be required for works that require temporary blockage of fish passage. **Pollution** • Undertake regular inspections of work practices. • Staff should be appropriately trained in the correct handling, storage, transport and disposal of hazardous substances as required as part of their works. **Thermal pollution** • The drawdown point of pipe is close to the surface of the lakes where temperatures are similar to that flowing in the Nepean River. **Invasive species** • Sufficient monitoring for invasive species within the Penrith Lakes Scheme and an eradication/control programme should be conducted to limit populations of invasive species during and immediately post construction. **Water quality** • A regular water quality monitoring programme is required within the Penrith Lakes Scheme to record parameters including algal concentrations, nutrient levels, dissolved oxygen, pH. A monitoring program is currently being employed at Penrith Lakes within the existing lakes. This program should be reviewed for compliance with these recommendations. **Bank stability** • Plans to maintain and strengthen the riverbank stability are to be considered in the detailed design (e.g. minimize unnecessary clearing).
Hydrology	• Following detailed design, any changes to river cross section or obstruction as a result of the dissipative structure should be reviewed in light of the potential impacts on peak flood levels by a suitably qualified hydrologist.
Aboriginal and Non-Aboriginal Heritage	• Subject to approval of amendment to the existing AHIP (ref: 2595), all works will be undertaken in accordance with the mitigation and management measures outlined as part of the AHIP and PLDC heritage conservation plans.

Environmental Parameter(s)	Environmental Safeguards and Management Measures
Soils, Sediment and Erosion	• The potential problems of post construction bank stability may be minimised by gentle contouring of the river bank adjacent to the backfilled trench and/or the employment of a soil confinement mat laid over the final surface plus the use of reinforced earth techniques. This will need to be investigated in the detailed design phase. • It may be appropriate to stage the construction of the riverbank to limit the flood risk. This should be addressed during both the detailed and the construction phase of the project. It is recommended that a Flood Emergency Response Plan be prepared for the construction phase of the work. This report may include a flood warning system, which could utilise the water level gauge at the Penrith Weir. • Measures will be required to prevent scouring at the pipe outlet. Detailed consideration of potential scour protection works was undertaken as part of the design report (Cardno, 2010a). Based on a consideration of the advantages and disadvantages and cost of the alternative outlet it was recommended that a baffle dissipator be provided at the river side outlet for the proposed pipe. The structure presented in the design report (Cardno, 2010a) report are based on the USBR Type VI dissipator.
Contaminated Land	• All refuelling is undertaken in appropriate and designated areas; • No construction equipment is stored within the riparian zone; • The site works manager shall consider the potential for flooding events during construction; • Application of fertilizers and pesticides shall not occur during rain events; • No fuel or oil should be stored within the construction zone; • An appropriate spill kit should be maintained at each of the work sites • Should any contaminants be encountered during construction earthworks, works shall halt until a further contamination assessment is undertaken by the site supervisor.
Air Quality and Dust	• Scheduled regular visual inspections of weather conditions and dust levels should be conducted in accordance with a site CEMP; • Work is to cease during periods of very strong winds (above 40km/hr) unless dust can be suppressed by water carts; • Dust suppression techniques should be regularly applied to any exposed surfaces and stockpiled materials; • The work should be scheduled so to minimise duration of construction activity and time to revegetation establishment; and • Regular servicing of construction equipment and vehicles should be undertaken to minimise exhaust emissions.

Environmental Parameter(s)	Environmental Safeguards and Management Measures
Hazards and Risks	• An Environmental Health and Safety Plan for the works should be prepared prior to the commencement of works. • A quarry induction is essential for all contractors. In addition, contractors required to drive through the quarry should undergo a quarry driving induction, and be familiar with all quarry roads and procedures/rules (e.g., use of UHF radios, flashing beacon/light, flag, four wheel drive) required for driving in the mines; • Quarry workers should be notified of the changed traffic conditions and volumes (signs may be required) operating in the quarry; • The work site should be fenced off and secured from public access; • The site induction for contractors should address the risk of encountering venomous snakes, spiders and feral pigs; • A safe evacuation programme needs to be developed in case of bushfires; • All contractors should have easy access to a First Aid Kit, and at least one member on site should have access to a four-wheel drive vehicle, in case of emergencies. • Weather forecasts should be monitored daily, and all operations should cease if conditions become hazardous.
Traffic And Access	• Traffic shall be managed in accordance with quarry Traffic Management Plans. • On site vehicle traffic will be required to comply with the existing traffic rules of the site which includes: Site driver training; Minimum vehicle requirements; Radio network; and Sign in/sign out procedures.
Landscape and Visual impact	• Proposed activities are expected to be short term. Rehabilitation of the worksites to follow natural contours, and revegetation with native species typical of a Riverflat Eucalypt Forest should proceed as soon as practical following pipe installation; • Any rubbish or waste material should be removed and disposed of correctly, and as frequently as possible; • All temporary fencing and unnecessary signage is expected to be removed from the site as soon as practicable.
Noise and vibration	• Works should be limited to the approved working hours of the quarry; and • All equipment used on site should be maintained to standards in place for existing equipment within the quarry.
Utilities and Infrastructure	• A Utilities Management Plan should be prepared by the contractor for the proposed site; • The contractor must investigate the nature and location of all services that may be encountered, and consult with relevant authorities prior to the commencement of any works if any services are located.

Environmental Parameter(s)	Environmental Safeguards and Management Measures
Waste Materials	• A Waste Management Plan for the site would be required prior to the commencement of the proposed works; • Any rubbish and waste material generated from the works is required to be disposed of in the correct manner, and as frequently as possible.
Water Quality	• A Water Quality Management Plan should be prepared prior to the commencement of works; • Use of heavy vehicle machinery near edges of the riverbank/within waters should be minimised; • Turbidity levels should be observed while activities are carried out near the edges of the riverbank/within waters. A sediment boom should be installed if required; • Algal growth along the river edge should be undertaken by visual monitoring. If required, an aquatic ecologist should be engaged to determine the most appropriate course of action; • A sediment boom should be installed around the work site within the Nepean River; • Stockpiling of soil material should occur at considerable distances from the riverbank edge, in a suitable location which takes into account the potential for strong winds; • Prior to vehicles entering the river/riverbank edge, vehicles should be washed down, and petrol and oil tanks should be sealed firmly to prevent oil, chemical or tank spills; • Appropriate sediment and erosion control measures should be employed.

7.2 Conclusion

In conclusion, the installation of the proposed pipe in the north-western portion of the Penrith Lakes site is unlikely to have any long term significant negative environmental impacts provided that the mitigation measures recommended in **Section 7.1** are effectively implemented by incorporation into a suitable Construction Environmental Management Plan.

The installation of the flood outlet pipe is an important component of a larger scheme to create lakes at the site of the existing quarry. Completion of the Penrith Lakes Scheme is expected to significantly improve ecological, visual, and amenity value of the area.

8 Qualifications

This report has been prepared on the basis of the following information and assumptions:

- That all information contained within secondary sources referenced is correct; and
- That all data from database searches were correct at the time of viewing.

9 References

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