upgrade

expansion

coal combustion

product management system

environmental assessment

Environmental Assessment
Upgrade and Expansion of the Coal Combustion Product Management System, Eraring Power Station

November 2007

Prepared for:
Eraring Energy
PO Box 5044
DORA CREEK NSW 2264

HLA Merged with ENSR in 2007

Eraring energy

CERTIFICATION

Submission of Environmental Assessment (EA)
prepared under the Environmental Planning and Assessment Act 1979 Section 75F

EA prepared by name qualifications	Kate Tilden Bachelor of Science (Marine Science)	Brett McLennan Bachelor of Town Planning (Hons), Bachelor of Science	Michael England Bachelor of Arts (Regional and Urban Planning)
	Project Environmental Scientist	Principal Environmental Planner	Senior Principal, National Practice Leader Environmental Planning
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in respect of: Upgrade and Expansion of the Coal Combustion Product Management System, Eraring Power Station

project application applicant name applicant address	Eraring Energy PO Box 5044 Dora Creek NSW 2264
land to be developed lot no., DP/MPS, vol/fol etc proposed project	The proposed project is to be carried out on the land shown in the maps included in the EA consisting of Lot 11 DP 1050120, Lots 301 & 302 DP 806475, Lot 3/8 Section L DP 6747, Lots 13/16 Section O & Part Lot 13/16 Section U DP 6747, Lot 7/16 DP 262501, Lot 19 DP 262501, Lot 1 DP 817425, Lots 100 and 101 DP 828283, Lot 211 DP 840670, Lots 50 and 51 DP 840671, Lots 1, 2 and 3 DP 621697, Lot 1 DP 816174; Lots 20 and 21 DP 734860, and Lots 1 and 2 DP 1109558. Map(s) attached
Environmental Assessment	an Environmental Assessment (EA) is attached
Certification	I certify that I have prepared the contents of this Environmental Assessment and to the best of my knowledge it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

Signature	Signature	Signature
Name: Kate Tilden	Name: Brett McLennan	Name: Michael England
Date 13/11/2007	Date 13/11/2007	Date 13/11/2007.

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CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Introduction

Eraring Energy (EE) is proposing to undertake an upgrade to the existing coal combustion product (CCP) management system at Eraring Power Station (EPS) to accommodate the CCP management needs of the power station for the expected life of the station. Concept Approval was granted by the Minister for Planning (the Minister) under the *Environmental Planning and Assessment Act 1979* (EP&A Act) for this project on 14 December 2006.

EPS's current CCP management involves the use of 'lean phase' CCP placement which comprises a mix of 30% fly ash and 70% water being pumped into the existing CCP storage facility. Whilst 35% of EPS's fly ash is sold for reuse, at current placement rates the existing CCP storage facility will be full by 2011/2012. As the power station has a life beyond 2030, a new means of fly ash management is required to meet the needs of the power station beyond 2011/2012.

The proposed project has been declared by the Minister as a 'major project' under the provisions of the EP&A Act and *State Environmental Planning Policy (Major Projects) 2005* (SEPP 2005), and is therefore subject to the provisions of Part 3A of the EP&A Act. As previously stated, Concept Approval was granted under the EP&A Act for this project on 14 December 2006.

The Site and Context

EPS is located on Rocky Point Road in the town of Dora Creek, some 40 km southwest of Newcastle. The EPS site comprises approximately 1200 ha of land on the western shore of Lake Macquarie, of which around 150 ha is taken up by the power station itself. The remainder of the land is largely undeveloped consisting of open grassland, canals and bushland. The existing CCP storage facility is located on the northern portion of the site.

Project Description

The proposed upgrade and expansion of the existing CCP management system involves two primary components:

- Implementation of a management system for CCP; and
- Expansion of the existing CCP storage facility.

The implementation of a CCP management system incorporates CCP collection, storage, conditioning and pumping facilities, which would provide greater efficiency in CCP management at the site. The second component of the project involves the expansion of the existing CCP storage facility to provide additional capacity to the existing facility. These two components are collectively referred to as the CCP management system.

A staged approach would be adopted for the commencement of works associated with the construction and operation of the CCP management system and expansion of the CCP storage facility. The works required for the expansion of the existing CCP storage facility at EPS would be staged to reflect the operational needs of EPS in terms of CCP management as well as to

mitigate and minimise the potential environmental impacts of the proposed expansion of the existing CCP storage facility.

Statutory Approvals

The proposed project has been declared by the Minister as a 'major project' under the provisions of the EP&A Act and *State Environmental Planning Policy (Major Projects) 2005* (SEPP 2005), and is therefore subject to the provisions of Part 3A of the EP&A Act.

Under section 75F of the EP&A Act, an EA was prepared in accordance with the requirements of the Director-General of the DoP. The Director-General's EARs for the Concept Application were issued on 19 December 2005. A Planning Focus Meeting (PFM) was held at EPS on 30 September 2005, and was attended by relevant statutory authorities. The PFM provided a forum for discussion and consideration of issues to be included in the Director-General's EARs.

The EA was lodged with the DoP for adequacy review in February 2006. The final EA for the Concept Application and was lodged in May 2006, and was subsequently placed on public exhibition for a period of 60 days. Concept Approval was granted for the proposed upgrade to the CCP management system on 14 December 2006 under the provisions of Part 3A of the EP&A Act. Concept Approval provides approval for the project, subject to fulfilling requirements outlined in the Concept Approval, and pursuant to section 75P(1)(a) of the EP&A Act.

Under section 75F of the EP&A Act, an EA must be prepared for the Project Application in accordance with the EARs issued by the Director-General as part of the Concept Approval. This EA forms the Project Application for the proposal.

Consultation

Statutory Consultation

As part of this environmental assessment process, consultation was undertaken in accordance with the EARs issued as part of the Concept Approval with the following agencies:

- Department Environment and Climate Change (DECC);
- Department of Water and Energy (DWE);
- Department of Primary Industries – Mineral Resources (DPI-MR);
- Hunter-Central Rivers Catchment Management Authority (CMA);
- Mine Subsidence Board;
- Lake Macquarie City Consultation (LMCC).

Stakeholder Consultation

Consultation was undertaken with the community at the EPS community forum held on 8 August 2007. In addition, the Indigenous Heritage Assessment undertaken as part of this EA involved consultation with identified Aboriginal community groups including:

- Koompahtoo Local Aboriginal Land Council;
- Wonnarua Nation Aboriginal Corporation (WNAC) (which administers an Aboriginal Land Use Agreement proximate to the study area);

- Yarrawalk Aboriginal Corporation;
- Awabakal Traditional Owners Aboriginal Corporation;
- Guringai Tribal Link Aboriginal Corporation; and
- Awabakal Descendants Traditional Owners Aboriginal Corporation.

Issues Prioritisation

A prioritisation analysis was undertaken in respect of the key issues identified to address the need to recognise that the higher the potential severity of adverse environmental effects and the greater the potential consequence of those unmanaged effects, the higher the degree of environmental assessment required.

Where greater potential impacts were identified, the attribute or issue was allocated a higher priority for assessment. The analysis assesses the potential risk on the basis of the potential severity of environmental effects and the likely consequences of those potential effects if unmanaged.

The assessment of potential environmental risk was undertaken for each of the environmental issues identified from the Director-General's EARs. This assessment aims to allow the prioritisation of issues for assessment and, at this stage, does not consider the application of mitigation measures to manage environmental effects.

Based upon the above analysis, the environmental issues identified in the EARs are prioritised as follows:

- High: terrestrial ecology (including compensatory habitat issues);
- Medium: surface and groundwater; and
- Low: aquatic ecology, indigenous heritage, geotechnical issues, and air quality (dust).

Environmental Assessment

Compensatory Habitat

The proposed CCP storage facility expansion requires the removal of approximately 21 ha of native vegetation to the north of the existing CCP storage facility to accommodate the future placement of CCP. The Concept Approval issued in respect of the proposal requires that compensatory habitat be provided at a ratio of no fewer than 2 ha for each hectare of vegetation removed.

The proposed expansion of the CCP storage facility would be undertaken in three stages, each requiring the removal of around 7 ha, and requiring the provision of a total of some 42 ha of compensatory habitat.

In order to minimise potential impacts associated with the removal of vegetation, and to satisfy the requirements of the Concept Approval, 28 ha of existing remnant bushland has been identified to provide compensatory habitat for the proposal for Stages 1 and 2. The area known as Area C, which is currently being rehabilitated by EE, provides some 21 ha of compensatory habitat for Stage 3, which would be subject to an assessment of character and quality of vegetation prior to Stage 3 clearing. Additionally, some 14 ha of potential compensatory habitat

has been identified to the east of the CCP storage facility, if Area C does not provide suitable compensatory habitat.

The proposed staging and strategy for vegetation clearing outlined in this EA is consistent with the Long Term Management Strategy (LTMS) and requirements of the Concept Approval, and is not anticipated to represent a significant impact to terrestrial ecology.

Terrestrial Ecology

The major impacts to terrestrial flora and fauna resulting from the proposal are associated with the clearing of native vegetation. The EA prepared for the Concept Application specified that some 52 ha of native vegetation would require clearing to accommodate the proposed expansion. However, during the detailed design of the project, the total area of the proposed expansion of the CCP storage facility footprint has been reduced to around 21 ha to minimise impacts associated with the removal of vegetation.

Potential impacts associated with the removal of vegetation include loss of habitat supporting native flora and fauna. Fauna species most likely to be affected by the proposed development are species that utilise this habitat including the small mammal population, arboreal mammals and insectivorous bats that roost in tree hollows.

The placement of dense phase fly ash within the CCP storage facility during operation would also reduce the aquatic habitat available to a variety of aquatic birds including *Himantopus himantopus* (Black-winged Stilts), *Cygnus atratus* (Black Swans) and *Anas gracilis* (Grey Teals) which currently use the existing CCP storage facility.

The ecological assessment undertaken for the Concept Application identified that the proposal would result in the removal of approximately 34 ha of habitat for *Tetratheca juncea.* The footprint of the proposed CCP storage facility expansion has been reduced in accordance with the requirements of the Concept Approval, therefore the amount of *Tetratheca juncea* habitat to be removed would be less than originally assessed. The ecological assessment is therefore considered to represent a conservative assessment of potential impacts.

While the proposed action involves clearing approximately 21 ha of native vegetation, the removal of trees would be offset by the proposed safeguards, in particular, the provision of some 42 ha of compensatory habitat, and the installation of artificial nest boxes and roosting boxes within compensatory habitat areas. In addition, mitigation and maintenance measures would be implemented during construction and operation to minimise potential impacts.

With the implementation of environmental safeguards, including mitigation and maintenance measures, as well as the provision of compensatory habitat offset areas, is anticipated that potential impacts to terrestrial ecology would not be significant.

Groundwater

Potential impacts to groundwater quality associated with the proposed upgrade and expansion of the CCP management system are primarily associated with the seepage and migration of potentially contaminated groundwater, which could ultimately impact the local groundwater quality, as well as the water quality of receiving water bodies such as Lake Macquarie.

Under existing conditions, it is anticipated that there is some seepage and downward vertical migration of water used in the conditioning and mixing of fly ash from the CCP storage facility after placement. Water seepage through the base of the CCP storage facility has the potential to impact local groundwater quality, and potentially impact the water quality of groundwater

receptors surrounding the site. Seepage has the potential to introduce contaminants potentially leached from the lean phase emplacement, and seawater trace element components.

Potential groundwater contaminants that may originate from the CCP storage facility primarily include heavy metals and trace elements such as selenium. Historical groundwater monitoring results indicate that there are a number of trace metals in groundwater beneath the CCP storage which have, on some occasions, been recorded in concentrations in excess of the adopted criteria (ANZECC (2000) *Guidelines for Fresh and Marine Water Quality*).

While the source of elevated concentrations of contaminants is unclear, the proposed expansion of the CCP storage facility and dense phase placement of fly ash is not anticipated to impact the groundwater quality beneath or downgradient of the CCP storage facility over and above existing groundwater quality. The proposed dense phase placement technique would require significantly less water during the conditioning and mixing process to form the dense phase slurry. This would reduce the quantity of water within the CCP storage facility, which is likely to result in a reduction in seepage to groundwater compared to the current lean phase placement. In addition, the cementitious nature of the dense phase emplacement would form an impervious blanket across the surface of the existing lean phase emplacement, as well as across the surface of the proposed expansion area of the CCP storage facility, thus minimising the potential for seepage to groundwater.

The proposed dense phase placement technique is not anticipated to impact groundwater quality beneath the CCP storage facility; rather it is likely to maintain the status quo, or result in an improvement to groundwater. The cementitious nature of the dense phase emplacement is likely to act as an impermeable blanket over the existing lean phase emplacement, and the proposed expansion area of the CCP storage facility.

EE proposes to undertake a review of the existing groundwater monitoring regime to assist in determining changes in current groundwater contaminant levels that may originate from activities associated with the proposal. The current EPS Groundwater Monitoring Plan would be revised to incorporate the results of the investigation.

The proposed expansion and upgrade of the CCP management system is therefore not anticipated to adversely impact existing groundwater quality.

Surface Water

Investigations were undertaken to assess potential impacts associated with surface water quality and alterations to hydrology resulting from the proposed expansion of the CCP storage facility.

Water Quality
Potential impacts to surface water quality and receiving waters resulting from the operation of the CCP storage facility predominantly include possible increased pollutant concentrations and sediments in surface runoff from the CCP storage facility, resulting in increased pollutant concentrations being discharged to Lake Macquarie.

The primary pollutant of concern associated with surface runoff within the CCP storage facility is selenium. The EPL applying to the site specifies that selenium concentrations should not exceed 2 µg/L in water discharged to Lake Macquarie via the cooling water outlet canal. As the proposed dense phase placement system would significantly increase the concentration of fly ash deposited with the CCP storage facility, investigations were undertaken to model the effect of dense phase placement on the concentrations of selenium in discharges to Lake Macquarie.

The proposed projection in fly ash sales and subsequent reduction in fly ash input resulting from increased sales is anticipated to result in a reduction in the selenium concentration of water in the CCP storage facility from current levels. In addition, management of the catchment area surrounding the CCP storage facility is expected to further reduce water inflows, and hence water discharges to Lake Macquarie. The mass of selenium in surface water discharged to the cooling water outlet canal is therefore expected to be correspondingly reduced.

Hydrology

Hydrological investigations were undertaken to model the capacity of the proposed CCP storage facility to cope with extreme weather conditions, and to determine the probable maximum flood (PMF) capability of the CCP storage facility. Potential impacts to surface water may include uncontrolled discharge to Crooked Creek in the event of extreme rainfall events, which could result in overflowing of the CCP storage facility, and the transfer of sediments and contaminants to Lake Macquarie.

The modelling indicated that under the proposed dense phase placement and existing operating instruction, the earliest time that uncontrolled discharge to Crooked Creek would be initiated is May 2013.

A modification to the operating instruction of the CCP storage facility would allow an increase in water level from RL 125.5 m to RL 126.0 m, and the modelled storm events would be held by the CCP storage facility without discharge to Crooked Creek. The hydrological investigations indicate that modifying the operating instruction of the dam would need to occur prior to May 2013. In addition, an increase in the height of the spillway overflow weir by 1 m to RL 127.61 m would also occur. Four engineering design options have been identified for further investigation to mitigate potential impacts.

The proposed expansion of the CCP storage facility is not anticipated to result in significant impacts to surface water quality or the local hydrological regime. Selenium modelling indicated that surface water quality is not likely to be impacted by an increase in selenium concentrations from the proposed dense phase emplacement until minimum stilling pond size is achieved after a period of approximately 15 years of dense phase operation. Selenium concentrations would continue to be routinely monitored following this period to ensure that the EPL concentration limit was not exceeded.

Hydrological investigations have indicated that engineering design options are required to address potential impacts associated with the project. Implementation of a combination of identified engineering options would provide additional capacity for the CCP storage facility, and would mitigate potential impacts associated with overflows from the CCP storage facility and weir during rainfall events.

Aquatic Ecology

Potential impacts to aquatic ecology would primarily occur indirectly as a result of surface water quality impacts to Lake Macquarie during construction works associated with the proposed expansion to the CCP storage facility, as well as during operation and maintenance of the CCP storage facility.

During construction works associated with the clearing and expansion of the CCP storage facility, potential impacts to surface water quality and aquatic ecology would be minimised by the containment of eroded sediments within the existing CCP storage facility, as well as the implementation of sediment and erosion control measures. During operation of the proposed expansion of the CCP storage facility, ambient water quality monitoring in Lake Macquarie near the cooling water outlet canal, currently undertaken in accordance with the EPL applying to the

site shall continue in accordance with the EPL to monitor potential impacts to water quality that may affect aquatic ecology.

The implementation of environmental safeguards and mitigation measures during construction, operation and maintenance would minimise potential impacts. As such, the project is not anticipated to significantly impact aquatic ecology.

Indigenous Heritage

A search undertaken on DECC's Aboriginal Heritage Information Management System (AHIMS) revealed that no sites have been previously recorded in the study area., Consultation and archaeological surveys were undertaken in 2006 and 2007 of the proposed expansion of the CCP storage facility (referred to in this discussion as "the study area") with Aboriginal community involvement and no evidence of Aboriginal sites was identified within the proposed study area. Aboriginal consultation followed the DECC's *Interim Community Consultation Requirements for Applicants* (DEC 2004) and commenced in November 2005 and continued through to September 2007.

The survey revealed the study area to be composed of medium to densely covered vegetated slopes of gentle relief. The survey covered about 30 to 40% of the study area and effectively observed about 8% of this area. Based on geomorphological interpretations and known sites in the area, the entire study area was found to have a very low potential for archaeological sites and/or deposits.

Known sites reveal a high correlation with the use of water resources, largely marine, and are predominantly middens located on the shoreline of Lake Macquarie or its major tributaries. Based on this evidence, the study area has few characteristics that would appeal to Aboriginal people for settlement, since it is composed of a series of slopes some distance from a main water body.

No evidence of surface Aboriginal sites were located during the survey and visual observations suggest the potential for subsurface archaeological sites is also low given the lack of a developed or *in situ* soil profile being evident within the study area.

Geotechnical

Disused mine workings have been identified beneath the north western portion of the CCP storage facility. The location of the disused mine workings and proximity to the proposed expansion of the CCP storage facility is shown in **Figure 7.5**. Potential impacts resulting from the presence of these workings relate to the risk of localised subsidence and slumping of the overlying land. While most of the area of overlap has had the pillars removed and collapsed, a small area remains where some pillars have not been removed, identified as portions of panels 101, 102 and 103 of Awaba Mine.

The EARs outlined in the Concept Approval require that an assessment of potential geotechnical impacts be prepared in consultation with DPI and the Mine Subsidence Board (MSB), having regard to the proximity of disused underground mine workings, owned by Centennial Coal, and the potential for impacts on the future extraction of coal reserves in the area.

Consultation with DPI was subsequently undertaken in relation to potential impacts from the interaction of underground mine workings and the proposed expansion of the CCP storage facility. Centennial Coal, which operates Awaba Mine, confirmed that the proposed expansion of the CCP storage facility overlays panels 101, 102 and 103, and indicated that these panels have been fully extracted and are contained within a substantial barrier pillar. As such,

Centennial Coal is satisfied that elevated vertical stress is not likely to impact upon underground pillar stability, and therefore it would not be necessary for the mine to be sealed. EE engaged technical engineering consultants Connell Wagner to review the advice provided by Centennial Coal. They confirmed that the mine would not require sealing, and that the cementitious nature of the dense phase emplacement would blanket seal the overlying surface of the mine workings.

The nature of the disused mine workings is not anticipated to be affected by elevated vertical stress that may be placed on the area by the expansion of the CCP storage facility and dense phase emplacement. Given the underlying panels of Awaba mine have been fully extracted, there is not likely to be future extraction of coal reserves in the area which would be impacted by the project.

Air Quality

Potential impacts to air quality resulting from the project are primarily associated with the generation of dust. Activities which would potentially result in the generation of dust include:

- Clearing of vegetation and stripping top soil associated with expansion of the CCP storage facility footprint; and
- Wind blown dust from stockpiles, exposed areas and access tracks.

Air quality impacts during the construction period and clearing campaigns for the expansion of the CCP storage facility would be largely contained on site. In order to minimise impacts associated with construction activities, a Construction Environmental Management Plan would be prepared and implemented taking into account potential sources of dust, and would include environmental safeguards to be implemented during construction to minimise environmental impacts.

Operation of the proposed dense phase placement system would result in less potential for dust generation than the existing lean phase placement system, due to the cementitious crust that is formed by dense phase emplacement.

The proposed dense phase placement system and placement techniques are anticipated to result in less dust generation than the existing lean phase placement system. Furthermore, current dust mitigation measures used on the site would continue to be implemented to minimise potential impacts.

Statement of Commitments

In accordance with the EARs issued by the Director-General, a Statement of Commitments (SoC) is provided in Section 8 this EA. The SoC states EE's environmental commitments and provides details on the environmental management and monitoring of the proposed project during its construction and operational activities.

EE commits to the preparation and implementation of the environmental management and monitoring plans and environmental mitigation measures detailed in the SoC for the proposed CCP management system. The SoC would form part of EE's day-to-day environmental management activities at EPS.

Residual Risk Analysis

Residual Environmental Risk has been assessed on the basis of the significance of environmental effects of the proposed project and the ability to confidently manage those effects to minimise harm to the environment.

The residual risk analysis undertaken for the project indicates that the proposal presents an overall low/medium risk in relation to each of the identified environmental issues, provided that the recommended mitigation, management and monitoring measures are implemented.

Proposal Justification

The assessment of the proposal undertaken for the preparation of this EA has considered the environmental impacts of the project in accordance with the Concept Approval.

The proposed upgrade and expansion to the CCP management system would result in a number of benefits associated with the increased efficiency of CCP management on the site. The proposal would allow the continued operation of EPS, and the provision of an important energy resource for NSW. Increased efficiency of CCP management would have resultant environmental benefits, including reducing current impacts associated with the potential for dust generation from the existing CCP storage facility, and enabling a greater volume of CCP to be stored on site without sterilising significant amounts of additional land or increasing environmental impact.

As required by the EARs for the project, environmental safeguards including mitigation, management and monitoring measures have been identified in relation to potential environmental impacts. The assessment undertaken for this EA, as well as the EA prepared for Concept Application, demonstrates that the project is able to be constructed and operated in a manner which is compatible with surrounding land uses and minimises environmental impact.

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1 INTRODUCTION

Eraring Energy (EE) is a State-Owned Corporation that manages a diverse set of electricity-generating assets located throughout NSW. Over the last five years, EE has maintained a relatively consistent share of the NSW electricity market averaging just over 20%.

EE operates Eraring Power Station (EPS) as part of assets which generate electricity for the National Electricity Market (NEM). EPS is a coal fired power station consisting of 4 x 660 MW units. Over the past two years, EE has embarked on a program of upgrades to the EPS to accommodate the projected future demands for electricity in the market. EPS contributed 17,500 GWh of power to the NEM in 2006/07.

EE is proposing to undertake an upgrade to the existing coal combustion product (CCP) management system at EPS to accommodate the CCP management needs of the power station for the expected life of the station beyond 2030. Concept Approval was granted by the Minister for Planning (the Minister) under the *Environmental Planning and Assessment Act 1979* (EP&A Act) for this project on 14 December 2006. A copy of the Concept Approval is provided in **Appendix A**.

1.1 Background

The *Energy Directions Green Paper* (December 2004) prepared by the NSW Government identified that whilst there is currently sufficient electricity generation capacity in NSW to meet demand, the level of maximum demand is increasing by approximately 4% per annum. In the event this trend continues, additional generation capacity or demand management would be required by 2010.

In addition, the *Inquiry into Electricity Supply in NSW* prepared by Professor Anthony Owen (the Owen Inquiry), was presented to the NSW Government in September 2007. The Owen Inquiry recommended that in order to avoid potential energy shortfalls, new baseload generation would be required to be operational by 2013-14, and that baseload energy needs are likely to be met by coal-fired generation.

EE has proposed a number of upgrades to EPS in order to meet the State's requirement for additional generation capacity, as well as to improve efficiency of existing generation capacity. The proposed upgrades to EPS comprise:

- The installation of an emergency gas turbine generator (EGTG) for black start/peaking capability. This project was granted Project Approval by the Minister on 14 December 2006 and is expected to be operational by early 2008;
- The upgrade of generating units from 660 MW to up to 750 MW. A Project Application has been lodged for this proposal and is currently being considered by the Department of Planning (DoP). Subject to approval it is anticipated that this upgrade would be implemented during 2009-2011;
- The construction of a cooling water attemperation reservoir and associated works. This forms part of the Project Application for the 660 MW to up to 750 MW upgrade works currently being considered by the DoP; and
- The upgrade and expansion of the existing CCP management system at EPS (the subject of this Environmental Assessment (EA)) to accommodate the CCP management needs of the power station over the expected life of the station beyond 2030. As previously stated, Concept Approval was granted for this project on 14 December 2006.

CCP is a by-product of electricity generation, produced through the burning of coal. CCP produced at EPS comprises fly ash and furnace bottom ash. Currently, approximately 35% of fly ash is sold through an agreement with Fly Ash Australia for use in other production processes, such as concrete manufacturing. All furnace bottom ash, and a proportion of reclaimed furnace bottom ash is sold through an agreement with Blue Circle Ash to be reused as a gravel substitute for use in landscaping and roads. Overall approximately 45% of all CCP produced at EPS is reused through these agreements. The remainder of the CCP is stored in the CCP storage facility to the north of the power station.

EPS's current CCP management involves the use of 'lean phase' fly ash placement which comprises a mix of 30% fly ash and 70% water being pumped into the CCP storage facility. Whilst 35% of EPS's fly ash is sold for reuse, at current placement rates the existing CCP storage facility will be full by 2011/2012. As the power station has a life beyond 2030, a new means of fly ash management is required to meet the needs of the power station beyond 2011/2012.

EE is therefore proposing to expand the existing CCP storage facility and introduce the use of 'dense phase' fly ash placement on the site. The proposed expansion would take place on land directly adjacent to the existing facility to the north. Dense phase fly ash placement comprises a mix of 70% fly ash and 30% water and allows for a smaller footprint for CCP placement. This method of placement also allows for greater control in CCP management and greater efficiency in terms of land uptake for this purpose as well as providing added environmental benefits associated with reduced water consumption when compared with lean phase placement. The use of this technology would provide EPS with sufficient CCP placement capacity to accommodate the full life of the power station.

The proposal has been granted Concept Approval by the Minister, subject to EE complying with requirements outlined in the Concept Approval.

1.2 Location

The EPS site comprises approximately 1200 ha of land and is located in a natural dip on the western shore of Lake Macquarie, near the township of Dora Creek (see **Figure 1.1**). EPS is located in the Lake Macquarie Local Government Area (LGA). The power station footprint covers approximately 150 ha, with the remaining area including natural ecosystems and water canals.

1.3 The Proponent

The Proponent, EE, is a State Owned Corporation operating under the *Energy Services Corporations Act 1995* and the *State Owned Corporations Act 1989* that manages a diverse portfolio of coal fired, wind, hydro and pumped storage electricity generating assets throughout New South Wales. EE was formed in August 2000, to administer the electricity generation activities of the corporation formerly known as Pacific Power.

EE has a generation portfolio consisting of 10 power stations, with total capacity of 3,043 MW. Of these, EPS is the largest, situated on Lake Macquarie, with a total generating capacity of 2,640 MW. EE also operates Blayney and Crookwell Wind Farms, a portfolio of hydro power stations including Warragamba, Burrinjuck, Keepit and Brown Mountain, and the Shoalhaven Scheme, which consists of the Kangaroo Valley and Bendeela Hydro and Pumping Stations, jointly owned by EE and the Sydney Catchment Authority.

1.4 Environmental Assessment Process

The EP&A Act and the *EP&A Regulation 2000* provide a framework for environmental planning in NSW.

Prior to a decision to proceed with a proposal that may have an impact on the environment, a detailed assessment of the likely impacts of the project must be undertaken. The proposed project has been declared by the Minister as a 'major project' under the provisions of the EP&A Act and *State Environmental Planning Policy (Major Projects) 2005* (SEPP 2005), and is therefore subject to the provisions of Part 3A of the EP&A Act.

Under section 75F of the EP&A Act, an Environmental Assessment (EA) must be prepared in accordance with the Environmental Assessment Requirements (EARs) issued by the Director-General of the Department of Planning (DoP) following declaration of the project by the Minister as a 'major project'.

Under section 75F of the EP&A Act, an EA was prepared in accordance with the requirements of the Director-General of the DoP. The Director-General's EARs for the Concept Application were issued on 19 December 2005. A Planning Focus Meeting (PFM) was held at EPS on 30 September 2005, and was attended by relevant statutory authorities. The PFM provided a forum for discussion and consideration of issues to be included in the Director-General's EARs.

The EA was lodged with the DoP for adequacy review in February 2006. The final EA for the Concept Application and was lodged in May 2006, and was subsequently placed on public exhibition for a period of 60 days.

Concept Approval was granted for the proposed upgrade to the CCP management system on 14 December 2006 under the provisions of Part 3A of the EP&A Act. Concept Approval provides approval for the project, subject to fulfilling requirements outlined in the Concept Approval, and pursuant to section 75P(1)(a) of the EP&A Act.

Under section 75F of the EP&A Act, an EA must be prepared for the Project Application in accordance with the EARs issued by the Director-General as part of the Concept Approval. A copy of the Concept Approval and EARs is provided in **Appendix A**.

1.5 Purpose of this Report

This EA has been prepared by HLA-Envirosciences Pty Limited (HLA ENSR) and EE for the Project Application for the proposed upgrade and expansion of the CCP management system at EPS.

In accordance with Part 3A of the EP&A Act, this EA has been prepared pursuant to the Director-General's EARs and addresses the matters listed by the Director-General. The purpose of this report is to assess the environmental effects of the proposal and to describe the measures that EE would implement in order to minimise the impact of identified adverse environmental effects such that the Minister can make an informed decision with regard to the proposal.

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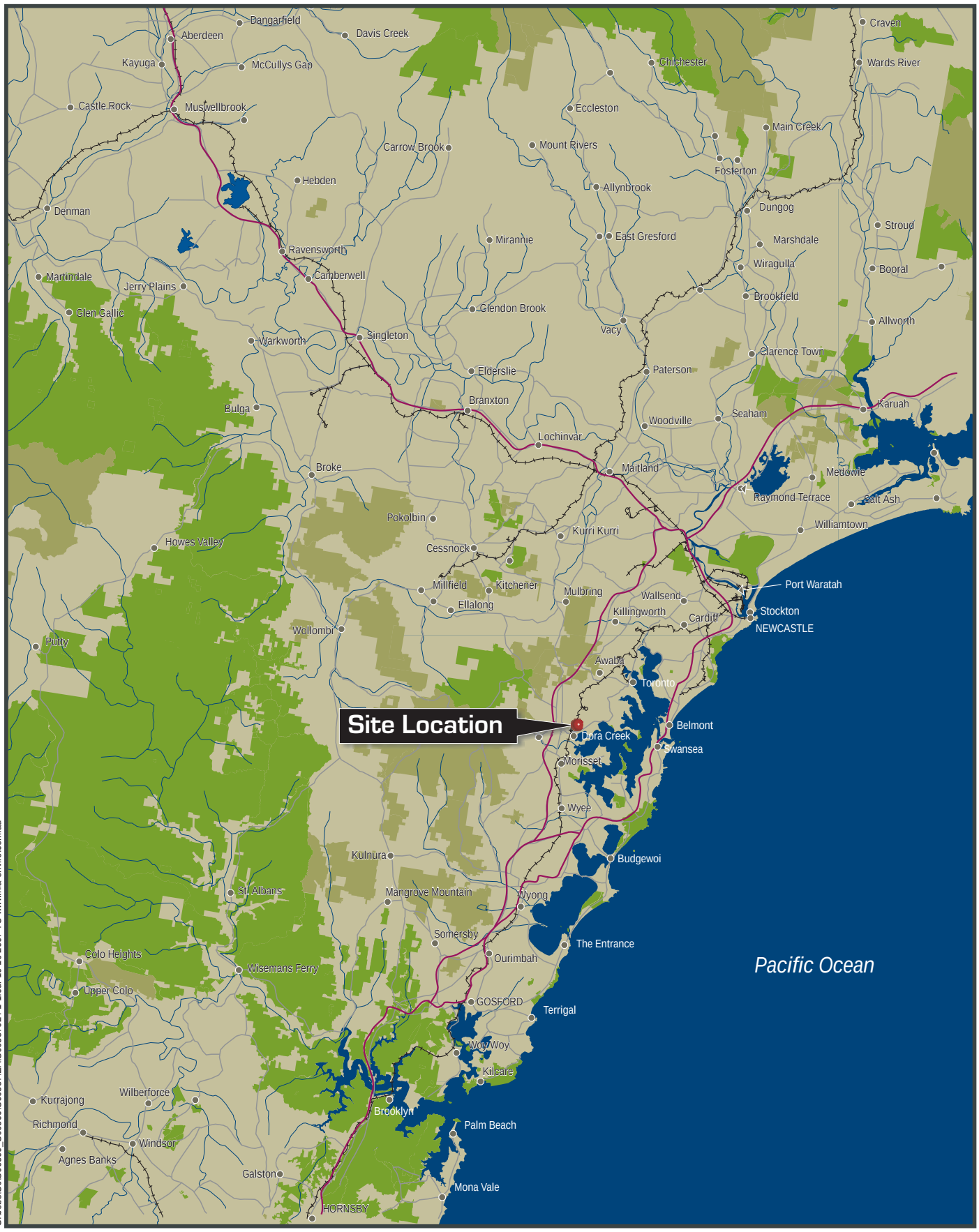

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HLA Merged with ENSR in 2007

0 20km

NPWS Estate
State forest
Highway
Road
River

Figure 1.1

Regional Site Location

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station

2 THE SITE

2.1 Site Description

EPS is located on Rocky Point Road in the town of Dora Creek, some 40 km south west of Newcastle (refer **Figure 1.1**). The EPS site comprises approximately 1200 ha of land on the western shore of Lake Macquarie of which around 150 ha is taken up by the power station itself. The remainder of the land is largely undeveloped consisting of open grassland, canals and bushland. A site layout is provided in **Figure 2.1**.

EPS is separated from surrounding land uses by extensive tracts of land which provide a buffer that minimises adverse visual and acoustic impacts. Surrounding land uses include:

- North – Quarries, coal loading and unloading and railway lines;
- South – Rural and residential lands and Lake Macquarie;
- East – Whiteheads Lagoon (surrounding lands zoned environmental protection) with residential lands to the south east; and
- West – Main Northern Railway Line, Cooranbong Colliery and Muddy Lake wetland. Land is zoned rural and environmental protection.

A ridgeline occurs immediately to the north of the proposed CCP storage facility from which a series of small creeks drain towards the existing CCP storage facility.

The geology of the site is of the Narrabeen Group, comprising conglomerate, pebbly sandstone, grey green and grey siltstone and claystone. The soils of the site are predominantly the Doyalson erosional landscape. Parts of the site, including the existing CCP storage facility are classified as disturbed terrain. Sites within the vicinity of the EPS are known to be affected by acid sulfate soils (ASS). The operational area of the site is already highly disturbed, comprising cleared and excavated areas within the existing power station facilities footprint.

2.2 Land Ownership and Legal Description

EE owns and operates the EPS site which comprises the following parcels of land:

- Lot 11 DP 1050120;
- Lots 301 & 302 DP 806475;
- Lot 3/8 Section L DP 6747;
- Lots 13/16 Section O & Part Lot 13/16 Section U DP 6747;
- Lot 7/16 DP 262501;
- Lot 19 DP 262501;
- Lot 1 DP 817425;
- Lots 100 and 101 DP 828283;
- Lot 211 DP 840670;
- Lots 50 and 51 DP 840671;
- Lots 1, 2 and 3 DP 621697;
- Lot 1 DP 816174; and
- Lots 20 and 21 DP 734860.

In addition to the abovementioned land, EE procured an additional parcel of land from the Department of Lands to the north of the existing CCP storage facility, known as:

- Crown Land adjoining the northern boundary of Lot 11 DP 1050120 to the ridge line comprising Lots 1 and 2 DP 1109558.

The purchase of this additional land enables the expansion of the CCP storage facility and proposed placement of dense phase fly ash to the north of the existing facility.

2.3 Existing Operations

2.3.1 Electricity Generation

EPS is a coal-fired power station comprising four 660 MW units with a total capacity of 2,640 MW. The first of these generating units came into service in 1982, followed by the second and third units in 1983 and the fourth in 1984. As previously stated, an upgrade to the generating units to 750 MW between 2009 and 2011 is proposed, which would take the generating capacity of EPS to approximately 3,000 MW. EE burns approximately 5 million tonnes of black coal per year, sourced from a number of coal mines, including local mines such as Cenntenial Coal's Newstan, Myuna and Cooranbong/Mandalong Collieries, as well as Xstrata's Ulan and Westside mines.

The four generating units at EPS contain steam driven, tandem compound reheat turbines with single flow high pressure, double flow intermediate pressure and two double flow low pressure exhaust cylinders. The four associated boilers are single-furnace, twin-drum and use natural circulation with divided back pass and balanced draught. A turbine steam by-pass system stabilises boiler firing at low load and enables easy matching of steam to turbine metal temperature during start-up.

Each generator is connected to a pair of generator transformers which raise the generated voltage of 23 kV to the transmission voltage of 330 kV on Units 1 and 2 and to 500 kV on Units 3 and 4. Electricity is transmitted overhead to the 330 and 500 kV switchyards which form part of the interconnected transmission system that supplies the NEM.

EPS uses saltwater from Lake Macquarie for cooling water. The cooling system is a once-through system where water drawn from Bonnells Bay is directed through the station by the cooling water inlet canal. Most of the water flows through the power station condensers, with the remainder used for attemperating the water before flowing back into Lake Macquarie and Myuna Bay via the cooling water outlet canal.

2.3.2 CCP Management

CCP is produced through the burning of coal for the generation of electricity. In 2005/06, 595,000 tonnes of CCP from EPS was reused, which represents a total of 44.5% of the CCP produced. While a large proportion of CCP is reused, the remainder is stored at the existing CCP storage facility to the north of the power station pending the development of reuse markets.

CCP generated at EPS represents a significant resource which could potentially be used in a wide range of applications, such as filler in cement, concrete manufacture, engineering fills and agricultural applications. When effectively utilised, ash can provide significant positive environmental and economic benefits to both the local and national economy. In order to take advantage of these benefits, EE has prepared a CCP Long Term Management Strategy (LTMS)

in accordance with the Concept Approval granted in respect of the project to address future management of CCP at EPS.

EE is also currently working with the Ash Development Association of Australia (ADAA) to develop innovative methods of CCP management and reuse, and has set a range of objectives relating to CCP reuse, including establishing and developing new markets for CCP across a variety of industry sectors, which are discussed in the LTMS.

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0 400m

Figure 2.1

Eraring Power Station Site Layout

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station

3 PROJECT DESCRIPTION

3.1 Overview

CCP is a by-product of electricity generation produced through the burning of coal, and is generally comprised of fly ash and furnace bottom ash. CCP has properties and characteristics that reflect the local source coal geology. In Australia, CCP mainly consist of silica and alumina oxides (80-85%).

Recent data published by the ADAA indicates that EPS is achieving very high levels of utilisation of current production volumes. Whilst a large proportion of the CCP generated at EPS is reused, the remainder is stored in the CCP storage facility to the north of the power station. EPS currently uses 'lean phase' placement, that comprises a mixture of CCP (30%) and water (70%) which is pumped into the existing CCP storage facility. Using lean phase placement, the current CCP storage facility is expected to be full by 2011/2012.

As EPS has a life beyond 2030, a new method of CCP management is required to meet the needs of the power station beyond 2011/2012. The proposed upgrade and expansion of the CCP management system involves two primary components:

- Implementation of a management system for CCP; and
- Expansion of the existing CCP storage facility.

The implementation of a CCP management system incorporates CCP collection, storage, conditioning and pumping facilities, which would provide greater efficiency in CCP management at the site. The second component of the project involves the expansion of the existing CCP storage facility to provide additional capacity to the existing facility. These two components are collectively referred to as the CCP management system.

The proposed upgrade and expansion of the CCP management system proposes to address the ongoing CCP management needs of the power station through:

- Introducing dense phase placement of CCP to increase efficiency of the use of the CCP storage facility;
- Expanding the footprint of the existing CCP storage facility to assist with meeting the CCP management needs of EPS into the future; and
- Investigation, development and implementation of strategies towards the increased reuse/recycling of CCP to reduce the overall volume of CCP requiring placement at EPS in the future.

The proposed project would ensure that EE has sufficient CCP placement capacity to accommodate the life of EPS beyond 2030. The proposed upgrade required the acquisition of approximately 30 ha of land adjacent to the existing CCP storage facility, as well as the construction of a range of new infrastructure including collection, storage and pumping facilities.

3.2 Consistency of Project with Concept Approval

The project has been granted Concept Approval, subject to fulfilling requirements outlined in the Concept Approval (refer **Appendix A**). The Concept Approval issued in respect of the project provides a number of conditions to be satisfied, including staging and scoping of works and provision of compensatory habitat, preparation of the LTMS and requirements for the project application.

An outline of the conditions of the Concept Approval is provided in Table 3-1 with references to this EA demonstrating consistency of the proposal with the Concept Approval conditions.

Table 3-1: Conditions of Concept Approval and consistency with this EA

Concept Approval Condition	Reference in EA	Consistent with Concept Approval
Consistency of the project with Major Projects Application 05_0138 and Proposed Upgrade Eraring Power Station Environmental Assessment (HLA, 2006)	**Section 3**	✓
Staging and Scoping of Works - Vegetation to be clearing to be staged such that it is undertaken in no fewer than three stages, with no more than 7 ha removed in a single stage. Compensatory habitat to be provided at a minimum 2:1 ratio	**Section 7.1**	✓
Long Term CCP Management Strategy – preparation and lodgement of LTMS prior to lodgement of Project Application	**Section 3.13**	✓
Preparation of the EA in accordance with the Environmental Assessment Requirements for the Project Application	**Section 5.1.1**	✓

3.3 Project Components

The proposed upgrade and expansion of the CCP management system would require new infrastructure to be constructed within the EPS site and at the existing CCP storage facility. The infrastructure at EPS and the CCP storage facility would be connected by discharge slurry pipelines.

At this stage, details provided on the infrastructure are indicative. EE is currently seeking tenders for the provision of detailed design of the infrastructure to support the proposed upgrade and expansion of the existing CCP management system. The specifications of this infrastructure may therefore vary slightly.

The proposed CCP management system at EPS includes the construction of new fly ash collection and storage/pumping plants which are likely to incorporate the following infrastructure:

- A new method of fly ash collection at each fabric filter hopper with the aim of collecting higher quantities of fine fly ash which will increase the sale of fly ash for use in the cement industry;
- Intermediate storage silos to allow segregation of the finer fly ash from the remainder of the fly ash;
- Transfer pipelines from intermediate storage silos to the main storage silos;
- Main storage silos;
- Fly ash conditioning, mixing and pumping plants; and
- Discharge slurry pipelines up to the discharge points at the CCP storage facility.

The location of the proposed CCP management system infrastructure is provided in **Figure 3.1**.

3.4 Fly Ash Collection Plants

New fly ash collection plants would be provided using a dense phase pneumatic system for transportation of the fly ash which is to replace the existing air slides which are prone to leaks. There are four generating units to be connected to the system.

A catch pot (or pressure vessel) would be installed underneath each fabric filter hopper to collect fly ash produced during the combustion cycle. There are 40 fabric filter hoppers per generating unit resulting in a total of 160 catch pots for the EPS. The fly ash collected in the catch pots would be pneumatically transferred to small intermediate silos as part of a cleaning sequence.

The plant would be designed to ensure that all fly ash produced from all four units can be collected and processed without jeopardising the output of the power station.

3.5 Fly Ash Storage

The fly ash collected in the catch pots would be pneumatically transferred to small intermediate silos which would allow segregation into fine and coarse fly ash. There would be four sets of intermediate silos with two sets between Units 1 and 2 and two sets between Units 3 and 4 where the fly ash from these units would be transferred respectively. A proportion of fly ash would be stored for collection by FAA for reuse. From the intermediate silos, the fly ash would be pneumatically transported to the main storage silos and to FAA.

The main fly ash storage silos would be located along the internal access road known as Construction Road on the eastern side of the EPS. There would be two silos, each approximately 1,000 m^3 in capacity. One silo would be connected to the Units 1 and 2 fly ash collection plants and the other to the Units 3 and 4 fly ash collection plants. Each system inlet would have the ability to be crossed over to the other system if required during abnormal operational periods.

The design has included a dry fly ash extraction port on each main storage silo suitable for discharge into bulk tankers for sale to new markets, as well as a facility to place ‘conditioned’ or slightly wetted fly ash into open topped trucks. Suitable roadway infrastructure has been incorporated.

A schematic diagram of the proposed fly ash collection and storage/pumping plant is provided in **Figure 3.2**. A plan of the proposed fly ash collection and pumping facilities is shown in **Figure 3.3**.

3.6 Fly Ash Conditioning and Pumping Plants

Below each of the main storage silos is a plant that would condition (wet) the fly ash before it is mixed with more water to form a dense slurry or paste at the correct density before the paste is pumped to the CCP storage facility for placement.

The conditioning plant would consist of pug mills and mixing tanks. The pug mills would wet the fly ash to a conditioned state that allows the material to flow in a controlled manner into mixing tanks. Here the fly ash is mixed with more water to a specific concentration before being pumped to the CCP storage facility.

The slurry pumps are designed to pump the dense material (typically 70% solids by weight) to the fly ash discharge points at the CCP storage facility some 3 km away.

3.7 Expansion of the CCP Storage Facility

Expansion of the CCP storage facility involves expanding the CCP placement area to land adjoining the northern boundary of the existing facility. Staged clearing would be undertaken in accordance with the LTMS prepared in respect of the project, and this EA. The expansion of the CCP storage facility would allow the placement of CCP within the new footprint area, providing a greater fly ash placement capability for future management of CCP.

The proposed dense phase placement would be undertaken in staged increments. Dense phase slurry would initially be placed on top of the existing CCP storage facility. There would be three dispersal or discharge points for each line positioned at the storage facility to allow for the most favourable placement of CCP. The dispersal pipelines would be designed to allow movement up the gradient as the fly ash level rises, allowing for controlled discharge and clearing of land incrementally in accordance with this EA and the LTMS.

As dense phase CCP is placed in the CCP storage facility, the volume of water stored in the facility would reduce. To ensure that rainfall events could be controlled without overflow of the CCP storage facility, hydrological modelling was undertaken to determine the optimal design for CCP placement and remaining pond volume. The hydrological investigations indicated that two engineering modifications would provide the CCP storage facility with additional capacity during rainfall events, and minimise the potential for discharge to Crooked Creek:

- Modification of the existing CCP storage facility dam wall to increase the storage capacity of the CCP storage facility; and
- Increase the height of the spillway overflow weir to RL 127.61 m.

These engineering modifications are further discussed in **Section 7.4.4**. The optimal encroach distance between the CCP emplacement and the pond was also modelled. An optimal distance of 250 m was determined, which would allow the most efficient placement of CCP, and ensure that the CCP storage facility would not overflow. CCP management plans have been developed to ensure the area of CCP placement does not encroach within this distance.

The slurry pipelines have been designed to transfer the dense phase slurry from the conditioning and mixing plant approximately 3 km to the CCP storage facility. Steel pipes would be used up to the CCP storage facility and heavy duty plastic (HDPE) pipes would be used to move the discharge points around the CCP storage facility. The design incorporates cross over facilities between each discharge pipeline in case of blockages or pump failure as well as unblocking connections along the pipelines.

The dispersal pipelines would be laid on formed roads typically up to 5 m wide to allow for access for operation and maintenance purposes. Disturbance of bushland would be kept to a minimum by using existing tracks and roadways wherever possible.

The Concept Approval issued in respect of the project contains conditions for the staging of works associated with the expansion of the CCP storage facility. Vegetation clearing would be staged such that the proposal is undertaken in no fewer than three stages and so that no more than 7 ha of vegetation is removed in a single stage of the proposal. Staging of works is further discussed in **Section 3.9**.

3.8 Ancillary Equipment and Buildings

An air compressor plant would be installed to supply air required for operations. This plant would include three 50% capacity air compressors, air dryers and air receivers for production and storage of air used in the process of pneumatic transportation of fly ash. This plant would

be positioned within the current power station footprint. A control room would also be attached to this building for the operation of the fly ash collection systems.

A main control room and switch room would be constructed at the dense phase pumping plant which would contain all electrical switchgear, computer control equipment and interfacing equipment for the project. This building would also contain amenities for operation personnel.

3.9 Staging

A staged approach would be adopted for the commencement of works associated with the construction and operation of the CCP management system and expansion of the CCP storage facility. The works required for the expansion of the existing CCP storage facility at EPS would be staged to reflect the operational needs of EPS in terms of CCP management as well as to mitigate and minimise the potential environmental impacts of the proposed expansion of the existing CCP storage facility.

The Concept Approval issued for the project contains certain requirements with respect to the staging of works, as follows:

- The extent of vegetation clearing for the fly ash emplacement is to be limited to the area generally delineated as “approximate extent of land clearance end of year 10” (this does not include areas required to be cleared for pipeline or roadway access);
- Vegetation clearing shall be staged such that the proposal is undertaken in no fewer than three stages and that no more than 7 ha of vegetation is removed in any single stage of the proposal;
- No fewer than 2 ha of compensatory habitat is to be provided for each hectare of vegetation removed; and
- Commencement of each stage of the proposal shall be contingent on the implementation of the compensatory habitat works for the previous stage of the proposal.

The proposed works would be undertaken in accordance with these requirements. The placement of CCP within the expanded storage facility is shown in **Figure 3.4**.

The clearing stages of the land required for the project would commence before the first unit is connected to the new dense phase pumping system (due in March 2009) to allow for commissioning of the dense phase placement process. **Figure 3.5** illustrates the proposed staging of clearing for the expansion works.

3.10 Construction and Operation

3.10.1 Site Establishment and Construction

The proposed project would require an initial site establishment period of some 39 weeks which would include the following:

- Site establishment and construction of the fly ash intermediate and final storage silos;
- Site establishment and construction of the fly ash conditioning and pumping plant;
- Construction of the dense phase pipe network;

- Construction and expansion of the CCP storage facility; and
- Installation and diversion of services and infrastructure.

Works associated with construction which were audible at adjoining residences would normally occur between the hours of 7.00 am to 6.00 pm Monday to Friday, and 7.00 am to 4.00 pm on Saturdays. There would be no audible construction work carried out on Sundays and Public Holidays. Post construction commissioning and testing activities would also occur following construction, and would be likely to occur on an as required basis, which may include Sundays, for works involved with commissioning and testing the fly ash pumping plant.

The connection of the fly ash collection systems would occur in conjunction with other programmed outage works for the power station. It may be necessary for this work to occur on Sundays or public holidays to ensure meeting programs of other outage works carried out by other contractors. Every measure would be taken to ensure that these periods are minimised.

3.10.2 Operation of the CCP Management System

The operation of plant and equipment comprising the CCP management system would be fully automated. Fly ash collection would operate on a continuous basis. As fly ash is produced during the combustion process, it would be removed in the fabric filters through which exhaust gases are passed. Some material collects directly on the fabric filter bags while coarser material falls into the hoppers.

The coarse material would be transferred to the EE intermediate silo prior to a cleaning cycle being carried out. Typically a number of fabric filter cells would be cleaned during a cleaning cycle. During the cleaning cycle (or shake), the fine material would be collected in the catch pots and when the last cell of the four or five is cleaned, the fly ash would be transferred to the FAA intermediate silo. All forty cells would be cleaned before the first four or five cells are again cleaned. The cleaning cycle would operate continuously.

The fly ash transfer from the intermediate silos would be in a batch process. When working level is reached in the intermediate silos, the material stored in that silo would be transported pneumatically to FAA for use or to the EE main storage silos. Once low level is reached in the intermediate silo, the transfer would cease until working level is reached again when the process would again commence. If high level is reached in the FAA silo, then all fly ash would be transferred to the EE storage silos until the level in the FAA intermediate silo reaches low level.

The dense phase pumping system would be batched controlled and therefore operate intermittently. When working level is reached in the storage silo, fly ash would be batched through the conditioning and mixing system before being pumped to the CCP storage facility. When low level is reached in the storage silo, the batching process would cease until working level is again reached in the storage silo.

Redundancy has been designed into the fly ash conditioning, mixing and pumping plants to ensure that EPS can still operate with a failure of one of these plants. The plant would be designed to enable manual processing should automatic systems be unavailable.

3.10.3 Project Timetable

The following project timetable is proposed for the upgrade and expansion of the CPP management system:

- Construction of works for the dense phase pumping system would commence mid 2008 and the project would be operational from early 2009 when commissioning of the dense phase pumping system would be finalised;
- The first unit would have the fly ash collection system connected to the dense phase pumping plant in the first quarter of 2009;
- The second unit would be connected during a planned outage in spring 2009;
- The third unit would be connected during a planned outage in autumn 2010; and
- The final unit would be connected during a planned outage in spring 2010.

The new fly ash collection plants may be connected outside outages if possible following the successful connection of the first fly ash collection plant.

3.11 Environmental Controls

Environmental safeguards and controls were identified as part of the Concept Approval for the project. In addition, the Statement of Commitments in **Section 8** of this EA outlines environmental controls and safeguards recommended for implementation to mitigate potential impacts associated with the proposed works.

3.12 Decommissioning

EPS has an expected life at least up to 2030. The proposed CCP storage facility would continue operations for the life of the EPS. Decommissioning for the facility would therefore coincide with the decommissioning of EPS.

3.13 CCP Long Term Management Strategy

The LTMS prepared in respect of the Concept Approval would be used as a tool for both EE and Government agencies to guide the achievement of significant reductions in CCP storage at EPS through an increase in reuse/recycling and/or development of new technologies in CCP management. The DoP provided conditional approval of the LTMS on 14 September 2007.

The key goal of the LTMS is:

> *To develop and implement strategies that target reuse levels of 80% of all ash (both fly ash and bottom ash) produced at Eraring Power Station by 31 December 2015.*

The LTMS will also be used as a management tool to allow for progress in these areas to be measured and monitored on a regular basis as well as a tool for reporting back to stakeholders on such developments.

The LTMS also represents a commitment by EE to improving the efficiency and reducing the environmental impact of its operations at the EPS, and has been prepared by EE to be a dynamic document which will be subject to regular review and adaptation subject to changes and developments in the area of CCP management.

The Concept Approval requires that the EA is consistent with the aims and objectives of the LTMS. The objectives of the LTMS are to:

- Work towards a change in the image of CCP from a waste to a product;
- Establish and develop new markets for CCP across a variety of industry sectors;
- Foster partnerships between EE, local industry, local industry associations, the State and local Government and the local community to work towards the reuse/recycling of CCP;
- Improve the efficiency and reduce the environmental impact of CCP management at EPS; and
- Set benchmarks for environmental best practice in CCP management across Australia and internationally.

This EA has been prepared to be consistent with the aims and objectives of the LTMS.

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0 400m

CCP Storage facility
Proposed CCP Storage facility expansion area
Fly Ash collection and pumping facilities

Figure 3.1

Location of CCP Management System

Environmental Assessment
Upgrade and Expansion of Coal Combustion
Product Management System
Eraring Power Station

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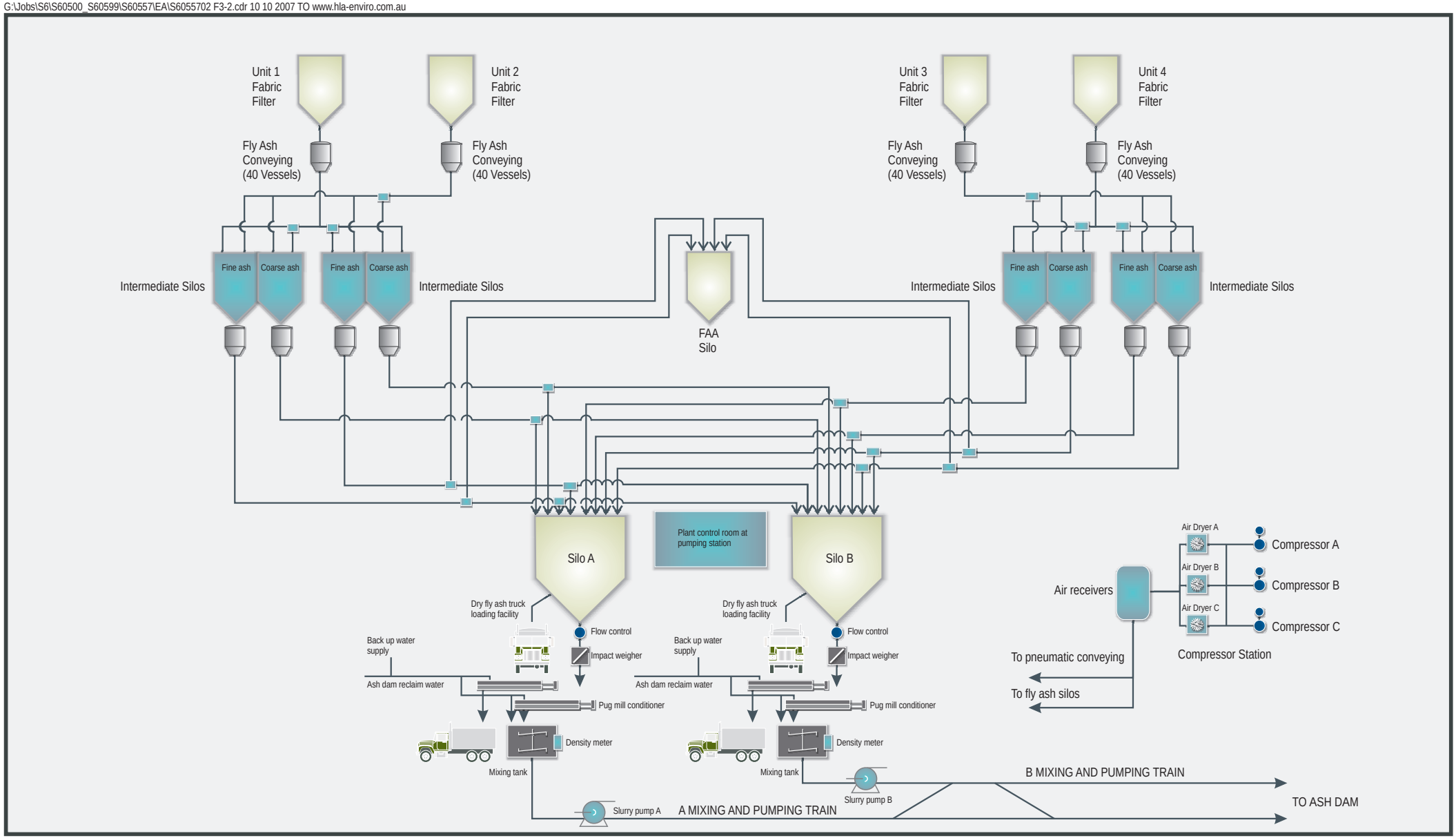

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Figure 3.2

Schematic Diagram of Fly Ash Collection and Pumping Facilities

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station

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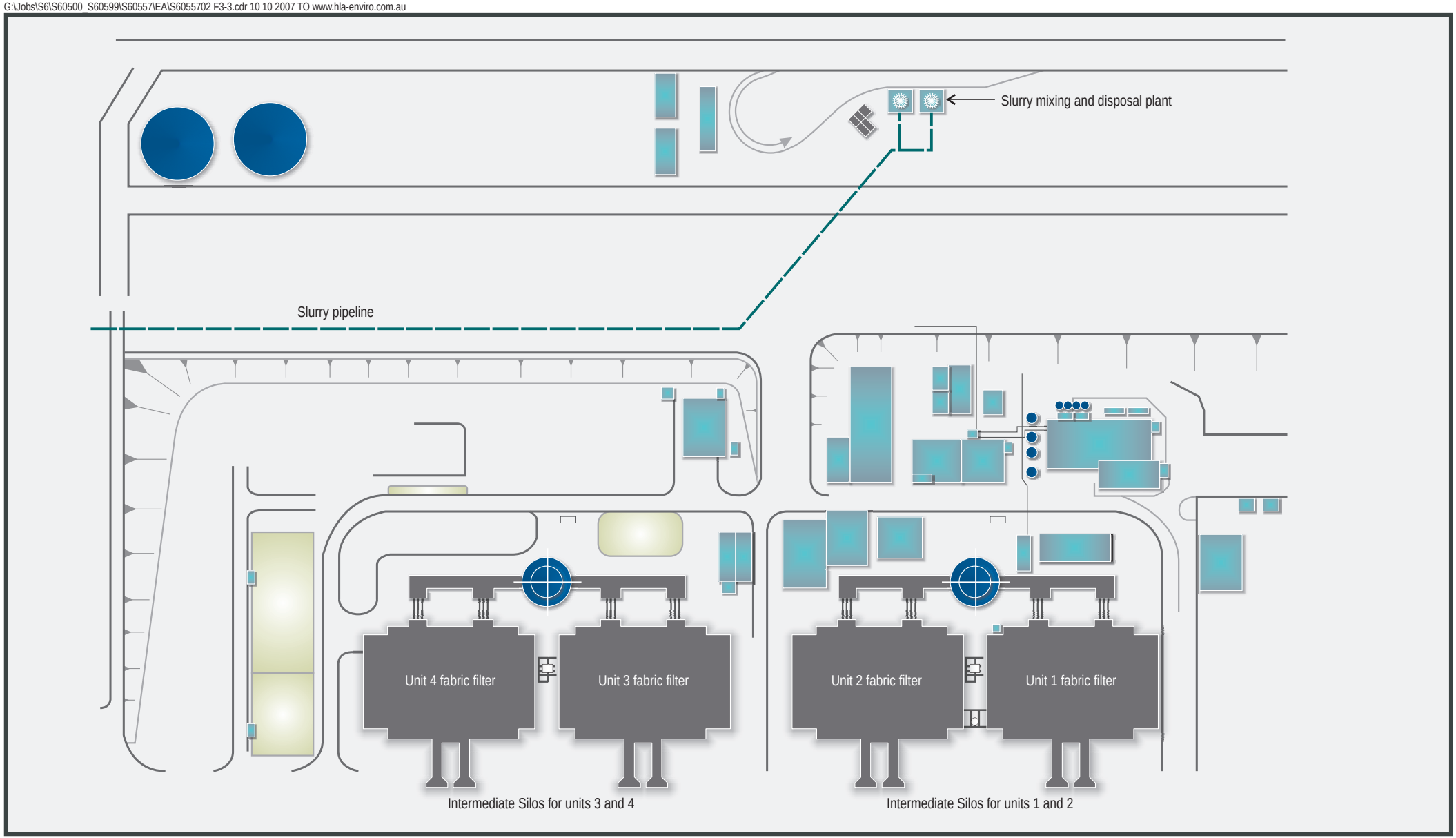

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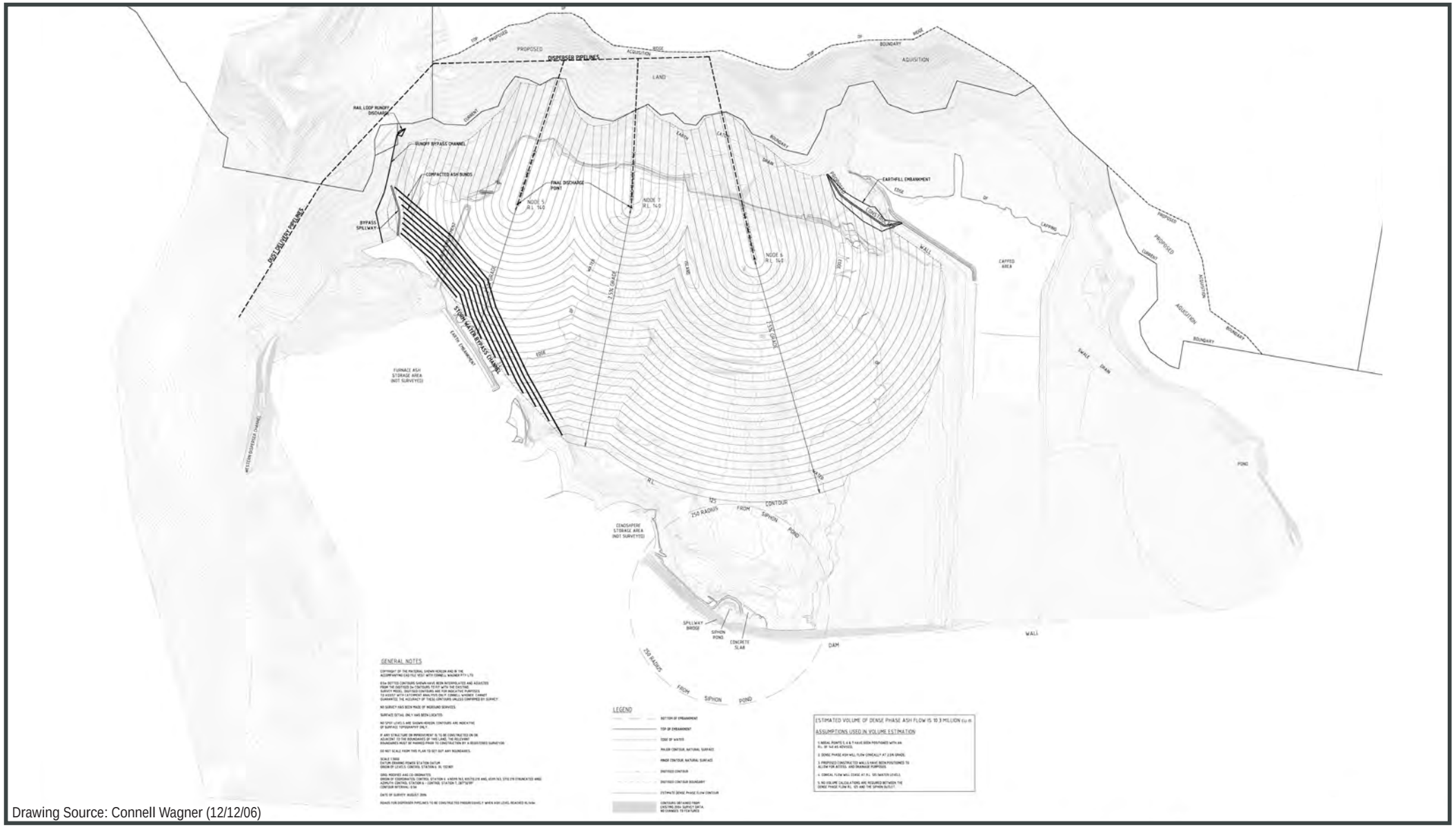
Figure 3.3

Plan of Proposed Fly Ash Collection and Pumping Facilities

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station



Drawing Source: Connell Wagner (12/12/06)

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Not to Scale

Figure 3.4

Dense Phase CCP Placement

Environmental Assessment
Upgrade and Expansion of Coal Combustion Product Management System at Eraring Power Station

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0 200m

Approximate extent of land clearance end of year 1 (R.L. 130)
Approximate extent of land clearance end of year 2 (R.L. 135)
Approximate extent of land clearance end of year 10 (R.L. 140)

Figure 3.5

Proposed Staging of Clearing for CCP Storage Facility Expansion

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station

4 STATUTORY PLANNING

4.1 Statutory Planning Process

The EP&A Act and the *EP&A Regulation 2000* provide a framework for environmental planning in NSW. Prior to a decision to proceed with a proposal that may have an impact on the environment, a detailed assessment of the likely impacts of the project must be undertaken. The proposed project has been declared by the Minister as a major project under the provisions of the EP&A Act and State Environmental Planning Policy (Major Projects) 2005, and is therefore subject to the provisions of Part 3A of the EP&A Act.

Section 75B(2) of the EP&A Act makes provision for 'major projects' to be identified through various means, including by way of declaration as a listed project in State Environmental Planning Policy (Major Projects) 2005 (SEPP 2005), or by notice in the Gazette. Schedule 1 of SEPP 2005 identifies classes of development which are major projects. This includes works for the purpose of an electricity generation facility with a capital investment of more than $30 million.

The proposed project comprises improvement works to an electricity generation facility requiring a capital investment of $35 million and is therefore classified as a 'major project' under SEPP 2005 and the Minister is the approval authority. The project was declared by the Minister to be a major project under SEPP 2005 on 6 December 2005.

An application was prepared in respect of the project in order to obtain Concept Approval for the proposal. The EA prepared for the Concert Approval was prepared in accordance with EARs issued by the Director-General, and was exhibited for public exhibition under Part 3A of the EP&A Act. The project was granted Concept Approval on 14 December 2006.

This EA has been prepared pursuant to Part 3A of the EP&A Act for the purpose of obtaining Project Approval for the proposal in accordance with the Director-General's requirements and EARs issued as part of the Concept Approval.

4.2 Statutory Planning Instruments

Statutory planning considerations for the proposal were detailed in Section 4 of the *Environmental Assessment – Proposed Upgrade to Eraring Power Station* (May, 2006), for which Concept Approval has been granted by the Minister.

The project was assessed against local, State, regional, and Commonwealth planning and legislative requirements. The project was found to be generally consistent with each of the relevant plans and policies.

Table 4-1 summaries the instruments considered during preparation of the EA for the Concept Approval.

Table 4-1: Statutory Planning Matters Considered for EA for Concept Approval

Matter	Detail
Local	
Lake Macquarie Local Environmental Plan 2004 (Lake Macquarie LEP)	The proposed works fit within the definition of 'utility installation' under the Lake Macquarie LEP and are permissible without Council consent.
Regional	
Hunter Regional Environmental Plan 1989	The proposal is considered to be generally in line with the provisions of the plan as they relate to economic development and environmental protection in the region.
State	
State Environmental Planning Policy 2005 (Major Projects) (SEPP 2005)	Under the provisions of Clause 24 in Schedule 1 to SEPP 2005, the proposal meets the criteria for classification as a major development, as a development with a capital investment of more than $30 million and being for the purposes of coal-fired and gas electricity generation, with the Minister being the approval authority.
State Environmental Planning Policy 14 – Coastal Wetlands (SEPP 14)	Eraring Wetland or 'Muddy Lake' is located on the EPS site and is listed under SEPP 14. It is located to the west of the site and is within a separate catchment to that of the power station therefore, there would be minimal impact upon the wetland in accordance with the aims of SEPP 14.
State Environmental Planning Policy 33 – Hazardous and Offensive Development (SEPP 33)	The proposed works are not hazardous or offensive development under the provisions of SEPP 33.
State Environmental Planning Policy 55 – Remediation of Land (SEPP 55)	The site is currently used as a power station and the proposed development is for upgrade works to existing facilities on the site. Given the nature of the existing and proposed uses, the site is considered to be suitable for the proposed development from a contamination perspective.
Environmental Planning and Assessment Act 1979	The proposed upgrade and expansion of the CCP management system has been declared a major project under Part 3A of the EP&A Act, and Concept Approval has been granted for the proposed works. In accordance with the provisions of the Part 3A of the EP&A Act, EE is now seeking Project Approval, with the Minister for Planning the approval authority.
Protection of the Environment Operations Act 1997 (POEO Act)	The subject site benefits from an existing environment protection licence (EPL) issued under the POEO Act. A variation to the licence under Section 58 of the POEO Act may be required.
National Parks and Wildlife Act 1974 (NPW Act)	An assessment of the proposed works on Indigenous Heritage is included in **Section 7.6** of this EA. The assessment concluded that Indigenous heritage was not likely to be impacted by the project. As the proposal is to be assessed under Part 3A of the EP&A Act, it is exempt from the need for a section 87 or section 90 Permit under the NPW Act.

Matter	Detail
Threatened Species Conservation Act 1995	The impact of the proposed CCP storage facility in relation to threatened species is discussed in **Section 7.2** of this EA. The assessment concludes that no threatened species would be adversely affected as a result of the proposed project.
Native Vegetation Act 2003	As the proposed upgrade and expansion of the CCP management system has been declared by the Minister as a major project under Part 3A of the EP&A Act, the provisions of the *Native Vegetation Act 2003* do not apply to the proposed project.
Heritage Act 1977 (as amended 1998)	There are no known items of heritage significance under the *Heritage Act 1977* on the site the subject of the proposed works.
Commonwealth	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) – Matters of National Environmental Significance (NES)	The EPBC Act lists seven matters of NES which must be addressed when assessing the impacts of a proposal. A search of the EPBC Protected Matters database was undertaken and it was found that the proposal would not have a significant impact on matters of NES, and as such, the EPBC Act is not triggered, and approval from the Commonwealth Minister for the Environment and Water Resources is not required.

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5 CONSULTATION AND ISSUES IDENTIFICATION

5.1 Formal Procedures for Consultation

5.1.1 New South Wales Formal Procedures

This EA has been prepared in accordance with Part 3A of the EP&A Act and its Regulation. Part 3A of the EP&A Act ensures that the potential environmental effects of a proposal are properly assessed and considered in the decision making process.

In preparing this EA, the requirements of the Director-General have been addressed as required by Clause 75F and 75P(1)(a) of the EP&A Act. Each of the EARs raised by the Director-General in the Concept Approval for consideration in this EA is outlined in **Table 5-1**, together with the relevant section of the EA which addresses that matter. A copy of the Concept Approval and EARs issued by the Director-General in respect of the project is provided in **Appendix A**.

Table 5-1: Concept Approval EARs

Matter	Reference in EA
Project details including any staging consistent with the requirements of Concept Approval, construction and operation methods, infrastructure and equipment requirements, duration of works for any stages and identification of the status of CCP management and storage needs of the EPS.	**Section 3**
Demonstration that the project is consistent with the aims, objectives and outcomes stipulated in an approved CCP LTMS.	**Section 3.13**
Project-specific Statement of Commitments with a clear indication of any new or amended commitments relating to the project.	**Section 8**
Details of the compensatory habitat package for the project developed having regard to contemporaneous surveys of the area to be affected by the project and the 'Lake Macquarie *Tetratheca juncea* Management Plan' (as amended 2001).	**Section 7.1**
Details of how construction, operation and maintenance of the project would be undertaken to minimise impacts on terrestrial and aquatic ecology.	**Section 7.2** and **Section 7.5**
An updated review of potential impacts on indigenous heritage, having regard to the status of any Native Title claims apply to the land to be affected by or surrounding the project, and consultation with relevant Aboriginal groups, elders and broader Aboriginal community.	**Section 7.6**
A risk analysis and geotechnical assessment for any CCP storage facility extension, prepared in consultation with the DPI and Mine Subsidence Board, having regard to the proximity of old mine workings (to verify that they are collapsed and there is no risk of future subsidence) and potential for impacts on the future extraction of coal reserves in the area.	**Section 7.7**
Details of mitigation, monitoring and management measures to be applied to the project with respect to dust generation and impacts, consistent with best environmental practice.	**Section 7.8**

Matter	Reference in EA
Details of mitigation, monitoring and management measures to be applied to the project with respect to surface and groundwater impacts, consistent with best environmental practice. The assessment shall include consideration of potential impacts on water quality, a plan to manage any identified impacts on waters (including Lake Macquarie) and a monitoring program for surface and groundwater. The assessment shall consider all chemicals of potential concern including, but not limited to, trace metals such as selenium. The assessment shall be prepared in consultation with the Department of Environment and Climate Change (DECC), the Department of Energy and Water (DEW) and the Hunter-Central Rivers Catchment Management Authority (CMA).	**Section 7.3** and **Section 7.4**
Results of consultation with the local community, relevant state agencies and Council.	**Section 5**
Demonstration that the project is consistent with this Concept Approval.	**Section 3.2**

5.2 Consultation with Stakeholders and Other Relevant Authorities

5.2.1 Statutory and Other Relevant Authorities

The Proponent has undertaken consultation with key local and state Government agencies as specified in the EARs during the preparation of the Concept Application, and during preparation of this EA. The purpose of this consultation has been to provide an overview of the project and to seek input into matters those stakeholders would like to see addressed in the EA.

In addition, the Concept Approval required that further consultation be undertaken with DECC, DWE and Hunter-Central Rivers CMA in relation to the water quality assessment undertaken in respect of the proposal. In this regard, comments were sought from relevant statutory agencies identified in the EARs to assist with the preparation of this EA. **Table 5-2** below summarises the outcomes of the consultation together with the relevant section of the EA which addresses the matter.

Table 5-2: Statutory and Other Agency Requirements and EA Reference

Agency Representative	Date of Consultation	Matters Discussed	Reference in EA
DECC Trevor Henderson Josh Gibson	14 September, 2007 Email sent 17 September, 2007 (refer **Appendix B**)	Details of proposed project. Broad discussion of compensatory habitat offset areas on the EPS property.	**Section 3** **Section 7.1**
		Discussion of potential air quality impact in relation to dust generation and likely benefits of the proposed dense phase placement technique.	**Section 7.8**

Agency Representative	Date of Consultation	Matters Discussed	Reference in EA
		Discussion of potential impacts to water quality. Discussion of historical groundwater monitoring results and potential water quality impacts associated with the proposed expansion of the CCP storage facility and dense phase placement. DECC provided in principle support to the proposed approach to the assessment of groundwater quality, and commitment to undertaking a review of groundwater monitoring on the EPS site as part of the Statement of Commitments.	**Section 7.3** and **7.4**
DWE Peter Johns Project Officer, Major Projects and Planning Branch	14 September, 2007 Email sent 14 September, 2007 (refer **Appendix B**)	Details of proposed project. Invitation for comments in relation to potential water quality impacts associated with the proposed expansion of the CCP storage facility and dense phase placement. Discussion in relation to advice provided by DNR during consultation undertaken during preparation of the Concept Application. DWE stated that it has no statutory approval role in the project, but requires that EE comply with the site EPL in relation to water quality monitoring and licence limits. HLA ENSR received email dated 25 September 2007 from Peter Johns. Hemantha De Silva, Team Leader, Licensing North Branch confirmed that there are no approvals required under water legislation administered by the Department of Water and Energy for the proposed upgrade. The advice of DWE (former DNR) dated 10 February 2006 therefore remains unchanged.	**Section 3** **Section 7.3** and **7.4** **Appendix B** **Appendix B**
Hunter-Central Rivers CMA Dean Chapman	14 September, 2007 Email sent 14 September, 2007 (refer **Appendix B**)	Details of proposed project. Invitation for comments in relation to potential water quality impacts associated with the proposed expansion of the CCP storage facility and dense phase placement. Provided link to EASR on DoP's website for further information about the proposal.	**Section 3** **Section 7.3** and **7.4**

Agency Representative	Date of Consultation	Matters Discussed	Reference in EA
DPI-MR	Letter dated 19 June, 2007 Letter dated 17 September 2007 Letter dated (refer **Appendix C**)	Discussion in relation to potential impacts associated with operational situation of mine workings in the vicinity of the proposed expansion of the CCP storage facility.	**Section 7.7**
Mine Subsidence Board	Letter dated 27 March, 2007 (refer **Appendix C**)	Discussion in relation to potential impacts associated with operational situation of mine workings in the vicinity of the proposed expansion of the CCP storage facility.	**Section 7.7**

In addition, consultation was also undertaken with LMCC and DECC during the preparation of the LTMS, prepared in respect of the Concept Approval. Details of consultation undertaken with LMCC are provided in **Appendix B**.

5.2.2 Stakeholder Consultation

Community Forum
In 2003, the EPS community forum was established to provide a means of communication between the power station and local community representatives. The community forum meets quarterly and consists of members of local community groups and EE staff.

At the community forum meetings of 17 August 2005 and 2 November 2005, the proposed upgrade and expansion of the CCP management system was presented to the members in attendance. An update on the proposal was provided at the community forum held on 8 August 2007. Community members and EE representatives in attendance at the forum on 8 August, 2007 are listed in **Table 5-3**.

Table 5-3: Attendees at the EPS Community Forum, 8 August 2007

Organisation	Representative
Coal Point Progress Association	Audrey-Ann Diggins
Cooranbong Chamber of Commerce	Antoinette Balnave
Dora Creek Catchment Group	Jenny Windibank
Dora Creek Ratepayers and Progress Association	John Shoebridge
Dora Creek Ratepayers and Progress Association	Jim Williams
Eraring Residents Association	Dennis Lyons
Lake Macquarie City Council	Quentin Espey
National Seniors Association Westlakes Branch Inc	Helen James
Native Animal Trust Fund	Audrey Koosmen
Responsible Fishing Association of NSW	Alison Dunne
Royal Volunteer Coastal Patrol	Margaret Teal
URGE of Lake Macquarie	Howard Morrison

Southlake Business Chamber and Community Alliance	Kathleen Mannile
Organisation	Representative
Southlake Landcare Group	Peter Kemp
HLA ENSR	Kate Tilden
General Manager EPS Plant (EE)	Wayne Winterbine
Environment Manager (EE)	Neil Williams
Environment Compliance Officer (EE)	Craig Sheridan
Environment Monitoring Officer (EE)	Will Wright
Environment Administration Officer (EE)	Kelly Tuimaualuga
Special Project Manager (EE)	Garry Craig
Operations Manager (EE)	Neil Morris
Administration Manager (EE)	Antony Cotic
Commercial Manager (EE)	David Woodroof

The community forum provided an opportunity for comments and questions in relation to the project. Issues raised by the community are provided in **Table 5-4**.

Table 5-4: Issues Raised at Community Forum – 8 August, 2007

Issue	Reference in EA
Terrestrial and aquatic ecological impacts	**Section 7.2** and **7.5**
Aboriginal consultation	**Section 7.6**
Timing and process of EA	**Section 1.4**

Aboriginal Community Consultation

An Indigenous Heritage Assessment was undertaken as part of the Concept Application and for the preparation of this EA. The Indigenous Heritage Assessment undertaken as part of this EA involved consultation with identified Aboriginal community groups including:

- Koompahtoo Local Aboriginal Land Council;
- Wonnarua Nation Aboriginal Corporation (WNAC) (which administers an Aboriginal Land Use Agreement proximate to the study area);
- Yarrawalk Aboriginal Corporation;
- Awabakal Traditional Owners Aboriginal Corporation;
- Guringai Tribal Link Aboriginal Corporation; and
- Awabakal Descendants Traditional Owners Aboriginal Corporation.

Results of this consultation are summarised in the Indigenous Heritage Assessment discussed in **Section 7.6** of this EA.

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6 ISSUES PRIORITISATION

6.1 Issues Identification

An assessment of the key environmental issues in relation to the proposed CCP management system was undertaken for the EA prepared in May 2006 for the Concept Application. Based upon the Concept Application, environmental assessment and scoping exercises previously undertaken for the project, and a review of the Director-General's EARs (listed in **Section 5.1**), the key environmental issues of importance to the Project Application are considered to be:

- Flora and fauna – in particular the provision of compensatory habitat areas;
- Indigenous heritage;
- Geotechnical issues;
- Air quality (dust); and
- Surface and groundwater.

6.2 Preliminary Environmental Risk Assessment

In order to prioritise the identified issues, a risk analysis exercise similar to that used in respect of the Concept Application has been undertaken. The analysis is based on the need to recognise that the higher the potential severity of adverse environmental effects and the greater the consequence of those unmanaged effects, the higher the degree of environmental assessment required.

Table 6-1 provides the Issues Prioritisation Matrix upon which the risk analysis has been based. This method assesses risk on the basis of the potential severity of environmental effects and the likely consequences of those potential effects if unmanaged.

Table 6-1: Issues Prioritisation Matrix

Severity of Effects	Consequence of Unmanaged Effects		
	3 High	2 Medium	1 Low
1 Low	**4 (Medium)**	**3 (Low)**	**2 (Low)**
2 Medium	**5 (High)**	**4 (Medium)**	**3 (Low)**
3 High	**6 (High)**	**5 (High)**	**4 (Medium)**

The assessment of potential environmental risk for each of the environmental issues identified from the Director-General's EARs is shown in **Table 6-2**. This assessment aims to allow the prioritisation of issues for assessment and, at this stage, does not consider the application of mitigation measures to manage environmental effects.

Table 6-2: Issues Prioritisation – Proposed Upgrade and Expansion of the CCP Management System

Potential Risk	Severity	Consequence	Risk
Aspect: Terrestrial Ecology (Including Compensatory Habitat Issues)			
Loss of habitat due to clearing and development	3	3	**6**
Reduction in biodiversity due to loss of habitat for native species	2	3	**5**
Detrimental impact on surrounding bushland due to edge effects	2	2	**4**
Spread of weeds and feral animals	2	2	**4**
Detrimental impact on surrounding bushland due to edge effects	2	2	**4**
Impact upon threatened species	3	3	**6**
Aspect: Aquatic Ecology			
Impact upon aquatic flora and fauna	1	2	**3**
Aspect: Indigenous Heritage			
Damage or removal of Aboriginal artefacts or places	1	2	**3**
Detrimental impact upon items of non-indigenous heritage significance	1	1	**2**
Aspect: Geotechnical Issues			
Impact upon existing disused mines	1	1	**2**
Aspect: Dust Generation			
Potential degradation of air quality due to dust	2	1	**3**
Aspect: Surface and Groundwater			
Degradation of water quality in the local area	2	2	**4**

Based upon the above analysis, the environmental issues identified in the EARs are prioritised as follows:

- High:
  - terrestrial ecology (including compensatory habitat issues);
- Medium:
  - surface and groundwater;
- Low:
  - aquatic ecology;
  - indigenous heritage;
  - geotechnical issues; and
  - air quality (dust).

7 ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Compensatory Habitat

7.1.1 Background

The proposed CCP storage facility expansion requires the removal of approximately 21 ha of native vegetation to the north of the existing CCP storage facility to accommodate the future placement of CCP. The Concept Approval issued in respect of the proposal requires that compensatory habitat be provided at a ratio of no fewer than 2 ha for each hectare of vegetation removed.

The proposed area for expansion of the CCP storage facility is part of a woodland buffer area maintained by EE. The area is mapped as the Coastal Plains Smooth-barked Apple Woodland vegetation community, with Coastal Plains Scribbly Gum Woodland occurring to the north of the ridgeline that forms the northern boundary of the study area. **Figure 7.1** shows the extent of vegetation communities in the study area.

An ecological investigation and targeted surveys were undertaken by HLA ENSR in July and November 2005. The ecological investigation assessed potential impacts associated with the removal of vegetation and indicated that there would be no significant impact upon threatened species, populations or ecological communities provided that appropriate safeguards were implemented on site.

7.1.2 Environmental Assessment Requirements

The EARs outlined in the Concept Approval require that full details of the compensatory habitat package for the project be addressed, having regard to previous ecological surveys undertaken, and the *Lake Macquarie* Tetratheca juncea *Management Plan* (as amended 2001).

The Concept Approval also contains certain conditions in relation to the staging of the works, as follows:

- The extent of vegetation clearing for fly ash placement is to be limited to the area generally delineated as “approximate extent of land clearance end of year 10” (this does not include areas required to be cleared for pipeline or roadway access);
- Vegetation clearing shall be staged such that the proposal is undertaken in no fewer than three stages and that no more than 7 ha of vegetation is removed in any single stage of the proposal;
- No fewer than 2 ha of compensatory habitat is to be provided for each hectare of vegetation removed; and
- Commencement of each stage of the proposal shall be contingent on the implementation of the compensatory habitat works for the previous stage of the proposal.

The proposal would be undertaken in accordance with these requirements. Staging of works is further discussed in **Section 7.1.4**.

7.1.3 Establishment of Compensatory Habitat

The EA prepared in May 2006 for the Concept Application identified potential impacts associated with the removal of vegetation, which is discussed in **Section 7.2** of this EA. In order to minimise potential impacts to flora and fauna associated with the removal of vegetation, and to satisfy the requirements of the Concept Approval for the provision of compensatory habitat, areas of potential vegetation offsets/compensatory habitat have been identified at the EPS site, as shown in **Figure 7.2**. As discussed in **Section 3.9**, the Concept Approval states that:

- Vegetation clearing shall be staged such that the proposal is undertaken in no fewer than three stages and that no more than 7 ha of vegetation is removed in any single stage of the proposal; and
- No fewer than 2 ha of compensatory habitat is to be provided for each hectare of vegetation removed.

The proposed expansion of the CCP storage facility would be undertaken in three stages, each requiring the removal of 7 ha, and requiring the provision of a total of some 42 ha of compensatory habitat. The identified areas of potential compensatory habitat and proposed staging are provided in **Table 7-1** below.

The compensatory habitat package proposed in this EA has been revised since the preparation of the LTMS. The LTMS would be updated to incorporate proposed measures when and if Project Approval is granted.

Table 7-1: Areas of Potential Offsets/Compensatory Habitat

Stage of Clearing	Location of Compensatory Habitat	Description	Area
Stages 1 & 2	Area directly to the north of CCP storage facility, above RL 150 m (refer **Figure 7.2**).	Strip of land along the ridgeline above RL 150m comprising existing remnant bushland.	≈ 13.2 ha
	Area to the north-east of the CCP storage facility, above RL 150 m (refer **Figure 7.2**).	Area of existing remnant bushland to the east of the above identified strip of land.	≈ 6.4 ha
	Area to the east of the CCP storage facility (refer **Figure 7.2**).	Area of undisturbed bushland to the east of the CCP storage facility.	≈ 8.4 ha
Total compensatory habitat provided for Stages 1 and 2			**28 ha**
Stage 3 – Potential Offset Areas	Area directly to the east of the CCP storage facility, known as Area C (refer **Figure 7.2**).	Area was previously used for CCP storage and has been capped. EE is in the process of an extensive rehabilitation program for this land. EE propose to offer this land as compensatory habitat for the Stage 3 clearing, subject to an assessment of the character and quality of the vegetation.	≈ 21 ha
Total compensatory habitat for Stage 3			**21 ha**

As shown in **Table 7-1**, the compensatory habitat offset for Stages 1 and 2 comprise three areas 13.2 ha, 6.4 ha and 8.4 ha of remnant bushland to the north, north east and east,

respectively, of the CCP storage facility. The two parcels of land to the north and north east were acquired by EE since the lodgement of the Concept Application, for the purpose of providing additional compensatory habitat. The third parcel of land was identified as a potential compensatory habitat area already owned by EE.

In acknowledgement of the fact that compensatory habitat Area C requires long term rehabilitation in order to provide habitat of the same character and quality as that to be cleared during Stage 3, an additional area of potential offset vegetation has been identified, as indicated in **Table 7-1**. An assessment of the character and quality of the vegetation in Area C would be undertaken prior to Stage 3 clearing. If the area is not suitable as compensatory habitat at this time, an additional 14 ha identified to the east of the CCP storage facility (refer **Figure 7.2**) would be provided as compensatory habitat. If this additional 14 ha area is used, this would equate to a total provision of up to 63 ha of compensatory habitat areas, which represents an additional 22 ha over that required under the conditions of Concept Approval.

EE is currently preparing a Masterplan for the EPS site to facilitate land use planning, enabling a holistic approach to land use management at EPS. The Masterplan identifies potential compensatory habitat offset areas on the EPS site, which could be used to provide compensatory habitat for current and future development proposals.

EE has already commenced an extensive program of rehabilitation and revegetation of areas affected by the operations of the EPS. EE is committed to this program which involves re-establishment of habitat and ecosystems of a similar character and quality to those previously existing on the site. It is EE's intention to continue this focus for the compensatory habitat areas provided in respect of the expansion of the CCP storage facility.

EE has also prepared an Ash Dam Vegetation Management Plan (ADVMP), which has informed the strategy for the development of compensatory habitat. Vegetation species to be used for the development of compensatory habitat are nominated in the ADVMP. EE is also implementing a Threatened Species Recovery Plan (TSRP) for *Tetratheca juncea* and *Acacia bynoeana,* which has been prepared by HLA ENSR in accordance with the *Lake Macquarie* Tetratheca juncea *Management Plan* (amended 2001), and is provided in **Appendix G**. The TSRP identifies recovery and management options to promote existing populations of *Tetratheca juncea* and *Acacia bynoeana*, and manage impacts associated with the removal of threatened species. Management will incorporate habitat protection, rehabilitation and management of key threatening processes.

Details of existing land rehabilitation works undertaken at EPS which would link with the compensatory habitat areas to be provided in relation to the approved expansion, along with details of the proposed preparation and management of the compensatory habitat Area C are provided below.

Corridor Preparation

EE has developed a corridor of compensatory habitat between the area that is to be cleared for the purposes of the expansion of the CCP storage facility, and the existing woodland to the east of the CCP storage facility. A general description of the corridor and the techniques used in its establishment is provided below:

- The corridor is based on floral assemblages of both Coastal Plains Smooth-barked Apple Woodland vegetation community and Coastal Plains Scribbly Gum Woodland both typical of the surrounding bushland;
- The corridor is intended to provide a strategic connection running west to east for the movement of arboreal and avian fauna across the decommissioned CCP storage facility;

- Topsoil that was stored from the original excavation of the CCP storage facility has been recovered and spread over approximately 5 ha of Area C at a depth of approximately 1 m;
- Locally sourced organic material has been placed on the topsoil to assist in the development of micro-organism activity and enhancement of soil nutrients. This material included (although was not limited to) chipped brush material from local plants that have developed on the topsoil stockpiles;
- Hollow stumps, branches and rocks have been placed strategically in the area for use by fauna and to provide roost sites for avian fauna;
- Direct seeding of topsoil material was undertaken with a range of endemic over and understorey plant species;
- Planting of the site was undertaken using tube stock of endemic species that are difficult to establish from direct seeding methods;
- The project includes weed control, vertebrate pest control and maintenance and monitoring of the site; and
- The Local Aboriginal Land Council (Koompahtoo) was involved in the development of this corridor providing assistance in planting out and early maintenance of the area.

This work was completed prior to the lodgement of the LTMS and DECC, DoP and local Council were invited to review the work carried out.

Establishment of Area C

Similar techniques to the methods used to prepare and establish the corridor (described above) would be used to prepare and establish the required compensatory habitat in Area C.

The focus of this area of compensatory habitat is the construction of a habitat corridor, integrating with the already established corridor described above, based on the same floral assemblages (Coastal Plains Smooth-barked Apple Woodland vegetation community and Coastal Plains Scribbly Gum Woodland). The following methodology would be adhered to for the preparation and establishment of this area of habitat:

- Capping of Area C using locally sourced chitter;
- Placement of locally sourced topsoil material across the area;
- Placement of locally sourced organic material on the topsoil, to assist in the development of micro-organism activity and the enhancement of soil nutrients;
- Placement of large woody debris across the surface of the topsoil. This material would serve as fauna habitat for species utilising the corridor and assist in the stabilisation of the soil surface. It would also provide roost sites and temporary refuge for avian fauna that choose to feed on the ground cover and understorey species that would develop across the corridor and that proliferate on the adjoining decommissioned CCP storage facility surfaces;
- Erection of log material across the area to serve as stag and roost trees. The timber for these features would be locally sourced from the vegetation that developed on the topsoil stockpiles, utilising the larger trees. These features would serve as refuges for both avian and arboreal fauna that utilise the area;

- Collection and propagation of native endemic seeds for on site planting. EE currently employ Koompahtoo LALC to collect and propagate seeds as part of a seed propagation program;
- Direct seeding of the topsoil material with a range of endemic cover and understorey plant species;
- Planting of the site using tube stock of endemic species that are known to be difficult to establish from direct seeding methods;
- Weed control as part of EE's current program to restrict the colonisation and spread of weed species that are known to exist locally;
- Vertebrate pest control as part of EE's ongoing site wide program; and
- Maintenance and monitoring of the site, including regular visual inspections of the entire site with data recorded on the success of the revegetation program, the need for supplementary plantings, the success of weed control programs and evidence of usage of the site by local fauna.

The primary objective of these proposed works is to create an area of compensatory habitat that is a stable, near-natural ecosystem. A second objective of this program is to utilise cultural practices and habitat reconstruction protocols that:

- Maximise seedling establishment and growth among both upper storey and understorey species;
- Determine the appropriate mix of species (and their establishment requirements) necessary to create ecosystems that would facilitate and/or encourage habitation of the reconstructed sites by fauna species; and
- Develop ecosystems that, through their diversity and structural composition, would have both resistance and resilience to the impact of major disturbances such as fire and drought.

These works to the compensatory habitat area would commence in advance of clearing, to allow sufficient time for the area to become established and begin to function as a stable ecosystem. This would ensure that in the long term, the compensatory habitat area would be providing a habitat of similar character and quality to that of the vegetation to be cleared.

7.1.4 Staging of Works

The works required for the expansion of the CCP storage facility would be staged to reflect the operational needs of EPS in terms of CCP management, as well as to mitigate and minimise the potential environmental impacts.

The proposed works would be undertaken in accordance with the requirements of the Concept Approval, and in accordance with the commitments presented in the CCP LTMS. The placement of CCP within the new expanded storage facility is shown in **Figure 3.4**.

Clearing of land required for the expansion of the CCP storage facility would commence prior to the first generating unit being connected to the new dense phase pumping system (due in March 2009) to allow for commissioning of the dense phase placement process. Details of the likely staging of proposed works are provided below.

Table 7-2: Likely Staging of Proposed Expansion Works

Stage	Actions	Timing
Preliminary	• Preparation of compensatory habitat plan for first stage of compensatory habitat. • Commencement of works on Area C including planting and establishment.	• January 2008 • October 2007-April 2008
Stage 1	• Preparation of compensatory habitat plan for second stage of compensatory habitat. • Dedication of first stage of compensatory habitat to satisfaction of DECC and DoP. • Further planting and establishment works on Area C. • The first stage of land clearing (up to 7 ha) would occur up to around RL 130m (see **Figure 3.5**).	• April 2008 • September 2008 • October 2008-April 2009 • October 2008
Stage 2	• Dedication of second stage of compensatory habitat to satisfaction of DECC and DoP. • Second stage of clearing (up to a further 7 ha) would be carried out up to around RL 135 m (see **Figure 3.5**).	• May 2010 • June 2010
Stage 3	• Undertake review of status of reuse/recycling options and CCP management needs of EPS to assess need for third stage of clearing. • Undertaken assessment of character and quality of vegetation in Area C. • Preparation of compensatory habitat plan for third stage of compensatory habitat Area C. • Dedication of third stage of compensatory habitat (either Area C or 14 ha to the east of the CCP storage facility) to satisfaction of DECC and DoP. • If required, the third stage of clearing (up to a further 7 ha) would be carried out up to around RL 140 m (see **Figure 3.5**).	• March 2015 • Commence October 2007 to provide seven years of growth prior to April 2015 • Commence October 2009 to provide seven years of growth prior to April 2015 • May 2015 (may be delayed if extent of CCP reuse means available capacity) • June 2015 (may be delayed if extent of CCP reuse means available capacity)

Figure 3.5 illustrates the proposed staging of clearing for the expansion works. The above staging program would be regularly reviewed as part of the LTMS review process and updated based upon the latest projections of CCP production and alternative CCP use.

The following protocol would be adopted for each stage of the proposed works:

- EE would prepare a compensatory habitat plan for each area of compensatory habitat to be provided prior to each stage of clearing;
- EE would utilise where possible disturbed areas rather than clear bushland for access to the area of placement particularly in regard to the pipeline route; and
- The third stage of clearing would be subject to an assessment of need based upon the operational requirements of the EPS and the level of alternative use of CCP.

EE has produced a CCP Management Plan for dense phase placement which shows the staging and method of CCP placement. This plan is shown in **Figure 3.4**.

7.1.5 Conclusion

The proposed expansion of the CCP storage facility would result in the removal of some 21 ha of native vegetation and habitat. In order to minimise potential impacts associated with the removal of vegetation, and to satisfy the requirements of the Concept Approval, 28 ha of existing remnant bushland has been identified to provide compensatory habitat for the proposal for Stages 1 and 2. The area known as Area C, which is currently being rehabilitated by EE, provides some 21 ha of compensatory habitat, which would be subject to an assessment of character and quality of vegetation prior to Stage 3 clearing. While this area does not currently provide habitat of the same character and quality as that to be cleared, by the time the third stage of clearing is to commence in 2015, this area should be a fully established and mature habitat of a high quality and characteristic of the vegetation communities proposed to be cleared as part of the proposal. Additionally, some 14 ha of additional potential compensatory habitat has been identified to the east of the CCP storage facility, if Area C does not provide suitable compensatory habitat.

The proposed staging and strategy for vegetation clearing outlined in **Section 7.1.4** of this EA is consistent with the LTMS and requirements of the Concept Approval, and is not anticipated to represent a significant impact to terrestrial ecology.

7.2 Terrestrial Ecology

7.2.1 Background

The flora and fauna assessment undertaken for the Concept Application included a description of the existing environment based on a review of existing information, general surveys and targeted surveys of the site. The assessment focussed on a study area of approximately 56 ha, located directly to the north of the existing CCP storage facility, which included land owned by EE and the land that was to be purchased.

The general flora surveys included a combination of walked survey transects and nine 400m^2 survey plots undertaken in July 2005. Further targeted surveys, comprising parallel walking transects 10 m apart over the entire study area, were undertaken for threatened species *Acacia bynoeana* (Tiny Wattle), *Callistemon linearifolius* and *Tetratheca juncea* listed under the *Threatened Species Conservation Act 1995* (TSC Act). Targeted surveys were also undertaken

for regionally significant species including *Genoplesium despectans* (Sharp Midge Orchid), *Hakea bakeriana*, *Bossiaea stephensonii* and *Pultenaea tuberculata*.

The surveys found that the vegetation of the CCP storage facility expansion area is characteristic of two communities; Coastal Plains Smooth-barked Apple Forest, and Coastal Plains Scribbly Gum Woodland.

Fauna surveys included trapping using cage traps and Elliott traps, spotlighting, echolocation detection, call playback, observation, listening and hand searches. Characteristic evidence of species presence was also noted which included the presence of scats, feathers, scratches, bone material, tree scarring, nests and burrows.

7.2.2 Environmental Assessment Requirements

The SoC prepared in respect of the Concept Application committed EE to:

- Adopting a staged approach to vegetation clearing for expansion of the CCP storage facility;
- Retention of a minimum 20 m buffer zone from the ridgeline within which no clearing would occur;
- Preparation and implementation of a Flora and Fauna Management Plan including details of staging of clearing to minimise impacts associated with critical periods in the lifecycles of significant species, and incorporating a Vegetation Clearance Protocol;
- Installation of artificial nest and roost boxes within nearby woodland prior to the first stage of clearing, to replace tree hollows at a ratio of 2:1. Monitoring details of nest and roost boxes would be included in the Flora and Fauna Management Plan for the site; and
- Preparation and implementation of a rehabilitation plan, including vegetation, soil and weed management.

In addition, the EARs outlined in the Concept Approval require that this EA identify details of how construction, operation and maintenance of the project would be undertaken to minimise potential impacts on terrestrial ecology.

7.2.3 Potential Impacts

The major impacts of the proposal to terrestrial flora and fauna are associated with the clearing of native vegetation. The EA prepared for the Concept Application specified that some 52 ha of native vegetation would require clearing to accommodate the proposed expansion. However, the total area of the proposed expansion of the CCP storage facility footprint has since been reduced to 21 ha to minimise impacts associated with the removal of vegetation.

Potential impacts associated with the removal of vegetation include loss of habitat supporting native flora and fauna, such as mature hollow bearing eucalypts, dense shrub understorey, dense ground cover, fallen logs and leaf litter. Fauna species most likely to be affected by the proposed development are species that utilise this habitat including the small mammal population, arboreal mammals and insectivorous bats that roost in tree hollows.

The disturbed landscape resulting from the proposed clearing would be susceptible to the establishment and spread of weeds and feral animals and also aggressive native species that are adapted to disturbed landscapes. Without the implementation of mitigation measures and

strategies to effectively manage the impacts of the proposed clearing, the remaining bushland surrounding the cleared area would suffer from edge effects.

The placement of dense phase fly ash within the CCP storage facility during operation would also reduce the aquatic habitat available to a variety of aquatic birds including *Himantopus himantopus* (Black-winged Stilts), *Cygnus atratus* (Black Swans) and *Anas gracilis* (Grey Teals) which currently use the existing CCP storage facility.

The ecological assessment undertaken for the Concept Application identified that the proposal would result in the removal of approximately 34 ha of habitat for *Tetratheca juncea.* The ecological assessment also showed that some 30% of the mapped occurrences occurred outside of the project footprint and similar habitat types are likely to occur to the north of the study area. Several hundred specimens of *Tetratheca juncea* are known to occur elsewhere within the EPS lands, while the locations of other threatened species known to occur within the EPS lands would not be impacted by the proposed expansion of the CCP storage facility. The footprint of the proposed CCP storage facility expansion has been reduced in accordance with requirements of the Concept Approval, therefore the amount of *Tetratheca juncea* habitat to be removed would be less than originally assessed. The ecological assessment is therefore considered to represent a conservative assessment of potential impacts.

Habitat is present within the study area for a further 18 threatened species. Seven-Part Tests of Significance were undertaken to determine whether the proposed project would have a significant impact on these species. The tests concluded that, with the implementation of the safeguards outlined below in **Section 7.2.4**, the proposed project would not have a significant impact upon these species.

As previously stated, the proposed action involves clearing approximately 21 ha of native vegetation. Clearing of native vegetation is a Key Threatening Process under Schedule 3 of the TSC Act. The removal of trees would be offset by the proposed safeguards, in particular, the provision of up to at least some 42 ha compensatory habitat, and the installation of artificial nest boxes and roosting boxes within compensatory habitat areas.

7.2.4 Environmental Safeguards

While the proposed CCP storage facility expansion would result in the removal of vegetation, compensatory habitat measures have been identified to offset identified impacts. Compensatory habitat offsets are discussed in **Section 7.1**. In addition, mitigation and maintenance measures would be implemented to minimise potential impacts, and are listed below.

Construction
To minimise impacts on terrestrial ecology during the construction phase, the following safeguards would be implemented:

- The proposed works would be undertaken in a staged manner in accordance with the Concept Approval and the LTMS (refer **Section 3.9**);
- Each stage of clearing would be subject to further ecological assessment prior to clearing;
- Prior to commencing the proposed works, EE would prepare, and then subsequently implement a Flora and Fauna Management Plan which would include:
    - Details of the timing of clearing to ensure that it does not adversely affect critical periods in the lifecycles of significant species;
    - General safeguards to be installed; and

- Flora and fauna monitoring programs to be implemented.

- The Management Plan would also include a Vegetation Clearance Protocol incorporating details on:
  - The delineation of areas of remnant vegetation to be cleared;
  - Progressive clearing;
  - The identification of fauna management strategies;
  - The collection of seed from the local areas;
  - The salvage and reuse of material from the site; and
  - The control of weeds during clearing activities;
  - Measures to minimise the occurrence of feral pests;
  - Selective planting of native vegetation; and
  - The provision of roosting/nesting resources for fauna.
- Prior to the first stage of clearing EE would install artificial nest boxes within nearby woodland. The boxes shall have a variety of entrance sizes to accommodate different species. Artificial nest and roost boxes shall be installed to replace tree hollows at a ratio of 2:1;
- Professional wildlife spotters shall be present during clearing of canopy trees;
- A local wildlife care group would be called if injury to wildlife occurs;
- Construction vehicles would remain on access roads and construction areas to avoid unnecessary disturbance; and
- Erosion and sediment control measures shall be installed around all construction works.

Operation and Maintenance

During operation of the proposed CCP storage facility, the following safeguards would be implemented to minimise impacts on flora and fauna:

- A flora and fauna monitoring programme would be implemented as outlined in the Flora and Fauna Management Plan, which would be developed prior to commencement of works;
- The condition of nest boxes would be monitored for damage and occupation by pest species until hollows in rehabilitated areas have developed sufficiently for targeted species to occupy;
- Provide ground shelter for terrestrial species by placing hollow logs and timber on the ground. Providing such shelter can also provide denning sites for feral predators such as *Vulpes vulpes* (European Red Fox) and as such, a feral animal monitoring and management programme shall be incorporated into the Flora and Fauna Management Plan;
- Develop and implement a weed monitoring and management programme as part of the Flora and Fauna Management Plan;
- Vehicles are to remain on designated access roads;
- A rehabilitation plan shall be prepared and implemented that utilises soil and regolith stripped during clearing in rehabilitation, and if practicable, the fly ash deposited as part of the proposed development. The rehabilitation of the

CCP storage facility shall utilise a similar community to that which is proposed to be cleared, particularly with regard to the nectar producing species.

- Species that are local to the area and flower regularly should be encouraged, particularly species that flower in winter. It is important that species that tend to dominate vegetation communities without providing foraging or denning opportunities for native fauna, such as *Casuarina glauca* (Swamp Oak) should be excluded from the rehabilitation plan; and
- Compensatory habitat shall be maintained in accordance with a compensatory habitat plan, to be prepared prior to each stage of clearing, as discussed in **Section 7.1**.

7.2.5 Conclusion

The proposed CCP storage facility expansion would require the removal of up to some 21 ha of vegetation, which would result in the loss of habitat for flora and fauna species. With the implementation of environmental safeguards, including mitigation and maintenance measures, as well as the provision of compensatory habitat offset areas discussed in **Section 7.1**, it is anticipated that potential impacts to terrestrial ecology would not be significant.

7.3 Groundwater

7.3.1 Background

The EA prepared for the Concept Application identified the geology of the area as consisting of Quaternary alluvium including gravel, sand, silt and clay in the vicinity of Lake Macquarie overlying Triassic Narrabeen Group claystone, sandstone and shale (1:250,000 Sydney Geological Map Sheet (S1 56-5)). The 1:100,000 Gosford-Lake Macquarie Soil Landscape Series Map identifies soils beneath the EPS site to consist of moderately deep yellow earths of sandstone and conglomerates of the Munmorah Conglomerate. The area comprising the existing CCP storage facility is identified as disturbed terrain. In the southern area of the site adjoining Myuna Bay, the soils are expected to consist of deep poorly drained deltaic and alluvial material with acid sulphate potential.

Groundwater beneath the site is expected to be present within the shallow soils and former CCP placement areas of the former Wangi Power Station. The existing CCP storage facility is a potential source of contaminants to the surrounding groundwater environment. The nearest groundwater receptors surrounding the CCP storage facility are Crooked Creek and Lake Macquarie.

7.3.2 Environmental Assessment Requirements

The EARs outlined in the Concept Approval require that the EA considers potential impacts to groundwater quality, and provides details of mitigation, monitoring and management measures to be applied to the project. The EARs also require that the assessment of potential impacts to groundwater quality be undertaken in consultation with DECC, DWE and the Hunter-Central Rivers CMA.

7.3.3 Potential Impacts

Potential impacts to groundwater quality associated with the proposed upgrade and expansion of the CCP management system are primarily associated with the seepage and migration of

potentially contaminated groundwater, which could ultimately impact the local groundwater quality, as well as the water quality of receiving water bodies such as Lake Macquarie.

Under existing conditions, it is anticipated that there is some seepage and downward vertical migration of water used in the conditioning and mixing of fly ash from the CCP storage facility after placement. Water seepage through the base of the CCP storage facility has the potential to impact local groundwater quality, and potentially impact the water quality of groundwater receptors surrounding the site. Seepage has the potential to introduce contaminants potentially leached from the lean phase emplacement, and seawater trace element components.

Potential groundwater contaminants that may originate from the CCP storage facility primarily include heavy metals and trace elements such as selenium. Currently, quarterly groundwater sampling from five monitoring bores is carried out at EPS. Quarterly analysis is undertaken for parameters including major ions; boron; manganese and iron. On an annual basis the analysis schedule is expanded to include the following metals: arsenic, cadmium, chromium, copper, selenium, lead and zinc. Additionally, other parameters including temperature, pH, conductivity, fluoride and phosphorus are also analysed.

Historical groundwater monitoring results indicate that there are a number of trace metals in groundwater beneath the CCP storage which have, on some occasions, been recorded in concentrations in excess of the adopted criteria (ANZECC (2000) *Guidelines for Fresh and Marine Water Quality*). Under the existing groundwater monitoring regime, it is difficult to determine whether the concentrations of some metals can be attributed to background or naturally elevated conditions.

While the source of elevated concentrations of contaminants is unclear, the proposed expansion of the CCP storage facility and dense phase placement of fly ash is not anticipated to adversely impact the groundwater quality beneath or downgradient of the CCP storage facility. The proposed dense phase placement technique would require significantly less water during the conditioning and mixing process to form the dense phase slurry. This would reduce the quantity of water within the CCP storage facility, which is likely to result in a reduction in seepage to groundwater compared to the current lean phase placement. In addition, the cementitious nature of the dense phase emplacement would form an impervious blanket across the surface of the existing lean phase emplacement, as well as across the surface of the proposed expansion area of the CCP storage facility, thus minimising the potential for seepage to groundwater.

The proposed implementation of dense phase placement is therefore anticipated to result in a reduction in groundwater seepage in comparison to current conditions.

7.3.4 Environmental Safeguards

As discussed in **Section 7.3.3**, the proposed dense phase placement technique is not anticipated to impact groundwater quality beneath the CCP storage facility; rather it is likely to maintain the status quo, or result in an improvement to groundwater. The cementitious nature of the dense phase emplacement is likely to act as an impermeable blanket over the existing lean phase emplacement, and the proposed expansion area of the CCP storage facility.

In addition, in order to monitor the existing groundwater environment beneath the CCP storage facility, EE propose to undertake a review of the existing groundwater monitoring regime to assist in determining whether current contaminant levels originate from existing activities associated with the EPS. The groundwater monitoring review would include:

- Surveying of existing monitoring bores to determine groundwater flow direction and gradient;

- Sampling of monitoring bores, with analytes to include major ions, total dissolved solids and a suite of heavy metals;
- Review of the adequacy of the existing groundwater monitoring network at EPS;
- Installation of an additional monitoring bore upgradient of the CCP storage facility to provide background concentrations of the local groundwater regime; and
- Preparation and implementation of a revised groundwater monitoring regime and updating of EE's existing Groundwater Management Plan in accordance with the review.

The revised groundwater monitoring regime and Groundwater Monitoring Plan would also include the development of response plans that would be prepared and implemented in the event that monitoring identified an adverse change in contaminant concentration in groundwater that could potentially be attributed to the expanded CCP storage facility.

7.3.5 Conclusion

Under current conditions at EPS, it is anticipated that there is some seepage and downward vertical migration of water used in the conditioning and mixing of fly ash from the CCP storage facility after placement. Potential impacts to groundwater quality associated with the proposed upgrade and expansion of the CCP management system are primarily associated with seepage and migration of potentially contaminated groundwater. However, due to the cementitious nature of the dense phase emplacement and reduced volumes of water, the proposed dense phase placement technique and expansion of the CCP storage facility is not anticipated to impact groundwater quality beneath the CCP storage facility.

In addition, EE proposes to undertake a review of the existing groundwater monitoring regime to assist in determining whether current contaminant levels originate from activities associated with EPS. The current EPS Groundwater Monitoring Plan would be revised to incorporate the results of the investigation.

The proposed expansion and upgrade of the CCP management system is therefore not anticipated to significantly impact groundwater.

7.4 Surface Water

7.4.1 Background

The EA prepared for the Concept Application identified existing water uses associated with the CCP storage facility and current lean phase placement. Water is currently used during operation of the current lean phase placement process, whereby a slurry of approximately 30% fly ash and 70% water is discharged to the CCP storage facility. Water is also used for dust suppression within the CCP storage facility.

Under existing conditions, the CCP storage facility collects natural inputs of surface from rain and surface runoff. Water collected on the surface of the CCP storage facility after the placement of fly ash is drawn off via a stilling pond in the southern portion of the CCP storage facility and discharged to a return water dam. Water is pumped from the return water dam to the return water tank, and is either re-used for ash slurry transport, or discharged to Lake Macquarie via the cooling water outlet canal. The return water tank provides buffer storage of water for use in the slurry process, and supplies water to the ash and dust plants.

The EPL applying to the site allows for controlled discharge from the CCP storage facility to Crooked Creek, which discharges to Lake Macquarie. EE operates and monitors the CCP storage facility to minimise the likelihood of controlled discharges. Controlled discharge via Crooked Creek only occurs during extreme rainfall events where the water level in the CCP storage facility reaches RL 125.5 m. Discharge is monitored at a licensed discharge point, and is reported to the DECC.

An assessment of potential impacts to surface water was undertaken in the EA prepared for the Concept Application to assess potential impacts of the proposal on water quality. Potential impacts to surface water resulting from the proposed works previously identified include:

- Potential water quality impacts to receiving waters;
- Alterations to the local hydrological regime;
- Changes to runoff patterns resulting in erosion and sedimentation; and
- Temporary impacts to water quality during the construction period as a result of earthworks and construction traffic.

Environmental safeguards were identified to ensure that potential impacts to surface water quality would be minimised. The assessment concluded that provided water monitoring programs were implemented as part of the operation of the CCP storage facility, and appropriate design and construction mitigation measures were undertaken, potential impacts to surface water would be minimal.

7.4.2 Environment Assessment Requirements

The SoC prepared in respect of the Concept Application committed the Proponent to undertaking a number of investigations to assess potential impacts on surface water, including:

- Likely quality and quantity of surface water runoff from the CCP storage facility and likely impact on receiving waters; and
- A hydrological study of the site to ensure that the proposal would not significantly alter site hydrology or the local flood regime.

In addition, the EARs outlined in the Concept Approval require that potential impacts to surface water quality be considered.

7.4.3 Potential Impacts

A number of investigations have been undertaken in order to assess potential impacts associated with surface water quality and alterations to hydrology resulting from the proposed expansion of the CCP storage facility, discussed in **Section 7.4.1** above. These are addressed below.

Water Quality
Potential impacts to surface water quality and receiving waters resulting from the operation of the CCP storage facility predominantly include increased pollutant concentrations and sediments in surface runoff from the CCP storage facility, resulting in increased pollutant concentrations being discharged to Lake Macquarie.

The primary pollutant of concern associated with surface runoff from the CCP storage facility is selenium. Selenium is a trace element commonly found in coal, and tends to be enriched in finer fly ash particles (CSIRO, 2007). The EPL applying to the site specifies that selenium

concentrations should not exceed 2 µg/L in water discharged to Lake Macquarie via the cooling water outlet canal.

The current fly ash placement system uses a lean phase of approximately 30%, with CCP terracing to minimise infilling of the pond. As the proposed dense phase placement system would significantly increase the concentration of fly ash deposited within the CCP storage facility, investigations were undertaken to model the effect of dense phase placement on the concentrations of selenium in discharges to Lake Macquarie.

The selenium modelling considered natural mechanisms of selenium removal from the pond, and included likely changes in pond volume, catchment areas and discharge volumes associated with the proposed dense phase placement. Natural mechanisms of selenium removal from the pond include:

- Losses from biological activity;
- Physical/chemical adsorption of selenium on the fly ash/sediments which form in the pond; and
- Equilibrium release back to the pond from the fly ash/sediments, and biological processes.

The selenium concentration modelling also accounted for projected sales of fly ash, and assumed a predicted increase to 55% in 2015. However, as part of the LTMS, EE has committed to achieving a target of 80% reuse of both fly and bottom ash. Therefore, the reuse assumptions used in the selenium concentration modelling provide a conservative assessment, and increased reuse would be likely to further reduce selenium concentrations.

The modelling estimated that under proposed dense phase operation, the ratio of pond volume to wetted fly ash surface would be 40% lower than under current conditions. This would result in a greater area of fly ash per unit volume of storage in contact with the overlying body of pond water during dense phase operation. This is anticipated to provide increased opportunity for re-adsorption of selenium onto the deposited fly ash surface, reducing the concentration of selenium in the stilling pond.

Other potential impacts to surface water quality may include erosion and sedimentation, resulting in increases in total suspended solids (TSS) in discharges to Lake Macquarie via the cooling water outlet canal. EE currently monitors the water quality of discharges to Lake Macquarie via the cooling water outlet canal in accordance with monitoring parameters specified in the EPL for the site. Monitoring parameters include concentrations of selenium, copper and iron, as well as temperature. Discharges to Lake Macquarie via Crooked Creek are also monitored for pH and TSS. No exceedences of monitoring parameters specified in the EPL from cooling water discharges have been recorded during the past four years of operation.

Predicted Selenium Concentrations

The proposed projection in fly ash sales and subsequent reduction in fly ash input resulting from increased sales is anticipated to result in a reduction in the selenium concentration of water in the CCP facility from current levels. The modelling of selenium concentrations for the operation of the proposed dense phase placement system indicated that the management of water inflow would be expected to reduce water discharges to the cooling water outlet canal to less than 5 ML/day during the pond infilling period (approximately 15 years) and to less than 4 ML/day after the minimum size is reached.

In addition, management of the catchment area surrounding the CCP facility is expected to further reduce water inflows, and hence water discharges to Lake Macquarie. The mass of selenium to the cooling water outlet canal is therefore expected to be correspondingly reduced.

A reduction of the pond size, and accumulation of selenium from the fly ash slurry processes are expected to result in minor concentration increases in the cooling water outlet canal with four cooling water pumps in service.

Overall, total selenium emissions to Lake Macquarie, from the initial operation of dense phase placement until the minimum pond size is reached, are predicted to be lower than during current operation, and below the limit specified in the EPL. Operation of the pond for an additional five years may give emissions about 30% lower than the average observed during the current operations, due to increased fly ash sales resulting in less selenium input to the CCP storage facility.

The modelling indicated that internal losses of selenium from the current CCP storage facility were high, at about 96% of the pond concentration increases due to fly ash slurry inputs. Laboratory tests undertaken in association with the modelling suggested that most of these losses were due to re-adsorption of leached selenium back onto fly ash deposits. Due to the range of factors that determine the selenium concentrations in the CCP facility, and possible changes during the actual operation of dense phase placement, selenium concentrations would be routinely monitored and compared to the model predictions. If significant increases were observed, appropriate mitigation measures would be implemented to ensure the EPL limit of 2 µg/L is not exceeded in the outlet canal.

Hydrology

Hydrological investigations were undertaken to model the capacity of the proposed CCP storage facility to cope with extreme weather conditions, and to determine the probable maximum flood (PMF) capability of the CCP storage facility (refer **Appendix D**). Potential impacts to surface water may include uncontrolled discharge to Crooked Creek in the event of extreme rainfall events, which could result in overflowing of the CCP storage facility, and the transfer of sediments and contaminants to Lake Macquarie.

Under current operating conditions, the CCP storage facility operates with a working level between RL 124.7 m and 124.9 m. When the water level reaches 124.9 m, controlled discharge is initiated to the outlet canal until the water level is reduced to RL 124.7 m. If the water level rises to RL125.5 m, controlled discharge to Crooked Creek can be initiated at the approval of the EPS Environment Manager. Uncontrolled discharge to Crooked Creek, or overflow of the CCP storage facility spillway occurs at RL126.61 m.

Modelling was undertaken using a range of design-storm durations, and analysed for annual exceedence probabilities up to the PMF to determine scenarios where water in the CCP facility would reach a level that would cause an uncontrolled overflow and discharge into Crooked Creek. Modelling results were then compared to historical rainfall data recorded at EPS between 1972 and 2006 to determine the manageability of the proposed operation of the CCP facility, and likelihood of discharge to Crooked Creek. The modelling indicated that under the proposed dense phase placement and existing operating instruction, the earliest time that uncontrolled discharge to Crooked Creek would be initiated is May 2013.

The proposed modification to the dam wall and operating instruction of the CCP storage facility would allow an increase in water level from RL 125.5 m to RL 126.0 m, and the modelled storm events would be held by the CCP storage facility without discharge to Crooked Creek. The hydrological investigations indicate that modifying the operating instruction of the dam would need to occur prior to May 2013. In addition, an increase in the height of the spillway overflow weir by 1 m to RL 127.61 m would also be undertaken.

Under these modelled scenarios, the optimal fly ash placement encroach distance was also modelled, to determine the optimal minimum encroach distance of fly ash placement from the

stilling pond. This distance was determined to be 250 m, which optimise the area available for fly ash placement, while maintaining sufficient pond volume to store water following extreme rainfall events.

7.4.4 Environmental Safeguards

Surface Water Quality

The proposed projection in the sale of CCP, and subsequent reduction in fly ash input is anticipated to result in a reduction in the selenium concentration of water in the CCP storage facility from current levels. The modelling indicated that discharges to the cooling water outlet canal would be reduced to less than 5 ML/day during the pond infilling period (approximately 15 years), and less than 4 ML/day after the minimum pond size is reached. The mass of selenium to the cooling water outlet canal is anticipated to be correspondingly reduced.

Overall, total selenium emissions to Lake Macquarie, from the initial operation of dense phase placement until the minimum pond size is reached, are predicted to be lower than during current operation, and below the limit specified in the EPL. Operation of the pond for an additional five years may give emissions about 30% lower than the average observed during the current operations, due to increased ash sales resulting in less selenium input to the CCP storage facility.

Due to the range of factors that determine the selenium concentrations in the CCP storage facility, and possible changes during the actual operation of dense phase placement, selenium concentrations would be routinely monitored and compared to the model predictions. If significant increases were observed, appropriate mitigation measures would be implemented to ensure the EPL limit of 2 µg/L is not exceeded in the outlet canal.

EE currently monitors water quality at a number of locations, including the cooling water outlet canal which monitors temperature as well as selenium, copper and iron concentrations, and the emergency discharge outlet from the CCP storage facility at the culvert under Wangi Road which monitors pH and TSS. This monitoring regime would continue, and would be updated in accordance with a surface water monitoring program to be prepared and implemented for the proposed upgrade and expansion to the CCP management system as part of a Soil and Water Management Plan.

Additionally, baffles would be installed below the Crooked Creek weir to reduce the rate of flow in the event that discharge to Crooked Creek is initiated, which would minimise potential impacts associated with erosion of the channel and subsequent impacts to Lake Macquarie.

Hydrology

The hydrological investigations indicated that, based on historical one and three day storm events, overflow and subsequent discharge to Crooked Creek would occur under the proposed dense phase placement and current operating levels, at the earliest in May 2013. The engineering modifications would provide the CCP storage facility with additional capacity during rainfall events, and minimise the potential for discharge to Crooked Creek. The modification would comprise:

- Modification of the existing CCP storage facility dam wall and water level operating instruction – this option would raise the level to RL 126.0 m at which controlled discharge to Crooked Creek would be initiated. This would allow a greater capacity to be stored in the CCP storage facility before discharging to Crooked Creek; and
- Increase the height of the spillway overflow weir by 1 m to RL 127.61 m during 2011/12 – This would need to occur prior to May 2013 to ensure that

overflow of the CCP storage facility is limited to greater than historical rainfall events. Some additional design work would be needed on the discharge chute from the spillway to ensure that it was capable of containing the extra capacity likely to occur from the increase in head.

In addition, the following operational management measures would be incorporated to maximise the capacity of the CCP storage facility to cope with rainfall events:

- Reduce the time of water storage capacity at high water level by increasing the return water pumping capacity and availability – the design of the return water pumps should be investigated with the aim to increase the output and reliability of the system; and
- Reduce the catchment area of the CCP storage facility – the catchment of the CCP storage facility could be reduced by the installation of clean water drains around the facility above RL140 m. The drains would direct water to the wetland area at the north east corner of the dam. This runoff then discharges as non contaminated runoff to Lake Macquarie.

7.4.5 Conclusion

The proposed expansion of the CCP storage facility is not anticipated to result in significant impacts to surface water quality or the local hydrological regime. Selenium modelling indicated that surface water quality is not likely to be impacted by an increase in selenium concentrations from the proposed dense phase emplacement until minimum pond size is achieved after a period of approximately 15 years of dense phase operation. Selenium concentrations would continue to be routinely monitored following this period to ensure that the EPL concentration limit was not exceeded.

Hydrological investigations have indicated that two engineering modifications would provide the CCP storage facility with additional capacity during rainfall events, and minimise the potential for discharge to Crooked Creek:

- Modification of the existing CCP storage facility dam wall to increase the storage capacity of the CCP storage facility; and
- Increase the height of the spillway overflow weir to RL 127.61 m.

These engineering modifications, as well as the implementation of operational management measures would provide additional capacity for the CCP storage facility, and would mitigate potential impacts associated with overflows from the CCP storage facility and weir during rainfall events. Further investigation into proposed engineering options would be undertaken following detailed engineering design prior to 2013.

7.5 Aquatic Ecology

7.5.1 Background

EPS operates a once-through cooling water system that uses salt water from Lake Macquarie for cooling processes within the power station. Water is drawn from Bonnells Bay, south of EPS, and is directed to the station via the cooling water inlet canal (refer **Figure 2.1**). A continuous supply of at least 80 m^3/s of cooling water is required to supply the condensers of the power station. Cooling water is discharged to Myuna Bay via the cooling water outlet canal, and is regulated by the EPL applying to the site.

Myuna Bay is a shallow enclosed bay on the south western shore of Lake Macquarie. It supports seagrass beds of *Zostera* and *Halophila* in shallower areas, and estuarine fauna. Turbidity in Myuna Bay is elevated compared to other bays in southern Lake Macquarie and is similar to that recorded in Bonnells Bay. Surrounding foreshore areas including Wangi Wangi Point, Pulbah Island and Bonnells Bay also support *Zostera* and *Halophila* seagrass beds and estuarine fauna, with a maximum depth of around 9 m.

7.5.2 Environmental Assessment Requirements

The EARs outlined in the Concept Approval require that the EA provides details of mitigation measures that would be undertaken during construction, operation and maintenance of the project to minimise potential impacts to aquatic ecology.

7.5.3 Potential Impacts

Potential impacts to aquatic ecology would primarily occur indirectly as a result of surface water quality impacts to Lake Macquarie during construction works associated with the proposed expansion to the CCP storage facility, as well as during operation and maintenance of the CCP storage facility.

Expansion of CCP Storage Facility
The proposed expansion of the CCP storage facility involves the clearing of vegetation and installation of transfer pipeline infrastructure which would result in disturbance to soils. Disturbance of soils during construction may temporarily increase potential erosion and sediment loads. Potential impacts to surface water quality are primarily associated with erosion and sedimentation, which would result in increased turbidity to receiving waters. Increased turbidity can affect light attenuation in the water column, which affects light availability to photosynthetic plants such as seagrass and macroalgae, and can impact the overall condition and productivity of an aquatic system. Suspended sediment can also smother benthic organisms and habitats when it settles. A range of sediment and erosion control measures would be implemented as part of a Soil and Water Management Plan (SWMP) during construction to minimise potential impacts associated with sedimentation and erosion, including:

- Installation of silt fences and straw bales; and
- Installation of surface drains and berms to collect/ divert surface runoff.

Sediment and erosion control measures that would be implemented for the project are detailed in **Section 7.4.4**. In addition, the works to be undertaken associated with the proposed expansion of the CCP storage facility would be primarily within the catchment of the existing CCP storage facility, therefore eroded sediments would be contained in the CCP storage facility rather than migrating into surrounding water bodies such as Lake Macquarie.

Operation and Maintenance
During operation of the proposed CCP storage facility and dense phase placement, aquatic ecology has the potential to be impacted by an increase in concentrations of contaminants derived from fly ash, such as selenium. Selenium modelling was undertaken to determine potential impacts of the proposed upgrade and expansion of the CCP management system on selenium concentrations discharged to Lake Macquarie, and is discussed in **Section 7.4.3**. As the existing selenium concentration limit of 2 ug/L specified in the EPL is not likely to be exceeded, the proposed project is not anticipated to have a significant impact to aquatic ecology are not anticipated to be significant.

Potential surface water quality impacts are identified in **Section 7.4.3**, and include impacts associated with increased concentrations of pollutants and sedimentation resulting in an

increase in TSS. Potential impacts to surface water quality are not anticipated to be significant. Therefore, as there would not be a significant change to surface water quality discharged to Lake Macquarie, aquatic ecology is not anticipated to be significantly affected as a result of the project.

7.5.4 Environmental Safeguards

The mitigation measures detailed below would be implemented to minimise the potential for impacts to aquatic ecology.

Expansion of CCP Storage Facility
During construction works associated with the clearing and expansion of the CCP storage facility, potential impacts to surface water quality and aquatic ecology would be minimised by the containment of eroded sediments within the existing CCP storage facility, as well as the implementation of sediment and erosion control measures including:

- Prior to commencing construction, all necessary erosion and sediment control measures as detailed in the SWMP would be installed. These would then be inspected on a daily basis during construction to ensure that they remain functional. Measures would include, but are not limited to:
  - Surface drains;
  - Berms; and
  - Sediment traps such as silt fences and straw bales.
- Erosion control drains and berms would be designed and constructed so as to ensure that surface water runoff is minimised, and diverted to the CCP storage facility catchment area.

Erosion and sediment control measures would be detailed in the SWMP which would be prepared and implemented for construction activities associated with the expansion of the CCP storage facility.

Operation and Maintenance

- Surface water monitoring shall be undertaken in accordance with the Surface Water Monitoring Program prepared as part of the SWMP;
- Ambient water quality monitoring in Lake Macquarie near the cooling water outlet canal, currently undertaken in accordance with the EPL applying to the site, shall continue in accordance with the EPL to monitor potential impacts to water quality that may affect aquatic ecology;
- CCP placement shall be in accordance with CCP management plans, to ensure that the stilling pond and minimum encroach distance of 250 m is maintained; and
- Baffles constructed downstream of the Crooked Creek weir as part of the proposal shall be maintained to ensure efficiency of operation in minimising sedimentation during events where the CCP storage facility discharges to Lake Macquarie via Crooked Creek.

7.5.5 Conclusion

The proposed expansion of the CCP storage facility has the potential to impact surface water quality, which may ultimately have subsequent impacts to aquatic ecology in Lake Macquarie, if not appropriately managed. Potential impacts to surface water quality have been identified in

Section 7.4.3, and the assessment concluded that surface water is not likely to be adversely impacted by the proposal. Potential impacts to aquatic ecology have been identified in **Section 7.5.3**, and mitigation measures would be implemented during construction, operation and maintenance to minimise potential impacts. As such, the project is not anticipated to significantly impact aquatic ecology.

7.6 Indigenous Heritage

7.6.1 Background

A search undertaken on DECC's Aboriginal Heritage Information Management System (AHIMS) revealed that no sites have been previously recorded in the study area., Consultation and archaeological surveys were undertaken in 2006 and 2007 of the proposed expansion of the CCP storage facility (referred to in this discussion as "the study area") with Aboriginal community involvement and no evidence of Aboriginal sites was identified within the proposed study area.

While effective coverage of the study area was limited due to the dense vegetation, the gentle to moderate slopes that comprise the study area are landforms generally not associated with the presence of archaeological sites. In the Lake Macquarie area Aboriginal sites are more strongly associated with the lake margins, with occasional grinding grooves and small artefact scatter sites in the hinterland along creeks. Furthermore, geomorphological investigation revealed minimal potential for subsurface archaeological deposits.

The conclusions of the field investigation reveal no Aboriginal heritage issues within the study area and recommend no further actions are required.

7.6.2 Aboriginal Consultation

Aboriginal consultation followed the DECC's *Interim Community Consultation Requirements for Applicants* (DEC 2004) which was commenced in November 2005 and continued through to September 2007. The latter stage of the consultation was conducted in response to a condition within the Concept Approval which required:

> *An updated review of potential impacts on Indigenous heritage, having regard to the status of any Native Title claims .apply to the land to be affected by or surrounding the project and consultation with relevant Aboriginal groups, elders and broader Aboriginal community*

HLA ENSR's initial consultation process involved contacting a number of agencies (namely DECC, the Koompahtoo Local Aboriginal Land Council (LALC), Native Title Tribunal, Office of Registrar and Lake Macquarie City Council (LMCC)) to identify the relevant groups, as well as advertising the project in the local newspaper, *Lake Macquarie News* (December 2005), for registrations of interest. Further enquiries were made in August 2007 to identify additional Aboriginal groups and elders of particular relevance to the study area. Consultation details are provided in **Appendix E**.

Initial enquiries in late 2005 and early 2006 identified three Aboriginal groups that wished to be involved in the process – the Koompahtoo LALC, Wonnarua Nation Aboriginal Corporation (WNAC) and Yarrawalk Enterprises Pty Limited (Yarrawalk). The Koompahtoo LALC is the body for the area, while the latter two were invited due to their involvement in an Indigenous Land Use Agreement (ILUA) with Power Coal Pty Limited covering an area of some 87km^2 ending just north of EPS. While this proposed project is not directly related to the activities outlined in

the ILUA, the two groups were considered interested parties by HLA ENSR and therefore included.

Subsequent enquiries in August 2007 identified three additional Aboriginal organisations: Awabakal Descendants Traditional Owners Aboriginal Corporation (ADTOAC), Awabakal Traditional Owners Aboriginal Corporation (ATOAC) and Guringai Tribal Link Aboriginal Corporation (GTLAC).

Furthermore, EE submitted a non-claimant determination of Native Title over the area of Crown Land above the CCP storage facility on 4 September 2006 in order to obtain the protection of section 24FA of the *Native Title Act 1993* providing protection for "future acts" on a defined area of land. No Native Title determination was filed within the statutory three month period under the Section 24FA application.

Mediation was entered into in response to a representation from Victor Perry regarding the applicability of the neighbouring ILUA (NIA2000/001) covering an area of the former Power Coal land to the north of the study area. The named parties to the ILUA include the former Powercoal Pty Ltd and "Victor Perry on behalf of the Wonnarua people, Stephen Siever and New South Wales Aboriginal Land Council". Mediation was entered into through the National Native Title Tribunal (NNTT) in regard to matter NSD1685/06 with Mr Perry whereby it was clarified that Eraring Energy is not a party to the ILUA, nor does the ILUA cover the land subject to the Section 24FA application and that the statutory three month period had passed without Native Title Application for the area and hence Section 24FA protection was obtained for the land purchase.

A search of the NNTT database indicates that there are currently no registered Native Title Claimants existing in the area and no responses were received to HLA ENSR's advertisement of the proposal interest advertised in the local media in late 2005.

Initial fieldwork was undertaken on 10 January 2006 with Mr Scott Franks of Yarrawalk and Mr Rob Lester of WNAC in attendance. While Raymond Smith of Koompahtoo LALC was invited to attend, for logistical reasons he cancelled on the morning of the 10 January 2006 prior to the survey beginning. Secondary site inspection fieldwork was undertaken on 4 September 2007 with Mr Shane Frost of ADTOAC and Ms Kerrie Brauer of ATOAC.

Mr Frost identified the significance of the Pulbah Island in Lake Macquarie (unaffected by the proposal) and an Aboriginal midden site known to him along the shore of the lake near the CCP storage facility (unaffected by the proposal).

Following a review of the draft Indigenous heritage chapter Ms Brauer noted in an emailed letter with review comments dated 25 September 2007 that there were conversations in the field about the association of the area with Pulbah Island. During fieldwork Ms Brauer also commented that she felt that she should not be in the area and that she felt that it was a men's area. In the letter Ms Brauer also stated, "We would like to affirm that the observation and information gathering process presented minimal evidence. However, it should not be assumed that no Aboriginal artefacts have survived within the proposed development area".

An area of shell fragments was identified by Mr Frost at the south eastern edge of the study area within 20 m of the water edge at MGA coordinates 363939E 6342418N (**Plate 7.1**). Shell fragments are dispersed over a 20 m stretch of graded dirt track and introduced soil and gravel on associated road and verge areas. The shell fragments occur at an approximate density of 1/20 m² with small clusters of shell fragments at 20/ m² density. The shell includes immature specimens of hairy mussel recently opened and with organic "hair" intact, occasional immature specimens of cockle and small fragment of mature cockle. The setting is a heavily disturbed

track and soil dump spread out towards the water with introduced coal fragments indicating the introduction of fill throughout the area. No artefacts are evident. There is no archaeological basis for considering these items as Aboriginal objects or the area as an Aboriginal site.

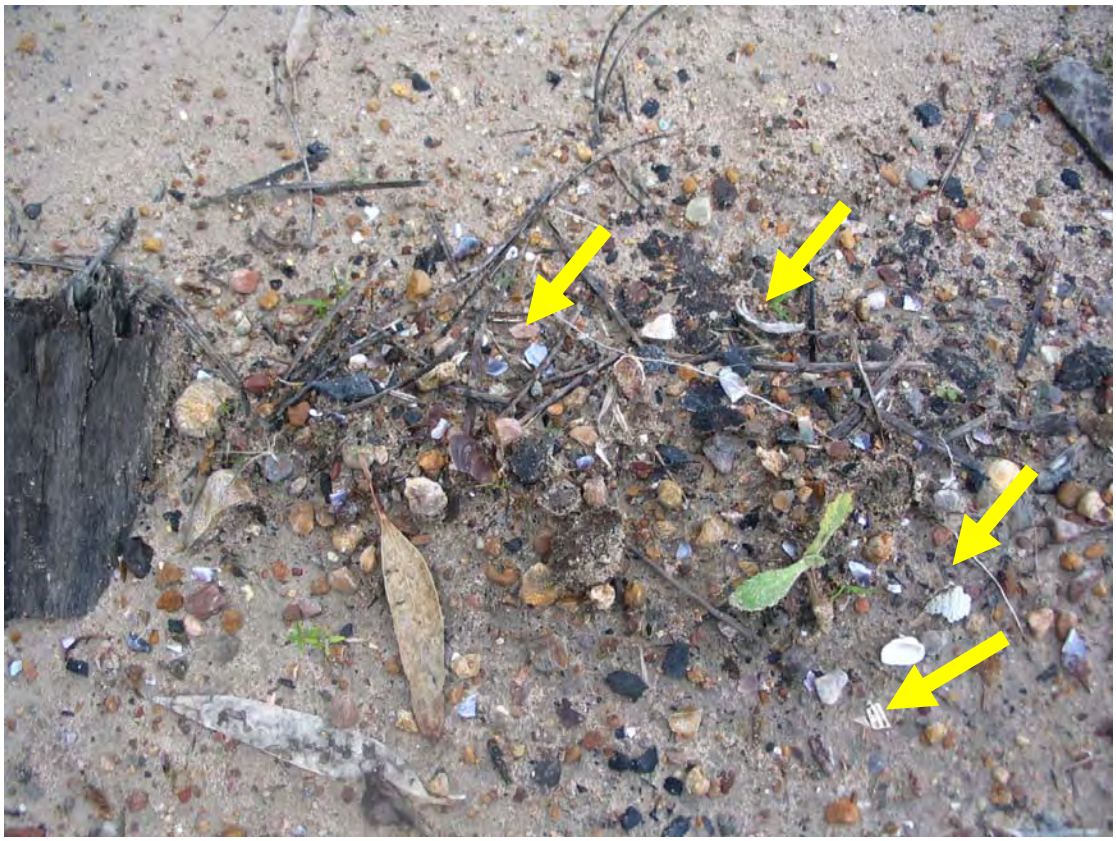

Plate 7-1: Shell fragments observed at northern edge of existing CCP storage facility.

7.6.3 Existing Environment

This section provides background information on the archaeological resource of the area, geomorphological discussions and field observations of the existing environment. General information on the existing environment is discussed in **Section 7.3** in relation to geology and soil profiles and in **Section 7.2** in relation to vegetation.

AHIMS Search

An AHIMS search was undertaken on 5 December 2005 over a 15 km by 15 km area, encompassing EPS and the CCP storage facility. The search revealed 97 Aboriginal sites in the general area, comprising 61 (63%) shell middens, 23 (24%) artefact scatters or isolated finds, three (3%) scarred trees, three (3%) PADs, one (1%) axe grinding groove, one (1%) mythological site, and five (5%) unidentified sites.

The distribution of known sites reveals that the majority of sites are located along the edge of Lake Macquarie and its major tributaries (such as Dora Creek and Pourmalong Creek). Only one site is found near the study area, namely #45-7-0070, a shell midden, which was located on Crooked Creek, south of the CCP storage facility (refer **Figure 7.3**).

In summary, the most common site type in this region, shell middens, reveals Aboriginal people's one-time reliance on the marine resources of Lake Macquarie and its surrounding watercourses. While Crooked Creek was a large water course prior to the CCP storage facility,

as can be seen in aerial photographs preceding the power station's construction in the 1980s, and was probably used by Aboriginals for its water resources, the study area has always been a series of slopes some distance from both Crooked Creek and Lake Macquarie.

Furthermore, at least back to historical times, permanent watercourses such as Dora Creek, Pourmalong Creek and Wyee Creek are likely to have been more attractive to Aboriginal people than the smaller ephemeral creeks in the region, which included Crooked Creek prior to its development into the CCP storage facility. It should also be noted that sites often occur along ridgelines in this region due to the movement of Aboriginal people from Lake Macquarie to the interior, ridgelines being clearer and flatter than the valleys or slopes. For these reasons, it seems unlikely that any sites would be found within the study area.

Field Investigation

The aim of the initial field survey in 2006 was to identify the archaeological sensitivity of the study area. This assessment was determined by the criteria outlined in the assessment of archaeological sensitivity provided later in this section. The later field inspection was conducted to familiarise the ATOAC and ADTOAC representatives with the study area to provide an informed basis for comment on the heritage assessment.

The presence or absence of archaeological materials and the terrain features and integrity of sites were documented using a specifically designed recording form (see **Appendix F**). A range of environmental attributes affects the detection of archaeological material during site surveys. Some of these features are vegetation cover, soil type and presence of naturally occurring surface rock. Ground surface visibility is also a major influence of artefact detection. The nature (i.e. size, colour, material type) of the archaeological material also affects the effectiveness of the field survey. To assess the reliability of the survey results the following features were recorded for the site:

1 Landform unit;

2 Environmental setting within landform unit;

3 Fall of slope along transect;

4 Type of vegetation cover;

5 Visibility levels measured as percentage of soil surface visible per transect;

6 Type of ground exposure i.e. erosion or disturbance from mining activities;

7 Frequency of exposures i.e. number in each transect;

8 Size of exposures;

9 Depth of soil erosion;

10 Soil type and profile level exposed;

11 Evidence of downslope movement of soil and rock particles;

12 Presence of naturally occurring rock suitable for artefact production; and

13 Presence of archaeological material.

Terminology for all landscape descriptions was obtained from McDonald *et al* (1998). Photography was also used to document the environmental and archaeological features of the survey area.

The aim of the survey and recording methodology was to divide the surveyed site into landscape zones and areas of land use that reflect the potential for archaeological material to

exist in these sections. This data would then be able to be assessed against the background information on the site and used to produce archaeological sensitivity areas for the site.

The field survey involved a thorough investigation of the study area, which runs along the north and east side of the existing CCP storage facility. The study area consists of upper slopes below a ridgeline to the north and above the shallow sloped edges of the CCP storage facility to the south. The slopes varied in elevation, but were typically between 3 to 8°.

HLA ENSR Archaeologist, Alan Williams with two Aboriginal community members surveyed the area to both identify surface Aboriginal sites and assess landforms for potential archaeological sites/deposits. The study area was split into a series of five transects (as shown in **Figure 7.4**) for later interpretation.

The five transects were comparable in their appearance, each consisted of a similar form of landform, namely slopes, with varying degrees of visibility and vegetation cover. Typically, the slopes were relatively uniform across the study area, although the steep slopes were located more frequently in transects 1 and 2. Evidence of ephemeral storm channels were also located within transect 2, which were currently vegetated but revealed evidence of substantial water and soil movements in the past . Where possible soil exposures and transects were investigated to provide an indication of the soil profile across the study area.

As required by DECC's (1997) *Standards and Guidelines Kit*, **Table 7-3** presents a summary of the survey's findings in relation to location, visibility and exposure:

As can be demonstrated from **Table 7-3**, the survey covered some 10 ha (equivalent to 101,050m^2) of which 8% was effectively covered due to substantial vegetation cover (**Plates 7.2** and **7.3**).

Table 7-3: Survey Coverage of the Study Area

Transect no.	Start Co-ordinate	End Co-ordinate	Landform Unit.	Total Area of LF unit (m^2)	Exposure (%)	Area of Exposure (m^2)	Visibility %	Area Available for Detection (m^2)	% of Landform Available for Site Detection
1	36812E, 6342320N	362889E, 6342615N	Slope	18,400	60	11,040	50	5,520	30
2	362889E, 6342615N	363235E, 634289N	Slope	20,650	10	2,065	15	310	1.5
3	363404E, 6342335N	363861E, 6342553N	Slope	27,350	20	5,470	30	1,641	6
4	363861E, 6342553N	364244E, 6342498N	Slope	19,300	10	1,930	15	290	1.5
5	364244E, 6342498N	364439E, 6342259N	Slope	15,350	10	1,535	15	230	1.5
			Average	*20,210*	*22*	*4,408*	*25*	*1,598*	*8*
			Total	**101,050**		**22,040**		**7,991**	

Plate 7-2: Transect 2 looking east. This photograph provides an indication of the poor visibility in some areas of the investigation.

Plate 7-3: Transect 3 looking northeast. This photograph provides an indication of the poor visibility in some areas of the investigation.

The survey identified no Aboriginal sites within the areas surveyed. Further, the assessment of the landform is gentle to moderate slopes with limited soil profiles (see below) and as such the site is unlikely to retain *in situ* archaeological material.

Assessment of Archaeological Sensitivity
The archaeological sensitivity of the study area was assessed on four criteria:

- the presence of known surface archaeological materials;
- the probability of undetected surface archaeological materials;
- the probability of subsurface archaeological materials; and
- the terrain integrity of each transect area.

The presence or absence of surface archaeological materials and the level of effective ground surface visibility were documented during the field survey. The probability of additional surface artefacts occurring was based on these attributes. The assessment of the subsurface archaeological potential of the study area was based on the known patterning of archaeological materials in the Eraring area and field observations of the environmental characteristics and terrain integrity. These characteristics included the availability of stone materials, proximity to water resources, soil depth and landform unit.

Geomorphological implications
Observations during the survey attempted to create a geomorphological model of the landscape in order to better understand its age and the formation processes identified in the survey and the potential of the area to retain archaeological deposits.

The majority of the study area displayed sandy to sandy clay soil derived from weathered conglomerate bedrock with some movement of soils in disturbed areas.

Bedrock crops out near the top of the slopes particularly in a small quarried area (**Plates 7.5** and **7.7**). Erosion, such as sheetwash (massive amounts of sediments being fluvially transported downslope with surface flow) and deposition of sediments, is promoted by the exposed graded roads and erosion channels (currently re-vegetated) within the study area. The roads provide an indication of the geomorphology of the study area following the removal of vegetation (such as through bushfires, which appear common in the study area) and the subsequent erosion that would have ensued. A common characteristic of this activity is sharp contacts between the shallow topsoil and the subsoil beneath, an *in situ* soil normally revealing a far more diffuse contact (**Plate 7.6**). **Plates 7.4, 7.5** and **7.6** show that many transects are missing topsoil. The reason for this is the actively eroding landscape. For this reason, attempts at subsurface investigation are likely to be unsuccessful, particularly in regard to archaeological integrity.

Plate 7-4: Transect 1 looking north. This photograph provides clear evidence of the heavy of erosion that has occurred within the study area. The pale soil exposed here is a B horizon indicating the complete removal of the topsoil and any potential subsurface archaeological deposit. Furthermore, the evidence of rilling and erosion gullies implies substantial and ongoing erosion in this area.

Plate 7-5: Transect 1 looking north. This road reveals the extent of erosion occurring without vegetation cover. Note the rilling down the road. It should be noted that numerous forest fires have occurred in this area, and it is likely that much of the study area would have been cleared and looked similar to this road.

Plate 7-6: Transect 2 looking north. This shows a section of the soil profile towards the base of the moderate to steeper slopes. The upper soil unit is a recent organic layer, most likely developed from decaying organic matter, while the lower unit is the clayey B horizon common in this area. Of note is the sharp contrast between the two units, which indicate that the topsoil has moved from upslope through colluvial process truncating the in situ topsoil, which has now moved downslope.

Plate 7-7: Similar to Plate 7-4, this photograph shows a heavily eroding road in Transect 5, looking northeast. Note the exposed bedrock in the right foreground, indicating the soil profile in this area is very thin.

This type of geomorphological activity essentially re-deposits archaeological material at the base of slopes and within alluvial flats - or more recently in the CCP storage facility and, preceding this, in Crooked Creek. These types of sites represent lag gravels, which include artefacts and natural gravels, rather than *in situ* knapping floors (single events) or knapping locations (multiple knapping events superimposed/overprinted over one another). The concentration of archaeological material in these locations therefore, represents natural accumulation (patterning) rather than archaeological accumulation. However no archaeological material was observed within the study area. Based on multiple personal observations in the Lake Macquarie region, it is likely that much of the 'archaeological' site patterning recorded for Lake Macquarie actually represents natural site formation processes – a fact previously noted and illustrated by Margrit Koettig's model for the Hunter Valley.

In summary, exposed areas within the study area, particularly on moderate to steep slopes, reveal a typical pattern of downslope erosion through mass movement, soil creep and sheetwash. Therefore, a common pattern can be seen across the study area of exposed bedrock and subsoil horizons on crests and slopes following the erosion of their upper soil unit(s) due to a combination of natural storm events, deforestation and clearing. Typically, these latter deposits accumulate at the base of slopes and in creek catchments and become integrated into the pedogenesis of these areas. However, in the case of this study area, these deposits are most likely to have been deposited within the CCP storage facility and/or Crooked Creek before its creation.

7.6.4 Potential Impacts

Following the archaeological investigation, there is no evidence that Aboriginal or archaeological sites would be impacted by the proposed project, nor is it considered likely that an Aboriginal or archaeological site would be found during the course of works involved with the CCP storage facility expansion.

Based upon the survey and assessment undertaken, no residual impacts are considered likely to occur as a result of the proposed works in relation to Aboriginal heritage. However it is possible that Aboriginal or archaeological sites and/or artefacts could be discovered. These could be removed/destroyed subject to appropriate permits being issued by the DECC.

7.6.5 Environmental Safeguards

Should any Aboriginal objects be identified during the course of site works, all works would cease and the DECC (North East Branch, Environment Protection and Regulation Division, Regional Archaeologist) would be contacted with regard to appropriate permit requirements before any further activity is undertaken. In addition, should suspected skeletal material be uncovered during the course of site works, all works would cease and the DECC, the NSW Police and the NSW Coroners office would be contacted immediately, regardless of any existing DECC permits for the proposed works.

7.6.6 Conclusion

The survey revealed the study area to be composed of medium to densely covered vegetated slopes of gentle relief. The survey covered about 30 to 40% of the study area and effectively observed about 8% of this area. It is considered that based on geomorphological interpretations and known sites in the area that the entire study area has a very low potential for archaeological sites and/or deposits.

Known sites reveal a high correlation with the use of water resources, largely marine, and are predominantly middens located on the shoreline of Lake Macquarie or its major tributaries.

Based on this evidence, the study area has few characteristics that would appeal to Aboriginal people for settlement, since it is composed of a series of slopes some distance from a main water body.

The geomorphology of the study area reveals a heavily modified landscape. While much of the vegetation is relatively mature, numerous lightening strikes across the study area suggest large storm events occur regularly in this region. Therefore, although direct human impact to this area is still confined (by roads, tracks, etc), widespread erosion is driven by natural events, which are almost certainly exaggerated by anthropogenic impacts. Observations of the study area reveal substantial erosion has lead to the removal of the soil profile (particularly the topsoil). This process was identified across the study area, but was particularly obvious on exposed tracks and erosion channels running down the slope to the existing CCP storage facility. No constraint to the proposed development has been identified by the Aboriginal community member who identified the sensation suggesting a 'men's area' and connection to Pulbah Island.

No evidence of surface Aboriginal sites were located during the survey and visual observations suggest the potential for subsurface archaeological sites is also low given the lack of a developed or *in situ* soil profile being evident within the study area.

7.7 Geotechnical

7.7.1 Background

The project involves the expansion of the CCP storage fly ash placement onto land immediately north of the existing CCP storage facility. The EARs outlined in the Concept Approval require that an assessment of potential geotechnical impacts be prepared in consultation with DPI and the Mine Subsidence Board (MSB), having regard to the proximity of disused underground mine workings, owned by Centennial Coal, and the potential for impacts on the future extraction of coal reserves in the area.

7.7.2 Geotechnical Assessment and Consultation

EE consulted with the MSB in relation to potential impacts associated with the workings. The MSB gave conditional approval of the proposal in June 2006, providing that the risk of subsidence be taken into account in the design of improvements to be built in the subject area. The MSB also recommended consultation with DPI.

Disused mine workings have been identified beneath the north western portion of the CCP storage facility. The location of the disused mine workings and proximity to the proposed expansion of the CCP storage facility is provided in **Figure 7.5**. Potential impacts resulting from the presence of these workings relate to the risk of localised subsidence and slumping of the overlying land. While most of the area of overlap has had the pillars removed and collapsed, a small area remains where some pillars have not been removed, identified as portions of panels 101, 102 and 103 of Awaba Mine.

Consultation with DPI was subsequently undertaken in relation to potential impacts from the interaction of underground mine workings and the proposed expansion of the CCP storage facility. DPI indicated that the subject mine workings were likely to be relatively shallow, approximately 20 m deep at the edge of the workings, and were not likely to be impacted until the dense phase emplacement reached RL 133 m. Based on predicted CCP reuse, the timing for dense phase placement at RL 133 m is not anticipated to occur for another two to three years. DPI indicted that prior to ash placement above RL 133 m, confirmation should be obtained from Centennial Coal that this area of the mine has been sealed.

Centennial Coal, which operate Awaba Mine, confirmed that the proposed expansion of the CCP storage facility overlays panels 101, 102 and 103, and indicated that these panels have been fully extracted and are contained within a substantial barrier pillar. As such, Centennial Coal is satisfied that elevated vertical stress is not likely to impact upon underground pillar stability, and therefore it would not be necessary for the mine to be sealed.

EE engaged technical engineering consultants Connell Wagner to review the advice provided by Centennial Coal, who confirmed that the mine would not require sealing, and that the cementitious nature of the dense phase emplacement would blanket seal the overlying surface of the mine workings.

Given that Centennial Coal has confirmed that the underlying panels of Awaba Mine have been fully extracted, and the risk of subsidence is considered to be negligible, the proposed expansion of the of the CCP storage facility is not anticipated to affect the future extraction of coal reserves in the area.

EE subsequently submitted a letter to DPI requesting confirmation that the approach to geotechnical assessment and risk analysis undertaken in respect of the proposal is consistent with the advice provided during initial consultation. A copy of the letter is provided in **Appendix C**.

7.7.3 Conclusion

The geotechnical assessment and consultation with the MSB, DPI and Centennial Coal undertaken in respect of the project indicates that the proposed expansion of the CCP storage facility would not impact disused mine workings in the vicinity of the CCP storage facility. The nature of the disused mine workings are not anticipated to be affected by elevated vertical stress that may be placed on the area by the expansion of the CCP storage facility and dense phase emplacement.

Furthermore, given the underlying panels of Awaba mine have been fully extracted, there is not likely to be future extraction of coal reserves in the area which would be impacted by the project.

7.8 Air Quality

7.8.1 Background

An assessment of potential impacts to air quality associated with the proposed expansion of the CCP storage facility was undertaken for the EA prepared in respect of the Concept Application. Potential impacts to air quality as a result of the proposal include:

- Temporary impacts to local air quality associated with dust generation during construction period; and
- Potential reductions in local air quality during operation of the CCP storage facility due to dust generation.

Activities during the construction period for the proposed expansion of the CCP storage facility would involve disturbance of soils associated with the clearing of vegetation. However as the proposed vegetation clearing would be undertaken in a staged manner, the exposure of soil would be minimised, thereby reducing the potential for dust generation.

During operation of the proposed dense phase placement system, the potential for dust generation would be minimised by the placement technique used in dense phase system. The placement technique results in a more stable surface, which is less vulnerable to wind action when compared with the current lean phase placement. Dust control measures currently used on the site such as wetting during dry, high wind conditions would continue to be used to ensure that dust emissions are maintained at an acceptable level. Therefore there are not expected to be significant air quality impacts arising due to dust.

7.8.2 Environmental Assessment Requirements

The SoC prepared in respect of the Concept Application for the CCP management system committed EE to undertaking an assessment of potential impacts to air quality resulting from the generation of dust, and a description of proposed mitigation measures. In addition, the EARs outlined in the Concept Approval require that potential impacts are minimised with mitigation and monitoring measures consistent with best environmental practice.

7.8.3 Potential Impacts

Construction
The proposed expansion of the CCP storage facility and construction of the dense phase placement system incorporating fly ash collection, storage, conditioning and transport facilities would require clearing and construction activities, which may have potential impacts on air quality resulting from the generation of dust. Activities which would potentially result in the generation of dust include:

- Clearing of vegetation and stripping top soil associated with expansion of the CCP storage facility footprint; and
- Wind blown dust from stockpiles, exposed areas and access tracks.

Air quality impacts during the construction period and clearing campaigns for the expansion of the CCP storage facility would be largely contained on site. In order to minimise impacts associated with construction activities, a Construction Environmental Management Plan would be prepared and implemented taking into account potential sources of dust, and would include environmental safeguards to be implemented during construction to minimise environmental impacts. Dust generation associated with vegetation clearing for the proposed expansion of the CCP storage facility would be minimised using environmental safeguards, as well as the implementation of a staged approach to clearing, discussed in **Section 3.9**.

Operation
Potential impacts during operation of the CCP management system include the generation of dust from the surface of the dense phase emplacement. However, as the proposed system of dense phase placement results in a firm, cementitious crust on the fly ash surface, dense phase placement is anticipated to result in less potential for dust generation than the existing lean phase placement system.

7.8.4 Environmental Safeguards

Construction
The following safeguards would be implemented to manage potential air quality impacts associated with dust generation during construction activities:

- Minimising the stockpiling of material that has a high dusting potential (i.e topsoil);

- Use of water sprays on access roads and stockpiles that may remain for significant lengths of time;
- Ensuring trucks do not have excessive soil on tyres when leaving the site that may fall onto roadways generating dust, through the use of measures such as rumble strips, wheel washes etc.;
- Conducting daily audits of dust-generating sources during typical work activities to ensure visible dust emissions are mitigated as quickly as possible; and
- Ensuring vehicles drive only on designated routes.

Operation

Operation of the proposed dense phase placement system would essentially result in less dust generation than the existing lean phase placement system, due to the cementitious crust that is formed by dense phase emplacement. In addition, the following mitigation measures would also be implemented:

- Current control measures used for minimising dusting using lean phase fly ash placement would continue to be used, including the use of water sprays and the controlled placement of fly ash;
- Dense phase fly ash placement and reduces the likelihood of dusting due to reduced release of cenospheres (the lightweight spherical particles within CCP which sit on the surface in lean phase placement and can be 'beached' when water levels change) which are major causes of wind blown dust;
- Roadways would be constructed on top of already placed fly ash to the centre of the CCP storage facility to allow more controlled fly ash placement. These roadways can be accessed to place sprays closer to the area of placement helping to reduce the likelihood of dusting;
- Three discharge points per discharge line (total six discharge points) would be installed and would allow the placement of fly ash to various points at the CCP storage facility to keep the area wet and reduce the likelihood of dusting;
- Dust generation would be monitored regularly by operating staff. Monitoring would be increased during windy periods; and
- Additional water would be sprayed on fly ash emplacements during wind events.

7.8.5 Conclusion

Potential impacts to air quality resulting from the project are primarily associated with the generation of dust from the fly ash emplacement. The proposed dense phase placement system and placement techniques are anticipated to result in less dust generation than the existing lean phase placement system. Furthermore, dust mitigation measures outlined in **Section 7.8.4** would continue to be implemented to minimise potential impacts. The project is therefore not anticipated to result in significant impacts to air quality

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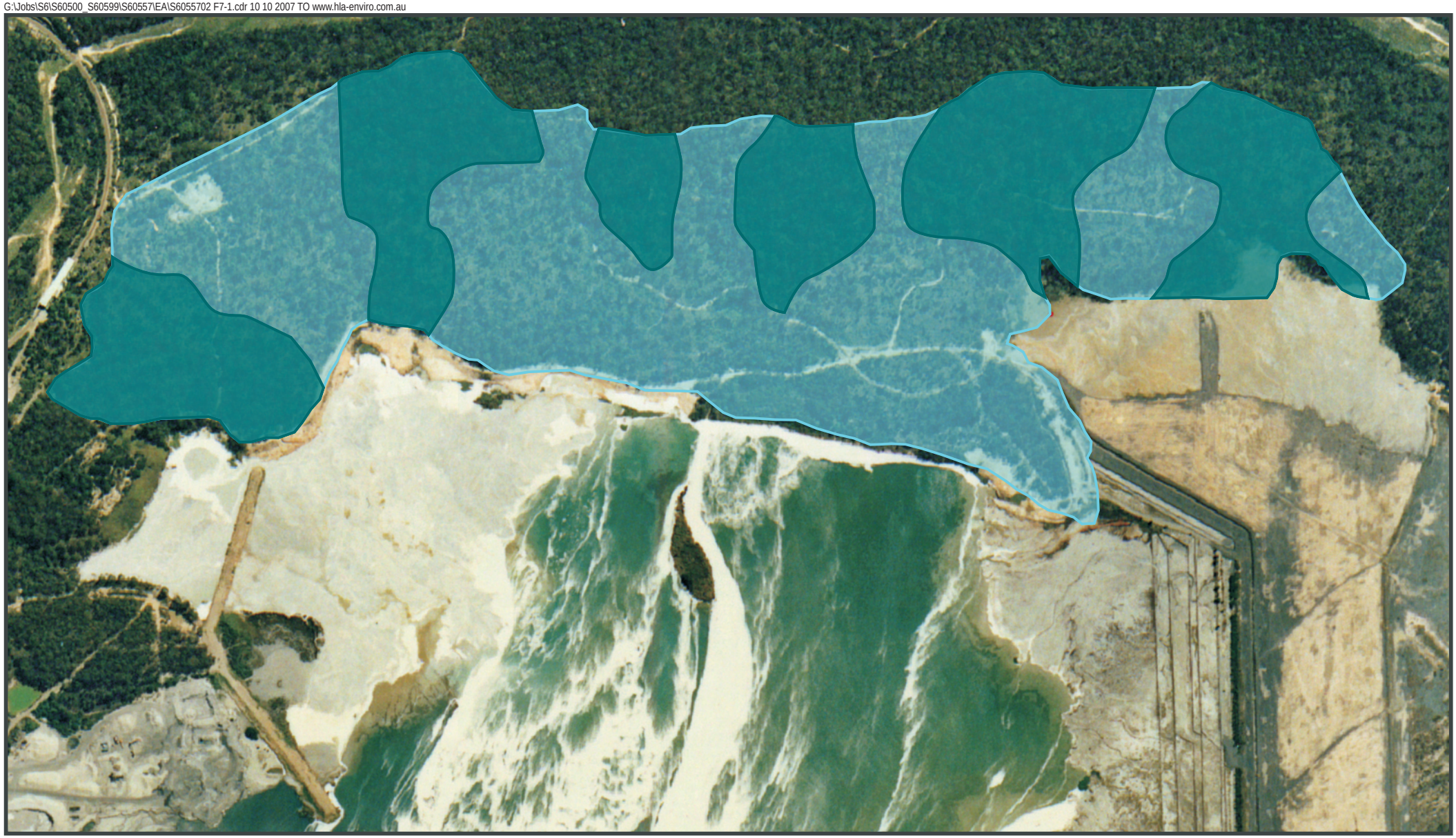

HLA Merged with ENSR in 2007

0 150m

Coastal Plains Smooth-barked Apple Woodland
Coastal Plains Scribbly Gum Woodland

Figure 7.1

Extent of Vegetation Communities Within CCP Storage Facility Expansion Footprint

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station

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HLA Merged with ENSR in 2007

0 200m

Area C - Compensatory Habitat
Areas recently acquired by Eraring Energy
Alternate compensatory habitat area for Stage 3

Figure 7.2

Proposed Compensatory Habitat/ Vegetation Offset Areas

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station

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HLA Merged with ENSR in 2007

0 2km

- Artefact scatter
- Midden, Artefact scatter, Shelter
- Potential archaeological deposit
- Scarred/Carved tree

Figure 7.3

Known Archaeological Sites

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station

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HLA Merged with ENSR in 2007

0 200m

Transect location

Figure 7.4

Archaeological Survey Transects

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station

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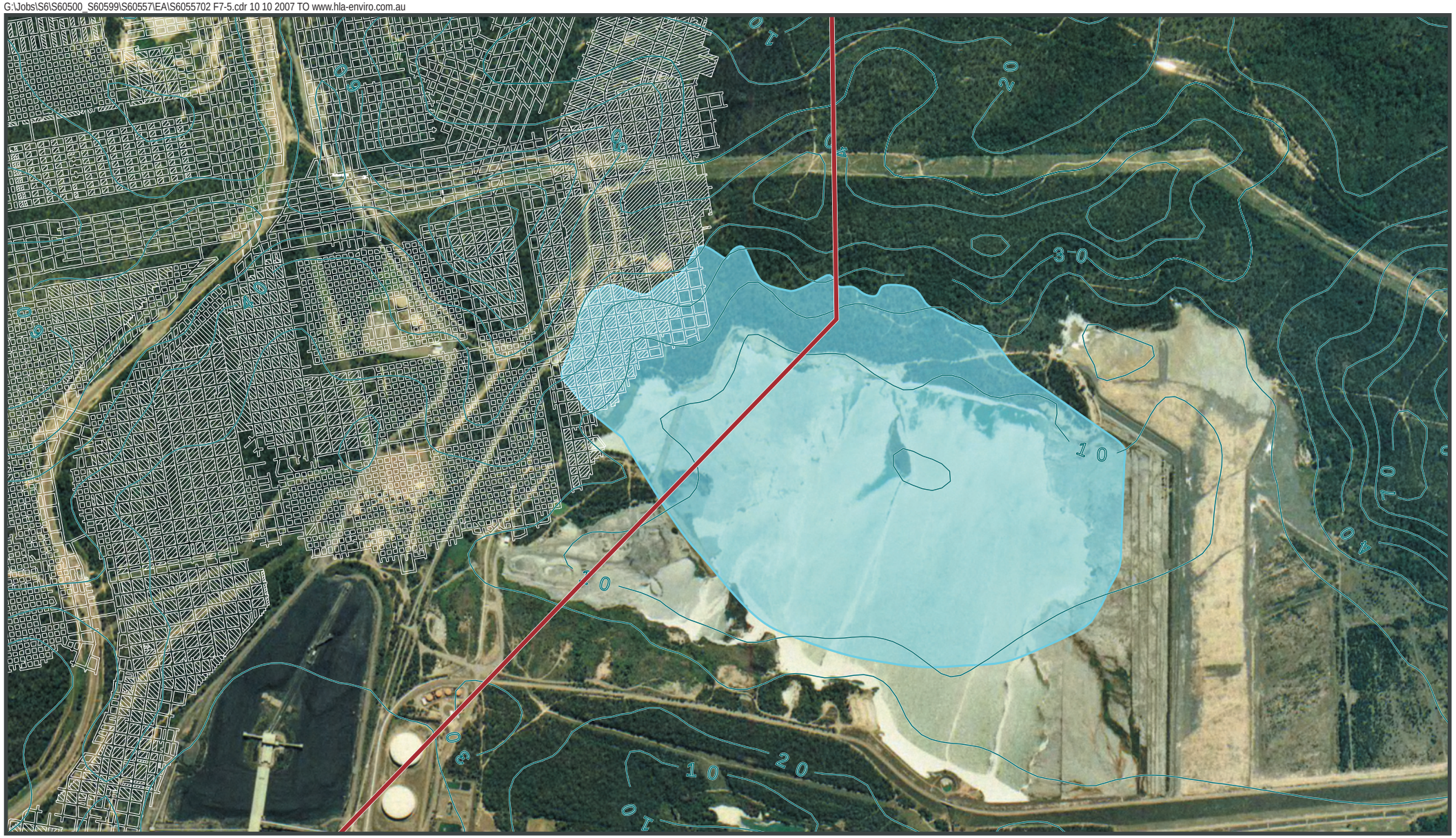

HLA Merged with ENSR in 2007

Figure 7.5

Location of Disused Awaba Mine Workings and Proposed CCP Storage Facility

Environmental Assessment - Upgrade and Expansion of Coal Combustion Product Management System Eraring Power Station

8 STATEMENT OF COMMITMENTS

8.1 Introduction

In accordance with the EARs the following Statement of Commitments (SoC) is provided. The SoC states EE's environmental commitments and details on the environmental management and monitoring of the proposed project during its construction and operational activities.

EE commits to the preparation and implementation of the environmental management and monitoring plans and environmental mitigation measures detailed in the SoC for the proposed CCP management system as detailed below. The SoC would form part of EE day-to-day environmental management activities at EPS.

8.2 Statement of Commitments

The SoC prepared in respect of the proposed CCP management system has been compiled on an issues basis and is informed by the environmental risk analysis and impact assessment undertaken as part of this EA. The SoC has been written in a format which can be incorporated into a Project Approval issued to act as the conditions of that approval. In addition, the SoC which formed part of the Concept Application also forms part of the SoC for the Project Application.

Table 8-1: Statement of Commitments

Environmental Issue	Commitment
Construction	EE shall prepare and implement a Construction and Environmental Management Plan prior to commencement of construction works;
Compensatory Habitat	EE commit to the provision of compensatory habitat at a ratio of 2:1 to offset the long term impact of vegetation clearing associated with the project;
	EE shall undertake the proposed works in accordance with the requirements of the Concept Approval, and in accordance with the commitments presented in the CCP LTMS;
	EE shall prepare a compensatory habitat plan for each area of compensatory habitat to be provided, prior to each stage of clearing. Compensatory habitat plans would incorporate revegetation techniques and methods and land management activities described in **Section 7.1** of this EA, and in accordance with best environmental practice;
Terrestrial Ecology	EE shall prepare and implement a Flora and Fauna Management Plan prior to commencing the proposed works which would include: • Details of the timing of clearing to ensure that it does not adversely affect critical periods in the lifecycles of significant species; • General safeguards to be installed; • Flora and fauna monitoring programs to be implemented during both construction and operation; and • A Vegetation Clearance Protocol.

Environmental Issue	Commitment
	EE shall install artificial nest and roost boxes within nearby woodland to replace tree hollows at a ratio of 2:1 prior to clearing of vegetation. The condition of nest boxes shall be monitored for damage and occupation by pest species until hollows in rehabilitated areas have developed sufficiently for targeted species to occupy;
	EE shall prepare and implement a rehabilitation plan that utilises soil and regolith stripped during clearing in rehabilitation, and if practicable, the fly ash deposited as part of the proposed development.
Groundwater	EE shall undertake a review of the existing groundwater monitoring regime, including: • Surveying of existing monitoring bores; • Sampling of monitoring bores, with analytes to include major ions, total dissolved solids and a suite of heavy metals; • Review of the adequacy of existing groundwater monitoring network at EPS; • Installation of an additional monitoring bore upgradient of the CCP storage facility; and • Preparation and implementation of a revised groundwater monitoring regime. EE shall update its existing Groundwater Management Plan in accordance with the groundwater monitoring regime review.
	EE shall undertake a groundwater assessment to understand whether levels of trace metals and other elements are elevated due to pre-existing/background levels, or due to activities on the EPS site. Based on results, EE would investigate potential mitigation measures;
Surface Water	EE shall prepare and implement a Soil and Water Management Plan which shall include: • An Erosion and Sediment Control Plan; and • An update to the existing Surface Water Monitoring Programme on the site. EE shall ensure that all necessary erosion and sediment control measures detailed in the SWMP are installed prior to commencing construction.
	EE shall take all practicable measures to minimise erosion and potential discharge of sediments from the site;
	EE shall construct baffles below the Crooked Creek weir to reduce the rate of flow in the event that discharge to Crooked Creek is initiated;

Environmental Issue	Commitment
	EE shall undertake detailed engineering investigations prior to 2013 into the four identified engineering design options, which include: • Modification of the existing CCP storage facility water level operating instruction to increase the storage capacity of the CCP storage facility; • Increasing the height of the spillway overflow weir to RL 127.61 m; • Increasing the return water pumping capacity and availability; and • Reducing the catchment area of the CCP storage facility.
	CCP placement shall be in accordance with CCP management plans, to ensure that the stilling pond and minimum encroach distance of 250 m is maintained;
Indigenous Heritage	EE shall ensure that in the event that Aboriginal objects are identified during the course of site works, works would cease and the DECC (North East Branch, Environment Protection and Regulation Division, Regional Archaeologist) would be contacted with regard to appropriate permit requirements before further activity is undertaken. In addition, should suspected skeletal material be uncovered during the course of site works, all works would cease and the DECC, the NSW Police and the NSW Coroners office would be contacted immediately, regardless of existing DECC permits for the proposed works.
Air Quality	EE shall implement all practicable measures to minimise dust generation during construction works associated with the expansion of the CCP storage facility.
	EE shall conduct daily audits of dust-generating sources during typical construction activities to ensure visible dust emissions are mitigated as quickly as possible;
	EE shall regularly monitor dust generation from the CCP storage facility. Monitoring shall be increased during windy periods, and appropriate mitigation measures implemented to prevent dusting;
	EE shall construct access roadways on top of the fly ash placement in accordance with the CCP management plan, which would be used to place water sprays closer to the active area of placement in order to minimise dusting;

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9 RESIDUAL RISK ANALYSIS

9.1 Approach

The Residual Environmental Risk Analysis for the proposed Project is based on a process adapted from Australian Standard AS 4360:2004 Risk Management, as well as environmental risk tools developed by other organisations. The process is qualitative and is based on the Residual Risk Matrix shown in Table 9-1.

Residual Environmental Risk is assessed on the basis of the significance of environmental effects of the proposed project and the ability to confidently manage those effects to minimise harm to the environment.

The significance of environmental effects is given a numerical value between 1 and 5 based on the receiving environment, the level of understanding of the type and extent of impacts and community response to the environmental consequences of the project. This enables both the actual and perceived impacts to be considered. The manageability of environmental effects is similarly given a numerical value between 1 and 5 based on the complexity of mitigation measures, the known level of performance of the safeguards proposed and the opportunity for adaptive management. The numerical value allocated for each issue is based upon the following considerations:

Significance of Effects

5. Extreme	Undisturbed receiving environment; type or extent of impacts unknown; substantial community concern.
4. High	Sensitive receiving environment; type or extent of impacts not well understood; high level of community concern.
3. Moderate	Residual receiving environment; type and extent of impacts understood; community interest.
2. Minor	Disturbed receiving environment; type and extent of impacts well understood; some local community interest.
1. Low	Degraded receiving environment; type and extent of impacts fully understood; uncontroversial project.

Manageability of Effects

5. Complex	Complicated array of mitigation measures required; safeguards or technology are unproven; adaptive management inappropriate.
4. Substantial	Significant mix of mitigation measures required; limited evidence of effectiveness of safeguards; adaptive management feasible.
3.Straightforward	Straightforward range of mitigation measures required; past performance of safeguards is understood; adaptive management easily applied.
2. Standard	Simple suite of mitigation measures required; substantial track record of effectiveness of safeguards; adaptive management unlikely to be required.
1. Minimal	Little or no mitigation measures required; safeguards are standard practice; adaptive management not required

The numbers are added together to provide a result which provides a ranking of potential residual effects of the project when the safeguards identified in this EA are implemented.

Table 9-1: Residual Risk Matrix

Significance of Effects	Manageability of Effects				
	5 Complex	4 Substantial	3 Straightforward	2 Standard	1 Minimal
1 Low	**6 (Medium)**	**5 (Low/Medium)**	**4 (Low/Medium)**	**3 (Low)**	**2 (Low)**
2 Minor	**7 (High/Medium)**	**6 (Medium)**	**5 (Low/Medium)**	**4 (Low/Medium)**	**3 (Low)**
3 Moderate	**8 (High/Medium)**	**7 (High/Medium)**	**6 (Medium)**	**5 (Low/Medium)**	**4 (Low/Medium)**
4 High	**9 (High)**	**8 (High/Medium)**	**7 (High/Medium)**	**6 (Medium)**	**5 (Low/Medium)**
5 Extreme	**10 (High)**	**9 (High)**	**8 (High/Medium)**	**7 (High/Medium)**	**6 (Medium)**

9.2 Analysis

The analysis of residual environmental risk for issues related to the proposed project is shown in Table 9-2. This analysis indicates the environmental risk profile for the proposed project based on the assessment of environmental effects, the identification of appropriate safeguards, and the SoC included in this EA.

Table 9-2: Risk Profile

Issue	Significance	Manageability	Residual Risk
Terrestrial ecology	3	2	**Low/Medium(5)**
Aquatic ecology	1	1	**Low (2)**
Groundwater quality	2	2	**Low/Medium (4)**
Surface water quality	2	2	**Low/Medium (4)**
Indigenous heritage	2	1	**Low (3)**
Geotechnical	2	1	**Low (3)**
Air quality	1	1	**Low (2)**

The above residual risk analysis indicates that the proposal presents an overall low to low/medium risk in relation to each of the identified environmental issues, provided that the recommended mitigation, management and monitoring measures are implemented.

10 PROPOSAL JUSTIFICATION

The proposed upgrade and expansion to the CCP management system would result in a number of benefits associated with the increased efficiency of CCP management on the site. Should the proposed upgrade and expansion of the CCP management system not be undertaken, EPS would not be able to continue to operate under current arrangements, which would likely lead to limited output, thereby necessitating construction of an alternative base load power station elsewhere in NSW. The proposal would allow the continued operation of EPS, and the provision of an important energy resource for NSW. The proposal would therefore have resultant benefits for the local and wider community and the environment, as well as for present and future generations.

The proposed CCP management system allows for greater separation of fine and coarse fly ash materials, increasing the opportunities for the reuse of fly ash in the cement and related industries, whilst coarse material can be reused in other industries. Increased efficiency of CCP management would have resultant environmental benefits, including reducing current potential for impacts associated with dust generation from the existing CCP storage facility, and enabling a greater volume of CCP to be stored on site without sterilising significant amounts of additional land or increasing environmental impact. EE has committed to increased reuse targets of CCP, which are set out in the LTMS. The provision of a new fly ash collection system and pumping system, which forms part of the proposal, is critical in realising these achievements.

As required by the EARs for the project, environmental safeguards including mitigation, management and monitoring measures have been identified in relation to potential environmental impacts, and are presented in the SoC provided in **Section 8** of this EA. The project design and assessment of potential impacts presented in **Section 3** and **Section 7** of this EA, as well as the EA prepared for Concept Application, demonstrate that the project is able to be constructed and operated in a manner which is compatible with surrounding land uses.

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11 CONCLUSION

The proposal comprises an upgrade to the CCP management system and placement technique, and an expansion of the existing CCP storage facility to accommodate the CCP management needs of the power station over the expected life of EPS, beyond 2030. Without the expansion, EPS would not be able to continue to operate under current arrangements.

Concept Approval was granted for the project on 14 December 2006. This EA has been prepared pursuant to the EARs issued by the Director-General as part of the Concept Approval, to provide an assessment of environmental impacts associated with the proposal.

The proposal has been subject to environmental assessment in accordance with Part 3A of the EP&A Act and the requirements issued by the Director-General. Potential environmental impacts resulting from the proposal have been assessed and measures and safeguards have been identified throughout the EA to manage these. The proposal would be constructed and operated to meet existing environmental standards and the environmental performance of the proposal would be monitored to ensure achievement of these standards.

The EA concludes that whilst the project would have some residual impacts, the mitigation measures identified would effectively reduce these to an acceptable level and enable the project to operate without detriment to the existing or future land uses. The proposal stands to provide significant public benefit in terms of the continued provision of a critical source of energy to meet projected future demand. These benefits are considered to outweigh the residual environmental impacts identified in this EA.

The proposal is considered to be environmentally acceptable and would have significant local and regional environmental, economic and social benefits, including the provision of safe efficient and secure energy supplies for NSW into the future.

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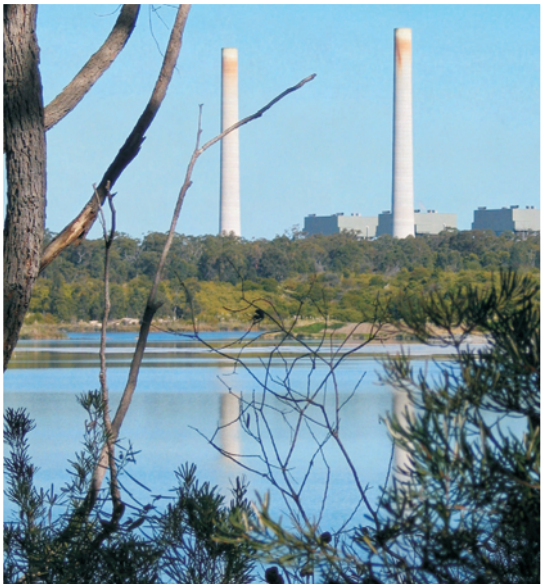


appendix a

concept approval

Concept Approval

Section 75O of the *Environmental Planning and Assessment Act 1979*

I, the Minister for Planning, under the *Environmental Planning and Assessment Act 1979* determine:

a) to approve the concept plan referred to in Schedule 1, subject to the modifications in Schedule 2; and

b) pursuant to section 75P(1)(a) of the *Environmental Planning and Assessment Act 1979*, the further environmental assessment requirements for approval to carry out the project.

Frank Sartor MP
Minister for Planning

Sydney 16th Dec 2006 File No: 9040403

SCHEDULE 1

Application No:	05_0138
Proponent:	Eraring Energy
Approval Authority:	Minister for Planning
Land:	Lot 11 DP 1050120; Lots 301 & 302 DP 806475; Lot 3/8 Section L DP 6747; Lots 13/16 Section O & Part Lot 13/16 Section U DP 6747; Lot 7/16 DP 262501; Lot 19 DP 262501; Lot 1 DP 817425; Lots 100 and 101 DP 828283; Lot 211 DP 840670; Lots 50 and 51 DP 840671; Lots 1, 2 and 3 DP 621697; Lot 1 DP 816174; and Lots 20 and 21 DP 734860. Crown Land adjoining the northern boundary of Lot 11 DP 1050120 to the ridge line. Eraring Power Station, Rocky Point Rd, Dora Creek, Lake Macquarie local government area
Proposal:	Upgrade of the ash disposal facility at the Eraring Power Station
Major Project:	The proposal is declared a Major Project under section 75B(1)(a) of the *Environmental Planning and Assessment Act 1979*, because it is a project of a kind described in clause 24 of Schedule 1 to *State Environmental Planning Policy (Major Projects) 2005*
Concept Plan Authorisation:	On 26 January 2006, the Minister for Planning authorised the submission of a concept plan for the proposal.

KEY TO CONDITIONS

SCHEDULE 2

Act, the	*Environmental Planning and Assessment Act, 1979*
Conditions of Approval	The Minister's conditions of approval for the proposal.
Council	Lake Macquarie City Council
DEC	Department of Environment and Conservation
DNR	Department of Natural Resources
Department, the	Department of Planning.
Director-General, the	Director-General of the Department of Planning (or delegate).
Director-General's Approval	A written approval from the Director-General (or delegate). Where the Director-General's Approval is required under a condition the Director-General will endeavour to provide a response within one month of receiving an approval request. The Director-General may ask for additional information if the approval request is considered incomplete. When further information is requested the time taken for the Proponent to respond in writing will be added to the one month period.
Director-General's Report	The report provided to the Minister by the Director-General of the Department under section 75I of the EP&A Act.
EA, the	*Proposed Upgrade Eraring Power Station Environmental Assessment*, prepared by HLA-Envirosciences Pty Ltd and dated May 2006
Minister, the	Minister for Planning
Proponent	Eraring Energy
Proposal	The proposed upgrade of the ash disposal facility the subject of Major Projects Application 05_0138
Publicly Available	Available for inspection by a member of the general public (for example available on an internet site or at a display centre).
Site	Land to which Major Projects Application 05_0138 applies.
Submissions report	*Proposed Upgrade to Eraring Power Station (Application Number: 05_0138): Response to Submissions*, prepared by Eraring Energy and dated 8 August 2006

1. ADMINISTRATIVE CONDITIONS

Terms of Concept Approval

1.1 The Proponent shall carry out the proposal generally in accordance with:
   a) Major Projects Application 05_0138;
   b) *Proposed Upgrade Eraring Power Station Environmental Assessment*, prepared by HLA-Envirosciences Pty Ltd and dated May 2006;
   c) the *Submissions Report* prepared by Eraring Energy and dated 8 August 2006;
   d) the supplement to the *Submissions Report* titled *Proposed Upgrade to Eraring Power Station – Response to Submissions* prepared by Eraring Energy and dated 30 August 2006;
   e) the conditions of this approval.

1.2 If there is any inconsistency between the above, the most recent document shall prevail to the extent of the inconsistency.

1.3 The Proponent shall comply with any reasonable requirement(s) of the Director-General arising from the Department's assessment of:
   a) any reports, plans or correspondence that are submitted in accordance with this approval; and
   b) the implementation of any actions or measures contained in these reports, plans or correspondence.

Limits of Approval

1.4 This concept approval shall operate from the date the approval is endorsed by the Minister.

1.5 This concept approval shall lapse 10 years after the date the approval is endorsed by the Minister, unless works the subject of a related project approval are physically commenced on or before that date.

1.6 Nothing in this approval permits the commencement of works unless and until a project approval is obtained for those works.

2. STAGING AND SCOPING OF WORKS

2.1 The proposal is modified to limit the extent of vegetation clearing for ash disposal to the area generally delineated as "approximate extent of land clearance end of year 10" in the document referred to under condition 1.1d). This condition does not include areas required to be cleared for pipeline or roadway access, which shall be undertaken in a manner that minimises any additional vegetation clearing.

2.2 Notwithstanding condition 2.1 of this approval, vegetation clearing shall be staged such that:
   a) the proposal is undertaken in no fewer than three stages; and
   b) no more than seven hectares of vegetation is removed in any single stage of the proposal.

2.3 The Proponent shall provide no fewer than two hectares of compensatory habitat for each hectare of vegetation removed as part of the proposal. Specifications for the compensatory habitat, including location, composition and quality, shall be subject to the approval of the Director-General and may be the subject of further detailed conditions as part of a project approval. All compensatory habitat measures shall be developed in consultation with the DEC.

2.4 Commencement of each stage of the proposal shall be contingent on the implementation of the compensatory habitat works for the previous stage of the proposal to a level approved by the Director-General, or as otherwise specified as part of a project approval.

3. LONG-TERM ASH MANAGEMENT STRATEGY

3.1 Prior to 31 December 2011, or the lodgement of a project application, whichever is the sooner, the Proponent shall prepare and submit for the approval of the Director-General, a **Long-Term Ash Management Strategy** for the site. The Strategy shall be developed in consultation with the DEC and Council, and shall include, but not necessarily be limited to:

a) a stipulated goal of 80% reuse or recycling of ash from the Eraring Power Station by 31 December 2015. This goal may only be altered with the prior written agreement of the Director-General, based on a demonstration by the Proponent that market conditions reasonably preclude this goal being achieved;

b) a program for the investigation of alternative ash management measures over time, with a particular focus on the minimisation of ash disposal on site and beneficial reuse of ash;

c) a framework for the identification and assessment of alternative ash management measures from time to time, having regard to the operational needs of the Eraring Power Station, and social, economic and environmental implications of those measures;

d) a staging strategy for the implementation of works the subject of this approval, having regard to the status and outcomes of the investigations referred to under a) and the requirements of conditions 2.1 to 2.4;

e) a staging strategy for the implementation of compensatory habitat areas required under this approval, having regard to the status and outcomes of the investigations referred to under a) and the requirements of conditions 2.1 to 2.4;

f) a strategic management framework for the optimisation of ash disposal capacity on the site, and periodic review of ash management practices to achieve this outcome;

g) an environmental management framework for the on-going management of ash disposal and ash management measures on site, consistent with contemporary best environmental practice; and

h) a strategy for the reconciliation of the generating life of the Eraring Power Station and the availability and management of ash produced by the Power Station.

In respect to a), if reuse options are slow to emerge, or they are not feasible on economic, environmental, or industrial reliability criteria, the timeframe goal be may extended with the agreement of the Director-General , in consultation with the DEC, and subject to the Proponent providing to the satisfaction of the Director-General information of available reuse options, justification of why these cannot be – or have not been - adopted, and a description of what measures will be implemented to facilitate the reuse of all ash generated on the premises for a beneficial purpose. After reviewing this information, the Director-General in consultation with the DEC, may approve a modified timeframe goal(s), and may require the Proponent to carry out further investigations or works into reuse of all ash generated on the premises for a beneficial purpose.

4. SPECIFIC REQUIREMENTS FOR PROJECT APPLICATION

4.1 The Proponent may lodge a project application(s) for one or more of the stages of the proposal (refer to condition 2.2) from time to time.

4.2 Pursuant to section 75P(1)(a) of the *Environmental Planning and Assessment Act 1979* the following environmental assessment requirements apply with respect to the project(s):

a) full details of the project, including any staging consistent with the requirements of this approval, construction and operation methods, infrastructure and equipment requirements, duration of works for any stages and clear identification of the status of ash management and disposal needs of the Eraring Power Station;

b) demonstration that the project is consistent with the aims, objectives and outcomes stipulated in an approved Long-Term Ash Management Strategy (refer to condition 3.1);

c) a detailed project-specific Statement of Commitments, consistent with the Statement of Commitments included in the documents referred to under condition 1.1, with a clear indication of any new or amended commitments relating to the project;

d) full details of the compensatory habitat package for the project (refer to condition 2.3), developed having regard to contemporaneous surveys of the area to be affected the project (if a project application is lodged later than one year after the date of this concept approval) and the 'Lake Macquarie *Tetratheca juncea* Management Plan' (as amended 2001);
e) details of how construction, operation and maintenance of the project will be undertaken to minimise impacts on terrestrial and aquatic ecology;
f) an updated review of potential impacts on indigenous heritage, having regard to the status of any Native Title claims apply to the land to be affected by or surrounding the project, and consultation with relevant aboriginal groups, elders and broader aboriginal community;
g) a risk analysis and geotechnical assessment for any ash dam extension, prepared in consultation with the Department of Primary Industries (Mineral Resources) and Mine Subsidence Board, having regard to the proximity of old mine workings (to verify that they are collapsed and there is no risk of future subsidence) and potential for impacts on the future extraction of coal reserves in the area;
h) details of mitigation, monitoring and management measures to be applied to the project with respect to dust generation and impacts, consistent with best environmental practice;
i) details of mitigation, monitoring and management measures to be applied to the project with respect to surface and groundwater impacts, consistent with best environmental practice. The assessment shall include consideration of potential impacts on water quality, a plan to manage any identified impacts on waters (including Lake Macquarie) and a monitoring program for surface and groundwater. The assessment shall consider all chemicals of potential concern including, but not limited to, trace metals such as selenium. The assessment shall be prepared in consultation with the DEC, the DNR and the Hunter-Central Rivers Catchment Management Authority;
j) results of consultation with the local community, relevant state agencies and Council; and
k) demonstration that the project is consistent with this concept approval.

5. COMPLIANCE MONITORING AND TRACKING

Compliance Tracking Program

5.1 The Proponent shall develop and implement a **Compliance Tracking Program** to track compliance with the requirements of this concept approval and all related project approvals. The Program shall include, but not necessarily limited to:
a) provisions for periodic review of the compliance status of the proposal and each of its components;
b) provisions for periodic reporting of compliance status to the relevant approval authority;
c) a program for independent environmental auditing of the proposal, in accordance with *ISO 19011:2002 - Guidelines for Quality and/ or Environmental Management Systems Auditing*; and
d) mechanisms for rectifying any non-compliance identified during environmental auditing or review of compliance.

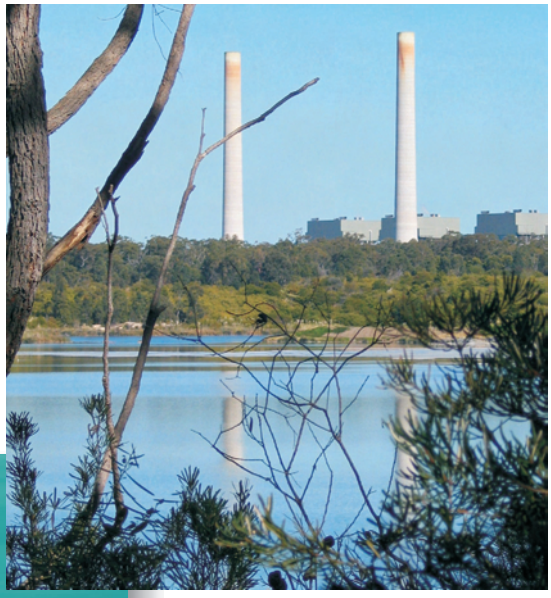
6. COMMUNITY INFORMATION, CONSULTATION AND INVOLVEMENT

6.1 Subject to confidentiality, the Proponent shall make all documents required under this concept approval and any relevant project approval available for public inspection on request.

Provision of Electronic Information

6.2 Prior to the commence of the proposal, the Proponent shall establish and maintain a new website, or dedicated pages within its existing website for the provision of electronic information associated with the proposal. The Proponent shall publish and maintain up-to-date information on this website or dedicated pages including, but not necessarily limited to:

a) information on the proposal, each of its components and the current implementation status of each component and stages;
b) a copy of this concept approval and related project approval;
c) a copy of each relevant environmental approval, licence or permit required and obtained in relation to the proposal;
d) a copy of each monitoring program and each environmental management plan required under this concept approval or under the relevant project approval;
e) details of the outcomes of reviews and audits of the proposal and each of its components undertaken in accordance with the Compliance Tracking Program referred to under condition 5.1; and
f) details of a contact point(s) to which community complaints or inquiries may be directed, including a telephone number, a postal address and an email address.



appendix b

agency consultation

Kate Tilden

From: Kate Tilden
Sent: Thursday, 13 September 2007 3:50 PM
To: 'peter.johns@dnr.nsw.gov.au'
Cc: Brett McLennan
Subject: Eraring Energy Project Application Consultation

Peter,

As discussed today in our phone conversation, Eraring Energy is proposing to undertake an upgrade to the existing Coal Combustion Product (CCP, or ash) Management System. We are preparing an Environmental Assessment to accompany a Project Application to the Minister for Planning under Part 3A of the EP&A Act for the upgrade, which follows on from a Concept Approval issued by the Minister under the Act. The Concept Approval granted in respect of the project requires that consultation be undertaken with DWE during preparation of the Project Application in relation to potential water quality impacts associated with the proposal.

As you have indicated, correspondence was sent from DWE (then DNR) dated 10 February 2006 (your ref. ER6821) in relation to the Concept application stating that your department has no statutory approval role in the project.

Could you please confirm by email that, as discussed, DWE do not intend to submit any requirements for the Environmental Assessment?

Kind regards,

Kate Tilden
Project Environmental Scientist
T +61 2 8484 8934

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Kate Tilden

From: Peter Johns [Peter.Johns@dnr.nsw.gov.au]
Sent: Tuesday, 25 September 2007 11:55 AM
To: Kate Tilden
Subject: Re: Eraring Energy Project Application Consultation

Kate
Sorry for delay in responding. I wanted to access our file (ER6821) from archives and then I had a few days off with the flu. Just catching up now.

DWE advice is as follows: Discussed with Hemantha De Silva, Team Leader, Licensing North Branch and he confirmed that there are no approvals required under water legislation administered by the Department of Water and Energy for the proposed upgrade. The advice of the department (former DNR) dated 10 February 2006 remains unchanged.

Regards

Peter Johns
Project Officer
Major Projects and Planning Branch
Newcastle

>>> "Kate Tilden" <ktilden@hlaensr.aecom.com> 13/09/2007 3:50 pm >>>
Peter,

As discussed today in our phone conversation, Eraring Energy is proposing to undertake an upgrade to the existing Coal Combustion Product (CCP, or ash) Management System. We are preparing an Environmental Assessment to accompany a Project Application to the Minister for Planning under Part 3A of the EP&A Act for the upgrade, which follows on from a Concept Approval issued by the Minister under the Act. The Concept Approval granted in respect of the project requires that consultation be undertaken with DWE during preparation of the Project Application in relation to potential water quality impacts associated with the proposal.

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Kind regards,

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Kate Tilden

From: Kate Tilden
Sent: Monday, 17 September 2007 2:35 PM
To: 'trevor.henderson@environment.nsw.gov.au'
Cc: Brett McLennan
Subject: Eraring Energy Project Application Consultation

Dear Trevor,

As discussed on Friday in our phone conversation, Eraring Energy is proposing to undertake an upgrade to the existing Coal Combustion Product (ash) Management System. HLA ENSR is preparing an Environmental Assessment to accompany a Project Application to the Minister for Planning under Part 3A of the EP&A Act for the upgrade, which follows on from a Concept Approval issued by the Minister under the Act. The Concept Approval granted in respect of the project requires that consultation be undertaken with the DECC during preparation of the Project Application in relation to potential water quality impacts associated with the proposal.

Groundwater monitoring undertaken by Eraring Energy has indicated elevated analytical results for some monitoring parameters down gradient of the CCP storage facility. The source of the elevated results is unclear at this stage, but could potentially be naturally occurring. As you indicated, the proposed dense phase placement system is not anticipated to impact groundwater quality, rather it is likely to maintain the status quo. As such, as part of the Statement of Commitments for this project, Eraring Energy propose to undertake a groundwater monitoring review of the EPS site to determine the source of current contaminant levels. Investigations and modelling have also been undertaken to determine potential impacts associated with selenium, and hydrological impacts such as flooding.

Other environmental issues including dust and provision of compensatory habitat are subject to conditions outlined in the Concept Approval issued by DoP. As discussed, Eraring Energy has implemented dust control and suppression measures which have substantially improved dust management under current conditions. The proposed dense phase placement is likely to further reduce impacts associated with dusting.

In relation to the provision of compensatory habitat, Eraring Energy have consulted with DECC and DoP previously, and note the concerns of DECC regarding the adequacy of proposed compensatory habitat measures. The compensatory habitat measures proposed in the Project Application are consistent with the Concept Approval, and also potentially provide additional areas of compensatory habitat. Details of the proposed compensatory habitat are provided in the CCP Long Term Management Strategy (LTMS) which has been submitted to DoP for approval.

Please don't hesitate to contact myself or Brett McLennan on 8484 8999 if you require further information regarding the project.

Kind regards,

Kate Tilden
Project Environmental Scientist

HLA ENSR
Level 5, 828 Pacific Highway
GORDON NSW 2072
PO Box 726 Pymble NSW 2073
T +61 2 8484 8999 F +61 2 8484 8989

http://www.hlaensr.aecom.com

Kate Tilden

From: Kate Tilden
Sent: Friday, 14 September 2007 3:07 PM
To: 'dean.chapman@cma.nsw.gov.au'
Cc: Brett McLennan
Subject: Eraring Energy Project Application Consultation

Hi Dean,

As discussed today in our phone conversation, Eraring Energy is proposing to undertake an upgrade to the existing Coal Combustion Product (ash) Management System. HLA ENSR is preparing an Environmental Assessment to accompany a Project Application to the Minister for Planning under Part 3A of the EP&A Act for the upgrade, which follows on from a Concept Approval issued by the Minister under the Act. The Concept Approval granted in respect of the project requires that consultation be undertaken with the Hunter-Central Rivers CMA during preparation of the Project Application in relation to potential water quality impacts associated with the proposal.

The Environmental Assessment Scoping Report prepared for the proposal can be found at http://www.planning.nsw.gov.au/asp/pdf/07_0084_eraring_prelimasst_.pdf.

Please don't hesitate to contact me on 8484 8934 if you require further information regarding the proposal.

Kind regards,
Kate

Kate Tilden
Project Environmental Scientist
T +61 2 8484 8934

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Kate Tilden

From: Dean Chapman [Dean.Chapman@cma.nsw.gov.au]
Sent: Friday, 28 September 2007 2:54 PM
To: Kate Tilden
Subject: Re: Eraring Energy Project Application Consultation

Hi Kate,

The CMA is preparing comments as requested. Could you please advise who the CMA should address these comments to?

Thanks

Dean Chapman
Acting Program Manager

p (02) 4337 1214
m 0427 781 242

>>> "Kate Tilden" <ktilden@hlaensr.aecom.com> 14/09/2007 15:07 >>>
Hi Dean,

As discussed today in our phone conversation, Eraring Energy is proposing to undertake an upgrade to the existing Coal Combustion Product (ash) Management System. HLA ENSR is preparing an Environmental Assessment to accompany a Project Application to the Minister for Planning under Part 3A of the EP&A Act for the upgrade, which follows on from a Concept Approval issued by the Minister under the Act. The Concept Approval granted in respect of the project requires that consultation be undertaken with the Hunter-Central Rivers CMA during preparation of the Project Application in relation to potential water quality impacts associated with the proposal.

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Please don't hesitate to contact me on 8484 8934 if you require further information regarding the proposal.

Kind regards,
Kate

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Hunter - Central Rivers
CMA CATCHMENT MANAGEMENT AUTHORITY

Our Ref: Our ref:

Your Ref: Your ref:

Ms Kate Tilden
Project Environmental Scientist
HLA
PO Box 726
GORDEN NSW 2073

Dear Kate,

Re: Environmental Assessment Scoping Report for Upgrade and Expansion of Coal Combustion Product Management Facility at Eraring Power Station

Thank you for the opportunity to review and comment on the proposal listed above, the following comments from the CMA are provided for consideration.

The Catchment Management Authority has developed a set of guiding principles that express the CMA's position on how natural resource management should occur in the Hunter-Central Rivers region. The guiding principles provide direction for all natural resource managers to achieve Ecologically Sustainable Development and allow organisations to align their activities so that they are compatible with the CMA's Catchment Action Plan (CAP).

When developing plans and strategies, the CMA requests that the guiding principles of the CAP as well as the state-wide natural resource management targets developed by the Natural Resources Commission be taken into account.

Attached with this letter is the CMA's guiding principle on Rivers and Freshwater Wetlands and Groundwater for your reference in developing the environmental scoping report for the proposal listed above. For further information on the CMA's guiding principles, please refer to the Guiding Principle section within the Catchment Action Plan at www.hcr.cma.nsw.gov.au/catchmentactionplan_download.php3

The CMA strongly recommends that detailed consultation be undertaken with the both the Department of Environment and Climate Change and the Department of Water and Energy, both of which have a great deal of expertise with respect to water management matters.

With respect to the impacts of native vegetation associated with the proposal, the CMA considers the potential clearing of vegetation a key issue that should be addressed as part of the Environmental Assessment for the project.

Clearing of native vegetation is regulated by the *Native Vegetation Act, 2003* and is administered by the CMA. One of the objects of the *Native Vegetation Act 2003* is 'to prevent broadscale clearing unless it improves or maintains environmental outcomes'.

Under the Act, clearing can only be approved where it improves or maintains environmental outcomes. In certain circumstances, however, clearing is permitted without approval such as the clearing associated with prescribed Routine Agricultural Management Activities or native vegetation that has regrown since 1990.

The CMA understands that the Native Vegetation Act does not apply to this project as it is being assessed under Part 3A of the Environmental Planning and Assessment Act 1979.

The CMA, however, expects the 'improve or maintain' principle will be adopted as part of the assessment of the proposal. The CMA would further expect to see a full assessment of the conservation value of the vegetation communities existing on the site and an assessment of how any clearing following a rezoning could 'improve or maintain environmental outcomes' for example what offsets to mitigate against the impact of any clearing are proposed.

Yours sincerely

Dean Chapman
for Glenn Evans
General Manager

28 September 2007

RIVERS AND FRESHWATER WETLANDS

Maintain or improve the condition of rivers and freshwater wetlands[1]

INTENT

Rivers are important living, functioning ecosystems that carry water from the catchment into estuaries and oceans. Rivers and creeks provide important habitat for fish, frogs, aquatic plants and insects. They provide water for agriculture, industry and town water as well as recreation, and hydro-electric power. Access to water is now a marketable commodity that can be bought and sold. This means that water must be used efficiently and for the best possible value. Water is a limited resource and careful management is essential to ensure that it will be available in sufficient quantity and quality for future needs. In order for our rivers and creeks to continue to provide these important services, we must ensure that:

- diverse aquatic ecosystems are protected and sustained;
- water is used efficiently;
- the ownership of water, including access rights and responsibilities, is clearly defined;
- water storage and extraction is balanced with the natural resource requirements of water sources;
- priority areas for improving water flow and quality are identified; and
- the cost of environmental flows reflects the value of the limited resource and the cost of managing it. All those who benefit from this resource, both directly and indirectly, should meet these costs.

A large proportion of rivers and streams in the Hunter-Central Rivers region have been significantly impacted by human activity. Many are still deteriorating and will require significant rehabilitation before they reach a level of stability and a condition that is more like their original state.

MAINTAINING OR IMPROVING WATER QUALITY

Water quality in rivers and creeks should be protected and improved. The condition of rivers and creeks is strongly linked to catchment vegetation cover, the intensity and type of landuse, and riparian vegetation. Good water quality not only benefits river ecosystems but also improves recreation opportunities due to greater numbers of native fish and other aquatic animals, safer swimming and increased tourism.

Guiding Principles

1. Community education programs that raise awareness of the factors that influence water quality in rivers and creeks should be supported—e.g. Waterwatch.
2. Management activities should target streams that are highlighted as having lower water quality than the community agreed Water Quality Objectives (according to the NSW Interim Environmental Objectives for Water Quality and River Flow).
3. Education programs should target landholder and community awareness of the impact of disposing rubbish in waterways.
4. Land should be managed appropriately to minimise pollution.
5. Vegetation cover should be maintained and increased, as one of the most effective ways of managing diffuse source pollution.
6. Current best practice nutrient management should be adopted for all industries and landuses that contribute significant diffuse source pollution to rivers and creeks.
7. Current best practices should be universally and equitably applied and must be continually reviewed and adjusted.

[1] For guidelines relating to saline wetlands see Estuary and Marine guiding principles on page 49

8. Current best practice should also be used to manage point source pollution (see 'Managing Point Source Pollution' below).
9. Any activity or regulatory control should not compromise the community agreed environmental objectives of the water source.
10. New and existing developments should consider the opportunities to enhance water quality.
11. Environmental values for water should be related to the ecological processes in waterways.
12. The trading of water rights should improve, or at least not degrade, ecological processes in water sources.
13. Activities that improve water quality should consider the National Water Quality Management Strategy.

Benefits

- improved habitat quality in streams
- improved quality of drinking water that requires less treatment
- safer water for agricultural use
- healthier estuaries
- improved biodiversity
- economic benefits for industries such as fishing and tourism, and the broader community

MAINTAINING OR IMPROVING RIPARIAN VEGETATION

Vegetation along rivers and water bodies is important because this is where the land joins the water. Good quality riparian vegetation has many benefits for water quality, habitat and biodiversity both on the land and instream. Weeds are a significant issue for protecting riparian vegetation as riparian corridors are linear, more disturbed by activities like stock access and have good soil and moisture, which allows the easy spreading of weeds.

Guiding Principles

14. Good quality riparian vegetation of an appropriate width should be protected to maintain or improve a stream's natural resource values.
15. Degraded riparian vegetation should be rehabilitated and weeds controlled.
16. Riparian vegetation should cover land over the entire waterfront to sustain and improve riverine processes.
17. Information should be provided to land managers about the importance of riparian vegetation.
18. Riparian rehabilitation should use native, locally sourced (provenance) species.

Benefits

- improved water quality
- greater number of naturally-stable stream channels
- greater habitat corridors for land based animals
- improved riparian habitat
- improved instream habitat

MAINTAINING OR IMPROVING AQUATIC HABITAT

Rivers, creeks and wetlands support considerable biodiversity as they provide habitat (in snags, silt, sand, gravel, pebbles and boulders, overhanging stream-banks and pools) for a diverse range of native species. Pools are important retreat sites for fish during low river flows; wetlands provide significant refuge and nursery habitat for many aquatic species; streambed material provides protection for juvenile fish and instream insects; and large woody debris in rivers also creates pools and riffles.

Past degradation of this habitat caused by the removal of riparian vegetation and woody debris (e.g. logs), altered hydrology, sedimentation and infilling etc. has meant that

many rivers and wetlands can no longer support healthy communities, and instead support depleted native populations and exotic species. Healthy aquatic habitat supports native species and allows them to out-compete exotic species. Therefore, high quality aquatic habitat should be preserved and degraded aquatic habitat improved.

Guiding Statements

19. Stream rehabilitation and instream engineering works should consider stream habitat and geomorphic processes during the planning stage.
20. Education programs should be developed to help decision makers locate appropriate pump sites, roads and stock crossings to minimise river degradation.
21. There should be no removal of snags from rivers where possible. If necessary, obstructions causing safety hazards or inappropriate river processes should be relocated within the river—e.g. fallen tree relocated to an area where it does not cause erosion.
22. Instream sand and gravel extraction should not be allowed in rivers except where it can be shown that extraction would be beneficial to natural instream aquatic ecosystem processes.
23. Instream activities—e.g. dredging, sand and gravel extraction should consider stream habitat during the planning and operational phase.
24. On removing instream barriers and tidal floodgates:
    a. There should be a full assessment of all barriers to fish passage.
    b. Instream structures such as weirs and road crossings should be modified or removed where necessary to allow natural ecosystem processes to be restored or to continue. Floodgates should have regular, controlled openings at appropriate times to allow fish passage or, where appropriate, should be removed.
    c. Further research should be conducted to increase our understanding of the types of instream structures that allow fish passage.
    d. Information should be made available to landholders to increase their awareness of specific floodgates on their properties and the importance of floodgate management for fish passage and tidal exchange.
25. Wetland protection:
    a. Buffer areas should be established around wetlands to minimise impacts from surrounding landuses.
    b. Development in environments upstream of wetlands should also put in place measures that protect wetlands.
    c. If wetland habitat is degraded or disturbed by development, even where that impact is not on the development site, offset areas should be protected or enhanced by developers (see guiding principles on 'economic tools' on page 63).
    d. Education programs should be developed to increase community awareness on the importance of protecting wetlands.

Benefits

- greater proportion of good quality habitat
- native species given competitive advantage over exotic species
- reduced number of pest species
- improved water quality resulting from naturally functioning wetlands
- protected fishery habitat resulting in larger numbers of native fish species
- compliance with international migratory bird agreements
- better biodiversity protection
- better marine and foreshore habitat protection
- better protection of resting, feeding, roosting and breeding habitat, particularly for birds

MAINTAINING OR IMPROVING FLOODPLAIN CONNECTIVITY AND FUNCTIONING

While flood management must restrict floodwaters from important assets on the floodplain such as towns and buildings, it is also important that some connectivity between floodplains and rivers exists, because natural riparian and floodplain ecosystems require intermittent flooding to remain healthy.

Highly urbanised floodplains tend to have extensive flood mitigation schemes compared to less developed floodplains. The separation of the floodplain and the river is more substantial in these areas to minimise the risks to human life and property. Where it would not significantly reduce the protection to life and community assets, retrofitting current flood mitigation schemes should be considered to increase the connectivity of rivers with their floodplains.

Guiding Principles

Where it will not significantly compromise the protection of populations or infrastructure from flooding:

26. Levee systems should be redesigned and floodgates managed/removed to improve the connectivity between the floodplain and the river so that wetlands that require intermittent flooding do not dry out completely. This should be considered at any time when work will be undertaken to modify a levee system, and where it will not increase risks to life and property.
27. Where appropriate, stream rehabilitation should include raising streambed heights to reconnect with the floodplain and re-establish access to groundwater for plants, and restoring the health of the alluvial system.
28. Local government zoning and planning decisions (development approvals and local environment plans) should prevent inappropriate development on the floodplain. Floodplain management plans should be developed and implemented.
29. There should be consistent flood mitigation strategies between local planning organisations within a catchment.

Benefits

- increased area of floodplain habitat
- increased connectivity between species and communities resulting in more resilient wetlands
- improved function of river and wetland ecosystems
- increased biodiversity

MANAGING WATER EXTRACTION

Water extracted from rivers contributes to the economic wealth of the region, but extracting too much water may have severe impacts on aquatic ecosystems especially during periods of low river flows. Natural aquatic ecosystems have adapted over tens of thousands of years to natural flow regimes and extraction of water should not compromise the basic ecosystem processes supported by these regimes.

Guiding Principles

30. Water sharing plans should deliver the targets of the NSW Water Management Outcomes Plan (the SWMOP summarises the key goals of Water Management in NSW)—i.e. protect environmental flows, promote natural flow variability etc.
31. A plan should also be developed for the use of the Environmental Contingency Allowance (ECA) in the Hunter Regulated Water Source.
32. At the commencement of the CAP, the CMA holds no Adaptive Environmental Water. Should the CMA have this capacity in the future, then this water allocation will be managed for maximum natural resource benefit in the Hunter-Central Rivers region.
33. Water Sharing Plans should consider water flow objectives in the NSW Interim Environmental Objectives for Water Quality and River Flow for each catchment.

34. The significant value of water to Aboriginal culture and heritage should be considered when establishing environmental flows.
35. All water extraction should be metered and monitored.
36. Water extraction should not result in the use of water within natural water pools during low flows.
37. Water entitlements in rivers not currently impacted by over-extraction should be capped at levels that maintain adequate environmental flows.
38. There should be no further growth in water extraction from rivers where extraction is already high (based on the targets in the NSW Water Management Outcomes Plan).
39. Regulated stream flows should mimic variable natural flows as much as possible.
40. Development in some areas may need to be limited because of a lack of water, or the potential impact of development on water.
41. There should to be conservatively based critical flow levels below which no further extraction is allowed.
42. Incentives should to be available for the introduction of better landuse practices. For example the right to extract water at low flow could be tied to adoption by landholders of better landuse practices.
43. Basic rights access to water in some catchments can result in ecological processes being compromised at low flow. Where necessary landuse planning should ensure no additional basic rights to water are created in rivers where ecological processes are likely to be at risk. In many rivers the growth of basic rights through subdivision should be prevented by appropriate land planning rules. At times of water restrictions for irrigators, basic right users should also have mandatory water conservation rules e.g. limiting watering around domestic dwellings.
44. BASIX should be supported as minimum requirement together with the adoption of a process to introduce complimentary policies in existing developments.
45. Urban water usage should be subject to a bulk limit that should not be exceeded unless the urban area has adopted high levels of water conservation practices and has a low per capita average use of water.
46. Where appropriate there should be permanent water conservation conditions on some urban activities that contribute to excess water consumption (e.g. hosing down paths where not required for health reasons, watering lawns in the heat of the day etc.).
47. Water sharing plans should contain rules that allow adoption and/or adaptation over time. Licence holders may need time to structurally adjust to the rules (and subsequent changes). If possible the plans should specify the timeframes for changes and/or the limits of change as a result of new information.
48. Comprehensive natural resource monitoring may need to be undertaken to assess the environmental benefits of providing water for natural resources.

Benefits

- better balance between rural productivity and natural resource sustainability
- fairer and more equitable sharing of a valuable resource
- recognition of the fact that streams need water, and ensuring that sufficient water is available for environmental processes to be maintained
- better connection between surface and groundwater
- increased habitat diversity
- improved health of ecosystems in streams
- improved downstream ecosystems such as estuaries

Improving Urban Stormwater Management

Urban areas have large areas of impervious surfaces such as roads, driveways and roofs, which result in far higher volumes of water (or stormwater) runoff than natural systems and also lead to higher peak flows. Urban land can also contribute pollution such as fall-out from vehicle emissions, disturbed land from new developments, litter and chemicals

or fertilisers used on gardens. The extra volume of water can carry large volumes of pollutants into rivers and estuaries, adversely affecting water quality.

Guiding Principles

49. Locally appropriate current best practice stormwater management should be used in urban, commercial and industrial areas to reduce the impact of stormwater on natural resources (e.g. Water Sensitive Urban Design).
50. The reuse of stormwater before it enters rivers and estuaries should be supported where appropriate (i.e. better collection and infiltration of rainwater) and better management of stormwater itself (e.g. constructed wetlands, temporarily storing stormwater).
51. The hydrological regimes of waterways impacted by stormwater should be managed to mimic appropriate cycles. For example, downstream peak discharges, low flows and drying cycles should be managed to ensure that they do not impact downstream waterways and wetlands.
52. Urban planning should have a catchment based approach to stormwater management.

Benefits

- slower water flows, helping to reduce erosion and improve water quality
- better storage and reuse of runoff, reducing demand on town water supplies
- better filtering and absorption of pollutants within the catchment
- improved downstream habitat in streams and estuaries
- better awareness on the effects of urban land on natural resources
- increased local groundwater infiltration

Reducing the Impact of Thermal Pollution

Water released from a large storage dam is often colder than the river water downstream from the dam, especially if the river has other tributaries that join downstream. Depending on the volume of water released, the temperature change can vary in a single day. Instream species that are adapted to natural flow regimes have difficulty surviving sudden and unnatural changes in water temperature. Where possible these water releases should ensure there is minimal temperature difference between the discharge and receiving waters so that the impact extends downstream for a small distance only.

Warm water pollution occurs where power generation or other industrial processes discharge warm water to the environment. Warm water discharges can locally alter the aquatic habitat and disrupt the normal functioning of the ecosystem. This can result in an increase in the abundance of pest species and local extinctions of native species.

Guiding Principles

53. The Hunter-Central Rivers CMA supports the appropriate use of structures that can extract water from different levels in the two major dams in the region to minimise cold water release impacts downstream.
54. The rate of temperature change is equally important as the range of temperatures so the release rate of water from dams should aim to lessen rapid temperature change.
55. Power generator discharges should minimise their thermal impacts on the local environment.

Benefits

- Improvements in natural stream channels
- competitive advantage of exotic fish species reduced
- improved native species habitat
- reduction in the impact of thermal shock on species survival
- minimisation of low dissolved oxygen levels in cold water

Managing Point Source Pollution

Sometimes the bi-products of industry or landuse are released into waterways at a concentrated point such as through a pipe. These discharges are regulated through licences, administered by the Department of Environment and Conservation.

Guiding Principles

56. All industries that release point source pollution should use current best practice to minimise (and where possible eliminate) pollution entering rivers and estuaries.
57. Natural resource managers should consider the cumulative impact of point source pollution in their planning.
58. A timetable should be set for point source pollution to meet the water quality objectives of receiving waters. New point source discharges should meet the objectives as a condition of their approval and ongoing operation.
59. Effluent treatment (including effluent improvement) processes should not be planned within waterways.

Benefits

- improved water quality
- improved habitat

Relationships To Government and/or Industry Association Policies, Plans and Strategies

National

- JAMBA (Japan-Australian Migratory Birds Agreement) and CAMBA (China-Australia Migratory Birds Agreement) (International Agreements)
- National Action Plan for Salinity and Water Quality
- The Australian Government's Wetlands Policy
- Australian Water Reform Framework
- The National Water Initiative

State

- NSW Floodplain Development Manual, 2005 (including the Flood Prone Land Policy)
- NSW Water Management Act 2000
- NSW Biodiversity Strategy
- NSW Coastal Policy
- NSW Estuary Management Policy
- NSW Protection of Environment Operations Act 1997
- NSW Policy and Guidelines for Aquatic Habitat Management and Fish Conservation
- NSW Rivers and Estuaries Policy
- NSW Water Management Outcomes Plan
- NSW Water Quality Objectives
- NSW Weirs Policy
- NSW Wetlands Management Policy
- NSW Environment Planning Policy 14 - Coastal Wetlands
- Crown Land Foreshores Tenures Policy 1991
- Crown Land Assessment Manual (draft) 2004

Regional

- Local environment plans

GROUNDWATER

Maintain or improve the condition of groundwater systems

INTENT

Groundwater systems provide an important resource for town water supply and irrigation. Groundwater is also an importance source of water flow in rivers, especially in times of very low flow, and can be vital to the survival of Groundwater Dependent Ecosystems. The impacts of inappropriate land or water use often take some time to become apparent in groundwater quality. Sustainable and responsible land and water use are therefore essential to protect groundwater sources from pollution and ensure the availability of clean groundwater in the future.

General Guiding Principles

1. Ecologically sustainable management of groundwater should be encouraged in all individuals, communities and agencies that own, manage or use the water source.
2. The time lag between the effects of current landuse and negative impacts on groundwater should be considered in planning to protect water resources.
3. The entire landscape must be managed and should consider the cumulative effects of development and farming practices in planning for groundwater protection.
4. All activities within groundwater areas should ensure the long-term sustainability of the ecosystems supported by groundwater.
5. The full range of beneficial uses of groundwater needs to be maintained, but non-sustainable uses should be phased out.
6. The degradation of groundwater sources should be reversed or stopped and, where appropriate, degrading processes and practices should be replaced with more efficient and ecologically sustainable alternatives.
7. Where appropriate, the management of surface and groundwater sources should be integrated.
8. In assessing the potential risks of activities to groundwater, the worst case credible scenario should be identified and management options developed to eliminate the risk of occurrence.
9. Monitoring of a development that impacts on groundwater must be carried out throughout the life of a project (planning, operational, and post project), whilst the activity has the potential to impact on groundwater, river flows, water quality, river stability or ecosystem health.
10. An open and transparent process for natural resource monitoring and reporting to the relevant stakeholders should be part of any development that may adversely impact on groundwater systems. Specifically water management audits should be regularly undertaken and made available to the community.

MAINTAINING OR IMPROVING THE QUALITY OF GROUNDWATER

Some landuses can degrade the quality of groundwater if they are not managed properly. Because it takes a long time for pollution to filter down into groundwater the effect of these activities is sometimes not identified until it is too late to do anything about it. It is important to manage the way we use the land so that we do not affect the value of this water in the future.

Guiding Principles

11. An aquifer's highest beneficial use or an inter-connected groundwater dependent ecosystem's requirements should not be significantly reduced. The full complement of Ecologically Sustainable Development (ESD) principles need to be considered (particularly the precautionary principle) when dealing with the

potential impacts to groundwater systems, and the long-term ramifications of inappropriate management.

12. The achievement of the agreed water quality objectives and/or CAP targets should not be compromised by development or activities affecting groundwater source catchments
13. On-site sewage systems (such as septic systems) should be managed to minimise the release of sewage pollution into the environment. Local government should actively support current best practice and regulation of on-site sewage systems.
14. Awareness of urban communities and landholders in agricultural areas should be raised, on actions that can contaminate groundwater—such as excessive fertiliser and pesticide use, animal waste, and the disposal and storage of liquid waste.
15. Groundwater should be protected from pollution sources including leaky underground storage (e.g. underground fuel tanks) and leaky pipes (e.g. sewage pipes). Urban stormwater retention should consider the impact of the infiltration of pollutants from stormwater into soil and groundwater.
16. The end mining landform, particularly its stability and ability to intercept water (runoff and groundwater) should take into account in the development, and progressive implementation of coal mining post closure management plans and site rehabilitation programs for saline groundwater and surface water, including derelict mine sites.
17. Adequate buffers should be maintained between mining activities and adjacent surface water/alluvial aquifers. The CMA recognises the legislative framework under which mining operations function but also promotes the implementation of controls that go beyond those legislative requirements.

Benefits

- groundwater can be used without being treated (i.e. no risks to public health)
- reduced pollution caused by use of chemicals (such as fertilisers and pesticides)
- improved health of aquatic ecosystems that depend on groundwater

MANAGING RECHARGE TO GROUNDWATER

In places where large areas of land clearing have taken place, water that would normally be used by plants can filter down into the groundwater. This results in the groundwater rising to the ground surface, evaporating and concentrating salts in the soil surface. In other areas (such as urban areas, which are largely constructed from impenetrable surfaces) moisture cannot filter into the ground. These areas must be managed to repair and prevent the degradation of the groundwater system.

Guiding Principles

18. Groundwater recharge areas should to be clearly identified.
19. Groundwater recharge should be reduced in saline landscapes where groundwater aquifers significantly influence salinity issues and where they would be responsive to actions that reduce recharge.
20. Groundwater should be protected in urban areas by controlling surface development (e.g. through local environment plans and development control plans).

Benefits

- greater farm productivity due to healthier soils
- increased biodiversity on the farm when native vegetation regenerates
- improvements in water quality, aquatic health and biodiversity in rivers
- protection of biodiversity in Groundwater Dependent Ecosystems
- sustainable groundwater extraction

MANAGING THE EXTRACTION OF GROUNDWATER

The NSW Water Management Outcomes Plan (SWMOP) summarises the key goals of Water Management in NSW. All Water Sharing Plans (WSP) should be consistent with the SWMOP.

Guiding Principles

21. The growth in the use of water accessed through Basic Rights must be managed appropriately to protect sensitive ground water sources. The growth of basic rights through subdivision should be minimised by appropriate land planning rules.
22. All extraction of groundwater should be metered and monitored especially for sensitive or vulnerable groundwater sources.
23. Fresh groundwater sources should be protected from salt water intrusion by ensuring that the extraction of water from sand beds and alluvium is sustainable.
24. Water extraction should be managed within the sustainable yield so that the groundwater is available for future generations and ecological processes that depend on them remain viable.

Benefits

- adequate groundwater is available for use in the future
- fair and equitable sharing of a valuable resource
- baseflow of rivers protected
- Groundwater Dependent Ecosystems protected

IDENTIFYING AND PROTECTING GROUNDWATER DEPENDENT ECOSYSTEMS

The types of ecosystems that can be dependent on groundwater include terrestrial vegetation wetlands, estuarine and near shore marine systems, river base flow systems, cave and aquifer ecosystems and terrestrial fauna (see No. 1 in the Reference List on page 211). To date there is little known about some of these ecosystems; however, they should be protected from a decline in the amount or the quality of groundwater using the best information available.

Guiding Principles

25. Ecosystems that rely on groundwater must be clearly identified.
26. Groundwater dependent ecosystems should be considered in landuse planning so that any threats to these ecosystems are reduced.
27. Stream rehabilitation should include raising incised streambeds to a level where groundwater tables can support groundwater dependent ecosystems.

Benefits

- increased knowledge and awareness of the value of Groundwater Dependent Ecosystems
- Groundwater Dependent Ecosystems and biodiversity protected

RELATIONSHIPS TO GOVERNMENT AND/OR INDUSTRY ASSOCIATION POLICIES, PLANS AND STRATEGIES

National

- A National Action Plan for Salinity and Water Quality
- National Objectives and Targets for Biodiversity Conservation 2001-2005 - for dryland salinity

State

- Water Management Act 2001
- Mining Act 1992
- Environmental Planning and Assessment Act 1979

- NSW Salinity Strategy
- Policy for Sustainable Agriculture in New South Wales
- NSW Groundwater Policy
- NSW Groundwater Dependent Ecosystem Policy

Regional

- Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002
- Hunter Water Special Areas Regulation (2003)

E-mail Message

From:	Craig, Garry [EX:/o=Eraring Energy/ou=ErEnergy/cn=Recipients/cn=L66432]
To:	SWalpole@lakemac.nsw.gov.au [SMTP:SWalpole@lakemac.nsw.gov.au]
Cc:	
Sent:	20/11/2006 at 3:41 PM
Received:	20/11/2006 at 3:41 PM
Subject:	Draft Ash Management Strategy
Attachments:	Draft Ash Management Strategy.doc

```
>Hi Symon,
>
>As part of the draft Concept Approval for the new ash disposal
project at EPS, EE was required to prepare in consultation with the
DEC and Council an Ash Management Strategy. EE has prepared a draft
document for the Council to review and I have attached a copy. Please
note this is the first draft and EE welcome's input from the Council
so that the strategy will meet their requirements as well as put in
place a template for EE to meet their stipulated goal. The strategy
is required to be in place prior to EE gaining project approval. EE
expects to apply for this approval in early 2007 to allow tenders to
be submitted for the work. Can you please review the documentation
and return your department's comments to me so that they can be
incorporated into the strategy within three weeks if at all
possible..
>
>Regards
>Garry Craig
>Ash Disposal Project Manager
>Eraring Power Station
>Phone +61 2 49730521
>Mobile 0438 243402
>Fax +61 2 49730710
>E-mail garry.craig@eraring-energy.com.au
>
>
```

E-mail Message

From:	Symon Walpole [SMTP:SWalpole@lakemac.nsw.gov.au]
To:	Craig, Garry [EX:/O=ERARING ENERGY/OU=ERENERGY/CN=RECIPIENTS/CN=L66432]
Cc:	Craig Manhood [SMTP:CManhood@lakemac.nsw.gov.au], Robbie Economos [SMTP:reconomos@lakemac.nsw.gov.au]
Sent:	12/01/2007 at 11:14 AM
Received:	12/01/2007 at 11:15 AM
Subject:	RE: Draft Ash Management Strategy

Dear Garry

My appologies for the lateness of Council's response to your request.

Comments compiled by Council staff concerning the draft Ash Management Strategy are provided below:

1. In general, the EE Ash Management Strategy offers no benchmarking and limited targets. The one goal set by EE is 100% recycling of fly ash and bottom ash by 31 December 2011. This goal is contradicted at point 5 under Strategy for Staged Land Clearing for Ash Disposal Site. There is no indication throughout the strategy of quantities of fly ash and bottom ash currently produced and there is subsequently no targets set for a gradual increase in recycling.
2. With regard to specific strategies, there is limited reference to timeframes, no reference to cost implications and no reference to the potential recycling/ reuse increases that may result from these strategies.
3. The fly ash and bottom ash uptake is proportional to the health of the building and construction industry but it is also price and performance dependant. Currently EE ash products listed under Council's annual Tenders, however their uptake is limited due to other fill products such as recycled asphalt pavement (RAP) being cheaper and fit for purpose.
4. Loading and transport efficiencies have the greatest potential to increase the reuse of fly ash on other sites. Synergy with the Department of Planning and Coal Mining Proponents is necessary when Consideration of a rail loading facility at EE. In the interest of the State Government commitment to extended producer responsibility, coal mines share the responsibility for the management of fly ash as well as having the obligation to rehabilitate mine sites.

9. What was the response to the EoI place by EE in 2005. How many companies are "interested" and what is the extent of their interest?

5. The only specific detail in the strategy relates to the clearing of land to an extent, which contradicts the goal of 100% recycling by December 2011.
6. In the method there is no mention of contributions to research into other uses (it could be elsewhere in the document or could be conducted by the ADAA but I am not sure).
7. With regard to compensatory habitat the emerging rules include replacement of like for like and compensatory habitat should be assessed by improving and maintaining the extent, connectivity, security and persistence of native vegetation and habitat. An assessment by qualified flora and fauna professional should be conducted to identify such areas.
8. Rehabilitation of highly disturbed areas take such a long time to

be of value biodiversity value that alone, should not be considered to be compensatory habitat. Where it is considered as compensatory habitat the areas required to be rehabilitated have been much greater than those cleared.

9. Rehabilitation of the Ash Dam may have been a requirement of the establishment of the power station any way and it is my understanding that this has been part of the existing power station operation for some time.

10. With a land holding as big as Eraring and with the biodiversity values that it holds, there is plenty of scope to increase the security and improve the management of other parts of the site that support higher biodiversity values through a VCA (or other means) rather than rely on rehabilitation of highly degraded habitat that will take over 30-100 years to perform a similar level of ecological function to the cleared land.

11. Without a map of exactly where it is in relation to surrounding bushland, the value of the constructed corridor is uncertain.

I hope this is of assistance. Please let me know if you require further information or clarification on the above.

Regards - Symon

Symon Walpole

Catchment Management Officer
Environmental Systems Department
Lake Macquarie City Council
Ph: 4921 0393
Fax: 4921 0351
email: swalpole@lakemac.nsw.gov.au

E-mail Message

From:	Craig, Garry [EX:/o=Eraring Energy/ou=ErEnergy/cn=Recipients/cn=L66432]
To:	Symon Walpole [SMTP:SWalpole@lakemac.nsw.gov.au]
Cc:	
Sent:	12/01/2007 at 12:11 PM
Received:	12/01/2007 at 12:11 PM
Subject:	RE: Draft Ash Management Strategy

Thank you Symon for the reply. EE is expecting a reply from the DEC early next week which will be reviewed along with your comments and EE will supply a reply based upon both submissions which can be reviewed further by Council. It is hopeful that when this second review takes place that a final Ash Management Strategy can be submitted to the Dept of Planning for approval. I will keep in contact.

Regards
Garry Craig
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E-mail garry.craig@eraring-energy.com.au

E-mail Message

From:	Craig, Garry [EX:/o=Eraring Energy/ou=ErEnergy/cn=Recipients/cn=L66432]
To:	swalpole@lakemac.nsw.gov.au [SMTP:swalpole@lakemac.nsw.gov.au]
Cc:	
Sent:	23/05/2007 at 9:38 AM
Received:	23/05/2007 at 9:38 AM
Subject:	Long Term Management Strategy
Attachments:	S6055701_FinalLTMS_01May07.pdf

Hi Symon,

EE has prepared a final draft Long Term Management Strategy as required under the Concept Approval. The DECC and LMCC have reviewed the original draft and EE has incorporated the comments made by both organisations. Can you please review the document and have your comments back to me ASAP. This document is intended to be lodged with the DoP following your review. .

Regards
Garry Craig
Project Manager/CCP Management Project
Eraring Energy
Eraring Power Station
Dora Creek, NSW, Australia
Phone +61 2 49730521
Fax +61 2 49730710
Mobile 0438 243402 or +61 4 38 243402

E-mail Message

From:	Symon Walpole [SMTP:SWalpole@lakemac.nsw.gov.au]
To:	Craig, Garry [EX:/O=ERARING ENERGY/OU=ERENERGY/CN=RECIPIENTS/CN=L66432]
Cc:	Robbie Economos [SMTP:reconomos@lakemac.nsw.gov.au], Craig Manhood [SMTP:CManhood@lakemac.nsw.gov.au], Quentin Espey [SMTP:qespey@lakemac.nsw.gov.au]
Sent:	31/05/2007 at 10:31 AM
Received:	31/05/2007 at 10:31 AM
Subject:	Eraring Energy Long Term Ash Management Strategy May 2007
Attachments:	Eraring Ash Mgt Strategy Comments May 2007.doc

Dear Garry

Please find attached Council staff comments on the May 2007 version of the LTMS for CCP at Eraring Power Station.

Regards - Symon

Symon Walpole

Catchment Management Officer

Environmental Systems Department

Lake Macquarie City Council

Ph: 4921 0393

Fax: 4921 0351

email: swalpole@lakemac.nsw.gov.au

30 May 2007

Garry Craig
Project Manager - CCP Management
Eraring Energy
PO Box 5044
DORA CREEK 2264

Our Ref: F2006/01644
Your Ref: Ash Strategy Comments May 2007
ABN 81 065 027 868

Dear Garry

SUBJECT: COUNCIL COMMENTS ON LONG TERM MANAGEMENT STRATEGY - COAL COMBUSTION PRODUCTS MAY 2007

Council officers have reviewed the Eraring Power Station – Long Term Management Strategy for Coal Combustion Products (01 May 2007 Version) and provide the following comments.

Ash Reuse Issues

Eraring Energy's Long Term Management Strategy (LTMS) – CCP is a substantial improvement on the Draft presented to Council in January 2007. However, significant concerns are still apparent, namely:

- Nowhere in the document are the actual quantities in volume or mass of CCP produced by Eraring in the past, currently or in the future mentioned. This data is central to the discussion and it's omission raises Council concerns over the effectives of the strategy.
- Also central to the discussion are what areas of land is currently available for CCP storage, what air space is contained within this area of land and what volume of air space will be available through the proposed clearing of 21 hectares of bushland.
- *1.2.1 Trends in the Use of CCP* identifies a market value of CCP. This section identifies that 15% of products reused in Australasia offer some financial return and that revenue from this product amounts to $100mil. This translates into a market value for CCP of $50/tonne. This analysis indicates a higher value than indicated by CCP derived products to alternative materials. Council believes that the effect of pricing of CCP products and the subsequent effect on quantities reused is not adequately detailed in the strategy, and further efforts to reduce the market price of CCP are essential to the wider use of CCP.
- *Opportunity 4, New Truck Loading Facility* discusses a feasibility study into a truck **loading** facility that will enable more sales to new markets. The corresponding point in Table 2 discusses a feasibility study into a new truck **unloading** facility as part of the new plant at EPS. Firstly, the nature of this loading or unloading facility needs to be clarified and consistent within the document. Secondly, loading and unloading facilities will enable the transport of CCP to any number of facilities, including voids

created by quarries or disused mines. To improve the feasibility of filling voids with CCP, there is potential for storing the material for reuse beyond the life of EPS and when current supplies are exhausted.

Biodiversity Implications

Council's Environmental Planning staff have assessed the biodiversity implication of the strategy and offer the following comments.

Management Framework

Section 5.2 Environmental Management of CCP should incorporate not only discussions with the relevant authorities but also implementation of actions required to rectify problems that are identified in the reviews.

Compensatory Habitat

In many ways, the previous comments made on compensatory habitat are still valid. These were as follows:

5. *"With regard to compensatory habitat, the emerging rules include replacement of like for like and compensatory habitat should be assessed by improving and maintaining the extent, connectivity, security, and persistence of native vegetation and habitat. An assessment by qualified flora and fauna professional should be conducted to identify such areas.*
6. *Rehabilitation of highly disturbed areas takes such a long time to be of value biodiversity value that alone, should not be considered compensatory habitat. Where it is considered as compensatory habitat, the areas required to be rehabilitated have been much greater than those cleared.*
7. *Rehabilitation of the Ash Dam may have been a requirement of the establishment of the power station any way and it is my understanding that this has been part of the existing power station operation for some time.*
8. *With a land holding as big as Eraring and with the biodiversity values that it holds, there is plenty of scope to increase the security and improve the management of other parts of the site that support higher biodiversity values through a VCA (or other means) rather than rely on rehabilitation of highly degraded habitat that will take over 30-100 years to perform a similar level of ecological function to the cleared land.*
9. *Without a map of exactly where it is in relation to surrounding bushland, the value of the constructed corridor is uncertain. '*

Mature Forest as Compensatory Habitat

The Strategy includes compensatory habitat however, there is little in the way of assessment presented which justifies the compensatory areas in terms of matching the attributes of the vegetation being cleared with the attributes of the compensatory habitat.

Whilst it is beneficial that the areas of compensatory habitat have been identified, the methods by which they will be secured in perpetuity are not described. Table 2 P13-14 – it is unclear as to what the word dedication means and if this is a measure to increase the security of the land.

The conservation of additional mature forest as a compensatory measure is supported. The amount proposed in the Strategy is in excess of 30ha. However,

- It corresponds exactly to the crown land to be secured from the Department of Lands and there appears to be some doubt about securing this in the Strategy. Therefore, either the plan cannot be finalised until the land is secure OR there should be an alternative proposed.
- It would be preferable for such compensatory habitat to be contiguous. It should not be separated by land that is not secured and could be disturbed in the future. It is therefore recommended that these two areas be joined by additional secure land.
- There are no management actions specified in the Strategy for this compensatory habitat. For example, measures for increased security, weed management and rehabilitation of a small disturbed area on the western tip.
- There are no management actions specified to minimise and avoid disturbance with regard to the disperser pipeline.

Rehabilitation of the Ash Dam as Compensatory Habitat

Table 3 P15– the statements in the description opposite Stages 1, 2 and 3 are misleading. It is stated that by 2015 the 40ha of area C to be rehabilitated will be "fully established and mature habitat of high quality and characteristic of the vegetation communities proposed to be cleared as part of the proposal." It is highly misleading and unachievable for mature high quality vegetation to be established in 8years. It will take 30-50 years before the ecological function of the rehabilitated area C are restored.

The rehabilitation of Cell C is of much less ecological value than the mature forest being cleared. However, if rehabilitation of the Ash Dam is to be included as part of the compensatory/offset package along with the mature forest area on the ridge then:

- it is good to see that the ratio of rehabilitated area to area cleared is higher than 2:1
- it is much more important to rehabilitate areas of the Ash Dam that are adjacent to existing vegetation communities that will not be cleared. For example the edge of the Ash Dam at the interface with native vegetation. Whilst cells A and B have already been rehabilitated, there may be some enhancement measures that could be put in place at the edge of the Ash Dam area.

Figure 4 Proposed Vegetation Offsets and Compensatory Habitat, shows 40ha of Area C to be rehabilitated as an offset. Nevertheless, once the vegetation is removed for the Ash Dam expansion the rehabilitated area will be isolated, as it does not join the native vegetation to the north. If fauna, by chance, moves through the rehabilitated area C they get to a dead end at the Ash Dam wall.

The Ash Dam area to the north of the 40ha of area C (shaded on Figure 4) is of much higher priority for rehabilitation and should be included as an offset as it would compliment the existing native vegetation and habitat.

The Rehabilitated Corridor (Section 4.2.1 Corridor Preparation)

This area has not been delineated on a map, despite previous comments from Council (point 9 above). Its ecological effectiveness cannot be ascertained nor can its role in the context of other compensatory measures be assessed.

Ash Dam Vegetation Management Plan

The species list for planting should be derived from onsite surveys rather than LHCCREMS, which was a regionally based vegetation-mapping project. Table 1 contains a number of species (listed below) that do not appear to be identified in onsite surveys of the surrounding vegetation communities by Biosis in 1999. There may however, be more recent surveys conducted. It is undesirable to introduce new plant species to the site.

Banksia integrifolia

Banksia serrata

Baumea articulate

Baumea juncea

Gahnia clarkei

Leptospermum trinervium

Melaleuca ericifolia

Viminaria juncea

The Vegetation Management Plan should as far as possible collect and use seed from the Eraring site and in particular collected from those vegetation communities that will be cleared.

In Table 2 Point 9 – avian and arboreal habitat is intended to be created by ring barking 1-5% of advanced Casuarina trees. Such a method would not be supported unless there are other reasons to do this eg the wrong species of Casuarina was used or they are growing too thick to allow appropriate diversity of species to grow.

Section 3 Ash Dam Vegetation Management Strategy

Table 4 Key Performance Indicators

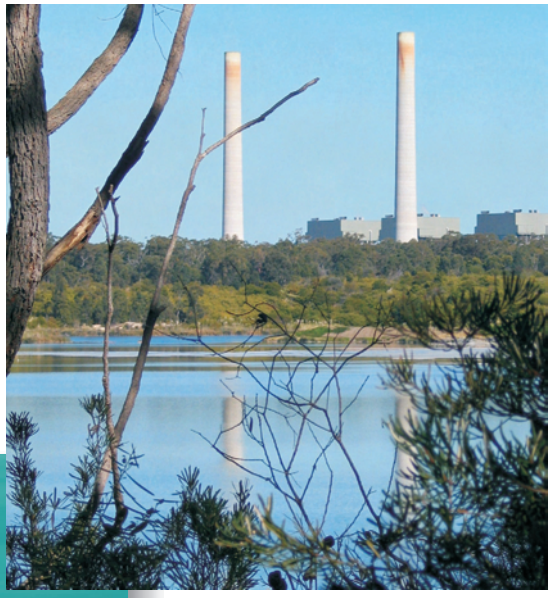
If the Ash Dam rehabilitation is going to form part of the compensatory habitat package, it is not sufficient to maintain plant communities the rehabilitation must result in an improvement.

The Key Performance Indicators do not lend themselves to be checked for compliance. That is, they are not measurable. It is important for Eraring to be able to demonstrate compliance with the Strategy and Vegetation Management Plan as well as for the regulators to assess compliance.

We hope these comments are of assistance in the finalisation of this important strategy. Should you require further information, please contact me on 4921 0393.

Yours faithfully

SYMON WALPOLE
CATCHMENT MANAGEMENT OFFICER (TEAM COORDINATOR)
ENVIRONMENTAL SYSTEMS DEPARTMENT



appendix c

geotechnical consultation

In reply please send to: Newcastle District Office

Our reference: FN81-01050L0

Your reference: Ash Dam Facility Expansion- Garry Craig

Contact: Paul Gray (02) 4908 4300

ERARING ENERGY
PO Box 5044
DORA CREEK NSW 2264

27 March 2007

Dear Garry

APPLICATION NO. TBA06-04666L4
PROPOSED EXPANSION OF THE ASH DAM FACILITY
LOT 11 DP 1050120 ERARING ENERGY

The Members of the Board conditionally approved this project in June 2006 subject to geotechnical assessment of the abandoned mine workings under the Ash Dam expansion.

The plans supplied to the Board show there is a small section of the project over the abandoned mine workings in the North West corner. The Board requires the risk of subsidence of those workings to be assessed and the effect of any possible subsidence to be taken into account in the design of any improvements to be built over that area.

The Board also recommends that the Department of Primary Industries-Mineral Resources be consulted regarding any possible interaction between the Ash Dam and the underlying mine workings. The Director Mine Safety, Mr Rob Regan should be contacted regarding DPI's requirements (49316621).

Yours faithfully

Paul Gray
Acting District Manager

cc: DPI-Director Mine Safety, Rob Regan

Standard (Auto) BAs

MINE SUBSIDENCE BOARD

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BG:GC:doc07/31616

Eraring energy

19th June 2007

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Department of Primary Industries
Mineral Resources
1 Civic Avenue
PO Box 51
SINGLETON NSW 2330

Attention: Mr Tim Martin

Dear Mr Martin

UPGRADE AND EXPANSION OF ASH DAM AT ERARING POWER STATION

Eraring Energy has received Concept Approval from the Department of Planning for the upgrade and expansion of the Ash Dam at Eraring Power Station. One of the issues that Eraring Energy requires to finalise before progressing the concept approval to project approval is a geotechnical assessment of abandoned mine workings located under the proposed ash dam expansion. This was identified during the planning process. The Department of Planning recommended that Eraring Energy discuss this issue with the Mine Subsidence Board. Following on from the discussions with the Mine Subsidence Board correspondence was received that Eraring Energy should further discuss this issue with the Department of Primary Industries – Mineral Resources (refer attached).

From discussions with the Department of Primary Resources - Mineral Resources and it was requested that Eraring Energy investigate the long term operational situation with the mine workings identified by the Mine Subsidence Board at the north western corner of the proposed expansion. Eraring Energy can now confirm that the current mine with close workings to the proposed area for upgrade and expansion of the ash dam at Eraring Power Station, Newstan mine, will be closing in 2008. This closure was identified in a press release from Centennial Coal in November 2006 which is attached. It is the understanding of Eraring Energy that the mine will be sealed by the owner at the time of closure.

Further, Eraring Energy will not be placing fly ash above the current level of RL 125m prior to 2009 when a new dense phase disposal plant will come into service. During the first 12 months of operations of the new system it is intended to place fly ash up to RL 130m. During the next 12 to 24 months it is intended to place fly ash up to RL 135m. The maximum height that fly ash will be placed (as required under the Concept Approval requirements) is RL 140m. This will not occur until some time beyond 2012 and is dependant upon the success of fly ash sales for reuse over time.

Eraring Energy believes that there will be no adverse interaction with the mine because it will be closed and sealed prior to the expansion of the ash dam at Eraring Power Station being carried out. It is requested that the Department of Primary Resources - Mineral Resources please review this information and provide comments in order for Eraring Energy to attain final project approval.

If you have any questions please do not hesitate to contact the Project Manager, Mr Garry Craig on 4973 0521 for more information.

Yours faithfully

WAYNE WINTERBINE
GENERAL MANAGER ERARING PLANT

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

→ G. CRAIG - for discussion & response please.

Now incorporating Department of Mineral Resources
ABN 51 73 412 4190-003

W. Winterbine 6/7/07.

Mr. W. Winterbine
General Manager Eraring Plant
Rocky Point Road
PO Box 5044, DORA CREEK
NSW, 2264

WW 6/7/07

Comet ID - 317543269001
Our Ref: 07/4313

27 June 2007

Re: Upgrade and Expansion of Ash Dam at Eraring Power Station

Dear Sir,

I refer to the Eraring Energy letter dated 19 June 2007, wherein comment was sought from the Department of Primary Industries as to possible impacts from the interaction of underground mine workings and the Eraring Ash Dam projected expansion.

Technical officers of the department have reviewed the information presented, and I make the following comments:

1. The workings in the impacted area are shallow, approximately 20 metres at the edge of the workings. It would be extremely likely that there is a nexus between the surface and the workings in this area.
2. The underground workings will not be impacted until the ash emplacement has reached a height of approximately RL 133. The current timing for ash emplacement to impact the area is not for another two to three years.
3. The "Market Release" document notes that the Centennial Group **plan** to close their Newstan, Awaba and Mannering operations sometime in 2008.

Based on this information I require that prior to ash emplacement occurring above RL 133 within the impacted area noted on Plan – "Eraring Power Station Ash Disposal Area", Drawing No VS006, that you confirm through Centennial Coal that this area of the mine has been sealed.

Note:
Your letter comments that Newstan will be closing in 2008. I would like to confirm that the Awaba operation is the mine which has workings within this area.

Yours faithfully,

R. Regan
DIRECTOR - MINE SAFETY OPERATIONS &
CHIEF INSPECTOR OF MINES

BG:GC:doc07/46002

Eraring energy

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17th September, 2007

NSW Department of Primary Industries
Mineral Resources
1 Civic Avenue
PO Box 51
SINGLETON NSW 2330

Attention: Mr Tim Martin

Dear Mr Martin

Re: Upgrade and Expansion of the Coal Combustion Product (CCP) Dam (Ash Dam) at Eraring Power Station

As part of the Concept Approval requirements for the Coal Combustion Products Project received from the Department of Planning, Eraring Energy was requested to carry out a risk analysis and geotechnical assessment for the expansion of the ash dam. This assessment was to be carried out in consultation with the Mine Subsidence Board (MSB) and Department of Primary Industries, Mineral Resources (DPIMR) having regard to the proximity of old mine workings to verify that they are collapsed and there is no risk of future subsidence and the potential for impacts on the future extraction of coal reserves in the area.

The MSB recommended consultation with the DPIMR. The DPIMR recommended that Eraring Energy confirm through Centennial Coal that, the area of the mine where the proposed ash dam extension was to overlap had been sealed.

Eraring Energy produced an overlay plan of the proposed fly ash placement area and the Awaba mine workings (see attached). This overlay indicated that there was a small overlap between the area for ash placement and the Awaba mine workings. Much of the area of overlap had the pillars removed and had collapsed. However, there was a small area where some pillars had not been removed and these were identified as portions of panels 101, 102 and 103.

Awaba mine indicated that they noted that the footprint overlays panels 101, 102 and 103 and that these panels have been fully extracted and are contained within a substantial barrier pillar. As such Awaba mine was satisfied that any elevated vertical stress will not impact upon underground pillar stability. Therefore, Awaba mine did not feel that it was necessary to seal the mine (see letter attached).

Eraring Energy also engaged Connell Wagner to review the information and they also agreed that the mine did not require sealing. Connell Wagner indicated that the dense phase fly ash placement would act like a blanket over the workings due to the cement like nature of the material (see e-mail attached).

Based on this information Eraring Energy requests that the DPIMR confirm that the risk analysis and geotechnical assessment carried out by Eraring Energy in regard to the overlap of the extension of the ash dam and the old mine workings at Awaba mine is acceptable to the DPIMR.

It is the intention of Eraring Energy to include this information in the Environmental Assessment for the Coal Combustion Product Project which is to be lodged with the Department of Planning.

Yours faithfully

WAYNE WINTERBINE
GENERAL MANAGER ERARING PLANT

Centennial Coal

awaba colliery

*Ref: w\management\managermine\dmr\dmr***

Geoff Byrnes
Fuel Supply manager
Eraring Power Station
Eraring Energy

24th August 2007

Attention Mr Geoff Byrnes
Fuel Supply Manager

Dear Geoff

Upgrade and Expansion of Ash Dam at Eraring Power Station.

I have reviewed your plan for the proposed expansion of the Eraring Ash Dam. I note that the footprint overlays 101, 102 and 103 panels. These panels have been fully extracted and are contained within a substantial barrier pillar. As such I am satisfied that any elevated vertical stress will not impact upon underground pillar stability.

As the depth of cover in this area is shallow I believe there exists a conduit for surface waters to migrate into the underground workings. This is currently experienced in many areas of the Colliery and is controlled via our underground pumping systems.

The Colliery has not been in the practice of sealing off old working areas of the mine and the construction of a rated seal around these panels, to cater for a substantial head of water, would be an expensive exercise. It is proposed that a better method of dealing with an increased water make from the expanded ash dam would be to upgrade the pumping capacity from the area adjacent to the ash dam. I am satisfied this would ensure the extended Eraring ash dam would not impact upon Awaba Colliery for the duration of its remaining life.

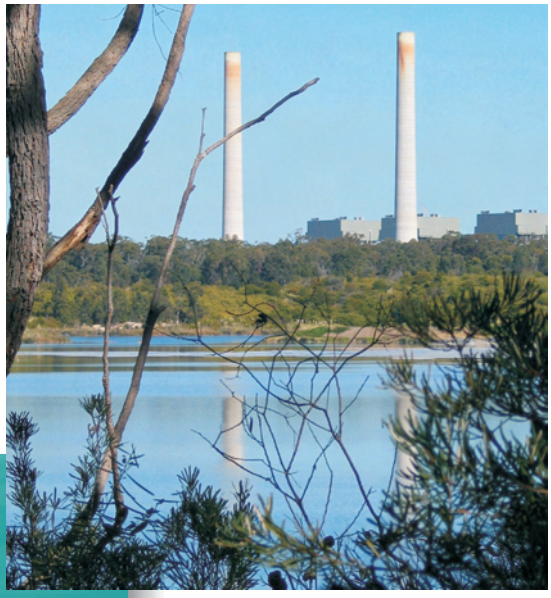
Yours sincerely

Keith Falconer
Colliery Manager

ACN 052 533 070

Wilton Road
Awaba NSW 2283

Tel: 0249 503 435
Fax: 0249 594 171



appendix d

hydrological specialist studies

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Eraring Power Station Ash Dam Water Forecast for Dense Phase Slurry Proposal

Eraring Energy

3 August 2007
Reference 0C6C02
Revision 3

Connell Wagner

Connell Wagner

Document Control

Document ID: H:\PCHEM\Water\Water Treatment Projects\Eraring Ash dam dense phase water quality\July 07 - Final Revised Report\Eraring Ash Dam report - final rev 3.doc

Rev No	Date	Revision Details	Typist	Author	Verifier	Approver
0	29/06/2006	Final Preliminary Report	JL	JL	CG	MH
1	03/04/2007	Included updated survey data and forecast ash data	JL	JL	CG	MH
2	24/04/2007	Revised table numbering and Appendix A	JL	JL	CG	MH
3	31/07/2007	Revised storm runoff capacity calculation without discharge to Crooked Creek & Discussion modified	JL	JL	CG	MH

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Table of Contents

1. Introduction

Eraring Power Station was originally designed and constructed to transport furnace bottom ash (ash) and flyash (dust) to an ash storage dam (ash dam). The ash & dust are transported separately by lean phase slurry systems to the ash dam for sedimentation, with the water recovered for further use in ash and dust slurry transport. The ash dam requires management of the water system to control discharge within environmental limits via a licensed discharge point to Crooked Creek or the outlet canal to Myuna Bay. The ash dam receives discharges from a number of site water systems along with its natural catchment and can have a positive water balance.
As the storage capacity of the ash dam is limited and the volume of deposited ash has exceeded 50% of its original design capacity [Ash Disposal Strategy Sept 2003], Eraring Energy initiated a review of alternate ash disposal techniques [Eraring Energy – Fly Ash Disposal, Awaba Mine Options Study]. From this review, the favoured option is to modify the flyash slurry system to a High Concentration Slurry Disposal (HCSD) system.

2. Workscope

To determine impacts of proposed changes in the ash system, the following parameters are to be calculated.

i) The minimum working volume of return water is to be determined based on existing bottom ash and proposed dense phase flyash systems.
ii) The rate at which the volume of ash dam free-standing water will reduce due to the effects of the existing ash disposal systems and the forecast installation of the dense phase flyash disposal system.
iii) A water balance of the ash dam is to be undertaken including short-term storm rainfall events and the need to discharge or make-up.
iv) The development of a model may be required for sensitivity analysis for water quality.

The workscope was expanded at the request of Eraring Energy to include:

v) Calculation of ash encroach distance to the stilling pond (to determine corresponding pond size from above) without need for discharge to Crooked Creek.

3. Findings

3.1 Return Water Volume

The water decanted from the ash dam after settlement of solid ash is drawn off via a stilling pond and discharged to the return water dam. Water is pumped from the return water dam to the Return Water Tank either for re-use in ash slurry transport, or discharge to the CW outlet canal. Make-up to the Return Water Tank may also be provided by make-up pumps drawing water from the CW outlet canal, rather than from the Return water dam.

The return water tank provides buffer storage of water for use in ash slurry and is the single source of water supply to the ash and dust plants. As previously noted, the make-up to the Return Water Tank can be supplied from either the return water dam or the CW outlet canal.

As the water requirements for the flyash HCSD are less than that for the existing lean phase slurry, the current design of return water tank storage volume is considered to be sufficient.

3.2 Ash Deposition

Current ash disposal technique results in approximate ash delta deposition gradients given in Table 1 below. This data is important in estimating the volumes of both flyash deposits and free-standing water bodies.

Table 1: Eraring Power Station Ash Deposition Gradients

	Above water	Below water
Flyash (lean phase)	1:500	1:15
Flyash (dense phase)	1:40	1:15

3.3 Ash Dam Capacity Forecasts

The storage capacity of the ash dam was estimated for two proposed scenarios. The first scenario assumes that the dam would continue to be filled using lean phase dust (flyash) slurry, from a single point, in a conical manner until the surface of the ash delta is within 250mtrs of the stilling pond. The distance from the ash deposit at water level to the stilling pond is referred to as the encroach distance, and 250m was initially suggested to maximise the storage capacity for ash, but still maintain a separation distance to the ash dam water outlet to minimise the risk of solids entrainment in return water (refer to Figure A 3).
The second scenario assumes dense phase dust slurry is deposited from the northern bank of the ash dam, and that the ash would propagate as an east-west aligned deposit until filled to a delta within 250mtrs of the stilling pond (refer to Figure A 2). The estimated ash dam capacities are shown in Table 2 below. These calculations took into account the relevant geometries and ash settling characteristics above the waterline of RL 125.0 and those below to the dam bottom of RL 110.0 m. The method and calculations are given in Appendix A.

Table 2: Estimated Storage Capacity for Ash Dam for possible scenarios

	Encroach Distance (m)	Remaining surface area of water in Dam (m^2)	Remaining Dam Volume (m^3)	Remaining Dam Volume (ML)
Scenario1 (Lean Phase)	250	256250	854000	854
Scenario 2 (HCSD)	250	148000	480000	480

Previous ash production forecasts were taken from the Eraring Power Station Ash Disposal Strategy Report, 2003, Table 1a, and are shown in Table 3 below. The forecasts shown are for a situation where the most likely flyash is produced and the ash sales remain at the current value.

Table 3: Forecast of annual ash deposited into ash dam. (Adapted from 'Eraring Power Station Ash Disposal Strategy Report, 2003, Table 1a)

Year	Total Flyash produced (kilotonne)	Flyash Sold (kilotonne)	Fly Ash Sold Precentage (%)	Forecast Flyash Disposal in Ash Dam (kilotonne)
2006	1266	400	31.60	866
2007	1275	400	31.37	875
2008	1320	400	30.30	920
2009	1354	400	29.54	954
2010	1342	400	29.81	942
2011	1313	400	30.46	913
2012	1220	400	32.79	820
2013	1150	400	34.78	750

This table of data was superseded by more recent data provided by Eraring Energy (see Table 4). The revised ash deposit forecast is based on the total coal consumption, from 2007 onwards, of 6.5 Mtonne/year with 24.3% coal ash, which gives the total ash production of 1,580,000 tonne/year. Taking into account the ratio of 10:90 between bottom ash and flyash and a predicted 55% of total ash sales as flyash in future, this gives the total forecast flyash deposition of 553,000 tonne/year or 1515 tonne/day into the ash dam. The flyash is slurried with recycled ash dam water at the total slurry rate of 8912 tonne/day for Lean Phase Operation (17% solid/slurry) or 2164 tonne/day for dense phase operation (70% solid/slurry).

Table 4: Revised Forecast of annual ash deposited to ash dam (more recent data provided by Eraring Energy)

	Total ash produced	Flyash 90% of total	Flyash sales	Flyash to ash dam	Flyash to ash dam	% flyash sales of
	(ktonnes/yr)	(ktonnes/yr)	(ktonnes/yr)	(ktonnes/yr)	(tonnes/day)	total ash
2007	1580	1422	505	916	2510	32
2008	1580	1422	537	885	2423	34
2009	1580	1422	569	853	2337	36
2010	1580	1422	600	821	2250	38
2011	1580	1422	632	790	2164	40
2012	1580	1422	679	742	2034	43
2013	1580	1422	742	679	1861	47
2014	1580	1422	806	616	1688	51
2015	1580	1422	869	553	1515	55

4. Water Balance Model

The purpose of this section is to determine the capacity of the proposed ash dam systems to cope with extreme weather conditions that could lead to an uncontrolled discharge from the dam into the receiving environment.
The methodology was thus to first determine the dimensions of the dam for the given scenario (i.e. the volume, catchments, inputs, outputs, etc). Secondly the discharge capability was noted i.e. the ultimate storm run-off capacity of the dam and the discharge rate of the pumps (the discharge rate would remain constant under the assumption that the current system is maintained). This data allowed the determination of the situations in which the water in the dam would reach a level that would cause an uncontrolled overflow (discharge criteria were obtained from Eraring Energy and are included in Appendix C). This could then be compared to historical weather events to determine the manageability of the proposed schemes and likelihood of discharge to Crooked Creek.

4.1 Model Inputs

Scenario 1 – Lean Phase Operation

- Ash dam pond surface area – 256000 m^2 (based on ash dam volume calculation, see Appendix A)
- Ash dam ash runoff area - 861750m^2 (estimated runoff coefficient 0.7 – 0.9)
- Ash dam natural runoff area – 1082000m^2 (estimated runoff coefficient 0.3)
- The total catchment area of 2.2 km^2 was calculated separately (Fred Karkour Connell Wagner). The ash natural runoff area is calculated by the difference between Total catchment area and the sum of pond surface area and ash runoff area.
- Return water dam pond surface area - 50000 m^2
- Return water dam natural runoff area – 0 m^2
- CHP Perimeter runoff area - 50000 m^2 (estimated runoff coefficient 1)
- CHP coal stack runoff area - 300000 m^2 (estimated runoff coefficient 0.3)
- Ash Circuit Inflow (water component of slurry) – 7.3 ML/day on basis of 17% solids/slurry (assuming ash dam water density about 1.01 t/m^3 and an average 55% of total ash sales as flyash from the ash production rate of 1580 ktonne/year)
- Awaba mine pump inflow – 0 ML/day
- Seepage lagoon Return inflow – 6 ML/day
- Water Reclamation Plant inflow – 0.75 ML/day
- Ash circuit outflow (water component of slurry) – 7.3 ML/day
- Seepage to Mine outflow – 0 ML/day
- Seepage to lagoon outflow – 6 ML/day
- Evaporation – 0 ML/day (assuming effective worst case during storm event)
- Controlled Discharge – 47.52 ML/day (when the dam level rises above RL 124.9 m, a second return water pump will be placed in service at a maximum rate of 550L/s);

Scenario 2 – Dense Phase Operation

- Ash dam pond surface area – 148000m^2 (Calculation done by Programs - AutoCAD, 12D & CivilCAD)
- Ash dam natural runoff area – 912000m^2 (estimated runoff coefficient 0.7 – 0.9)
- Ash dam ash runoff area - 1140000m^2 (estimated runoff coefficient 0.3)
- Return water dam pond surface area - 50000 m^2
- Return water dam natural runoff area – 0 m^2
- CHP Perimeter runoff area - 50000 m^2 (estimated runoff coefficient 1)
- CHP coal stack runoff area - 300000 m^2 (estimated runoff coefficient 0.3)

- Ash Circuit Inflow (water component of slurry) – 0.64 ML/day on basis of 70% solids/slurry (assuming ash dam water density about 1.01 t/m^3 and an average 55% of total ash sales as flyash from the ash production rate of 1580 ktonne/year).
- Awaba mine pump inflow – 0 ML/day
- Seepage lagoon Return inflow – 6 ML/day
- Water Reclamation Plant inflow – 0.75 ML/day
- Ash circuit outflow(water component of slurry) - 0.64 ML/day
- Seepage to Mine outflow – 0 ML/day
- Seepage to lagoon outflow – 6 ML/day
- Evaporation – 0 ML/day (assuming effective worst case during storm event)
- Controlled Discharge – 47.52 ML/day (when the dam level rises above RL 124.9 m, a second return water pump will be placed in service at a maximum rate of 550L/s);

4.2 Results

The results of the study, with the method and calculations are given in Appendix B. For both dam filling scenarios, the calculated rainfall was that needed to cause the dam to reach the specified water level in one day or three days. The RL 125.5 m level was deemed significant as this is the level at which a controlled discharge into Crooked Creek would be initiated. RL 126.61 m was also used as a second reference level as this is the level of the overflow spillway at which the dam will overflow uncontrollably into Crooked Creek.
In the following calculated data, it was assumed that the second return water pump is operated (within the level range from RL 124.9 to RL 126.61m and controlled discharge into Crooked Creek is initiated (within the level range from RL 125.5 to RL126.61m).

Table 5: Storm Runoff Capacity Estimates for Eraring Ash Dam in one day

Rainfall Needed Over 1 Day Starting From RL 124.9 (mm) Second return water pump is operating, plus controlled discharge to Crooked Creek.		
Final Dam Level	**Scenario**	
RL (m)	**1**	**2**
125.5	130	83
126.61	411	275

Table 6: Storm Runoff Capacity Estimates for Eraring Ash Dam over three days

Rainfall Needed Over 3 Day Starting From RL 124.9 (mm) Second return water pump is operating, plus controlled discharge to Crooked Creek.		
Final Dam Level	**Scenario**	
RL (m)	**1**	**2**
125.5	190	140
126.61	665	515

Historical Storm Rainfall Data and Design Rainfall Intensity Data

Data for storm events were taken from 'Eraring Power Station Ash Dam Management Plan', October 1996, and latest rainfall monitoring data provided by Eraring Energy. The major storm events were reported for the periods 1972 to 1995 and 1996 to March 2006 and are shown in Table 7 and Table 8.

Table 7 : Historical Storm Rainfall Data for Dam Region from 1972 to 1995

Event	Frequency (years)	Duration (days)	Total Rainfall (mm)	Rate (mm/day)
1	1 / 70	3	438	146
2	1 / 7	2	242	121
3	1 / 10	1	185	185

Table 8: Historical Storm Rainfall Data for Dam Region from 1996 to 2006

Event	Dates	Duration (days)	Rainfall (mm)	Rate (mm/day)
1	(22/4/98-18/5/98)	26	440	16.9
2	(1/5/98-5/5/98)	5	203	41
3	(1/3/06)	1	100	100

It can be seen from comparison of Table 5, Table 6 and Table 7 that the rainfall from each of these events is not enough to cause the dam water level to reach RL 126.61m within one day and three days, but the discharge to Crooked Creek under controlled conditions (ash dam water level over RL 125.5) could occur for any of these rainfall events.

The NSW Department of Environment & Conservation has advised Eraring Energy that any discharge to Crooked Creek is of environmental concern.

The rainfall data reported in Table 8 for the periods of 1996 to March 2006 were much lower than the three storm events reported for the periods of 1972 to 1995, therefore the worst case rainfall scenario from Table 7 has been used in the model, as part of this report.

As requested by Eraring Energy, the theoretical storm rainfall events of 1 in 100 years, 1 in 70 years, 1 in 50 years, 1 in 20 years, 1 in 10 years, 1 in 5 years and 1 in 2 years frequency were included and shown in Table 9 below. Those data were taken from design intensity diagram provided by Hydrometeorological Advisory Service – Melbourne © Commonwealth of Australia, Bureau of Meteorology 1987 (see Figure 1) for the Eraring district.

Table 9: Theoretical Storm Rainfall Events in Location (33.050 S 151.525 E)

Event	Frequency (years)	Duration (days)	Total Rainfall (mm)	Rate (mm/day)
1	1 / 100	1	288	288
2	1 / 100	3	446	149
3	1 / 70	1	270	270
4	1 / 70	3	418	139
5	1 / 50	1	254	254
6	1 / 50	3	392	131
7	1 / 20	1	215	215
8	1 / 20	3	328	109
9	1 / 10	1	185	185
10	1 / 10	3	279	279
11	1 / 5	1	161	161
12	1 / 5	3	242	81
13	1 / 2	1	122	122
14	1 / 2	3	181	60

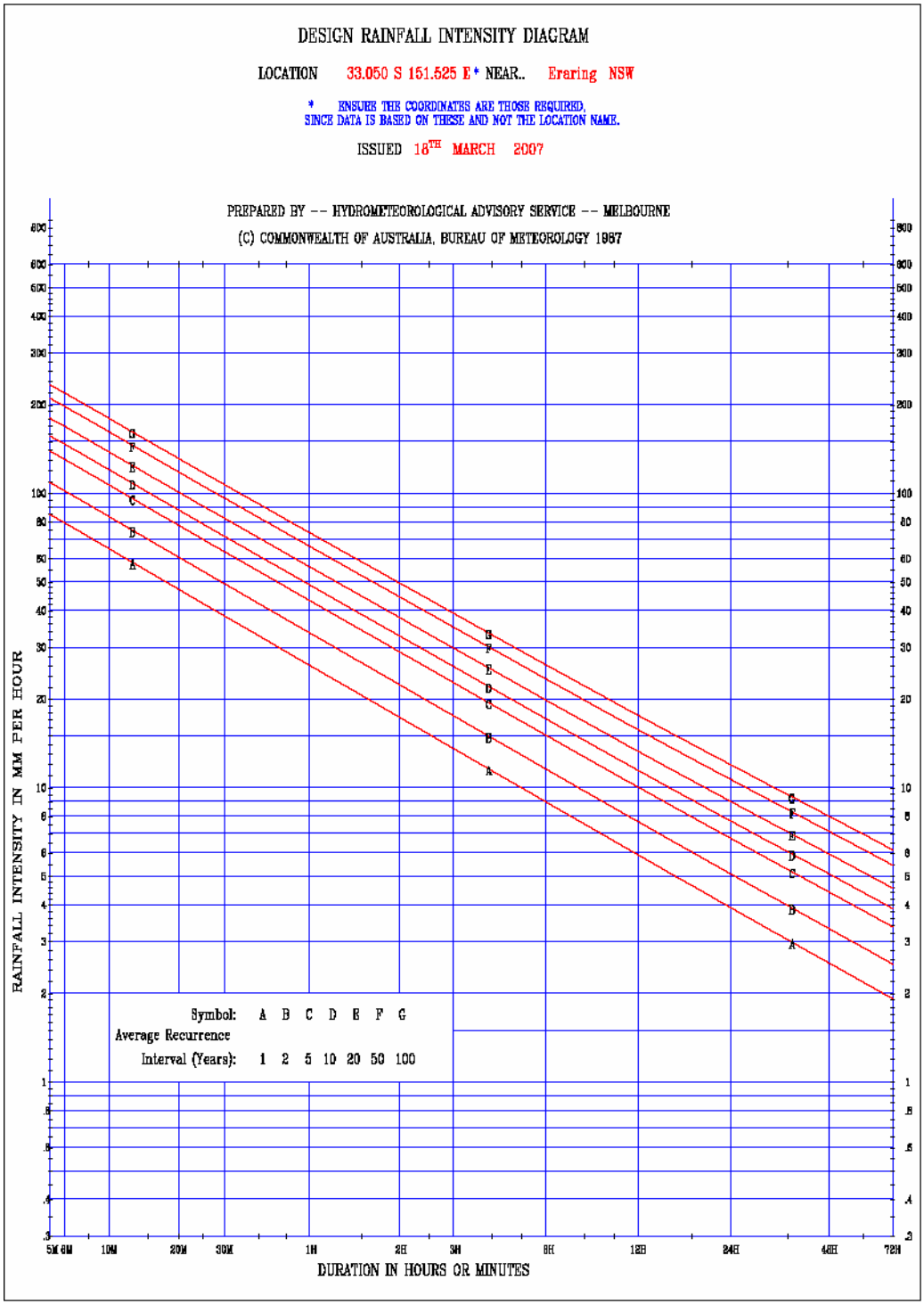

Figure 1: Design Rainfall Intensity Diagram

5. Determination of the minimum ash dam pond size

Referring to the current Ash Dam Operating limits (see Appendix C), Figure 2 summarises the ash dam level control and discharge requirements.

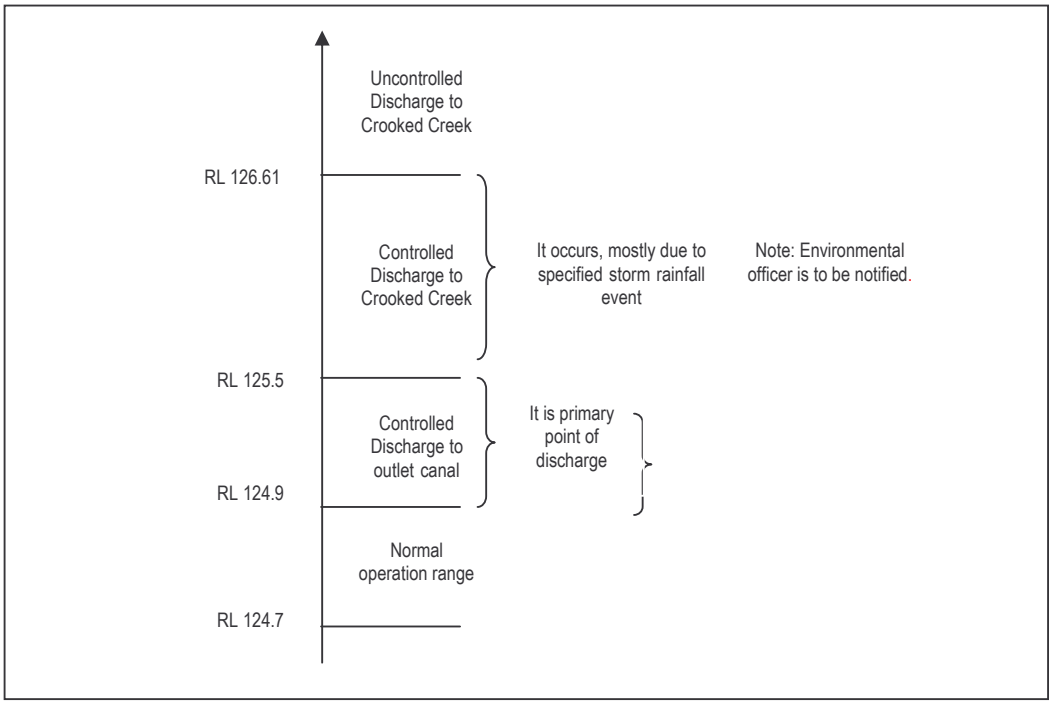

Figure 2: Ash Dam level control and discharge requirements

This figure shows that water is manually discharged to the outlet canal by the return water pump if the ash dam water level rises above RL 124.90m. If the ash dam water level exceeds RL 125.50m (eg due to a storm event), the additional water is discharged to Crooked Creek. Due to environmental concern with any ash dam water discharging to Crooked Creek, Eraring Energy has advised that this instruction may be reviewed such that overflow to Crooked Creek is only to occur as a last resort and at a higher ash dam water RL (ie closer to the dam spillway at RL 126.61). Discharge to the outlet canal is to remain as the primary point of discharge.

In section 4.2, Table 5 showed that only a very low rainfall (86mm/day) is needed over one day to raise the ash dam water level to RL125.5 (where controlled discharge to Crooked Creek is initiated) under scenario 2. Comparing this to the historical rainfall data in Table 6, it can be seen that any one of these three rainfall events is enough to cause the dam water level to exceed RL 125.5m.
If it is assumed that the current ash dam water level operating instructions are retained, the minimum pond size would require an increase to cope with the rainfall run off. In order to ensure that controlled discharge to Crooked Creek doesn't occur for any storm rainfall events in Scenario 2, the encroach distance, surface area of water in dam and pond water volume were re-evaluated.

5.1 Determination of encroach distance

As the ash dam's ash and water storage capacity are directly linked to the encroach distance, a number of calculations were made to find the relationship between encroach distance, surface area of water in dam, pond water volume, ash runoff area and the rainfall needed over one day and three days from RL 124.9 to RL 126.61m.

This relationship will allow determination of the encroach distance under Scenario 2 to have a minimum pond size to store any historical and theoretical storm rainfall events (1 day and 3 days) without requiring any controlled or uncontrolled discharge to Crooked Creek by allowing storage of water up to RL 126.61m.

In the following calculated data, it was assumed that the excess ash dam water may be retained within the level range RL 125.5 to RL 126.61m (thus preventing discharge to the Crooked Creek) by utilising the discharge to outlet canal only[1]. This will result in a higher dam water level being retained longer until discharged, and it may cause an increase in downstream seepage as the water level rises against the dam wall. As this storage level rise is only temporary, it may not be a problem, however this requires confirmation.

Several different encroach distances (from 200 m to 450 m) were used in the calculation; the method and data are included in Appendix B.

The summary of results is shown in Table 10 with Figures 3 & 4 showing the relationship between encroach distance and the rainfall needed over one day and three days to increase water level from RL 124.9 to RL 126.61m.

Table 10: Encroach distance versus ash dam catchment & water storage capacities

Ash Dam Dimension \ The distance from dam to spilling pond (m)	200	250	350	450
Total remaining water area (m^2)	109878	148000	195096	266634
Total remaining water volume (m^3)	232206	480000	786124	944994
Ash Runoff Area (m^2)	1178122	1140000	1092904	934034
Rainfall needed over 1 day from RL124.9 to RL 125.5 (mm)	69	83	100	129
Rainfall needed over 1 day from RL124.9 to RL126.61 (mm)	144	183	232	305
Rainfall needed over 3 days from RL124.9 to RL 125.5 (mm)	126	140	157	182
Rainfall needed over 3 days from RL124.9 to RL126.61 (mm)	201	240	289	361

1. The second return water pump is to be operated manually to discharge water to the outlet canal

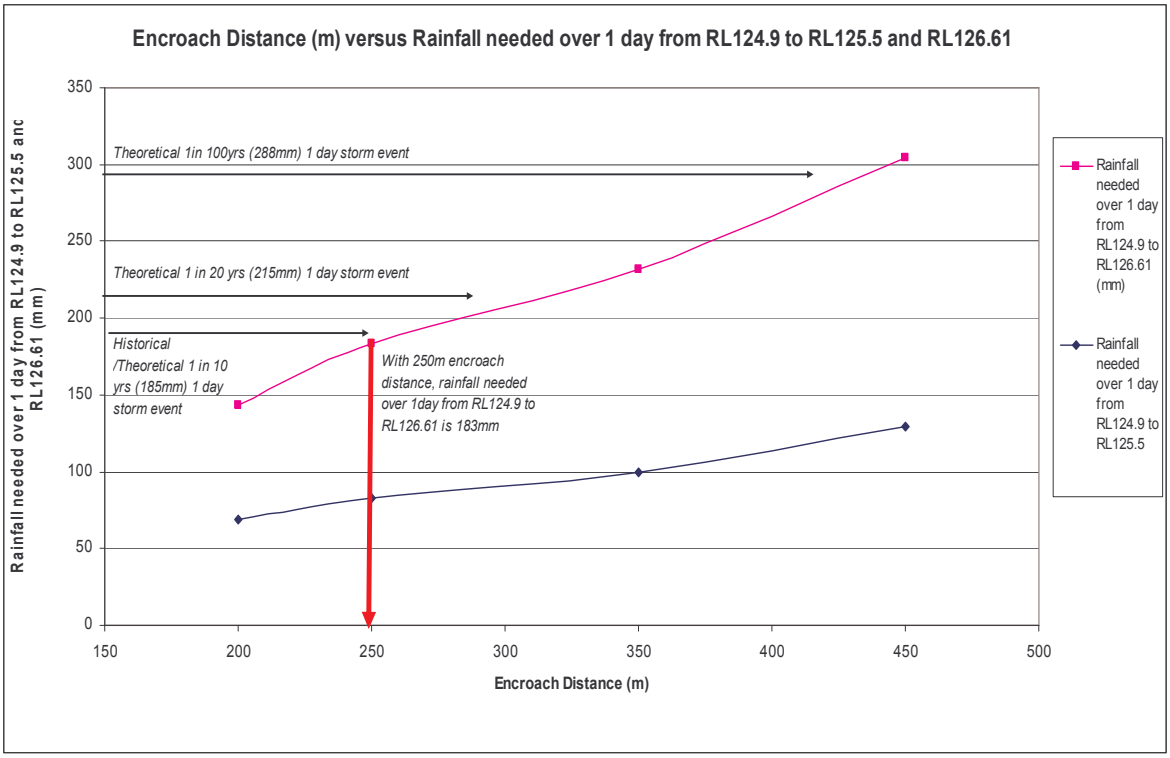

Figure 3: Ash dam encroach distance, water storage capacity & one day rainfall under scenario 2

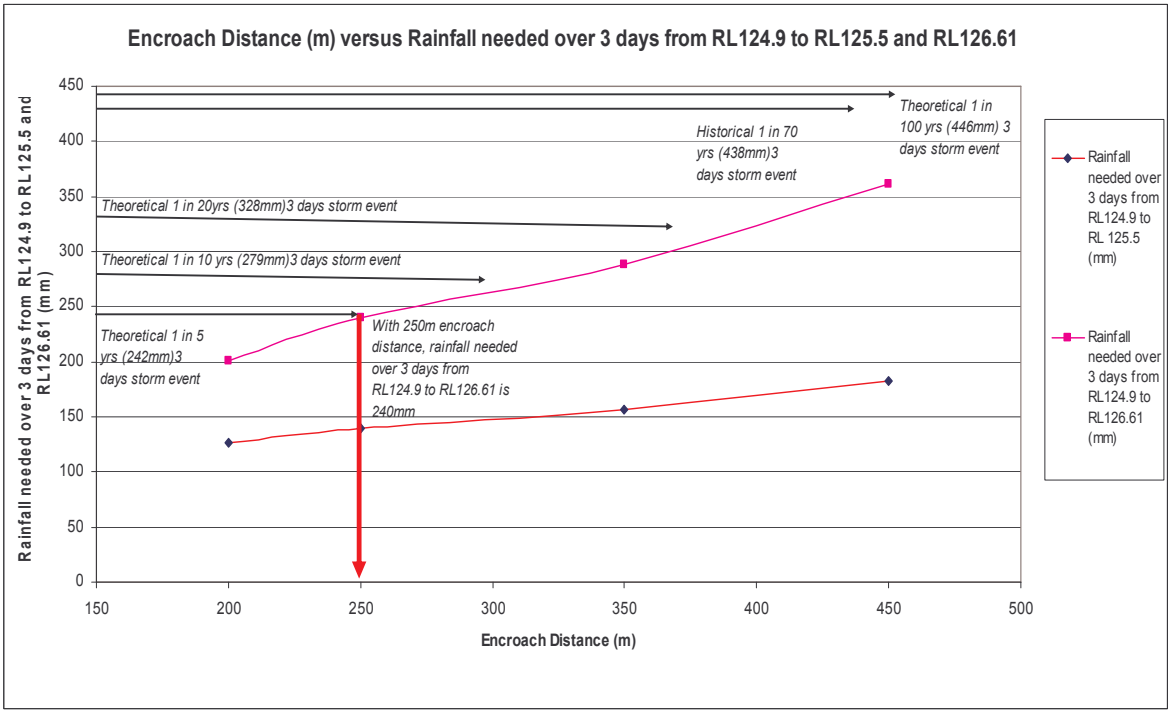

Figure 4: Ash dam encroach distance, water storage capacity & three days rainfall under scenario 2

In Figure 3, the arrow (red bold colour) shows that encroach distance of 250m from the ash delta to the stilling pond would be able to tolerate a single day rainfall of 183mm and three days rainfall of 240mm without any uncontrolled discharge. This is achieved by storing the water to RL 126.61m while using second return water pump to discharge excess ash dam water to the outlet canal only. Table 11 and Table 12 show the estimated storm runoff capacity for Eraring ash dam (with 250m encroach distance) in one and three days.

Table 11: Storm Runoff Capacity Estimates for Eraring Ash Dam (without controlled discharge to Crooked Creek) in one day

Rainfall Needed Over 1 Day Starting From RL 124.9 (mm) - Second return water pump is operating, without controlled discharge to Crooked Creek		
Final Dam Level	**Scenario**	
RL (m)	**1**	**2**
125.5	130	83
126.61	314	183

Table 12: Storm Runoff Capacity Estimates for Eraring Ash Dam (without controlled discharge to Crooked Creek) in three day

Rainfall Needed Over 3 Day Starting From RL 124.9 (mm) - Second return water pump is operating, without controlled discharge to Crooked Creek		
Final Dam Level	**Scenario**	
RL (m)	**1**	**2**
125.5	190	140
126.61	374	240

Figure 3 and Figure 4 also indicate that uncontrolled discharge (water level over RL126.61) to Crooked Creek will be marginal during a historical one day storm rainfall of 185mm (1 in 10 years) and a theoretical three days storm rainfall of 242mm (1 in 5 years).

Encroach distances shorter than 250m will not have the required water storage volume to cope with a storm event of 185mm in one day (1 in 10 years) without the need to discharge water to Crooked Creek. Encroach distances greater than this will provide larger water storage but consequently increase the surface area of water in dam and therefore reduce ash storage capacity.

6. Discussion

From the comparison of the two scenarios, the final dam water volume calculated and date of this occurrence is dependant on the positioning of the deposited flyash. Using an initial assumption that flyash will only be allowed to encroach up to 250m of the stilling pond stop logs (measured at RL125m), the dense phase deposition will leave a smaller pool of water (480 ML) and surface area (148000 m^2) with more flyash deposited in the dam.

With a pond area of 148000m^2 due to dense phase placement, if controlled discharge to Crooked Creek is permitted in accordance with existing ash dam instructions, this discharge will occur following 83mm rainfall to increase dam water level from RL124.9 to 125m; this equates to a rainfall frequency of less than 1 in 1 year (3.5mm/hr for 24hrs).
Uncontrolled discharge will occur following 275mm rainfall in one day to increase dam water level from RL124.9 to 126.61m, which equates to a rainfall frequency of 1 in 100 years (11.5mm/hr for 24hrs). Uncontrolled discharge will also occur following 515mm rainfall in three days to increase dam water level from RL124.9 to 126.61m, which equates to a rainfall frequency of greater than 1 in 100 years (7.2mm/hr for 72hrs). These assume that discharge to outlet canal and controlled discharge to Crooked Creek are utilised as the dam water level increases.

If controlled discharge to Crooked Creek is not allowed, an uncontrolled discharge will occur following 183mm rainfall in one day to increase dam water level from RL124.9 to 126.61m, which equates to a rainfall frequency of 1 in 10 years (7.6mm/hr for 24hrs). Uncontrolled discharge will also occur following 240mm rainfall in three days to increase dam water level from RL124.9 to 126.61m, which equates to a rainfall frequency of 1 in 5 years (3.4mm/hr for 72hrs). These assume that discharge to outlet canal is utilised as the dam water level increases.

The controlled discharge to Crooked Creek of 150ML/day is equivalent to 92mm/day of rainfall over the entire ash dam catchment. With the pond area of 148000 m^2, this discharge rate would reduce the pond water level from RL126.61 to RL124.9 in 1.7 days, assuming no further inputs.
The spare return water pump discharge rate to outlet canal of 550L/s (47.5ML/day) is equivalent to 29mm/day of rainfall over the entire ash dam catchment. With a pond area of 148000 m^2, this discharge rate would reduce the pond water level from RL126.61 to RL124.9 in 5.3 days, assuming no further inputs. When the dense phase system is implemented the return water flow requirements will likely be less than that of one return water pump, therefore the spare pumping capacity for ash dam discharge to the outlet canal will be greater than one (but less than two) return water pumps.

It is clear that maintaining a large water surface area (& volume) within the ash dam to store a specific storm event would dramatically decrease the amount of flyash that can be deposited in the dam. If the ash dam operating instruction was modified to allow an increase in the water level from RL125.5 to RL 126.61m, before discharge to Crooked Creek is initiated, this would allow larger rainfall events to be contained. An increase in the height of the ash dam spillway overflow weir (currently at RL126.61) will also further increase the water storage capacity of the dam.

An increase in ash dam water level will have other operational consequences. This may increase the downstream seepage through the dam wall as the water level rises against the dam wall, but as this storage level rise is only expected to be temporary, it may not be a problem, however this requires confirmation.
Another concern is the operation of the Blue Circle Ash recovery plant on the bottom ash delta at the western end of the ash dam as this would be affected by an increase in water level, and may require protection from flooding.

If the likelihood of discharge to Crooked Creek is to be reduced, a number of issues should be considered:

- Modify the existing ash dam water level operating instruction to raise the level at which controlled discharge to Crooked Creek is initiated,
- Increase the height of the spill way overflow weir,
- Reduce the time of storage at high water level by increasing the return water pumping capacity,
- Reduce the ash dam catchment area

7. Recommendations

To maximise the ash storage capacity and retain some capability to handle rainfall run off from storm events, it would be recommended to revise the ash dam operating instruction to increase the level at which controlled discharge is initiated to Crooked Creek.

It is also recommended that the ash delta only be allowed to encroach to within 250m of the stilling pond to maintain a reasonable buffer storage volume.

To further evaluate the concentration of selenium in the ash system water, it is recommended that further investigations be undertaken to more accurately predict the likely concentration as the pond approaches minimum size.

Appendix A

Ash Dam Volume Calculations

Ash Dam Volume calculations

The ash dam volume calculations were based on the contour map (Ash Dam Survey VS001 and VS006, May 2006, Paul Stivano, Connell Wagner PPI) shown in Figure A-1 and Figure A-2

The Current (2006) and Scenario 2 (Proposed Dense Phase Operation)
Ash Dam Surface area of water and under water volume

The pond surface area, pond volume and ash runoff area under current lean phase and future proposed dense phase operation were calculated using software (AutoCAD, 12D & Civil CAD) and shown in Table A 1 below:

Table A 1: Current (2006) and Future Proposed Dense Phase Ash Dam characteristics

	Remaining surface area of water in Dam (m^2)	Remaining under water Dam Volume (m^3)	Ash Runoff Area (m^2)
Current Dam (May, 2006)	745000	4000000	373000
Scenario 2- Future Proposed Dense Phase (250m encroach distance)	148000	480000	1140000

Scenario 1 - Lean Phase Operation
Ash Dam Surface area of water and pond volume

Using the contour map VS011 in Figure A-3, the remaining water volume was approximated by using basic geometric shapes. A circular sector of radius equal to 1000 m (black curve line) was drawn with centre at the western slurry outlet. This simulated the edge of the flyash delta in the lean phase slurry deposition proposal. The remainder of the water surface area was estimated to have an area of 256000m^2. To account for the pond bed and flyash delta beneath the water surface, the remaining quadrilateral was approximated to an inverted square based pyramid of height 6.5m that gives a remaining water volume for the lean phase slurry proposal of 854 ML.

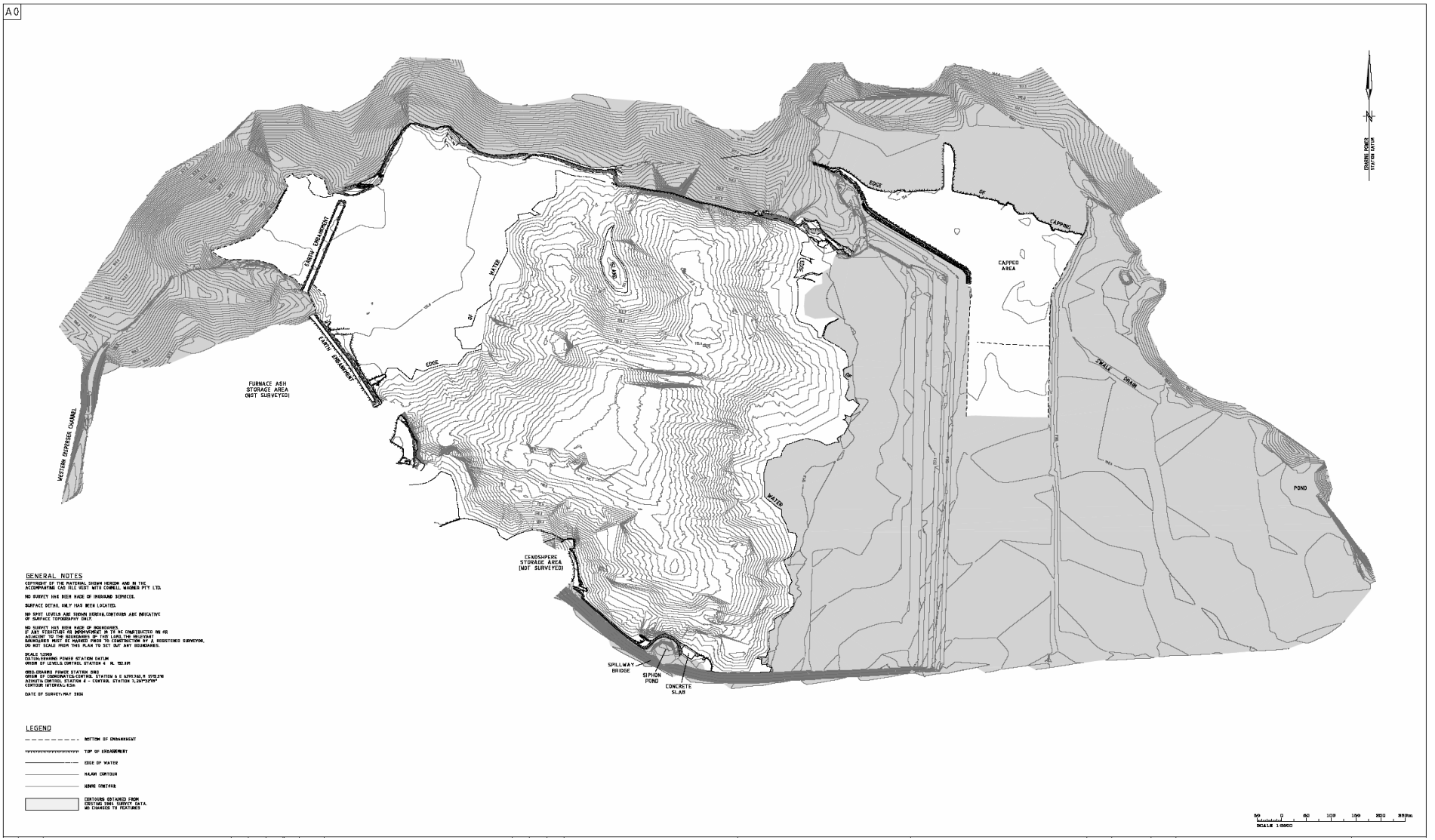

Figure A 1: Contour Map of Eraring Ash Dam VS001 (Survey May 2006)

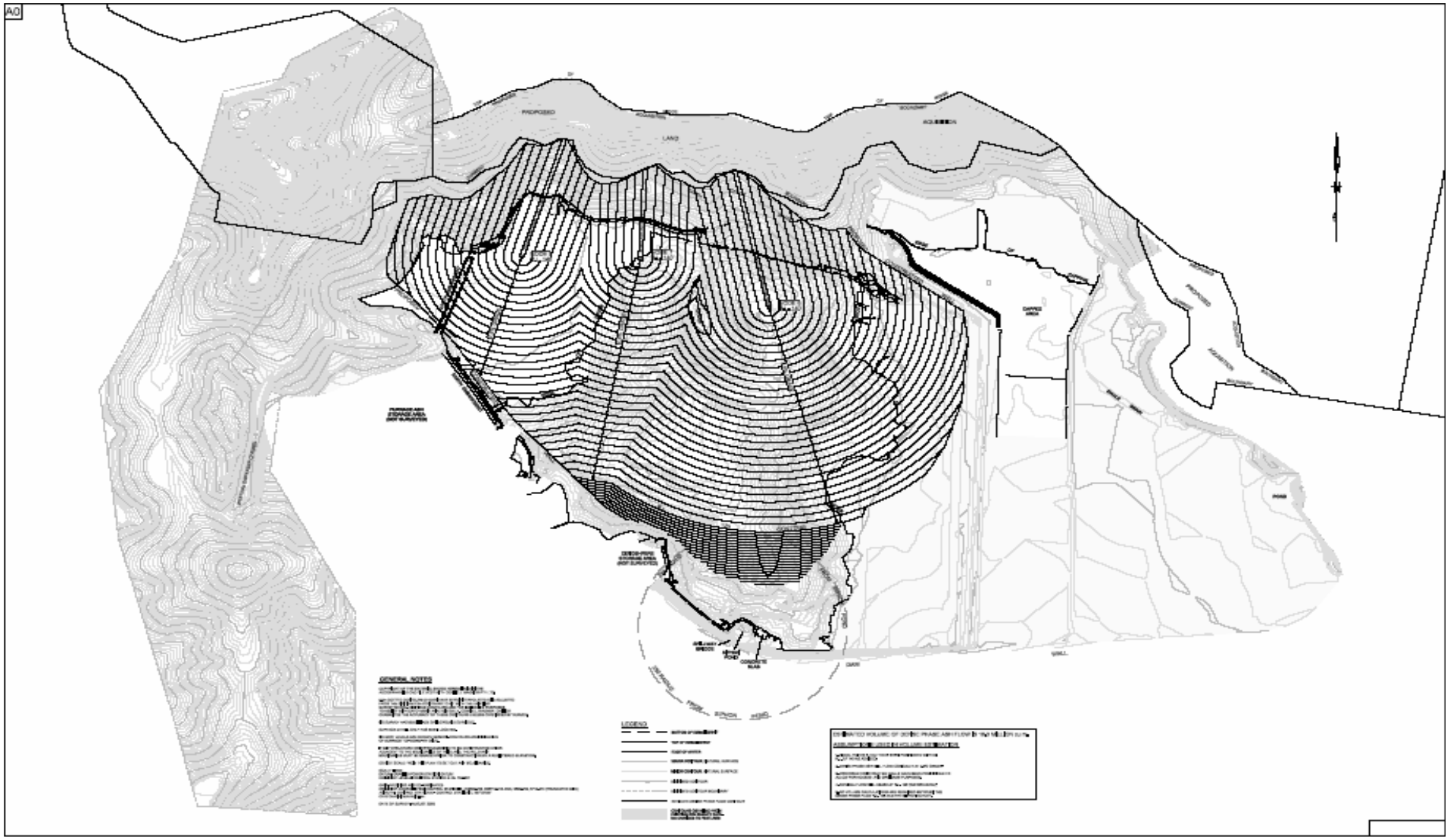

Figure A 2: Contour Map of Eraring Proposed Layout of Dense Phase Ash Placement VS006 (Based on Survey May 2006).

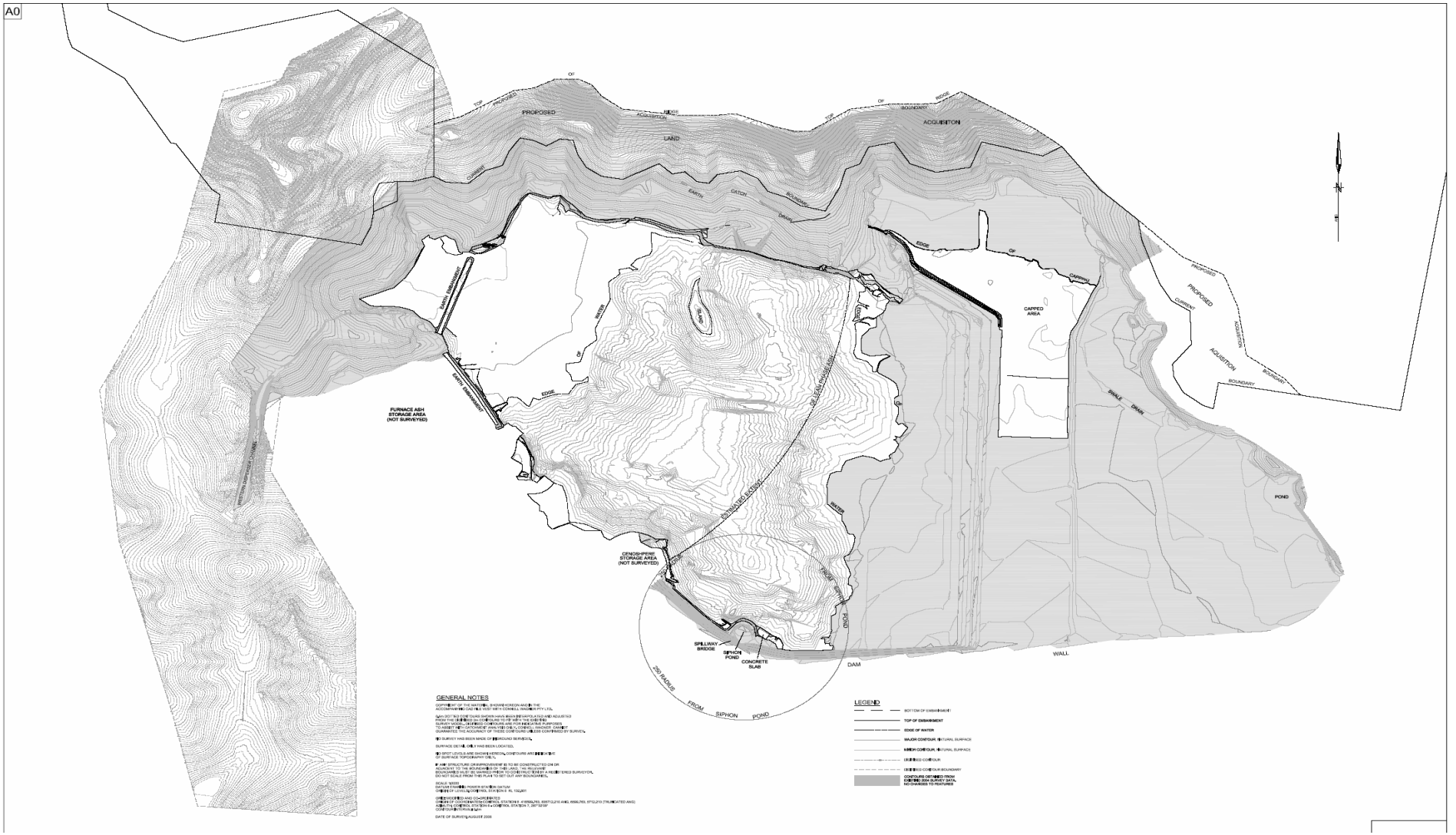

Figure A 3: Contour Map of Eraring Ash Dam continue to be filled using Lean Phase Ash Placement in ash dam VS011 (Based on Survey May 2006).The black line represents the predicted lean phase ash delta where it would meet RL125 m water.

Appendix B

Catchment & Water Volume Calculations

Catchment & Water Volume Calculations

In order to assess the viability of proposed ash dam filling options, it was necessary to determine whether the water in the dam could be managed properly in a worst case scenario.

The first step was to note the important aspects of the dam. The maximum normal operating level of RL 124.9 m was taken as the starting level for the worst case scenario. The level of RL 125.5 m was noted as it is the minimum level for which controlled discharge into Crooked Creek is required. Finally, RL 126.61 m was noted, as it is the level for which the ash dam overflows uncontrollably into Crooked Creek. Consequently, the volume of water needed to fill the ash dam from RL 124.9 m to RL 125.5 m and RL 126.61 m was estimated for each scenario.

To estimate the volume of water needed to reach the dam RLs mentioned above in each ash filling scenario, the surface area of the water in the dam was required. The water surface area at RL 124.9 m was taken as the value estimated in Appendix A. This area value was then multiplied by the relevant water level increase in the dam to give the calculated volume of water. This is a conservative estimate, as it assumes the dam fills as a trapezoidal prism.

Following this calculation, a basic water balance was set up to determine the volume of water required from a rainfall event (runoff) to cause the dam to rise to the specified level. For this calculation, the following equation was used:

Change in water volume = Inflows + Runoff – Outflows – Evaporation – Controlled Discharges

The inflows included the water from the ash cycle, return from the Awaba mine, and toe drain seepage water return and the effluent from the water treatment plant. The outflows included return water, Awaba mine seepage and toe drain seepage water, all of which are assumed to cancel out the corresponding inflows (data shown in Figures B1 – B4). Given the situation of a rainy or stormy day, the evaporation was assumed to be zero.

There were two cases of controlled discharge to be considered. The first occurs when the dam level rises above RL 124.9 m, a second return water pump on the ash water circuit can be placed in service to pump ash dam water directly to the outfall canal. The maximum flow rate achievable here was assumed to be the same as the ash circuit, i.e. 47 ML/day (550 l/s). If the water level of the dam was to rise above RL 125.5 m, a controlled overflow into Crooked Creek may be initiated in conjunction with the outfall canal discharge, with an EPA specified maximum flow rate of 150 ML/day to Crooked Creek. However in the following calculation the controlled discharge to Crooked Creek was not initiated between RL125 and RL126.61 (assuming excess dam water may be retained within this level range, thus preventing discharge to Crooked Creek, by utilising the discharge to outlet canal only.
Finally, each input and output value was scaled to give a volume over a single day period. This enabled a calculation of the volume of water needed from a single day rain or storm event to reach the specified dam level - Data taken from Pacific Power International 'Eraring Power Station Ash Dam Management Plan', October 1996, and Connell Wagner PPI 'Eraring Power Station Ash Disposal Strategy', September 2003.

With the rainfall volume calculated, this figure was converted into a comparable rainfall intensity reading, so as to determine the likelihood of such an event. This was done by noting all of the catchment areas for the dam, i.e. pond areas, natural land areas, and ash delta areas, assigning relevant runoff factors to each, and then adding all of these areas. An excel spreadsheet was used, with the goal seek tool used to find a rainfall value in millimetres that would return a runoff volume equal to that estimated for the situations outlined above.

Table B-1 below, shows the required rainfall in millimetres over a one day period to cause the specified rise in dam height, while Figures B1 – B4 show the data entered into the water balance for each case. Sample calculations follow.

Table B-1: Estimated rainfall required over a one day period to reach overflow conditions in ash dam (Second return water pump is operating, without controlled discharge to Crooked Creek).

Rainfall Needed Over 1 Day Starting From RL 124.9 (mm) - Second return water pump is operating, without controlled discharge to Crooked Creek		
Final Dam Level	**Scenario**	
RL (m)	**1**	**2**
125.5	130	83
126.61	314	183

Scenario 1: Lean Phase Ash Dam Filling				
Overflow Case A: RL 124.9 m to RL 125.5 m				
Rain Event: 1 Day				
Parameters	**Comment**			
Height Increase		0.6	m	Increase from RL 124.9 to RL 125.5
Surface Area of Water in Dam		256000	m^2	Based on calculations done on Appendix A
Volume of water needed to exceed level		153.6	Ml	Assume vertical gradient at pond edges
Inflows				
Ash Circuit Inflow		7.32	Ml/day	Based on 17% ash slurry and total flyash deposited 1515 tonne/day, ash dam water density of 1.01 t/m3
Awaba Mine Pump		0	Ml/day	Assume zero (advised by ERPS)
Seepage lagoon Return		6	Ml/day	Maximum
Water plant discharge		0.75	Ml/day	Data Provided by ERPS
Other inputs			Ml/day	
Outflows				
Ash Circuit Outflow		7.32	Ml/day	Cancels inflow
Seepage to Mine		0	Ml/day	Cancels inflow
Seepage to lagoon		6	Ml/day	Cancels inflow
Other outputs			Ml/day	
Evaporation		0	Ml/day	Effective worst case during storm event
Controlled Discharges				
Extra Pump to outfall canal		47.52	Ml/day	Assume only one return pump is available. Maximum rate (550 l/s)
Controlled Overflow		150	Ml/day	Maximum allowed, only used when water level exceeds RL 125.5 m
Rainfall Total Catchments (Runoff)		200.37	Ml/day	Value needed to reach RL 125.5 m
Rainfall Calculation				
Catchments				**Comment**
Ash Dam	Natural	1.082	km^2	Based on Inputs Data in Section 4.1
	Ash	0.86175	km^2	Based on Inputs Data in Section 4.1
	Pond	0.256	km^2	Based on calculations done on Appendix A
Return Water Dam	Natural	0	km^2	All natural catchments to return water dam diverted
	Pond	0.05	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996)
CHP	Perimeter	0.05	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996)
	Coal stack	0.3	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996).Estimated runoff coeff 0.3 same as natural coef.
Rainfall		129.59076	mm/day	Use goal seek to get this value
Natural Runoff Coefficient		0.3		arbitrary estimation
Natural Runoff	Ash Dam	42.065162	Ml/day	
	Return Water	0	Ml/day	
Ash Runoff Coefficient		0.9		conservative wost case (estimated runoff coef of 0.7 to 0.9)
Ash Runoff		100.50736	Ml/day	
Pond Catchments	Ash Dam	33.175236	Ml/day	
	Return Water	6.4795382	Ml/day	
CHP Perimeter Runoff Coefficient		1		conservative worst case
CHP Runoff		18.142707	Ml/day	
Rainfall Total Catchments (Runoff)		200.37	Ml/day	set to value calculated above

Figure B-1: Water balance for lean phase ash slurry, filling from RL 124.9 m to 125.5m

Scenario 1: Lean Phase Ash Dam Filling				
Overflow Case B: RL 124.9 m to RL 126.61 m				
Rain Event: 1 Day				
Parameters				**Comment**
Height Increase		1.71	m	Increase from RL 124.9 to RL 126.61
Surface Area of Water in Dam		256000	m^2	Based on calculations done on Appendix A
Volume of water needed to exceed level		437.76	Ml	Assume vertical gradient at pond edges
Inflows				0
Ash Circuit Inflow		7.32	Ml/day	Based on 17% ash slurry and total flyash deposited 1515 tonne/day, ash dam water density of 1.01 t/m3
Awaba Mine Pump		0	Ml/day	Assume zero (advised by ERPS)
Seepage lagoon Return		6	Ml/day	Maximum
Water plant discharge		0.5	Ml/day	Data Provided by ERPS
Other inputs			Ml/day	0
Outflows				0
Ash Circuit Outflow		7.32	Ml/day	Cancels inflow
Seepage to Mine		0	Ml/day	Cancels inflow
Seepage to lagoon		6	Ml/day	Cancels inflow
Other outputs			Ml/day	
Evaporation		0	Ml/day	Effective worst case during storm event
Controlled Discharges				
Extra Pump to outfall canal		47.52	Ml/day	Maximum rate (550 l/s)
Controlled Overflow		150	Ml/day	Maximum allowed, only used when water level exceeds RL 125.51 m
Rainfall Total Catchments (Runoff)		634.78	Ml/day	Value needed to reach RL 126.61 m
Rainfall Calculation				
Catchments				**Comment**
Ash Dam	Natural	1.082	km^2	Based on Inputs Data in Section 4.1
	Ash	0.86175	km^2	Based on Inputs Data in Section 4.1
	Pond	0.256	km^2	Based on calculations done on Appendix A
Return Water Dam	Natural	0	km^2	All natural catchments to return water dam diverted
	Pond	0.05	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996)
CHP	Perimeter	0.05	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996)
	Coal stack	0.3	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996).Estimated runoff coeff 0.3 same as natural coef.
Rainfall		410.548612	mm/day	Use goal seek to get this value
Natural Runoff Coefficient		0.3		arbitrary estimation
Natural Runoff	Ash Dam	133.264079	Ml/day	
	Return Water	0	Ml/day	
Ash Runoff Coefficient		0.9		conservative wost case (estimated runoff coef of 0.7 to 0.9)
Ash Runoff		318.41124	Ml/day	
Pond Catchments	Ash Dam	105.100445	Ml/day	
	Return Water	20.5274306	Ml/day	
CHP Runoff Coefficient		1		conservative worst case
CHP Runoff		57.4768057	Ml/day	
Rainfall Total Catchments (Runoff)		634.78	Ml/day	set to value calculated above

Figure B-2: Water Balance for Lean Phase Ash Slurry filling from RL 124.9m to RL 126.61m

Scenario 2: Dense Phase Ash Dam Filling				
Overflow Case A: RL 124.9 m to RL 125.5 m				
Rain Event: 1 Day				
Parameters				**Comment**
Height Increase		0.6	m	Increase from RL 124.9 to RL 125.5
Surface Area of Water in Dam		148000	m^2	Based on calculation done by Paul Stivano using softwares (AutoCAD, 12D & Civil CAD) see Appendix A
Volume of water needed to exceed level		88.8	Ml	Assume vertical gradient at pond edges
Inflows				
Ash Circuit Inflow		0.64	Ml/day	Based on 70% ash slurry and total flysh deposited 1515 tonne/day, ash dam water density of 1.01 t/m3
Awaba Mine Pump		0	Ml/day	Assume zero (advised by ERPS)
Seepage lagoon Return		6	Ml/day	Maximum
Water plant discharge		0.75	Ml/day	Data Provided by ERPS
Other inputs			Ml/day	
Outflows				
Ash Circuit Outflow		0.64	Ml/day	Cancels inflow
Seepage to Mine		0	Ml/day	Cancels inflow
Seepage to lagoon		6	Ml/day	Cancels inflow
Other outputs			Ml/day	
Evaporation		0	Ml/day	Effective worst case during storm event
Controlled Discharges				
Extra Pump to outfall canal		47.52	Ml/day	Maximum rate (550 l/s)
Controlled Overflow		150	Ml/day	Maximum allowed, only used when water level exceeds RL 125.5 m
Rainfall Total Catchments (Runoff)		135.57	Ml/day	Value needed to reach RL 125.5 m
Rainfall Calculation				
Catchments				**Comment**
Ash Dam	Natural	0.912	km^2	Based on Inputs Data in Section 4.1
	Ash	1.14	km^2	Based on Inputs Data in Section 4.1
	Pond	0.148	km^2	see Appendix A
Return Water Dam	Natural	0	km^2	All natural catchments to return water dam diverted
	Pond	0.05	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996)
CHP	Perimeter	0.05	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996)
	Coal stack	0.3	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996).Estimated runoff coeff 0.3 same as natural coef.
Rainfall		82.785784	mm/day	Use goal seek to get this value
Natural Runoff Coefficient		0.3		arbitrary estimation
Natural Runoff	Ash Dam	22.650191	Ml/day	
	Return Water	0	Ml/day	
Ash Runoff Coefficient		0.9		conservative wost case
Ash Runoff		84.938214	Ml/day	
Pond Catchments	Ash Dam	12.252296	Ml/day	
	Return Water	4.1392892	Ml/day	
CHP Runoff Coefficient		1		conservative worst case
CHP Runoff		11.59001	Ml/day	
Rainfall Total Catchments (Runoff)		135.57	Ml/day	set to value calculated above

Figure B-3: Water Balance for Dense Phase Ash Slurry filling from RL 124.9 to RL 125.5m

Scenario 2: Dense Phase Ash Dam Filling				
Overflow Case B: RL 124.9 m to RL 126.61 m				
Rain Event: 1 Day				
Parameters				**Comment**
Height Increase		1.71	m	Increase from RL 124.9 to RL 126.61
Surface Area of Water in Dam		148000	m^2	Based on calculation done by Paul Stivano using softwares (AutoCAD, 12D & Civil CAD) see Appendix A
Volume of water needed to exceed level		253.08	Ml	Assume vertical gradient at pond edges
Inflows				
Ash Circuit Inflow		0.64	Ml/day	Based on 70% ash slurry and total flysh deposited 1515 tonne/day, ash dam water density of 1.01 t/m3
Awaba Mine Pump		0	Ml/day	Assume zero (advised by ERPS)
Seepage lagoon Return		6	Ml/day	Maximum
Water plant discharge		0.75	Ml/day	Data Provided by ERPS
Other inputs			Ml/day	
Outflows				
Ash Circuit Outflow		0.64	Ml/day	Cancels inflow
Seepage to Mine		0	Ml/day	Cancels inflow
Seepage to lagoon		6	Ml/day	Cancels inflow
Other outputs			Ml/day	
Evaporation		0	Ml/day	Effective worst case during storm event
Controlled Discharges				
Extra Pump to outfall canal		47.52	Ml/day	Maximum rate (550 l/s)
Controlled Overflow		150	Ml/day	Maximum allowed, only used when water level exceeds RL 125.51 m
Rainfall Total Catchments (Runoff)		449.85	Ml/day	Value needed to reach RL 125.51 m
Rainfall Calculation				
Catchments				**Comment**
Ash Dam	Natural	0.912	km^2	Based on Inputs Data in Section 4.1
	Ash	1.14	km^2	Based on Inputs Data in Section 4.1
	Pond	0.148	km^2	see Appendix A
Return Water Dam	Natural	0	km^2	All natural catchments to return water dam diverted
	Pond	0.05	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996)
CHP	Perimeter	0.05	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996)
	Coal stack	0.3	km^2	Based on ERPS Ash Dam Management Plan (Oct 1996).Estimated runoff coeff 0.3 same as natural coef.
Rainfall		274.700782	mm/day	Use goal seek to get this value
Natural Runoff Coefficient		0.3		arbitrary estimation
Natural Runoff	Ash Dam	75.1581339	Ml/day	
	Return Water	0	Ml/day	
Ash Runoff Coefficient		0.9		conservative wost case
Ash Runoff		281.843002	Ml/day	
Pond Catchments	Ash Dam	40.6557157	Ml/day	
	Return Water	13.7350391	Ml/day	
CHP Runoff Coefficient		1		conservative worst case
CHP Runoff		38.4581094	Ml/day	
Rainfall Total Catchments (Runoff)		449.85	Ml/day	set to value calculated above

Figure B-4: Water Balance for Dense Phase Ash Slurry filling from RL 124.9m to RL126.61m

Sample Calculation for Scenario 1 Overflow case A.

Volume required reaching RL 125.5 m:

The height increase in the dam = 125.5-124.9 = 0.6 m

The surface area of water in the dam = 256000 m^2 (from Ash dam life forecast section)

Volume = Area x Height = 256000 X 0.6 = 153.6 ML = water volume change

Water Balance (for one day):

Water Volume Change = Inflows + Runoff – Outflows – Controlled Discharges – Evaporation

Water volume change = 15.6 ML

Inflows =Ash Circuit Inflow + Awaba Mine Pump + Seepage lagoon Return + Water Plant Discharge
=7.3 + 0 + 6 + 0.75 = 14.05 ML/day

Outflows = Ash Circuit Outflow + Seepage to Mine + Seepage to lagoon
= 7.3 + 6 = 13.3 ML/day

Evaporation = 0 ML
Control Discharges = 47.52 ML (for cases where RL 125.5 is exceeded, add 150 ML/day for controlled overflow into crooked creek)

Thus
Runoff = 153.6 – 14.05 + 13.3+ 47.52 + 0= 200.37 ML/day

Rainfall calculation
Natural Runoff = area x coefficient x rainfall = 1.08 km^2 x 0.3 x rainfall
Ash Runoff = area x coefficient x rainfall = 0.86175 km^2 x 0.9 x rainfall
Ash Dam Pond = Ash dam area x coefficient x rainfall = 0.256 km^2 x rainfall
Return Water Pond = area x rainfall = 0.05 km^2 x rainfall
CHP Runoff = Perimeter x coefficient x rainfall + Coal Stack x coefficient x rainfall
= 50000 x 1 x rainfall + 300000 x 0.3 x rainfall
Total Runoff = $\sum$ area x coefficient x rainfall = 200.37 ML/day = 200370 m3/day

Using Goal seek, rainfall = 129.59 mm

Appendix C

Eraring Power Station - Ash Dam Operating Instruction

ASH DAM OPERATING LIMITS

The ash dam target level is RL 124.70m, with a range RL124.70 - RL124.90m. Normal operation occurs within this range. Any changes to this range will be detailed in the Daily Operating Instruction.

Low Level (Make-up)

If the ash dam level drops below RL 124.60m, (eg. during periods of hot dry weather), the salt water make-up pumps are to be used in preference to the return water pumps until the level just exceeds RL 124.70m when normal operation is resumed.

High Level (Discharge to Outlet Canal)

If the ash dam level rises above RL 124.90m, the second return water pump is to be operated manually to discharge water to the outlet canal. This is to continue until the level reaches RL 124.70m when normal operation is resumed.

Extra High Level (Discharge to Crooked Creek)

If the ash dam level exceeds RL 125.50m, (due to unusually high rainfall or return water pump unavailability); the Environment Officer is to be notified, as discharge to Crooked Creek may be required for dam safety.

Note: Overflow to Crooked Creek is only to occur as a last resort in this circumstance as the discharge to the outlet canal is the primary point of discharge. (If discharging, the return water canal is not to exceed RL 110.32m as this corresponds to the EPA license discharge limit of 150ML/day)

The return water dam level is monitored with an alarm on high dam level (corresponding to Crooked Creek weir overflow). **Any unauthorised discharge to Crooked Creek is to be investigated immediately and actions logged.** The operation of the ash dam siphon outlet valve is to be checked daily by operating staff and logged on the Ash Dam Environmental Check sheet

Appendix D

Return Water Pump

Only one return water pump operating

In the following calculated data, it was assumed that the excess ash dam water may be retained within the level range RL 125.5 to RL 126.61m (thus preventing discharge to the Crooked Creek) by utilising only one return water pump (without the second return water pump which is to be operated manually to discharge water to the outlet canal).

The results of the study, with the method and calculations are given in Appendix B. For both dam filling scenarios, the calculated rainfall was that needed to cause the dam to reach the specified level in one day or three days.

Table D1 – Storm Runoff Capacity Estimates for Eraring Ash Dam (without controlled discharge to Crooked Creek and no extra return water pump) in one day

Rainfall Needed Over 1 Day Starting From RL 124.9 (mm) Without controlled discharge to Crooked Creek and no Extra return pump operating		
Final Dam Level	**Scenario**	
RL (m)	**1**	**2**
125.5	99	54
126.61	283	154

Table D2 – Storm Runoff Capacity Estimates for Eraring Ash Dam over three day

Rainfall Needed Over 3 Day Starting From RL 124.9 (mm) Without controlled discharge to Crooked Creek and no Extra return pump operating		
Final Dam Level	**Scenario**	
RL (m)	**1**	**2**
125.5	98	53
126.61	282	153

It can be seen from comparison of Table 7, Table 9 and Table D1 that the rainfall from each of these events is enough to cause the dam water level to reach over RL 126.61m (uncontrolled discharge to Crooked Creek) within one day or three days under the operating conditions of only one return water pump operating and without controlled discharge to Crooked Creek.

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Eraring Ash Dam Selenium Modelling of Projected Increase in Flyash Sales

Eraring Energy

2 July 2007
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Revision 3

Connell Wagner

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1	16/04/07	Final Draft Report	BRH	BRH	JM	CF
2	20/04/07	Final Report	BRH	BRH	CG	CF
3	02/07/07	Final Report with Eraring Energy Comments	BRH	BRH	CG	CF

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Contents

Tables

Figures

Figure 5. Eraring Ash Dam Selenium Mass Emission Trends under Actual (1996 to 2006) and Predicted Dense Phase Operating Conditions (2007 to 2023) Compared to Discharge Flows and Pond Concentrations

1. Introduction

Eraring Energy is planning to implement high concentration dense flyash slurry disposal (70% ash to water) at the Eraring Ash Dam to prolong the life of the ash dam. As part of the Concept Approval, the Department of Environment and Conservation (DEC) requested that Eraring Energy increase the level of ash reuse to minimise selenium release to Lake Macquarie. The current level of total flyash sales at Eraring Power Station averaged 32%. With the proposed dense phase operation, sales are projected to be increased by 2% per year until 40% in 2011 and then to increase to 43% in 2012, 47% in 2013, 51% in 2014 and 55% in 2015.

The current flyash disposal system uses lean phase of 17% with ash terracing to minimise infilling of the water pond used to slurry the ash. Due to concerns about the concentrations of selenium in discharges to Lake Macquarie, Eraring Energy engaged Connell Wagner to undertake modelling of the selenium concentrations and ash dam discharges to Lake Macquarie using the projected ash sales. Connell Wagner was also engaged to model the ash dam water balance using historical rainfall data.

The selenium modelling takes into account natural mechanisms of selenium removal from the pond on the predicted concentrations and to include the likely changes in pond volume, catchment areas (including proposed ash placement areas) and discharge volumes with conversion to a dense phase disposal system. Hence the aim of this report is to investigate, on an annual average basis, the likely selenium concentrations and selenium mass emissions from the ash dam due to:

- natural losses of selenium from the ash dam pond;
- reduction in volume of the pond to its minimum volume with operation of the proposed dense phase system, and
- increased ash sales.

Due to the various unknowns, including the actual processes governing the loss of selenium from the pond water column, a level of uncertainty was attempted to be allowed for in the dense phase modelling. Central to this was the use of the historical behaviour of the current lean phase ash dam selenium. This was modelled to estimate the overall rate of selenium losses in the ash dam and was used to model selenium concentrations during dense phase operation. Some of the unknowns, such as physio-chemical re-adsorption of selenium onto the surface layers of the deposited ash are attempted to be allowed for by laboratory investigations and these results were used in sensitivity checks. However, the predicted selenium concentrations cannot be guaranteed, with extrapolation to the dense phase scenarios, due to the complexity and the level of unknowns. Accordingly, behaviour of the ash dam selenium was recommended to be monitored closely following initiation of the dense phase operation.

Other than the current effects of the water reclamation brine waste on selenium processes in the ash dam, the report does not assess the effects, if any, of changes that may occur as a result of water reclamation brine wastes on selenium processes in the ash dam during dense phase operation.

The selenium modelling was undertaken on the basis of long-term annual average rainfall using the following information:

- Recorded changes in historical ash dam selenium and water quality data and measured discharges to the outlet canal;
- Leaching tests to simulate selenium leached from slurried ash for both lean and dense phase slurries;
- Estimate of the ash dam water balance using the current lean phase ash slurry, existing catchment areas and recorded discharges to the cooling water outlet canal;
- Water balance for the dense phase slurries using the estimated future catchment and ash placement areas for the proposed dense phase ash dam configuration;

- Estimate of the ash dam selenium mass balance for the lean and dense phase operation using laboratory tests on selenium leachates;
- Estimation the rate of loss of selenium from the pond by comparing modelled and measured selenium concentrations for the current operation. Mechanisms for the estimated losses are suggested and physio-chemical adsorption of selenium onto deposited ash estimated by laboratory adsorption tests.

Once the selenium concentration in the final dense phase ash pond was estimated, discharge issues related to the Protection of the Environment and Operation (POEO) licence limit of 2 ug/L, which applies to the end of the cooling water outlet canal, are discussed in the report.

1.1 The Proposed Dense Phase Ash Placement Scheme

The proposed dense phase flyash slurry scheme is shown in Figure 1. It involves infilling of the existing ash slurry water pond by ash placement, via three disperser pipelines located above the current ash placement height. Ash is placed until the pond volume is reduced to a minimum considered acceptable for ash slurry water recycling. After the minimum pond size is reached, the currently proposed dense phase placement would be either modified or other options for ash placement considered.

Rainfall runoff from the remaining forested catchment is proposed to be diverted from the ash placement area via an open drain. It will be sent to the ash water pond to maintain its volume against evaporative losses and uptake by the ash itself.

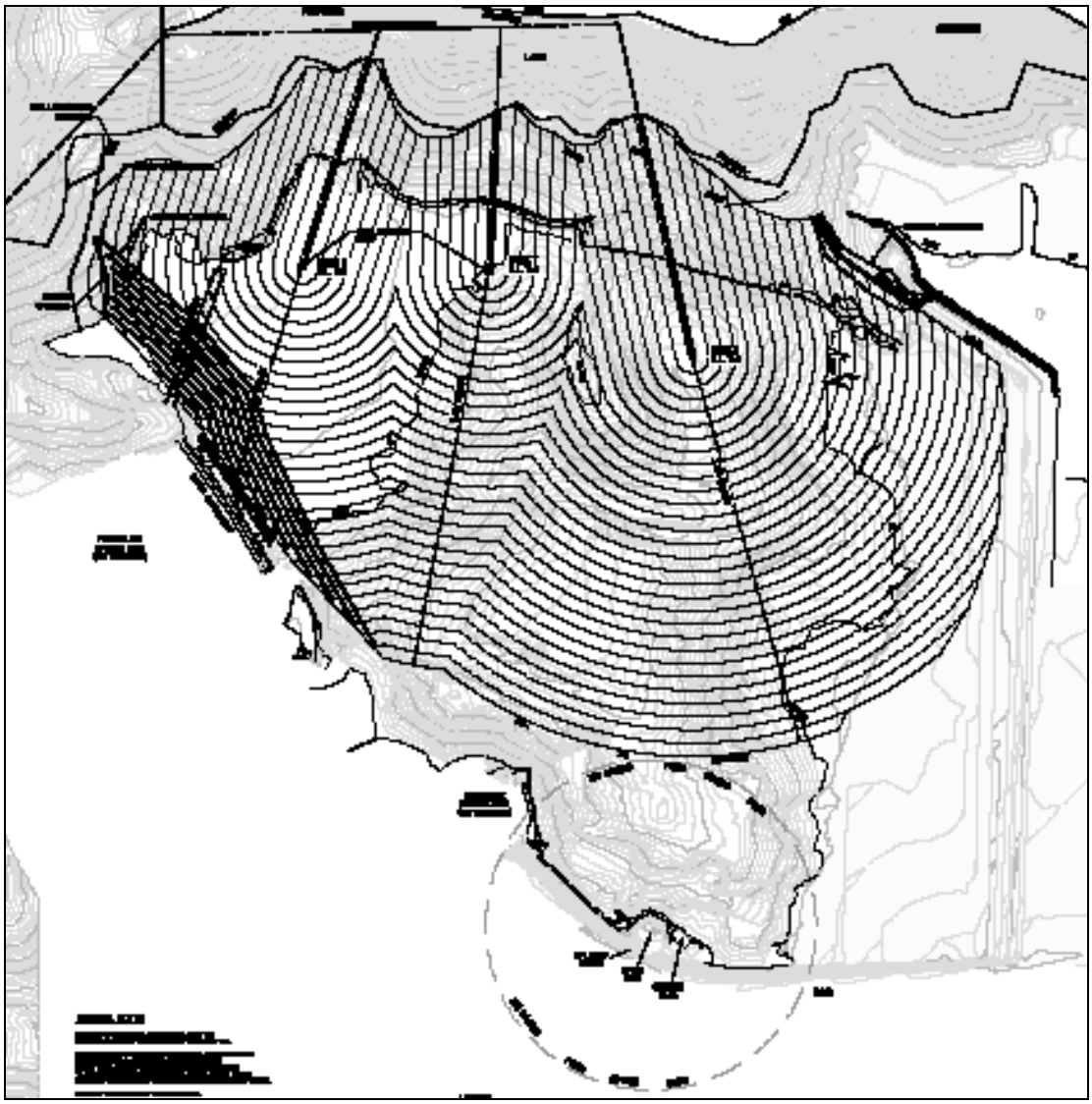

Figure 1. Eraring Ash Dam Proposed Layout of Dense Phase Ash Placement

1.2 Model Inputs

The data and information used as inputs to the water balance model was based upon the original sources of Connell Wagner PPI (2003) and the Eraring Ash Dam Management report (PPI, 1996). These parameters were used in this report for the selenium modelling and updated with recent information from a survey of the ash dam pond volume and ash areas in 2006. Eraring Energy provided the following data and information as part of the selenium modelling:

- Se discharge flows, concentrations and mass (kg) of Se discharged to the cooling water outlet each month from 1996 to 2006 as well as ash dam water quality;
- The current ash slurry characteristics of percent ash and flow rate.

The Eraring Energy information (indicated below with an *) and the remaining inputs were modified where necessary to take into account changes due to the proposed dense phase design shown in Figure 1. The main changes were for the natural catchment and ash placement areas for both the current lean phase and proposed dense phase operation. The inputs were discussed with Eraring Energy and verified before using the model to predict the current and future selenium concentrations. The various inputs and their sources are indicated below:

1.2.1 Current Lean Phase Operation

Ash Placement Characteristics

- Flyash was slurried with recycled ash pond water at the average rate of 2403 t/day from 1996 to 2006,which gives an average of 0.877mt/year of ash placed in the ash dam*;
- The pond volume in 2006 was verified by a bathymetry survey as 4,000 m^3. This volume was reduced by ash placed underwater from the 1996 volume of between 8,468m^3 to 9,600m^3 (see PPI,1996), depending upon the operating or full supply level;
- The estimated changes in pond volume indicate that about 49% of the ash (by weight) is deposited underwater where the equivalent dry flyash density is about 0.9 t/m^3 due to adsorption of pond water by the deposited ash to give a moisture content of about 55%.

Water Balance

- Discharge to outlet canal: 6.6 ML/day (average of measured discharge flows from 1996 to 2003)*. The discharge includes the volume of water displaced by ash placed in the pond, which was estimated to be 1.22 ML/day for 52.6% of the ash placed underwater.
- Water retained in slurried ash: 0.93 ML/day (weighted average 40% moisture content by water uptake in deposited ash – 55% in ash deposited underwater and 25% for above water level, from Connell Wagner, 2003 and ECNSW, 1988)
- Ash slurry flow rate: 14.18 ML/day made up of 2.33 ML/day of dry ash in the slurry (assuming an equivalent dry flyash density of 0.9 tonne/m^3 from 2403 t/day) and 11.85 ML/day of slurry water on basis of 17% ash/(ash + water)*
- Water Reclamation Plant (WRP) discharge to ash dam of 0.75 ML/day*
- Pond volume: 4,000 ML in 2006 (from ash dam survey – see Connell Wagner,2006).
- Pond surface Area – 745,000 m^2
- Return Water Pond Area – 50,000 m^2 (PPI, 1996). Note: catchment of the return water pond is diverted so only direct rainfall on the pond enters the ash dam;
- Ash runoff area – 0.373 km^2 (estimated runoff coefficient of 0.7 to 0.9 for sensitivity check)
- Natural catchment – 1.066 km^2 (estimated runoff coefficient 0.3)
- Coal Handling Plant rainfall runoff – 0.456 ML/day (based upon coal stack of 300,000 m^2 at 0.3 runoff coefficient and 50,000 m^2 of perimeter drains at 1.0 runoff coefficient; areas from PPI, 1996)
- Average evaporation - 1244 mm/year (PPI, 1996).

- Average rainfall - 1190 mm/year (local long-term average, from 1972 to 1995, taken from PPI, 1996).

Selenium Balance

- Pond Selenium concentration – average 147 ug/L in 2006*
- Ash slurry Selenium concentration – 253 ug/L, adjusted for recycled pond concentration
- Slurry input = 3.0 kg/day (11.85 ML/d x 253 ug/L Se concentration). Note that the laboratory leaching tests present the Se concentration as mass Se leached per volume of water used in the leaching test, so the Se input from the slurry uses the volume of water in the slurry;
- Release to outlet = 0.58 kg/day on basis of the 1996 to 2006 ash dam pond average of 88 ug/L*
- Loss by water retention in ash 0.08 kg/day

1.2.2 Proposed Dense Phase Operation

Ash Placement Characteristics

- Flyash would be slurried with recycled ash pond water at the rate of 2510 t/day to 1515 t/day as total ash sales increase from 32% to 55%. This gives 0.916 mt/year to 0.553 mt/year of ash placed in the ash dam*. The equivalent dry flyash density averages about 0.9 t/m^3 when placed underwater due to adsorption of the pond water, which makes the average moisture content about 55%. The density of the ash placed above water has been measured at Eraring ash dam and at other ash dams to average 1.25 t/m^3, with an average moisture content of 25% (Connell Wagner, 2003 and ECNSW, 1988).
- A total of 10.3 million m^3 of ash is proposed to be placed in the ash dam during the currently proposed dense phase operation*, with additional ash placement if the placement method is then modified;
- Under the proposed dense phase system, more of the 10.3 million tonnes of ash would be placed above the water level of the ash pond than underwater. The proposed ash placement strategy is shown in Figure 1 and is expected to give a change in volume of the ash dam pond from the current 4,000 ML to 480 ML. On this basis, and amount of ash expected to be placed underwater indicates that the percentage is most likely 30.75% on a weight basis. For modelling purposes, this proportion was taken as the mass of the ash deposited underwater. With correction for the underwater ash density, and the level of ash sales, this gave about 15 years until the final pond volume of 480 ML would be reached;
- Total ash sales: 2006, 32%; increased by 2% per year to 40% in 2011; increase to 43% in 2012, 47% in 2013, 51% in 2014 and 55% in 2015.

Water Balance

- Discharge to outlet canal: reduced to 4.53 ML/day, just before the minimum pond volume is reached, from the current average of 6.6 ML/day. The discharge includes the volume of water displaced by ash placed in the pond, which was estimated to average 0.52 ML/day while the ash pond is filled in with ash and displaced water sent to outlet canal with runoff water. The discharge due to runoff only was based upon the average of discharge data from 1996 to 2006 adjusted for changes in natural catchment and ash area runoff. After the minimum pond size is reached (about 12 years after dense phase commences), the discharge was estimated to be reduced to 3.67 ML/day due to lack of ash displaced water.
- Water retained in slurried ash – averaged 0.57 ML/day (weighted average 40% moisture content by water uptake in deposited ash – 55% in ash deposited underwater and 25% for above water level, from Connell Wagner, 2003 and ECNSW, 1988)
- Ash slurry flow rate – the water content flow rate is expected to be 0.72 ML/day to 1.19 ML/day, corresponding to flyash inputs of 1515 t/day to 2510 t/day. The slurry water flow rate

was estimated on the basis of an equivalent dry flyash density of 0.9 tonne/m^3 and 70% ash/(ash + water)*.

- Water Reclamation Plant (WRP) discharge to ash dam of 0.75 ML/day*
- Final pond volume – 480 ML (Connell Wagner,2006).
- Final pond surface Area – 148,000 m^2
- Return Water Pond Area – 50,000 m^2. Note: catchment of the return water pond is diverted so only direct rainfall on the pond enters the ash dam;
- Final ash runoff area – 1.14 km^2 (runoff coefficient 0.7 to 0.9)
- Natural catchment – 0.8937 km^2 (runoff coefficient 0.3. Note that 0.199 km^2 of the natural catchment runoff flows over deposited ash, but it was assumed that all this water entered the final pond, so the ash runoff coefficient was set a 1.0 for this part of the natural runoff)
- Coal Handling Plant rainfall runoff – 0.456 ML/day (based upon coal stack of 300,000 m^2 at 0.3 runoff coefficient and 50,000 m^2 of perimeter drains at 1.0 runoff coefficient; areas from PPI, 1996)
- Average evaporation - 1244 mm/year (PPI, 1996)
- Average rainfall - 1190 mm/year (long-term average at Norah Heads, from PPI, 1996)

Selenium Balance

- Ash slurry Selenium concentration – 618ug/L, on basis of 8 hours contact with expanded ash area from laboratory tests and adjusted for pond concentration at time of the test;
- Slurry input – 0.74 kg/day (618 ug/L x 1.19 ML/day). Note that the laboratory leaching tests present the Se concentration as mass Se leached per volume of water used in the leaching test, so the Se input from the slurry uses the volume of water in the slurry;
- Release to outlet - estimated by model on basis of the average selenium concentration in the ash dam pond each year over 15 years of dense phase operation;
- Loss by water retention in ash – estimated by model each year.

1.3 Effects of Flyash Sales on Selenium Input to the Ash Dam

The current (2006) total flyash production at the power station is about 3,894 t/day and total ash sales (expressed ash percentage of total flyash and furnace ash production) averaged 32% during 1996/06, which gives an average input to the ash dam of 2,094 t/day and, with ash sales of 26.1% in 2006 it was 2,575 t/day. The amount of flyash that would be disposed in the ash dam, assuming the total production remains unchanged, as projected ash sales increase from 32% (35.6% as flyash sales) to 55% (61.1% as flyash sales) to 2015 is shown in Table 1.

Table 1. Projected Flyash Sales, Ash placement, Water used for Ash Slurry and Estimated Selenium Inputs to the Eraring Ash Dam

Year	Total Flyash Production (t/day)	Flyash Sales (%)	Flyash Placement in Dam (t/day)	Water used in Slurry (ML/day)	Se Input (kg/day)
2007	3894	35.6	2510	1.086	0.67
2008	3894	37.8	2422	1.048	0.65
2009	3894	40.0	2336	1.011	0.63
2010	3894	42.2	2251	0.974	0.60
2011	3894	44.4	2165	0.937	0.58
2012	3894	47.8	2033	0.880	0.54
2013	3894	52.2	1861	0.806	0.50
2014	3894	56.7	1686	0.730	0.45
2015	3894	61.1	1515	0.656	0.41

The amount of water used to slurry the ash, at a constant 70% ratio of ash to ash plus water, and the estimated amount of selenium leached from the ash is also shown in Table 1. The selenium inputs were used to model the selenium concentrations in the ash dam pond and mass emissions to Lake Macquarie. As dense phase operation is expected to last for at least 15 years, it was assumed flyash sales remained at 55% after that year.

1.4 Model Assumptions

The selenium concentrations in the ash pond are determined by the volume of the ash water recycling pond, inputs from the ash slurry process and releases to the cooling water outlet canal. However, as selenium is an essential trace element, internal losses by biological activity (bacteria and algae) from the pond would be expected. Some bacteria may convert the selenium to the gaseous dimethlysulphide.

Internal losses from the pond were confirmed by the study of the estimation for selenium emissions from Eraring Power Station by Hodgson (1996), who also estimated the selenium mass balance of the ash dam. It was estimated that about 80% of the selenium added to the ash dam by the ash slurry process was lost from solution in the pond. As well as biological activity, losses may be caused by physical/chemical adsorption of selenium on the ash/sediments which form the pond, equilibrium release back to the pond from the ash/sediments and by biological processes. The addition of water reclamation brine waste to the ash dam is adding nutrients and would be expected to increase the rate of biological removal of selenium.

As these losses need to be defined for the model, they were estimated by modelling the existing ash dam conditions, assuming no losses, and comparing the concentrations to the measured concentrations. Modelling was undertaken for the period 1996 to 2006 and the percentage loss of selenium per year estimated. The estimated losses depend upon the accuracy of the information used to model the existing conditions. The loss estimates were attempted to be verified by undertaking laboratory adsorption tests at high concentrations of selenium to measure the net adsorption onto previously slurried ash. These adsorption tests would not include the effects of biological activity. The test procedures are outlined in Section 1.4 and took into account the ratio of pond volume and ash surface area of the final pond.

Under the proposed dense phase operation conditions, the pond volume of 480 ML with a maximum depth of 6.5m was estimated to have a surface area of ash forming the pond of 295,000m^2. The ratio of pond volume to wetted ash surface area was about 1.62:1. This is about 40% lower than under the current conditions where the volume is 4,000 ML, maximum depth about 16m and the ash surface area estimated to be 1,490,000 m^2, giving a ratio of volume to surface area of about 2.7:1. This means there would be a greater area of ash, per unit volume of storage, in contact with the overlying body of pond water for the final dense phase ash operation. This may provide increased opportunity for re-adsorption of selenium onto the deposited ash surface.

Although the laboratory measured ash uptake under simulated dense phase conditions does not account for losses by biological activity, the model estimates under the current conditions include the effects of biological as well as physiochemical removal processes. Hence, the laboratory results are expected to indicate if the modelled estimated current losses are reasonable for predicting the selenium concentrations under dense phase and minimum pond size conditions. Due to the unknowns involved, a range of loss rates was used to estimate the pond selenium concentrations under dense phase operation.

The selenium concentrations during dense phase operation were estimated on the basis of the above and these additional assumptions made in the development of the model:

- The rainfall runoff coefficient for the natural catchment was taken as 0.3 on the basis that the catchment is fully tree covered and has a relatively steep slope (Figure 1). Under the proposed dense phase operation, most of the runoff would be diverted around the uncapped ash placement area and directed into the pond for use in slurrying the ash via the ash water return system. About 0.199 km^2 of the natural catchment runoff would flow over the ash deposit and it was assumed no more losses of these flows would occur;

- For the uncapped ash placed around and above the pond water surface level, the runoff coefficient was taken as 0.7 to 0.9 because the ash surface will be near saturated with water to prevent dusting. Evaporative losses from the ash surface is expected to cause the runoff coefficient to be in the range used in the model;

- The total amount of evaporation from the uncapped ash areas was assumed to be higher than from the pond itself because the near saturated ash was assumed to dry between rainfall events. This effect was taken into account by setting the evaporation rate the same as for the pond and having a runoff coefficient less than 1.0 for the uncapped ash. These assumptions are considered reasonable because the ash is proposed to be kept wet by directing ash slurry water over the ash placement;

- Adsorption of the water used to slurry the ash, into the ash, results in 55% moisture content when placed underwater, and 25% when placed above water. These values were used on the basis of moisture measurements in Connell Wagner (2003) and ECNSW (1988). These percentages arise on the basis that the dry ash has about 30% of pore volume, which would fill with water and more water would be around each particle of ash when placed underwater and less in the above water conditions;

- Seepage from the ash dam was taken as nil because the seepage collection system returns essentially all seepage back to the ash dam;

- Selenium concentration in rainwater and in rainfall runoff from the natural catchment was taken as 0.1 ug/L. It was assumed that rainfall runoff over the uncapped ash would not add significant additional selenium into the pond than due to the ash slurry process;

- The model estimates the pond selenium concentration at the end of each calendar year. For the current operation, the concentration was adjusted by application of a loss factor to provide a best agreement with the changes in measured concentrations from 1996 to 2006. This factor was compared to those obtained by laboratory adsorption tests. As the current ash pond losses were comparable to the laboratory adsorption test results (see Sections 1.4 and 2.1.2), the factor was assumed to apply to the dense phase conditions;

- During the first year of operation of the dense phase system, the mass of selenium released to the lake is expected to exceed the mass input due to the slurry process. This would be due to a reduction in the selenium leaching rate from 3 kg/day to 0.74 kg/day. To account for this negative mass balance, the mass of selenium in the slurry that was lost to the ash dam sediments was estimated. For the current lean phase operation, the sediment uptake of selenium from the ash slurry was estimated to be 12%, 19.7% and 22% when the scenarios of overall losses of 96% (0.03 factor), 93.7 (factor 0.063) and 82.5% (0.175 factor) were used. During the dense phase operation, it was assumed the same proportion of selenium inputs to the ash dam from the slurry process were lost to the ash dam sediments. The sensitivity of the sediment uptake on the modelled pond selenium concentrations are discussed in Section 2.1.3;
- From the beginning of the dense phase operation to the minimum pond size, the ash dam natural catchment, pond surface and ash area placed above the water level, were each assumed to change in a linear manner over the 15 years.

- The predicted maximum selenium concentration in the final pond was used to estimate the concentration in the cooling water outlet for comparison with the POEO licence limit of 2 ug/L. The increase in outlet concentration was estimated using the predicted selenium concentrations in the ash dam and the cooling water flow rate of 7,220 ML/day. The ash dam discharge was taken as 4.53 ML/day for the last year of filling of the pond and 3.67 ML/day when the final pond size of 480 ML was reached. It was assumed that the ash dam would not overflow.

1.5 Laboratory Ash Leaching and Adsorption Tests

Laboratory leaching tests were undertaken to simulate selenium leaching from slurried ash and adsorption tests were also undertaken to simulate re-adsorption of the leached selenium by the ash forming the bottom of the ash pond.

1.5.1 Ash Leaching Tests

To simulate actual conditions, the current ash slurry process of 17% ash and 83% water was mixed for three hours using ash collected from the power station fabric filter bags and ash dam water (selenium concentration of 162 ug/L). The test was undertaken in duplicate with the following results (ug/L):

Ash Water Concentration	Slurry Concentration
162	436
162	394

The average increase in selenium concentration due to the lean phase slurry process, above the ash dam concentration, was 253 ug/L. This increase was used to model the selenium concentrations in the existing ash dam for the current lean phase operation.

Selenium leaching during dense phase operation was simulated by leaching tests with 70% ash and 30% current ash pond water. Duplicate tests were undertaken for mixing times of 0.5, 2 and 18 hours. The results were (ug/L):

Ash Water Concentration	Leaching Time	Slurry Concentration
162	0.5	282
162	0.5	332
162	2	538
162	2	819
162	18	649
162	18	630

From the expanded area of deposited ash during dense phase operation, the time of contact of the ash and water slurry was estimated at 8 hours. Using the above results, the estimated 8 hour average increase in selenium concentration due to the dense phase slurry process, above the ash dam concentration, was 618 ug/L. This increase was used to model the expected increases in selenium concentration in the ash pond during dense phase operation.

1.5.2 Adsorption Tests

Physio-chemical adsorption of selenium onto deposited ash was estimated by laboratory adsorption tests, which simulated the proposed final ash pond volume and the surface area of the ash forming the pond.

The ash pond is predicted to have a final volume of 480,000m^3, pond surface area of 148,000m^2 and, for a maximum depth of 6.5m, assuming a cone shape, the surface area of the wetted ash was estimated to be 295,000 m^2. This gives a pond volume to wetted area ratio of 1.62. Cores taken previously of the selenium concentration in the ash dam sediments indicated that the selenium exchange between the pond water column and the ash occurs in the top 0.2m of the ash. Hence, the volume of ash exchanging selenium with the pond was estimated to be 59000m^3.

Preliminary laboratory adsorption tests were undertaken in a container which had a surface area of 113 cm^2 of ash in contact with ash dam water to give a Volume/Surface ratio of 0.0578. This was considered to have too much ash in relation to the amount of water expected in the final pond, so the test was repeated (Section 2.1.2).

From the predicted final ash pond dimensions, the laboratory simulation adsorption test was repeated using a 23cm diameter container, with 400ml of water collected from the Eraring Ash Dam in contact with 50ml of previously leached ash, also collected from the Eraring ash dam. Analytical grade selenium was added to the ash dam water to produce the desired concentration. The sample containers were prepared in duplicate and shaken for 2 hours and then rested for 16 hours (total 18hours contact time) before filtration and analysis of the selenium content. The adsorption test results are shown and discussed in Section 2.1.2.

2. Results

Modelling of the changes in selenium concentrations in the ash pond was undertaken in two stages:

- The existing ash dam pond and current lean phase operation to determine the internal selenium losses;
- The proposed dense phase operation using the internal selenium losses estimated from the existing conditions and laboratory adsorption tests.

2.1.1 Existing Conditions

Selenium concentrations in the ash dam varied from an average of 61 ug/L in 1996 to 147 ug/L in 2006 (Figure 2).

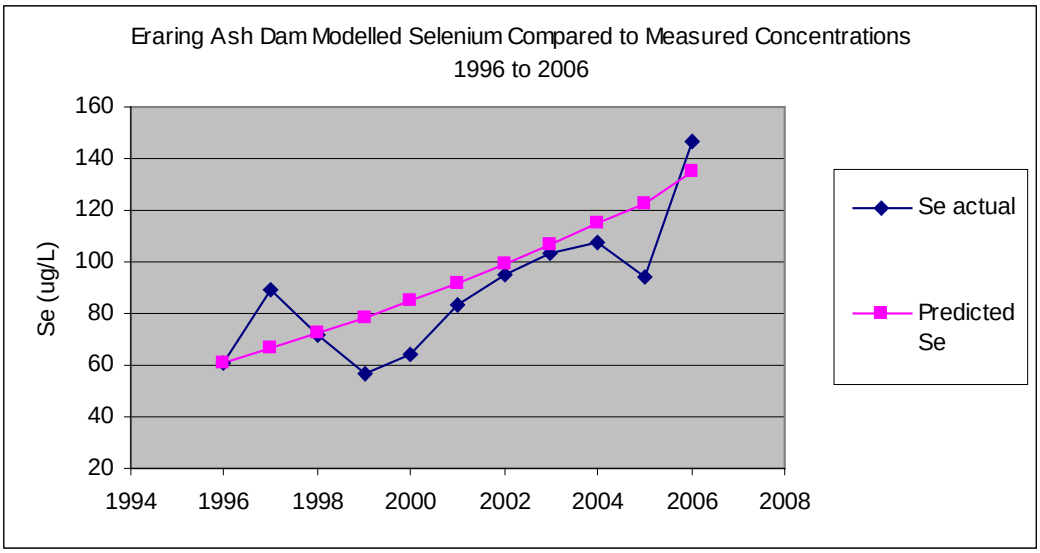

Figure 2. Eraring Ash Dam Predicted and Measured Selenium Concentrations for Current Lean Phase Operation from 1996 to 2006

Allowing only for ash slurry inputs, discharges to the cooling water outlet canal, and pond volume reduction, the theoretical pond concentration was predicted to increase to about 1450 ug/L by 2006, rather than the measured 147 ug/L (Figure 3). The large difference indicates that internal losses of selenium are occurring from the pond water column.

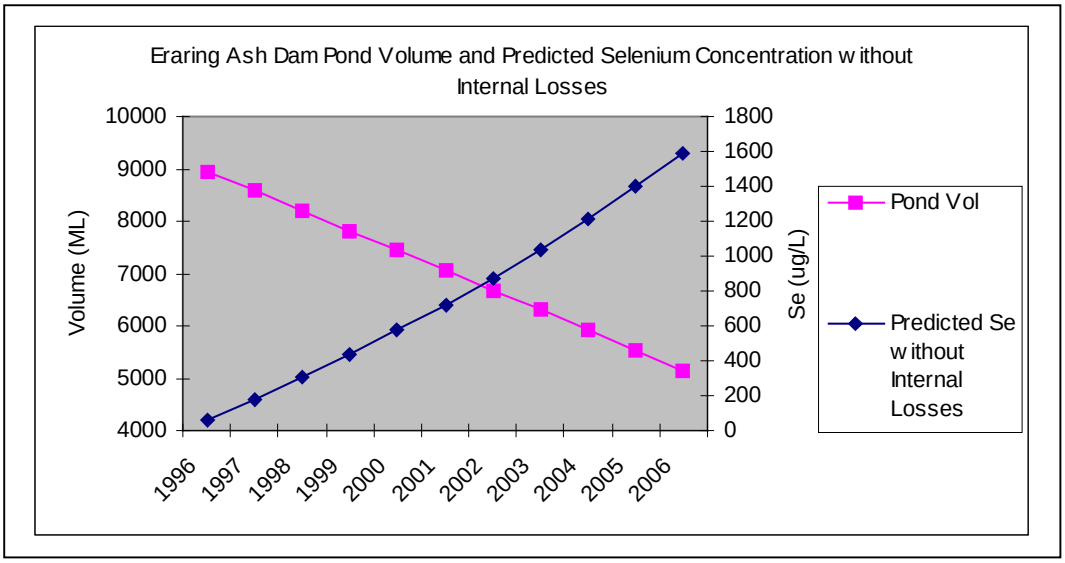

Figure 3. Eraring Ash Dam Volume Changes from 1996 to 2006 and Expected Selenium Concentrations without Internal Losses

2.1.2 Selenium Losses for the Slurry Water Pond

Losses of selenium from the existing pond were estimated in the following way. The measured selenium concentration in the pond has been increasing at the rate of 0.0237 ug/L/day from 1996 to 2006 compared to a net slurry input (slurry minus discharge to outlet canal and adsorption of water by the ash) of 0.375 ug/L/day (using the average pond volume during 1996 to 2006). Hence, a loss factor of 0.063 was applied to the modelled selenium concentrations to provide agreement with the measured concentrations (Figure 2).

Validation of the estimated 0.063 factor, which is equivalent to a 93.7% reduction in net input, was undertaken by comparison with measured losses in laboratory adsorption tests. Although these tests would not allow for the effects of biological uptake of selenium, they were expected to provide an indication of the relative balance between physio-chemical adsorption onto the ash surface and releases back to the water column from the sediments forming the ash pond.

Preliminary adsorption tests, in duplicate, on selenium uptake by previous leached ash gave the following results for 1000 ug and 500 ug added to the ash dam water concentration of 162 ug/L. This gave initial concentrations of 1,694 to 1,826 ug/L and 875 to 891 ug/L and final concentrations after 18 hours were as follows (Se ug/L):

Initial Concentration	Final Concentration	Average Loss (%)
1694	70	96.9
1826	40	
875	13	98.3
891	17	

The percentage reductions are equivalent to loss factors of 0.03 at 1760ug/L (average final of 55 ug/L divided by 1760 ug/L) and 0.017 at 883 ug/L. These results are similar to, but higher than, that estimated by modelling of the current ash dam selenium changes of 0.043 (95.7%). The laboratory results of a higher loss rate than measured in the ash dam was unexpected and indicates that, in this test, most of the leached selenium during the slurry process was re-adsorbed onto the ash deposits forming the test ash pond.

To get a better estimate of the physio-chemical uptake, the adsorption test was repeated using a more realistic ratio of test pond volume to ash surface area and volume of ash. The following test concentrations of 1,948 to 3,733 ug/L were used which were higher than from the ash slurry leaching to test for an excessive build up in concentrations in the ash dam pond. The final concentrations after 18 hours were as follows (Se ug/L):

Test Concentration	Final Concentration	Average Loss (%)
3733	648	82.6
1948	341	82.5

The percentage reductions are equivalent to an average loss factors of 0.175 and, as expected, is lower than estimated by modelling of the current ash dam selenium changes. The difference from the laboratory results and that modelled of 11.2% (93.7% - 82.5%) gives an indication of the net loss each year due to biological processes. These results indicate that most of the leached selenium during the slurry process could be expected to be re-adsorbed onto the ash deposits forming the ash pond. It should be noted that the results were independent of the initial test concentration, indicating that the loss factor could be applied over a range of pond concentrations.

The model and laboratory estimates of the selenium losses provide some confidence that the model factor of 0.063 could be used to model the selenium changes with conversion of the ash system to dense phase. The loss factor of 0.175 was also used to indicate the selenium concentrations in the dense phase pond should the biological losses be disrupted, or the rate of release from the pond sediments increase, due to unknown factors such as the discharge of treated sewage effluent concentrate to the ash pond.

2.1.3 Predicted Dense Phase Selenium Concentrations

The proposed ash dam management of reducing ash input by increasing ash sales is expected to give a reduction in the selenium concentration in the ash dam pond from the current levels. In addition, catchment management is expected to reduce water inflows, and hence water releases, and the mass of selenium to the cooling water outlet canal is also expected to be correspondingly reduced.

Discharge flows are expected to be reduced from the current 6.6 ML/day to about 6.1 to 4.5 ML/day (for ash runoff coefficient 0.7) during the pond infilling period and to about 3.7 ML/day after the minimum size is reached. The amount of rainfall runoff was predicted to be less than evaporation from the extensive area of deposited ash, which means that the rate of evaporation from the ash surface is the main determinant of the runoff coefficient and hence the discharge rate to the cooling water outlet canal. Under prolonged periods of dry weather, there may be no controlled discharge to the outlet canal. Under these conditions the selenium concentration could be expected to increase to above the annual average until there was a storm inflow of runoff to the pond.

The predicted selenium concentrations with dense phase infilling of the ash dam pond to the minimum volume of 480 ML and increasing ash sales is shown in Figure 4. Due to the reduction in flyash deposited in the ash dam, the time to reach the minimum pond volume was estimated to be about 15 years, assuming the proportion of ash deposited underwater was the assumed 31%.

A sensitivity check, using a range in ash area runoff coefficients and the range of loss factors discussed above, are shown. The minimum pond selenium concentration was estimated to range from 57 to 89 ug/L and, using the loss factor estimated from modelling of the current operation, it was estimated to be 75 ug/L. These are significantly lower than the current 2006 average selenium in the pond of 147 ug/L.

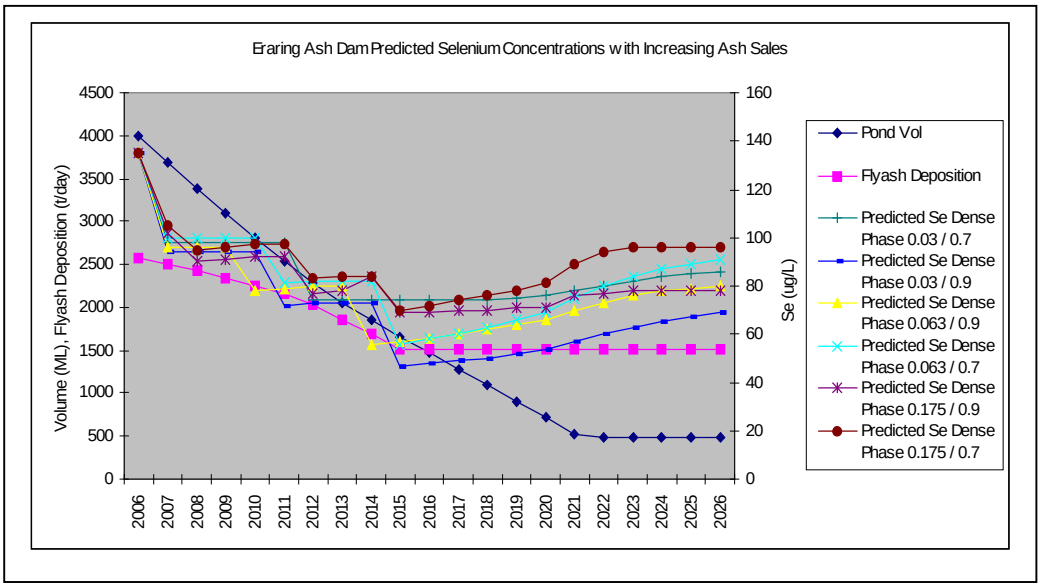

Figure 4. Eraring Ash Dam Predicted Selenium Concentrations with Dense Phase Operation and Pond Volume Reduction to the Minimum Size and for an Additional Five Years (Note: the various scenarios used are for 0.03, 0.063 and 0.175 are Se loss factors; 0.7 and 0.9 are ash area runoff coefficients)

Due to the counteracting effects of the reduction in the mass of selenium added to the ash dam pond with increasing ash sales and the reduction in pond volume by infilling, the selenium concentrations were predicted to have periods of reduction followed by steady or slightly increasing periods. However, there was predicted to be an overall reduction in line with the reduction in ash deposition until the target of 55% of total ash sales was reached nine years after the commencement of dense phase operation. With constant ash deposition thereafter, selenium concentrations were predicted to progressively increase until the minimum pond volume is reached.

The periods of reduction in selenium concentration was due to the negative selenium mass balance conditions where the mass release to the lake exceeding that due to the slurry process. This was initially caused by the conversion to dense phase operation in the first year and then due to the effects of reductions of selenium input from the slurry process as the amount of ash deposited is expected to be reduced with increasing ash sales. The step changes shown in Figure 4 are an artefact of the annual average modelling. For example, the reduction in the first year is predicted to reach a new equilibrium and turning point after about 7 months from the beginning of the dense phase operation, rather than at the end of one year. With a shorter time step, the modelling results would show a more smooth reduction in selenium concentrations with the reduction in total ash sales.

A sensitivity check on the effects of sediment uptake of selenium from the ash slurry during negative mass balances made only moderate differences in the minimum predicted concentration in the first year of about 96 to 105 ug/L. Reductions during subsequent negative balances varied for the various loss rate scenarios tested (0.03, 0.063 and 0.175) and affected the final concentration reached at the minimum pond size.

2.2 Effects of Pond Concentrations on Outlet Canal Selenium Discharge

The predicted maximum selenium concentration in the final pond of 96 ug/L was estimated to increase the concentration in the cooling water inlet canal by 0.01 ug/L from 0.5 ug/L, for the flow conditions of 4.53 and 3.67 ML/day (ash runoff coefficient 0.7) for the final pond size shown in Section 1.3.

The likelihood of exceedence of the POEO licence limit of 2 ug/L, which applies to the end of the cooling water outlet canal, depends upon a number of variables, including the inlet canal concentration

and the weather conditions affecting discharges from the ash dam. The routine water quality database for Eraring Power Station shows the inlet concentration to range from <0.2 ug/L to 3 ug/L. This is discussed further in Section 3.

2.2.1 Dense Phase Operation Continuing after Minimum Pond Size

Selenium concentrations in the pond were modelled for the scenario of dense phase operation continued to be used for five years after the minimum pond size was reached. This was undertaken to assess the possibility of alternative ways of the placing the ash, rather than dry ash placement, for about five years after reaching the minimum pond volume is reached but no further infilling of the ash ash pond occurs.

Figure 4 shows the selenium concentration in the pond would be expected to increase after the minimum pond size is reached. This is based upon the assumed inputs and outputs of the model remain unchanged after the minimum volume. For the lowest rate of selenium loss of 82.5% (0.175 factor), the selenium concentrations are expected to increase to about 96 ug/L and 69 ug/L for the 0.03 factor /0.9 scenario.

Application of the current loss rate of 0.063 to the dense phase operation predicted an increase in selenium concentration after the minimum volume was reached to about 91 ug/L in the fifth year. The predicted low final concentrations would be expected to have a minor effect on the outlet canal concentrations.

2.3 Mass Emissions of Selenium to Lake Macquarie

The mass emission of selenium to Lake Macquarie via the cooling water outlet from 1996 to 2006 ranged from 42 to 327 kg/year and averaged 189 kg/year. To show trends in emissions, if it is assumed dense phase operation started in 2007, the predicted mass emissions (modelled loss factor 0.043 and 0.7 ash runoff coefficient) for 15 years (2021) until the minimum pond volume was reached, is show in Figure 5. Note that the effects of the year-to-year variations in rainfall runoff from the catchment, which are evident during the measured emissions from 1996 to 2006, are not evident in modelled emissions from 2007 due to the use of annual average conditions.

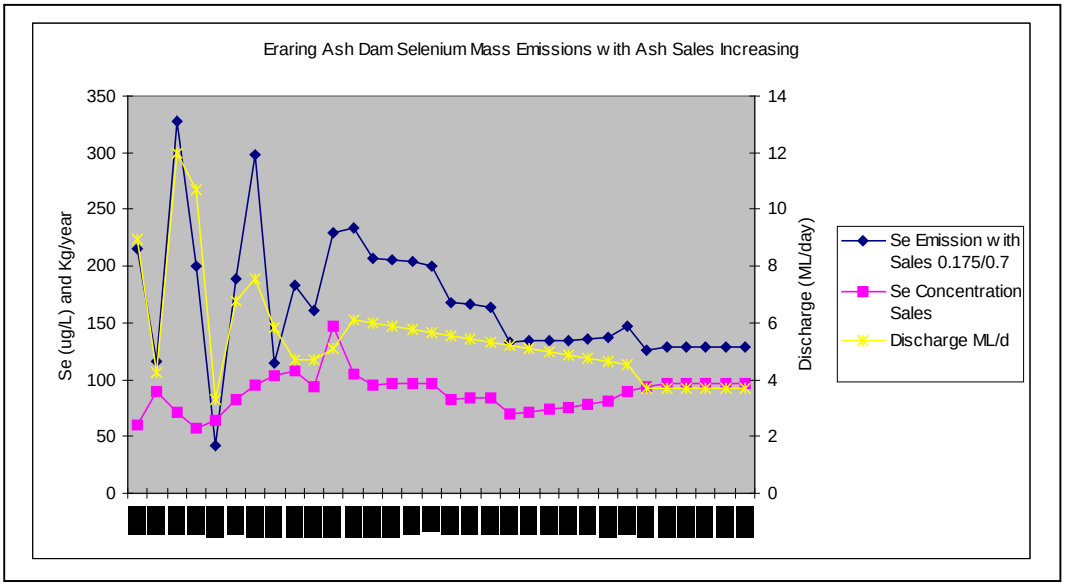

Figure 5. Eraring Ash Dam Selenium Mass Emission Trends under Actual (1996 to 2006) and Predicted Dense Phase Operating Conditions (2007 to 2023) Compared to Discharge Flows and Pond Concentrations

The decreasing selenium concentrations in the pond due to the increasing ash sales, and the decreasing discharge volumes, caused the predicted selenium mass emission to decrease progressively from 234 to 147 kg/year and average about 166 kg/year over the 15 year period from beginning of dense phase operation to the minimum pond size.

Figure 5 shows the selenium mass emissions if dense phase operation was continued without further infilling of the ash pond after the minimum pond size was reached. The predicted emission from 2021 is predicted to be about 129 kg/day due to the selenium concentration reaching an equilibrium level of 96 ug/L.

If the biological removal processes ceased to function and/or release of selenium from the pond sediments increased as the pond volume approached the minimum size, the selenium concentration in the ash dam is not expected to exceed the 96 ug/L predicted by the loss rate of 82.5%. The reason is due to equilibrium between the slurry inputs and the mass emission rate. With this concentration the maximum emission rate is predicted to be of 129 kg/year in the fifth year and to be about 30% lower than the average since 1996.

3. Discussion

The internal losses of selenium from the current ash dam were found to be high at about 96% of the pond concentration increases due to the ash slurry inputs. Laboratory tests suggested that most of these losses were due to re-adsorption of the leached selenium back onto the ash deposits. The applicability of these loss rates to the dense phase operation should be confirmed when operation of the proposed dense phase system begins.

Due to the number of factors that determine the selenium concentrations in the ash dam, and possible changes to the actual dense phase operating conditions, it is suggested that the concentrations be routinely monitored and compared to the model predictions. If significant increases are noted, appropriate mitigation measures should be implemented so that the outlet canal POEO licence limit of 2 ug/L is not exceeded. For example, the following pond concentrations would have to be reached to give a selenium concentration of 2 ug/L with a cooling water flow rate of 7,220 ML/day:

Inlet Canal Concentration ug/L	Pond Concentration ug/L	Discharge Flow Rate ML/d	Condition
0.5	2,950	3.67	Minimum Pond Size
1.0	1,970	3.67	Minimum Pond Size
1.5	985	3.67	Minimum Pond Size
1.5	800	4.53	Infilling Pond Period

The laboratory adsorption tests indicate that the selenium loss factor for the dense phase operation may be in the range of 0.03 to 0.175, which represent losses of selenium input by the slurry process of 82.5% to 97%. The actual loss rate would be influenced by a number of variables including the environmental factors that govern biological uptake, pond sediment uptake and release rates.

To put the effect of the selenium loss rate on potential to exceed the 2 ug/L licence limit into context, the maximum pond concentrations that may cause an exceedence of the POEO licence are shown in the above table. For example, a pond concentration of 2,950 ug/L, when the minimum pond size is reached, would be required to increase the cooling water inlet concentration from 0.5 ug/L to 2 ug/L at the outlet. During the last year of filling the pond, a pond selenium concentration of 800 ug/L would be required to increase the inlet from 1.5 ug/L to 2 ug/L at the outlet. However, as indicated above, exceedence of the POEO licence depends upon the actual concentration of the inlet and outlet canal concentrations, so it is suggested that measurements of selenium be undertaken at a detection limit similar to that expected by the increase due to the ash dam discharges.

For the worst case of a pond discharge rate of 4.53 ML/day and selenium at 96 ug/L, and only one cooling water pump in operation, the selenium increase in the outlet canal may be up to 0.24 ug/L. Under such circumstances, it may be necessary to prevent ash dam discharges to the outlet canal or additional cooling water pumps.

4. Conclusions

The following conclusions are drawn from the modelling predictions for the proposed dense phase operation:

- The ash dam water inflow management is expected to reduce water releases to the cooling water outlet canal to less than 5 ML/day during the pond infilling period and to less than 4 ML/day after the minimum size is reached;
- Internal losses of selenium concentrations in the pond by physiochemical and biological activity was estimated to be about 80 to over 90%;
- Reduction of the ash pond size and accumulation of selenium by the ash slurry processes is expected to give minor concentration increases in the cooling water outlet with four cooling water pumps in service. Management of the discharges may be required with less pumps in service;
- Selenium mass emissions to Lake Macquarie, from the beginning of dense phase operation until the minimum pond size, was predicted to be lower than during the current operation. Use of the pond for an additional five years may give emissions about 30% lower than the average observed during the current operations due to increased ash sales resulting in less selenium input to the ash dam.

5. Recommendations

The ash dam selenium modelling raised several issues, so the following recommendations are made:

- Measure the rate of evaporation from ash deposits and reassess the water balance of the ash dam;
- Confirm the model predictions by comparison with the monitored selenium concentrations;
- Selenium measurements at the cooling water inlet and outlet be undertaken at a detection limit similar to that expected by the increase due to the ash dam discharges;
- Confirm the selenium loss rates from the pond water after beginning of the proposed dense phase system.

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Eraring Ash Dam: Probable Maximum Flood Study

Eraring Energy

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Executive Summary

This report provides an analysis of the flood handling capacity of Eraring Ash Dam near Dora Creek, NSW.

A calibrated hydrological model, RORB, was used to estimate the inflow and outflow hydrographs for two storage scenarios. Scenario 1 investigated the current storage and scenario 2 investigated the storage of the dam after 20 years, assuming the adoption of dense phase ash deposition. A range of design storm durations were analysed for annual exceedance probabilities up to the Probable Maximum Precipitation (PMP).

For the Eraring Ash Dam, the following PMF results have been determined:

	Scenario 1	Scenario 2
Item	Current Storage 2007 Estimate	Storage after 20 years
1. PMP Depth	1240 mm	840 mm
2. PMF Inflow	36 m³/s	63 m³/s
3. PMF Outflow	14 m³/s	25 m³/s
4. Critical Duration	36 hours	12 hours
5. Max. Flood Level	RL 128.1 m	RL 128.7 m

For scenario 1, the current (2007) estimated maximum flood level, of RL 128.1 m is 1.9 m below the lowest point of the east side embankment (RL = 130.0 m) and hence the main dam would not be subject to overtopping during a PMF event.

For scenario 2, the proposed storage of the dam after 20 years, the estimated maximum flood level, of RL 128.7 m is 1.3 m below the lowest point of the east side embankment (RL = 130.0 m) and hence the main dam would not be subject to overtopping during a PMF event.

Since Eraring Ash Dam is currently classified in the “Significant” incremental flood hazard category, its spillway is required to pass a flood of 1 in 10,000 AEP. Based on the results of the study, it is concluded that the dam meets the DSC requirements for acceptable flood capacity, and there is currently no need for any spillway enhancement to accommodate additional flood capacity.

The study has also demonstrated that the spillway level can be raised by at least one metre to provide additional pond volume for operational controls, without the need for any spillway modifications. Although no spillway modifications will be required, additional works will be needed at the siphon spillway pond to minimise the escape of floating ash from the dam, if the operating level is raised.

This report makes several recommendations for Eraring Ash Dam as follows:

1. It is recommended that Stage 4 of the Eraring Ash Dam Future Ash Disposal study be undertaken. This study will investigate the works required to allow the operating level to be raised by one metre in the future, and will provide design drawings suitable for construction of the spillway raising and any other necessary works.

2. The flow capacity of the spillway chute is outside of the scope of this study. Further future investigations may be required to determine whether the current chute design will pass the

estimated flood peaks without overtopping the chute walls and threatening the security of the dam.

3. This study has been based on the current disposal strategy, which provides for dense phase disposal at three discharge points on the northern side of the storage, which will mound ash up to RL 140 m. Should the strategy change significantly in the future, it is recommended that the results of scenario 2 be revised to reflect any differences in the flood storage characteristics of the storage.

Table of Contents

Table of Contents (con't)

PLATES

FIGURES

TABLES

1. Introduction

As part of a review of future ash disposal options, Eraring Energy commissioned Connell Wagner to investigate of the flood handling capacity of Eraring Ash Dam near Dora Creek, NSW.

Eraring Ash Dam is a 25 m high zoned earthfill embankment, with a crest level which slopes from RL 129.0 m at the eastern end to RL 137.2 at the western end. As part of the dam has been capped, the lower point of the storage perimeter is at RL 130 m on the eastern side adjacent to the Capped Area C.

The spillway comprises an uncontrolled concrete chute with an Ogee Crest at RL 126.61 m. This is complemented by a siphon outlet works which acts as a service spillway for discharge of decant water and normal catchment runoff.

A computer based hydrological model (RORB, two scenarios), was established to determine the inflow hydrographs, outflow hydrographs and the peak flood level at the dam spillway for all design storm durations. Storms with Average Recurrence Interval (ARI) of 50 years and 100 years and with Annual Exceedance Probability (AEP) up to the Probable Maximum Precipitation (PMP) were analysed.

Using the models for different storm durations and frequencies enables estimation of the critical storm duration for ARI of 50 years, 100 years and the PMF, as well as the peak flood level within the dam storage. This data is then used to determine for both scenarios, whether the dam has an acceptable flood capacity (AFC) based on the requirement of the NSW Dam Safety Committee (DSC).

2. Flood Hydrology

The Eraring Ash Dam is located about 4 km north east of Dora Creek town on the Central Coast, NSW. The catchment is an approximate rectangle shape, occupying an area of 2.2 km^2 in total as shown in Figure 1.

The catchment is partially cleared with moderate to steep wooded slopes on the northern side. Eraring Ash Dam reservoir at full supply level occupies 50% of the catchment area. Areas below the spillway crest level of RL = 126.61 m were assumed in the hydrological (RORB) model to be water filled storage at the start of the PMP event.

Adopting the terminology recommended by the Dam Safety Committee (also Ref. 3), two probability terms will be used in this document. The Average Recurrence Interval (ARI) will be used for floods up to ARI of 100 years and the Annual Exceedance Probability (AEP) will be used for large floods such as Probable Maximum Flood (PMF) and Dam Crest Flood (DCF).

2.1 RORB Model Calibration

The RORB model used in this study is a runoff routing model using a conceptual non-linear storage relation of the format:

$$S = k_c Q^m$$

The parameters 'k_c' and 'm' are unique for a specific catchment, and using a recorded flood event, it is possible to estimate them for a given catchment.

2.1.1 'm' Parameter

The parameter 'm' is a measure of the catchment's non-linearity and one value is used for the whole catchment. Recent experience with runoff - routing models has led to the adoption of an average 'm' value of 0.8 for many catchments in NSW. This recommendation has been followed and a value of 'm' = 0.8 has been adopted for the Eraring Ash Dam model.

2.1.2 'k_c' Parameter

Usually for ungauged catchments, Australian Rainfall and Runoff (ARR, Ref. 3) suggests three general types of approach to estimate the k_c parameter.

i) subjective estimation based on physical considerations which includes approximation (may not be suitable for all catchments).
ii) regional relationships where the model parameter k_c has been derived for several broad regions of Australia.
iii) estimation of parameter k_c using historical rainfall and flood data.

For eastern regions of New South Wales, Kleemola (1987) derived a regional relationship based on data from 29 catchments east of the Great Dividing Range. It is also applicable for catchments on the tablelands and upper western slopes.

The regional relationship for k_c is (for a value of m = 0.80) as follows:

$$k_{c\ \text{Eraring Ash Dam}} = 1.22\ A^{0.46}$$
$$= 1.22 \times (2.2)^{0.46} = 1.75$$

Where A = 2.2 km^2 = Eraring Ash Dam catchment area.

A summary of calculated k_c parameters is included in Table 2.1, for the purpose of this report a k_c value of 1.75 will be adopted for use with RORB model applied to the Eraring Ash Dam catchment.

Table 2.1: RORB PARAMETER VALUES

Method	k_c	m
Regional Formula	1.75	0.8

Adopted losses for the PMF, 50 year and 100 year ARI floods are 0 mm initial loss and 1 mm/h continuing loss.

2.2 Probable Maximum Precipitation (PMP)

Probable Maximum Precipitation (PMP) is defined by the World Meteorological Organisation (WMO) as the theoretically greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular location at a certain time of the year.

The estimation of PMP has developed from "insitu maximisation" methods through "storm transposition" to the current "generalised methods". Early estimates of PMP in Australia (1950's to 1970's) were based on insitu maximisation and during the late 1960's and early 1970's the storm transposition method was gradually introduced. The generalised methods of estimating PMP have gradually been developed for various parts of Australia and were introduced from the mid-1970's onward.

Until recently the Bulletin 51 method was applicable for short storm durations (up to 6 hours) and was suitable for catchments less than 1000 km^2 anywhere in Australia. This method is based upon adjusted United States depth - duration - area rainfall data. The method has been recently updated to Generalised Short–Duration Method, June 2003 (Reference 4). Final generalised Probable Maximum Precipitation (PMP) design rainfall depths for short storm durations up to 6 hours were estimated using Generalised Short–Duration Method, June 2003 for Eraring Ash Dam catchment, (PMP) design rainfall depths for long storm durations up to 96 hours were estimated using Generalised Southeast Australia Method, October 2006 (see Table 2.2).

Table 2.2: PROBABLE MAXIMUM PRECIPITATION DEPTHS

Method of Estimation	***Storm Duration* (hours)**	**Total Rainfall Depth (mm)**
Generalised Short–Duration Method, June 2003, Reference 4	1 2 3 4.5 6	370 460 520 590 640
Generalised Southeast Australia Method, October 2006, Reference 13	12 24 36 48 72 96	840 1110 1240 1310 1370 1420

2.2.1 Temporal and Areal Patterns

For areas less than 1000 km^2 and duration up to 6 hours the Generalised Short–Duration Method, June 2003 (Reference 4) gives a standard temporal pattern as a mass curve for PMP, Figure 2. Temporal patterns for long durations were derived as recommended in Reference 13.

The design temporal patterns of Probable Maximum Precipitation for short and long durations are listed in Table 2.3 (a) and Table 2.3 (b).

The Generalised Short–Duration Method, June 2003 gives isohyet maps (areal patterns) for PMP of short duration.

Previous RORB modelling of the Liddell Main Cooling Water Dam for both uniform and non-uniform areal patterns gave results of negligible difference. Eraring Ash Dam has a smaller catchment and a similar analysis to this degree of complexity would produce comparable results. Hence, as an approximation, a uniform areal distribution was also adopted for the purposes of this report.

TABLE - 2.3 (a)
Eraring Ash Dam Catchment
Probable Maximum Precipitation - Temporal Patterns - Short Durations

Percentage of storm duration %	Percentage of total rainfall %	Time increment percentage %	Rainfall increment percentage %	Increment number	Rainfall depths in mm within time increment				
					1-hour PMP (mm)	2-hour PMP (mm)	3-hour PMP (mm)	4.5hour PMP (mm)	6-hour PMP (mm)
				Time increment (hours)	0.100	0.200	0.300	0.450	0.600
0	0								
		10	10	1	37.00	46.00	52.00	59.00	64.00
10	10								
		10	15	2	55.50	69.00	78.00	88.50	96.00
20	25								
		10	14	3	51.80	64.40	72.80	82.60	89.60
30	39								
		10	13	4	48.10	59.80	67.60	76.70	83.20
40	52								
		10	12	5	44.40	55.20	62.40	70.80	76.80
50	64								
		10	11	6	40.70	50.60	57.20	64.90	70.40
60	75								
		10	10	7	37.00	46.00	52.00	59.00	64.00
70	85								
		10	7	8	25.90	32.20	36.40	41.30	44.80
80	92								
		10	5	9	18.50	23.00	26.00	29.50	32.00
90	97								
		10	3	10	11.10	13.80	15.60	17.70	19.20
100	100								
				Total	**370**	**460**	**520**	**590**	**640**

TABLE - 2.3 (b)
Eraring Ash Dam Catchment
Probable Maximum Precipitation
Temporal Patterns For Long Duration(1) - Total Catchment, Uniform Spatial Distribution
Generalised Southeast Australia Method (GSAM - Coastal Zone)

Temporal Patterns For 12-Hour Duration(2)

Increment No.	Time	Time Cumulative	Rainfall Increment	Rainfall depths within time increment
	hour	%	%	mm
Time increment = 1.5 hours				
	0	0.00		
1	1.5	12.50	5.74	48
2	3	25.00	8.74	73
3	4.5	37.50	14.21	119
4	6	50.00	20.04	168
5	7.5	62.50	16.94	142
6	9	75.00	14.89	125
7	10.5	87.50	11.15	94
8	12	100.00	8.29	70
		Total	100	840

Temporal Patterns For 24-Hour Duration

Increment No.	Time	Time Cumulative	Rainfall Increment	Rainfall depths within time increment
	hour	%	%	mm
Time increment = 3 hours				
	0	0.00		
1	3	12.50	5.74	64
2	6	25.00	8.74	97
3	9	37.50	14.21	158
4	12	50.00	20.04	222
5	15	62.50	16.94	188
6	18	75.00	14.89	165
7	21	87.50	11.15	124
8	24	100.00	8.29	92
		Total	100	1110

Temporal Patterns For 36-Hour Duration(3)

Increment No.	Time	Time Cumulative	Rainfall Increment	Rainfall depths within time increment
	hour	%	%	mm
Time increment = 3 hours				
	0	0.00		
1	3	8.33	2.81	35
2	6	16.67	4.99	62
3	9	25.00	7.32	91
4	12	33.33	9.22	114
5	15	41.67	9.53	118
6	18	50.00	9.09	113
7	21	58.33	8.54	106
8	24	66.67	14.67	182
9	27	75.00	12.10	150
10	30	83.33	8.62	107
11	33	91.67	9.94	123
12	36	100.00	3.17	39
		Total	100	1240

Temporal Patterns For 48-Hour Duration

Increment No.	Time	Time Cumulative	Rainfall Increment	Rainfall depths within time increment
	hour	%	%	mm
Time increment = 3 hours				
	0	0.00		
1	3	6.25	1.54	20
2	6	12.50	2.97	39
3	9	18.75	3.92	51
4	12	25.00	5.54	73
5	15	31.25	8.70	114
6	18	37.50	10.61	139
7	21	43.75	13.87	182
8	24	50.00	9.45	124
9	27	56.25	6.62	87
10	30	62.50	6.39	84
11	33	68.75	8.04	105
12	36	75.00	7.76	102
13	39	81.25	5.39	71
14	42	87.50	4.60	60
15	45	93.75	3.43	45
16	48	100.00	1.17	15
		Total	100	1310

Temporal Patterns For 72-Hour Duration

Increment No.	Time	Time Cumulative	Rainfall Increment	Rainfall depths within time increment
	hour	%	%	mm
Time increment = 3 hours				
	0	0.00		
1	3	4.17	0.85	12
2	6	8.33	1.70	23
3	9	12.50	2.75	38
4	12	16.67	2.99	41
5	15	20.83	2.22	30
6	18	25.00	3.67	50
7	21	29.17	5.42	74
8	24	33.33	6.64	91
9	27	37.50	9.25	127
10	30	41.67	11.46	157
11	33	45.83	7.99	109
12	36	50.00	6.95	95
13	39	54.17	6.77	93
14	42	58.33	4.65	64
15	45	62.50	4.40	60
16	48	66.67	5.22	72
17	51	70.83	4.05	55
18	54	75.00	2.93	40
19	57	79.17	2.17	30
20	60	83.33	1.81	25
21	63	87.50	1.48	20
22	66	91.67	1.79	25
23	69	95.83	1.84	25
24	72	100.00	1.00	14
		Total	100	1370

Temporal Patterns For 96-Hour Duration

Increment No.	Time	Time Cumulative	Rainfall Increment	Rainfall depths within time increment
	hour	%	%	mm
Time increment = 3 hours				
	0	0.00		
1	3	3.13	0.79	11
2	6	6.25	0.91	13
3	9	9.38	1.12	16
4	12	12.50	1.49	21
5	15	15.63	1.67	24
6	18	18.75	1.16	16
7	21	21.88	0.88	12
8	24	25.00	1.99	28
9	27	28.13	3.85	55
10	30	31.25	5.05	72
11	33	34.38	6.74	96
12	36	37.50	7.05	100
13	39	40.63	6.43	91
14	42	43.75	5.25	75
15	45	46.88	4.26	60
16	48	50.00	4.62	66
17	51	53.13	5.32	76
18	54	56.25	4.94	70
19	57	59.38	4.17	59
20	60	62.50	4.73	67
21	63	65.63	5.77	82
22	66	68.75	5.12	73
23	69	71.88	3.54	50
24	72	75.00	2.79	40
25	75	78.13	2.22	32
26	78	81.25	1.63	23
27	81	84.38	0.88	12
28	84	87.50	0.57	8
29	87	90.63	1.11	16
30	90	93.75	1.56	22
31	93	96.88	1.36	19
32	96	100.00	1.03	15
		Total	100	1420

(1) - Since Eraring Ash Dam catchment lies approximately on the deviding line between GSAM-GTSMR Costal Treansition Zone and GSAM Coastal Zone. Eraring Ash Dam is a small catchment, GSAM Coastal Zone can be adopted approximately to estimate the PMP of long duration.

2.3 RORB Modelling of the Catchment

2.3.1 Modelling of the Catchment Storage

The estimation of a flood hydrograph by runoff-routing involves the routing of rainfall excess through a hydrological model representing the catchment. The catchment storage is the total volume of water on the surface of the catchment and in transit to the outlet. This catchment storage is located throughout the catchment, comprising the main stream, the tributary channels, the drainage lines that feed into the channels and the minor amount of storage in overland flow across the catchment surface.

Catchment storage is thus highly distributed in space, and the methods used in runoff routing to model the distributed nature of storage are various. RORB is a versatile runoff and streamflow routing model used for calculating flood inflow and outflow hydrographs from rainfall and other channel inputs. The model conforms to DSC requirements which specify the use of runoff routing models for flood estimations.

The Eraring Ash Dam hydrological RORB model, shown in Figure 3 (a) - Scenario 1 and Figure 3 (b) - Scenario 2 were prepared in the following manner:

i) Based on the major tributary network, the catchment was divided into 9 subcatchments;

ii) model “node” was placed at points selected as follows:

- in each sub-catchment as a point on the main stream adjacent to its centroid, being the point at which rainfall excess is input to the sub-area,
- at each confluence of streams from different sub-catchments;
- immediately downstream of the dam storage.

iii) The catchment is represented by a series of non-linear concentrated storages with storages placed between adjacent nodes on the streamlines.

The sequence of model operation commences with the deduction of losses from rainfall. The loss model adopted consisted of an initial loss followed by a continuing loss. Along a typical main stream length routing of the rainfall excess to model the streamflow commences by modelling the sub-area and then routing the hydrograph through the reach, storing the routed hydrograph and adding to it the inputs from other sub-areas. This process proceeds downstream until the confluence is reached with other main streams and finally the reservoir surface.

2.3.2 Modelling of the Dam Reservoir

The Nominal full storage level in the dam is RL = 126.61 m. This level is controlled by an Ogee crest spillway of 4m width. The spillway flows directly to a rectangular channel/chute on the right-hand side of the dam abutment, which reduces in width from 4 m to 2 m.

Two RORB models were established to investigate the flood handling capacity of the spillway. RORB Model 1 with the current flood storage capacity (scenario1) and RORB Model 2 with future flood storage capacity left in the dam after 20 years of operation (scenario 2) assuming ash counters predicted for the future dense phase as deposits.

For the purposes of the RORB model the storage level was assumed to be at full supply level of RL = 126.61 m at the commencement of the PMP event and all other events (both scenarios).

In addition, during the PMP event, zero discharge was assumed via the outlet siphon pipe on the basis that this outlet has limited capacity and may become blocked during large flood events.

The RORB model was run for the available storage (for both scenario) above RL = 126.61 m to determine the critical storm event in terms of the peak reservoir storage level.

To route the flood hydrograph through the storage it is necessary to define the relation between discharge from the reservoir and the reservoir storage above the flood spillway level otherwise known as the flood storage. For Eraring Ash Dam the spillway discharge - elevation relationship, (Figure 5), was determined from the Ogee crest weir formula with a coefficient of 2.05 (reference 1) and verified with original design discharge curve.

The flood storage - elevation, Figure 4 (a) - Scenario 1 and Figure 4 (b) - Scenario 2, were measured directly from the catchment drawing No.VS006 (Figure 16). The storage - discharge relation for the RORB model, Table 2.4(a) - Scenario 1, and Table 2.4(b) - Scenario 2 were then derived by relating both the discharge and storage to the elevation. This enables the final routing of the flood through the dam spillway to establish the peak flood elevation that occurs in the reservoir

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Table 2.4 (a)

Eraring Ash Dam
Flood Storage - Discharge Table
Scenario 1 (Current Storage)

Elevation RL (m)	Head (m)	Flood Storage Above RL 126.61 m (m^3)	Discharge (m^3/sec)
126.61	0.06	0	0
126.81	0.26		1
127.06	0.51		3
127.31	0.76		5
127.56	1.01		8
127.81	1.26		12
128.06	1.51		15
128.31	1.76		19
128.56	2.01		23
128.81	2.26		28
129.06	2.51		33
129.31	2.76		38
129.56	3.01		43
129.81	3.26		48
130.06	3.51	4,361,000	54
130.31	3.76		60
130.56	4.01		66
130.81	4.26		72
131.06	4.51		79
131.31	4.76		85
135.00	8.45	12,211,000	201

Notes:
1. Zero discharge assumed via outlet siphon pipe
2. Nominal Eraring Ash Dam Crest Level RL = 135.0 m
3. Flood Spillway Crest Level RL = 126.61 m

Table 2.4 (b)

Eraring Ash Dam
Flood Storage - Discharge Table
Scenario 2 (Storage after 20 Years)

Elevation RL (m)	Head (m)	Flood Storage Above RL 126.61 m (m^3)	Discharge (m^3/sec)
126.61	0.06	0	0
126.81	0.26		1
127.06	0.51		3
127.31	0.76		5
127.56	1.01		8
127.81	1.26		12
128.06	1.51		15
128.31	1.76		19
128.56	2.01		23
128.81	2.26		28
129.06	2.51		33
129.31	2.76		38
129.56	3.01		43
129.81	3.26		48
130.06	3.51	2,045,000	54
130.31	3.76		60
130.56	4.01		66
130.81	4.26		72
131.06	4.51		79
131.31	4.76		85
135.00	8.45	7,330,000	201

Notes:
1. Zero discharge assumed via outlet siphon pipe
2. Nominal Eraring Ash Dam Crest Level RL = 135.0 m
3. Flood Spillway Crest Level RL = 126.61 m

2.4 Estimation of Probable Maximum Flood (PMF)

Estimation of the Probable Maximum Flood (PMF) required modelling of Probable Maximum Precipitation design storms of different durations. Losses adopted were 0 mm initial loss and 1 mm / h continuing loss. Routing of the rainfall excess using the calibrated RORB model for design storms of duration from 1 hour to 96 hours was undertaken using the temporal and uniform spatial patterns discussed in Section 2.2.1.

Modelling of Probable Maximum Precipitation of different durations normally results in a single critical duration, which gives the largest peak flood (highest flood peak level assuming infinitely high embankment). For Eraring Ash Dam, the results of RORB catchment model are given in Table 2.5 (a) scenario 1 and Table 2.5 (b) scenario 2.

Table 2.5 (a)
Eraring Ash Dam
PROBABLE MAXIMUM FLOOD (PMF)
ESTIMATED FLOOD PEAKS
Scenario 1 (Current Storage)

Design Storm Duration (hours)	Estimated Peak Inflow (m³/s)	Estimated Peak Outflow (m³/s)	Estimated Peak Flood Storage (above RL = 126.61 m) x 10^6 (m³)	Estimated Peak Elevation (m)
1 hrs	304	4	0.775	127.2
2 hrs	204	6	0.978	127.4
3 hrs	157	7	1.080	127.5
4.5 hrs	121	8	1.210	127.6
6 hrs	100	9	1.300	127.6
12 hrs	67	11	1.570	127.9
24 hrs	44	14	1.790	128.0
36 hrs	**36**	**14**	**1.830**	**128.1**
48 hrs	36	13	1.700	128.0
72 hrs	31	11	1.560	127.8
96 hrs	20	11	1.490	127.8

Table 2.5 (b)
Eraring Ash Dam
PROBABLE MAXIMUM FLOOD (PMF)
ESTIMATED FLOOD PEAKS
Scenario 2 (Storage after 20 years)

Design Storm Duration (hours)	Estimated Peak Inflow (m³/s)	Estimated Peak Outflow (m³/s)	Estimated Peak Flood Storage (above RL = 126.61 m) x 10^6 (m³)	Estimated Peak Elevation (m)
1 hrs	211	11	0.713	127.8
2 hrs	169	15	0.893	128.1
3 hrs	140	17	0.980	128.3
4.5 hrs	113	20	1.070	128.4
6 hrs	95	21	1.120	128.5
12 hrs	**63**	**25**	**1.250**	**128.7**
24 hrs	43	25	1.240	128.7
36 hrs	33	23	1.170	128.6
48 hrs	35	19	1.030	128.4
72 hrs	31	18	0.988	128.3
96 hrs	20	14	0.828	128.0

Notes:

Nominal Minimum Dam Crest Level (RL)	= 135.0 m
Nominal Spillway Crest (RL)	= 126.61 m
Current Nominal Spillway Top of Wall Level (RL)	= 129.50 m

For scenario 1 (current storage), the most critical single storm duration, which produces the highest peak flood level in the storage, is the 36-hour PMP storm. The estimated peak inflow and outflow were, approximately, 36 m^3/s and 14 m^3/s respectively, as shown in Table 2.5 (a).

The results for the critical PMP storm indicate that the peak flood level of RL = 128.1 m is about 6.9 m below dam-embankment crest level of 135 m and is about 1.9 m below eastern dam-embankment minimum crest level of 130.0 m .

For scenario 2 (storage after 20 years), the most critical single storm duration, which produces the highest peak flood level in the storage, is the 12-hour PMP storm. The estimated peak inflow and outflow were, approximately, 63 m^3/s and 25 m^3/s respectively, as shown in Table 2.5 (b).

The results for the critical PMP storm indicate that the peak flood level of RL = 128.7 m is about 6.3 m below dam-embankment crest level of 135 m and is about 1.3 m below eastern dam-embankment minimum crest level of 130.0 m .

Figure 6 (a) and Figure 6 (b) show a plot of inflow and outflow hydrographs for the critical modelled PMP storms of 36 hours duration and 12 hours duration. Figure 7 (a) and Figure 7 (b) show a plot of the rainfall excess and the outflow hydrograph for the same storms. Further details are presented in Appendix 1, which includes the RORB input file (data file) and output file for the critical PMP design storm for scenario 1.

2.5 Dam Crest Flood (DCF) & Imminent Failure Flood (IFF)

The Dam Crest Flood (DCF) is defined as the flood event which, when routed through the reservoir, results in a still water level in the reservoir, excluding a wave effect that corresponds to the lowest point of the eastern embankment crest (130 m, nominal).

The term “Dam Crest Flood (DCF)” replaces the 1986 ANCOLD Guidelines term “Imminent Failure Flood (IFF)” which was not strictly correct and inconsistent in application. For example, IFF implies that the dam will fail as soon as overtopped, which may not necessarily be the case.

The Dam Crest Flood (DCF) for Eraring Ash Dam needs an event rarer (smaller probability) than the PMP event to be routed through the dam reservoir. The DCF event has a peak level of RL = 130.0 m and a resulting peak outflow of 51 m^3/s.

2.6 Estimation of the 50 Year and 100 Year ARI Floods

For more frequent flood events the choice of method of flood estimation to be used in a particular application is an important aspect of the design process.

Reference 3 recommends using rainfall-based methods (such as calibrated routing model) for estimation of larger floods of probabilities up to the limits of the rainfall- based method (say 1 in 100 AEP). Since we are concerned in this study about large to extreme floods, the rainfall-based method will be adopted to estimate 1 in 50 and 1 in 100 AEP floods using the RORB model.

The design rainfall for different durations is listed in Table 2.6. For an ARI of 50 years and 100 years the flood events were estimated by the RORB runoff routing model for a range of durations.

Table 2.6

Eraring Ash Dam

DESIGN RAINFALL DEPTHS FOR ARI OF 50 YEARS AND 100 YEARS

Design storm duration (hours)	Areal Reduction Factor* 50 years	Areal Reduction Factor* 100 years	ARI of 50 years			ARI of 100 years		
			Rainfall Intensity (mm/h)	Total Rainfall Depth (mm)	Reduced Total Rainfall Depth (mm)	Rainfall Intensity (mm/h)	Total Rainfall Depth (mm)	Reduced Total Rainfall Depth (mm)
1	0.93	0.93	67.3	67	63	75.1	75	70
2	0.94	0.94	45.4	91	86	50.7	101	96
3	0.95	0.95	35.9	108	102	40.1	120	114
4.5	0.96	0.96	28.4	128	122	31.7	143	136
6	0.96	0.96	24.0	144	138	26.8	161	154
9	0.97	0.97	19.0	171	165	21.2	191	184
12	0.97	0.97	16.1	193	187	17.9	215	209
18	0.98	0.98	12.9	231	226	14.4	259	253
24	0.99	0.99	11.0	263	260	12.3	295	292
30	1.00	1.00	9.6	289	289	10.8	325	325
36	1.00	1.00	8.7	312	312	9.8	352	352
48	1.00	1.00	7.3	351	351	8.2	396	396
72	1.00	1.00	5.6	405	405	6.4	459	459

* As recommended in clause 8.2.1 of Australian Rainfall and Runoff, Book six, revised 1998.

An initial water level of RL = 126.61 m has been assumed which is equivalent to the nominal spillway level. Zero discharge has also been assumed via the outlet siphon pipe as for the PMF events. Results for the RORB modelling (scenario 1 and scenario 2) are shown in Tables 2.7(a), 2.7(b), 2.7(c) and 2.7(d).

The relevant temporal patterns are included in Table 3.2, of Reference 3, Volume II. Further details about temporal pattern calculation can be found in Appendix 2.

As recommended in clause 2.6.2, reference 3, the critical peak discharges, and rainfall duration should be taken from the peak of the smooth curve in Figure 9,10, 11 and 12 rather than from the largest calculated value in table 2.7(a), 2.7(b), 2.7(c) and 2.7(d)

For Scenario 1, the critical estimated outflows are 1.9 m^3/s for ARI of 50 years with a duration of 36 hours and 2.3 m^3/s for ARI of 100 years with a duration of 36 hours. The corresponding critical inflows for ARI of 50 years and ARI of 100 years are 13.9 m^3/s and 15.5 m^3/s respectively.

For Scenario 2, the critical estimated outflows are 4.0 m^3/s for ARI of 50 years with a duration of 30 hours and 4.7 m^3/s for ARI of 100 years with a duration of 30 hours. The corresponding critical inflows for ARI of 50 years and ARI of 100 years are 12.8 m^3/s and 14.4 m^3/s respectively.

Table 2.7 (a)
Eraring Ash Dam
ESTIMATED FLOOD PEAKS OF ARI OF 50 YEARS
Scenario1 (Current Storage)

Design Storm Duration (hour)	Estimated Peak Elevation Above Spillway Crest(1) (m)	Estimated Peak Outflow (m³/s)	Estimated Peak Flood Storage x 10^5 (m³)	Estimated Peak Inflow (m³/s)
1	0.11	0.32	1.43	81.79
1.5	0.13	0.42	1.70	85.96
2	0.15	0.50	1.91	85.29
3	0.18	0.62	2.24	50.54
4.5	0.21	0.81	2.71	46.79
6	0.23	0.91	2.91	35.18
9	0.27	1.13	3.36	30.88
12	0.29	1.31	3.73	32.02
18	0.33	1.55	4.16	20.82
24	0.36	1.77	4.53	20.70
30	0.37	1.86	4.70	14.61
36	0.38	1.92	4.80	13.88
48	0.37	1.88	4.73	15.50
72	0.39	2.01	4.96	12.39

Table 2.7 (b)
Eraring Ash Dam
ESTIMATED FLOOD PEAKS OF ARI OF 100 YEARS
Scenario1 (Current Storage)

Design Storm Duration (hour)	Estimated Peak Elevation Above Spillway Crest(1) (m)	Estimated Peak Outflow (m³/s)	Estimated Peak Flood Storage x 10^5 (m³)	Estimated Peak Inflow (m³/s)
1	0.13	0.38	1.59	91.74
1.5	0.15	0.49	1.89	95.98
2	0.17	0.58	2.13	95.17
3	0.20	0.72	2.51	56.67
4.5	0.23	0.92	2.92	51.35
6	0.26	1.08	3.25	39.35
9	0.30	1.33	3.77	34.57
12	0.33	1.56	4.17	35.90
18	0.37	1.84	4.66	23.27
24	0.40	2.09	5.10	23.10
30	0.42	2.22	5.30	16.36
36	0.43	2.30	5.41	15.48
48	0.42	2.24	5.33	17.30
72	0.44	2.41	5.58	13.96

(1) Spillway crest elevation RL = 126.61 m

Table 2.7 (c)
Eraring Ash Dam
ESTIMATED FLOOD PEAKS OF ARI OF 50 YEARS
Scenario 2 (Storage after 20 years)

Design Storm Duration (hour)	Estimated Peak Elevation Above Spillway Crest(1) (m)	Estimated Peak Outflow (m³/s)	Estimated Peak Flood Storage x 10^5 (m³)	Estimated Peak Inflow (m³/s)
1	0.22	0.88	1.33	45.26
1.5	0.27	1.14	1.59	48.66
2	0.30	1.34	1.78	45.83
3	0.35	1.70	2.08	32.74
4.5	0.40	2.10	2.40	32.26
6	0.45	2.44	2.64	26.58
9	0.51	2.96	3.01	25.03
12	0.55	3.38	3.28	25.36
18	0.57	3.56	3.40	16.39
24	0.60	3.84	3.58	17.58
30	0.62	4.02	3.69	12.78
36	0.62	3.97	3.65	12.17
48	0.61	3.90	3.62	14.61
72	0.55	3.35	3.27	10.63

Table 2.7 (d)
Eraring Ash Dam
ESTIMATED FLOOD PEAKS OF ARI OF 100 YEARS
Scenario 2 (Storage after 20 years)

Design Storm Duration (hour)	Estimated Peak Elevation Above Spillway Crest(1) (m)	Estimated Peak Outflow (m³/s)	Estimated Peak Flood Storage x 10^5 (m³)	Estimated Peak Inflow (m³/s)
1	0.25	1.04	1.48	51.02
1.5	0.30	1.33	1.76	54.62
2	0.34	1.60	1.99	51.43
3	0.39	2.01	2.32	36.96
4.5	0.45	2.49	2.68	36.40
6	0.50	2.86	2.94	29.91
9	0.57	3.49	3.35	28.17
12	0.62	3.96	3.65	28.52
18	0.64	4.17	3.78	18.39
24	0.67	4.51	3.98	19.69
30	0.69	4.72	4.11	14.36
36	0.69	4.66	4.07	13.62
48	0.68	4.59	4.03	16.36
72	0.61	3.94	3.64	12.03

(1) Spillway crest elevation RL = 126.61 m

2.7 Assigned Probabilities and Flood Frequency Curve

The critical PMP for Eraring Ash Dam catchment is the 36 hour storm (scenario 1) and 36 hour storm (scenario 2) as discussed in Section 2.4. The total rainfall depth is 1240 mm (scenario 1) and 840 mm (scenario 2).

Scenario 1, the resulting PMF estimated by RORB model will have inflow and outflow peak discharges of 36 m^3/s and 14 m^3/s, respectively.

Scenario 2, the resulting PMF estimated by RORB model will have inflow and outflow peak discharges of 63 m^3/s and 25 m^3/s, respectively.

Following the procedures in clause 3.5, Book VI of Reference 3 the assigned probability for the PMF has been assessed as 1 in 10^7 AEP as an inflow flood event. To determine the shape of the flood frequency curve, values of two intermediate probabilities were calculated for inflow and outflow flood events using procedures in clause 3.6.2, Book VI of Reference 3.

Scenario 1, the flood event with AEP of 1 in 2,000 has estimated inflow and outflow peaks of 36 m^3/s and 14 m^3/s respectively. The flood event 1 in 200,000 has estimated inflow and outflow peaks of 63 m^3/s and 25 m^3/s respectively.

Scenario 2, the flood event with AEP of 1 in 2,000 has estimated inflow and outflow peaks of 15 m^3/s and 9 m^3/s respectively. The flood event 1 in 200,000 has estimated inflow and outflow peaks of 32 m^3/s and 17 m^3/s respectively

Figure 8 (a) and Figure 8 (b) show the complete flood frequency curve for events from the 50 year ARI flood up to the PMF. Based on this curves, the DCF has an average exceedance probability (AEP) smaller than 1 in 10,000,000. A summary table of all floods estimated in this study is included as Table 2.8 (a) and Table 2.8 (b).

Table 2.8 (a)

Eraring Ash Dam
Summary Table For All Estimated Floods
Scenario 1 (Current Storage)

Flood Event	Annual Exceedance Probability Inflow event	Total Rainfall Depth (mm)	Peak Inflow (m³/s)	Peak outflow (m³/s)	Critical Duration (hours)	Peak Flood Level AHD (m)
50 year flood	1 in 50	312	14	2	36	127.0
100 year flood	1 in 100	352	15	2	36	127.0
1 in 2000 AEP flood	1 in 2,000	585	16	5	36	127.3
1 in 200,000 AEP flood	1 in 200,000	942	27	10	36	127.7
PMF	1 in 10,000,000	1240	36	14	36	128.1
DCF	smaller than 1 in 10,000,000	-	-	210	-	135.0

Notes:

- Spillway level (RL) = 126.61 m
- Initial storage level (RL) = 126.61 m
- Nominal Minimum Dam Embankment Crest Level (RL) = 135 m
- Zero discharge assumed via outlet syphon pipe

Table 2.8 (b)

Eraring Ash Dam
Summary Table For All Estimated Floods
Scenario 2 (Storage After 20 years)

Flood Event	Annual Exceedance Probability Inflow event	Total Rainfall Depth (mm)	Peak Inflow (m³/s)	Peak outflow (m³/s)	Critical Duration (hours)	Peak Flood Level AHD (m)
50 year flood	1 in 50	312	13	4	30	127.2
100 year flood	1 in 100	352	14	5	30	127.3
1 in 2000 AEP flood	1 in 2,000	585	15	9	36	127.7
1 in 200,000 AEP flood	1 in 200,000	942	32	17	24	128.2
PMF	1 in 10,000,000	1240	63	25	12	128.7
DCF	smaller than 1 in 10,000,000	-	-	210	-	135.0

Notes:

- Spillway level (RL) = 126.61 m
- Initial storage level (RL) = 126.61 m
- Nominal Minimum Dam Embankment Crest Level (RL) = 135 m
- Zero discharge assumed via outlet syphon pipe

3. Discussion

3.1 Acceptable flood capacity

The results of the scenario 1 study (current storage) have indicated that the peak PMF induced flood level for Eraring Ash Dam is RL=128.1 m and would occur during the critical PMP storm of 36 hours duration and 1240 mm of total rainfall. The lowest nominal crest level of the eastern dam embankment is RL =130 m, which is above the peak PMF induced flood level. Hence the main dam embankment will not be overtopped during a PMF event for scenario 1.

The results of scenario 2 (storage after 20 years) study have indicated that the peak PMF induced flood level for Eraring Ash Dam is RL=128.70 m and would occur during the critical PMP storm of 12 hours duration and 840 mm of total rainfall. The lowest nominal crest level of the eastern dam embankment is RL =130 m, which is above the peak PMF induced flood level. Hence the main dam embankment will not be overtopped during a PMF event for scenario 2.

The Eraring Ash Dam is currently classified in the "Significant" flood consequence category. Based on the requirements of the NSW Dam Safety Committee the acceptable flood capacity (AFC) for this category of dam is the flood of 1 in 10,000 average exceedance probability (AEP). For scenario 1, this corresponds to spillway outflow of 7 m^3/s and a flood rise of about 1 metre to RL 127.6 m AHD. For scenario 2, the flood rise is 1.2 metres to RL 127.8 m AHD and the outflow 11 m^3/s. Clearly, for both scenarios, the acceptable flood capacity is easily met with the current spillway arrangements and no remedial measures are required to enhance the flood capability.

3.2 Available Freeboard

The draft update (February 2002) of "DSC 11, Acceptable Flood Capacity for Dams" Table 5.2, requires 0.3 m of freeboard, over and above the AFC, for dams of "Significant" Flood Consequence Category (FCC). For Eraring Ash Dam, the low point on the storage perimeter is RL 130 m on the eastern side, adjacent to the capped Area C. In addition, the spillway approach channel has wing walls up to RL 129.5 m. Any flow above this level would possibly scour out the area alongside the spillway leading to undercutting and potential failure of the dam. Consequently, the maximum flood level plus flood freeboard should not exceed this level (RL 129.5 m).

Since the maximum flood level for the AFC for scenarios 1 and 2 is RL 127.6m and RL 127.8 m respectively, the AFC plus flood freeboard for the two scenarios is RL 127.9 and RL 128.1 m. Both of these levels are below the spillway wing wall level of RL 129.5 m, so that the DSC requirements for flood freeboard are satisfied with the current arrangement.

3.3 Future spillway raising

Ongoing disposal of ash in the storage will serve to reduce the decant pond volume in the dam. While this has been taken into account in the current flood capacity evaluation, it may be necessary in the future to increase the size of the decant pond to provide an acceptable water quality discharge to Lake Macquarie. One means of achieving this outcome would be to raise the operating level of the dam by up to 1 metre. If this occurs, it will be necessary to raise the spillway crest level by a similar amount to retain the existing flood storage capacity, and minimise the chance of any uncontrolled discharge to Crooked Creek.

Raising the spillway crest will serve to reduce its flood handling capacity, and hence the magnitude of the raising needs to be limited so as to ensure that the dam still meets the requirements of the DSC for AFC and available freeboard. Otherwise, remedial measure may be required to further enhance the flood capability.

A nominal spillway raising of 1 metre would produce a new spillway level of RL 127.6, and leave a freeboard of 1.9 metres to the spillway wall level of RL 129.5 m. For scenario 2, the flood rise produced by a flood equivalent to the AFC is 1.2 metres, which would leave a flood freeboard of 0.7 metres to the top of the spillway walls. Given that the required flood freeboard is 0.3 metres, this arrangement would still meet the

current DSC guidelines for flood freeboard. It is therefore concluded that raising the spillway crest will reduce the overall flood capability of the dam, but the reduction will not be sufficient to reduce the capacity below an acceptable level.

It should be noted that this assessment assumes the flood rise for the storage at RL 126.6 m is identical to the flood rise for a similar storm event with the storage at RL 127.6 m. This is a conservative assumption, since the flood storage volume would be greater at the higher storage level, and would lead to a lesser flood rise.

While the spillway level could be raised by at least one metre without the need for additional spillway arrangements, the accompanying one metre rise in the operating level will require additional works at the siphon spillway pond to minimise the escape of floating ash from the dam.

4. Conclusions and Recommendations

A calibrated hydrological model, RORB, was used to estimate the inflow and outflow hydrographs for two storage scenarios. Scenario 1 investigated the current storage and scenario 2 investigated the storage of the dam after 20 years, assuming the adoption of dense phase ash deposition. A range of design-storm durations were analysed for annual exceedance probabilities up to the Probable Maximum Flood (PMP).

For the Eraring Ash Dam, the following PMF results have been determined:

	Scenario 1	Scenario 2
Item	**Current Storage 2007 Estimate**	**Storage after 20 years**
1. PMP Depth	1240 mm	840 mm
2. PMF Inflow	36 m³/s	63 m³/s
3. PMF Outflow	14 m³/s	25 m³/s
4. Critical Duration	36 hours	12 hours
5. Max. Flood Level	RL 128.1 m	RL 128.7 m

Since Eraring Ash Dam is currently classified in the "Significant" incremental flood hazard category, its spillway is required to pass a flood of 1 in 10,000 AEP. The current study has demonstrated that the existing spillway can pass floods up to the PMF (and greater) without overtopping the embankment. This capacity has been confirmed for the dam in its current condition (scenario 1), as well as for conditions that are predicted to prevail in 20 years time, when the dense phase ash deposits have mounded up to RL 140 m (scenario 2). Consequently, it is concluded that the dam meets the DSC requirements for acceptable flood capacity, and there is currently no need for any spillway enhancement to accommodate additional flood capacity.

This study has been based on the current disposal strategy, which provides for dense phase disposal at three discharge points on the northern side of the storage, which will mound ash up to RL 140 m. Should the strategy change significantly in the future, it will be necessary to review the results of scenario 2 to reflect any differences in the flood storage characteristics of the storage.

The study has also demonstrated that the spillway level can be raised by at least one metre to provide additional pond volume for operational controls, without the need for any spillway modifications. Although no spillway modifications will be required, additional works will be needed at the siphon spillway pond to minimise the escape of floating ash from the dam, if the operating level is raised. It is recommended that Stage 4 of the Eraring Ash Dam Future Ash Disposal study be undertaken. This study will investigate the works required to allow the operating level to be raised by one metre, and will provide design drawings suitable for construction of the spillway raising and any other necessary works.

The flow capacity of the spillway chute is outside of the scope of this study. Further future investigations may be required to determine whether the current chute design will pass the estimated flood peaks without overtopping the chute walls and threatening the security of the dam.

5. References

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8. Detention Basin at A, B & C Capped Area – Drainage Report, 28 January 2004, Eraring Energy.

9. Colongra Creek Ash Dam, Review of Probable Maximum Flood, Delta Electricity, 13 December 2004, Reference 7028.6E.EC

10. Book VI (revised 1998), Estimation of Large to Extreme Floods, Australian Rainfall and Run-off – Volume 1 - R J Nathan and P E Weinman.

11. Eraring Ash Dam and Return Water Dam, Dam Safety Inspection Report (intermediate), Eraring Energy, 21 October, 2006, Reference 7514.01.

12. Generalised Probable Maximum Precipitation Estimation for the Catchments of the Eraring, Colongra Creek and Mannering Creek Ash Dams, Hydrological Advisory Service, April 1994.

13. Guide to estimation of Probable Maximum Precipitation: Generalised Southeast Australia Method, Version 1, October 2006, Australian Government, Bureau of Meteorology.

Plate 1 - Eraring Ash Dam

Plater 2 - Flood Outlet Spillway

Plate 3 - Flood Outlet Chute Looking Downstream

Figure 1
Eraring Ash Dam
Locality Plan

% of time	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
% of PMP	0	4	10	18	25	32	39	46	52	59	64	70	75	80	85	89	92	95	97	99	100

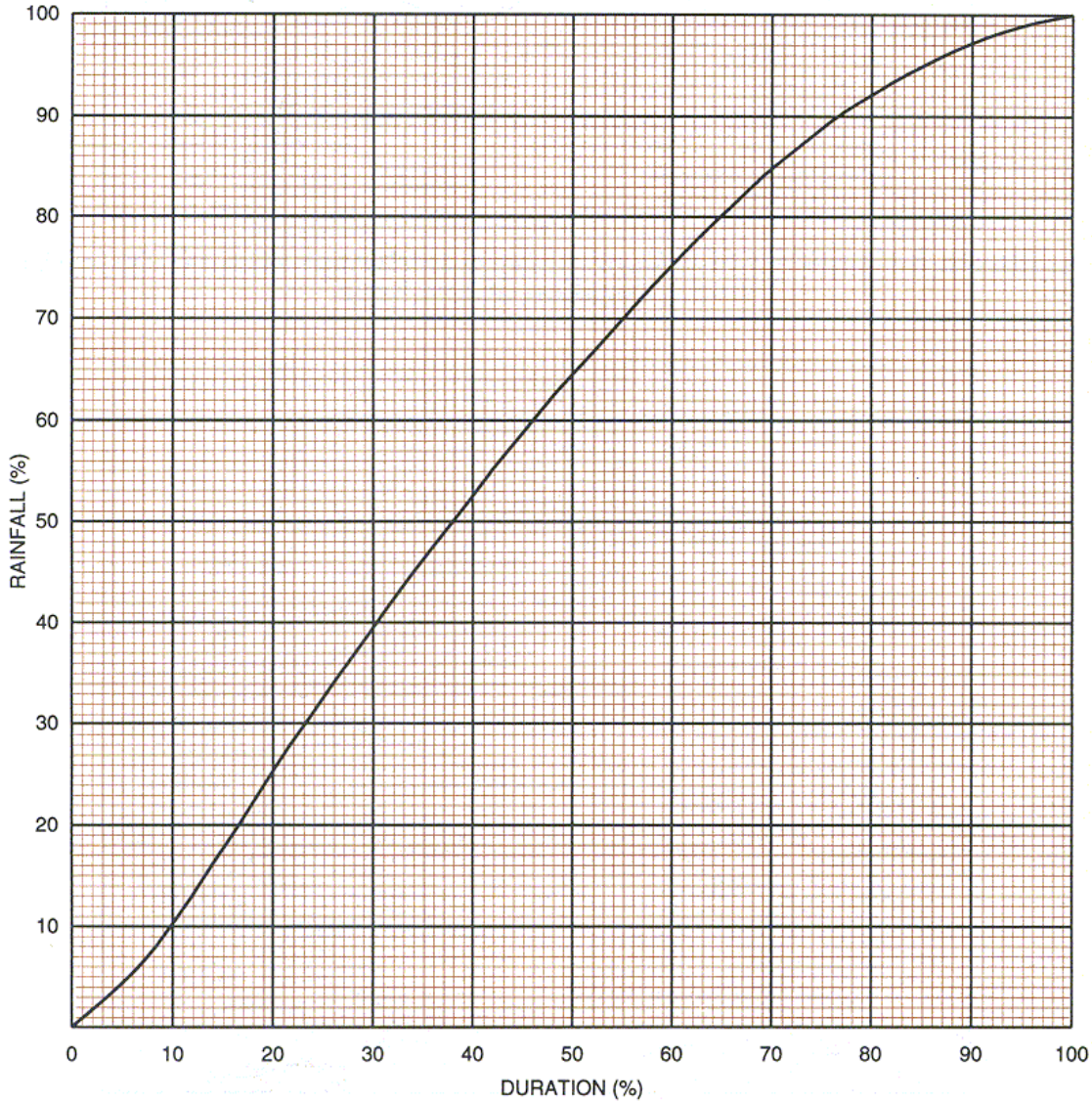


Figure 2 PMP Generalised Short –Duration Method temporal distribution.

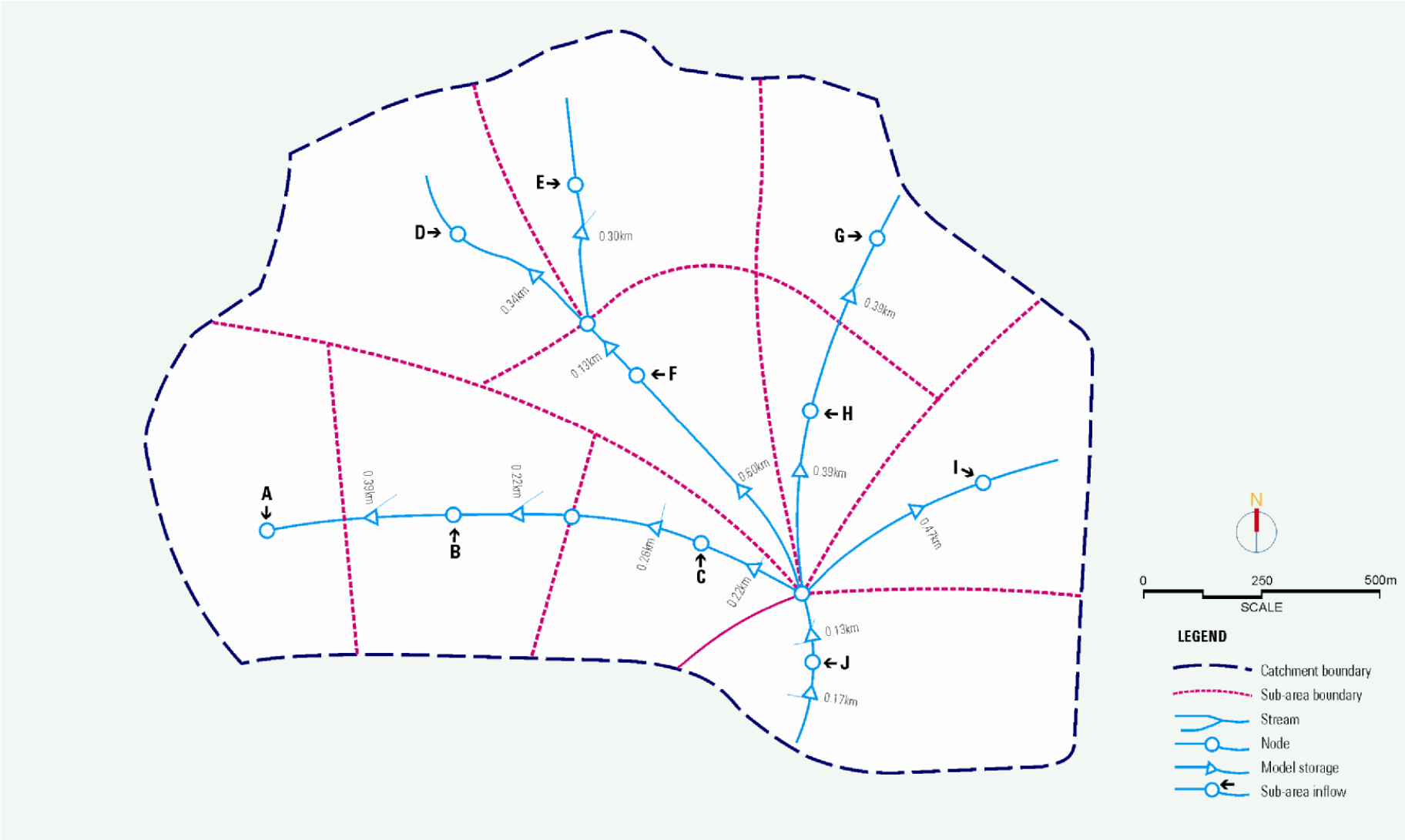


Figure 3 (a)
RORB Catchment Model - Scenario 1

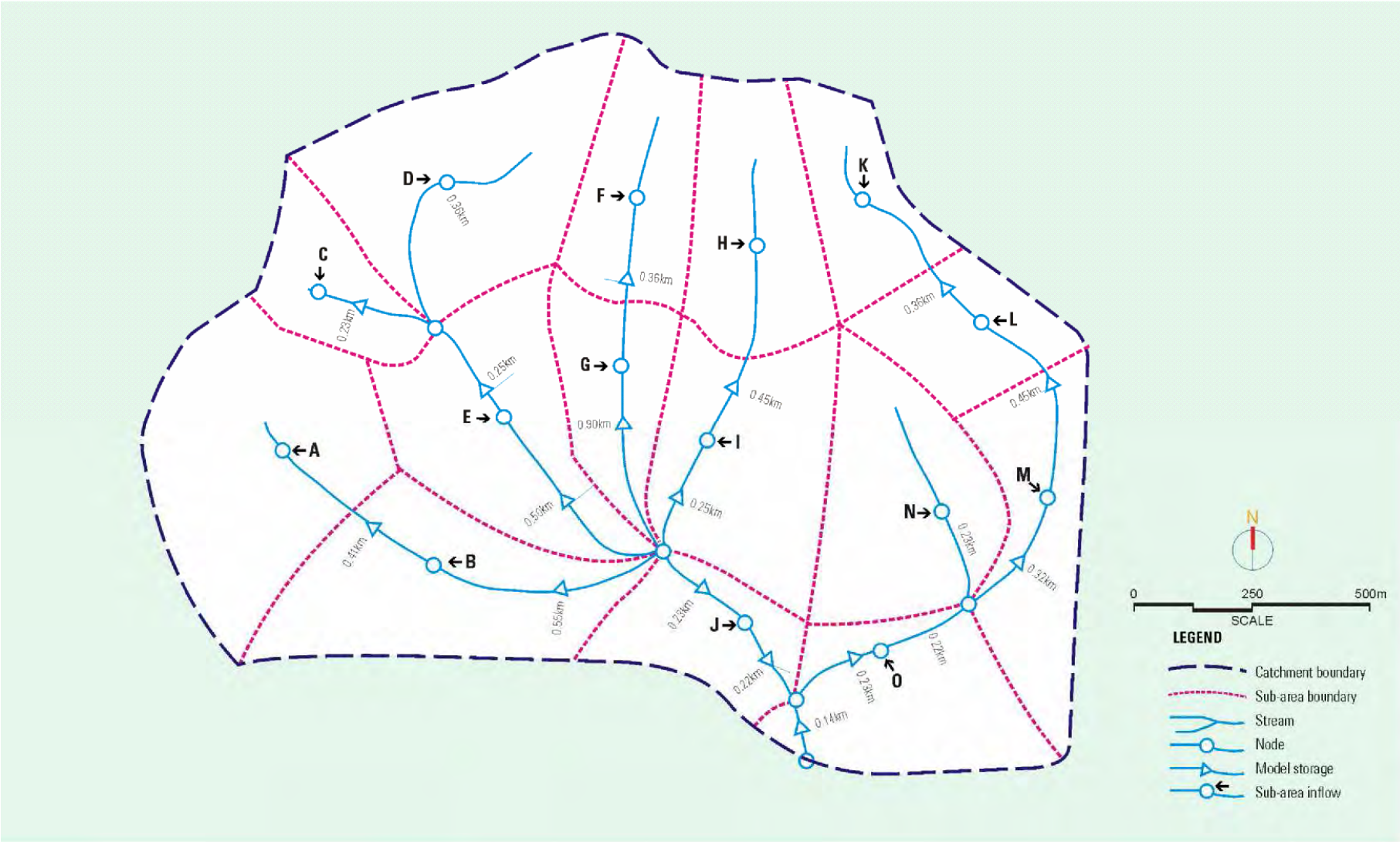


Figure 3 (b)
RORB Catchment Model - Scenario 2

Figure 4 (a) - Eraring Ash Dam
Flood Storage - Elevation Curve
Scenario 1 (Curent Storage)

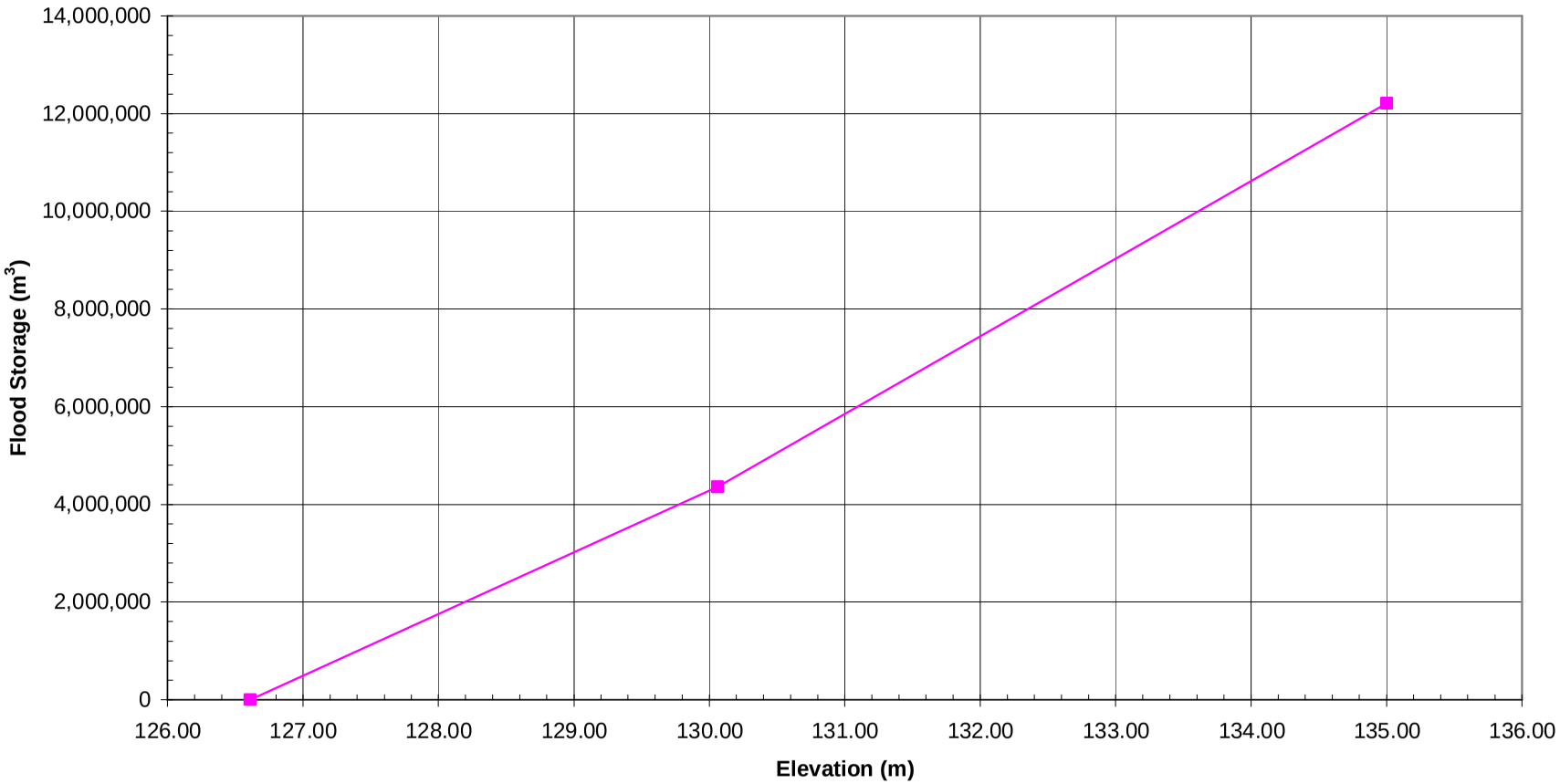


Figure 4 (b) - Eraring Ash Dam
Flood Storage - Elevation Curve
Scenario 2 (Storage after 20 years)

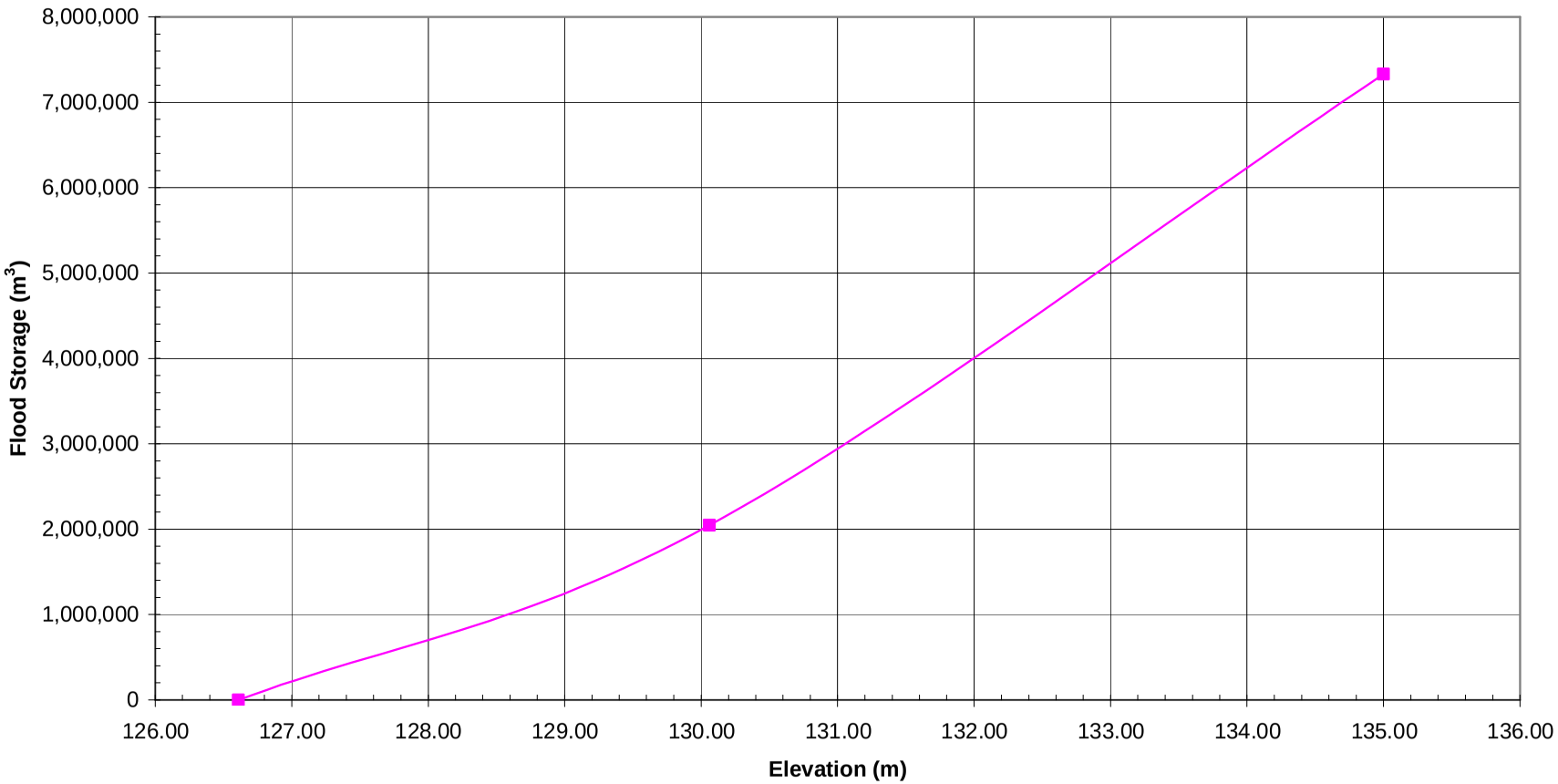
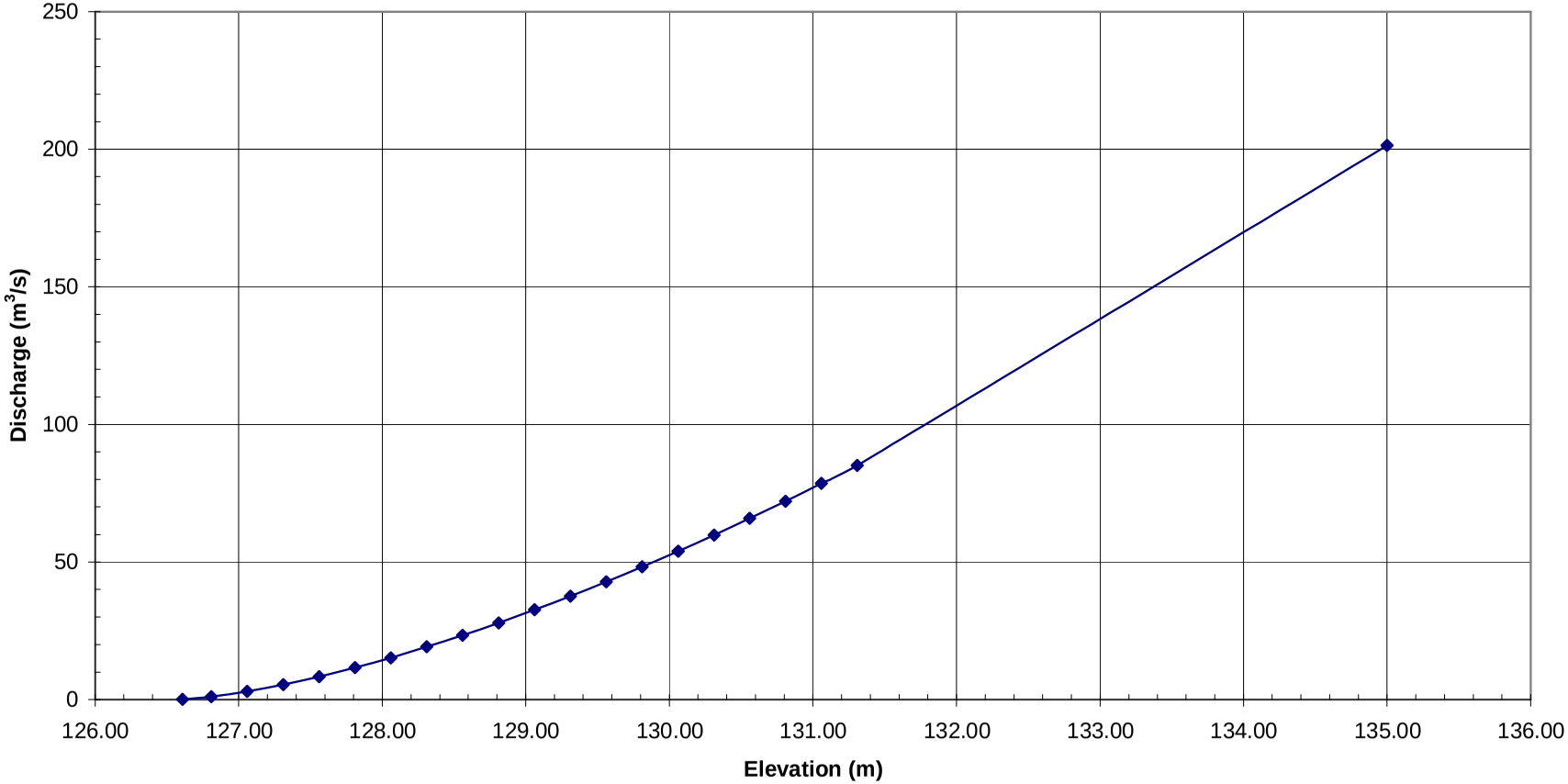


Figure 5 - Eraring Ash Dam
Spillway Discharge Elevation Curve
Scenario 1 & 2



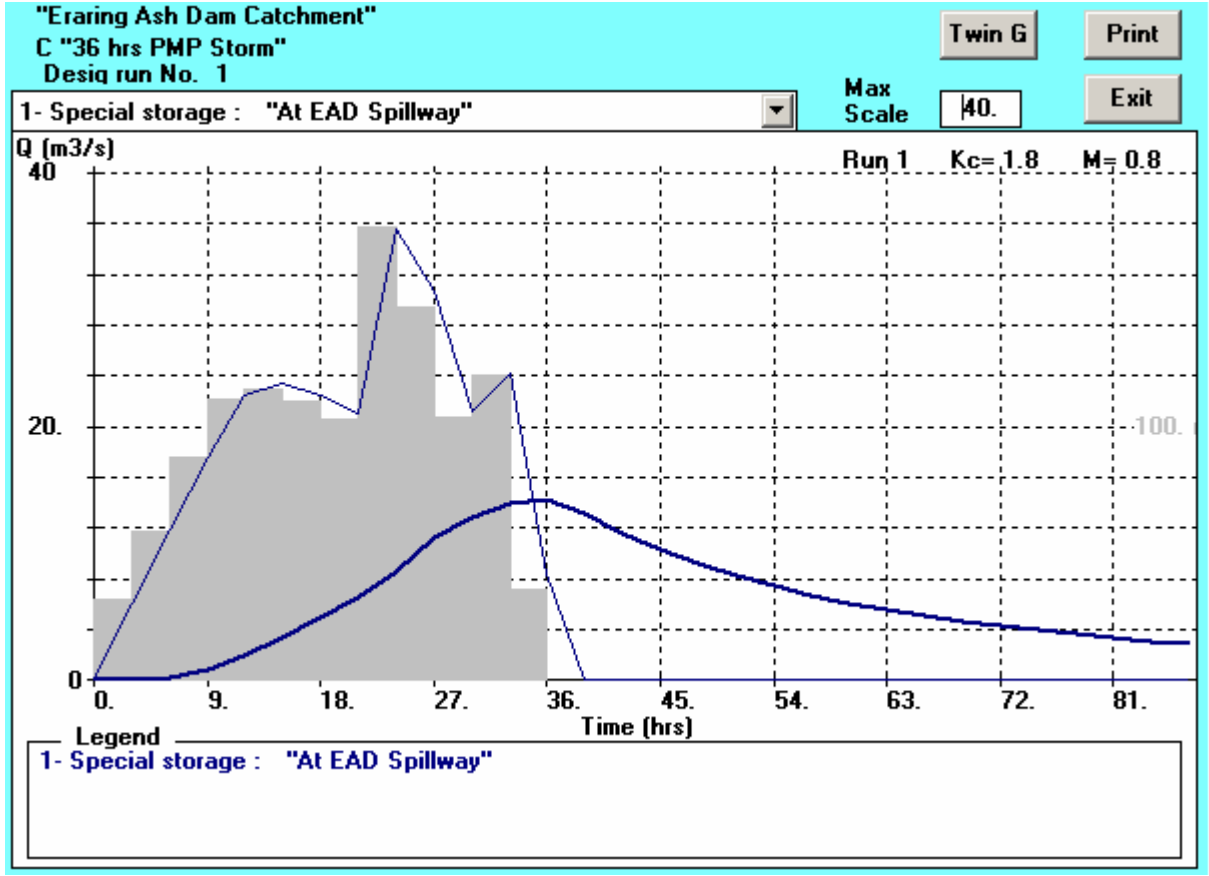


FIGURE 6 (a) - Scenario 1, Inflow and Outflow Hydrograph for the critical PMP Design Storm of 36 hours

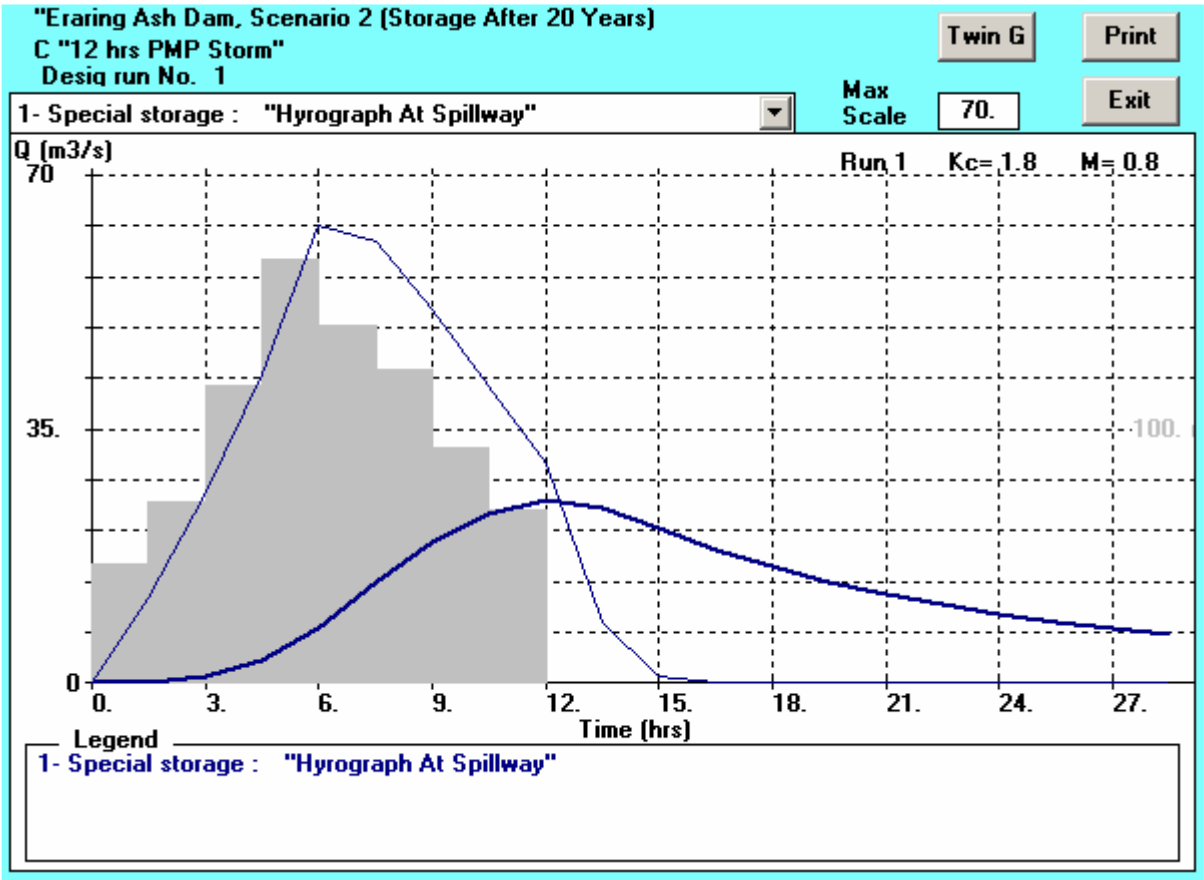


FIGURE 6 (b) - Scenario 2, Inflow and Outflow Hydrograph for the critical PMP Design Storm of 12 hours

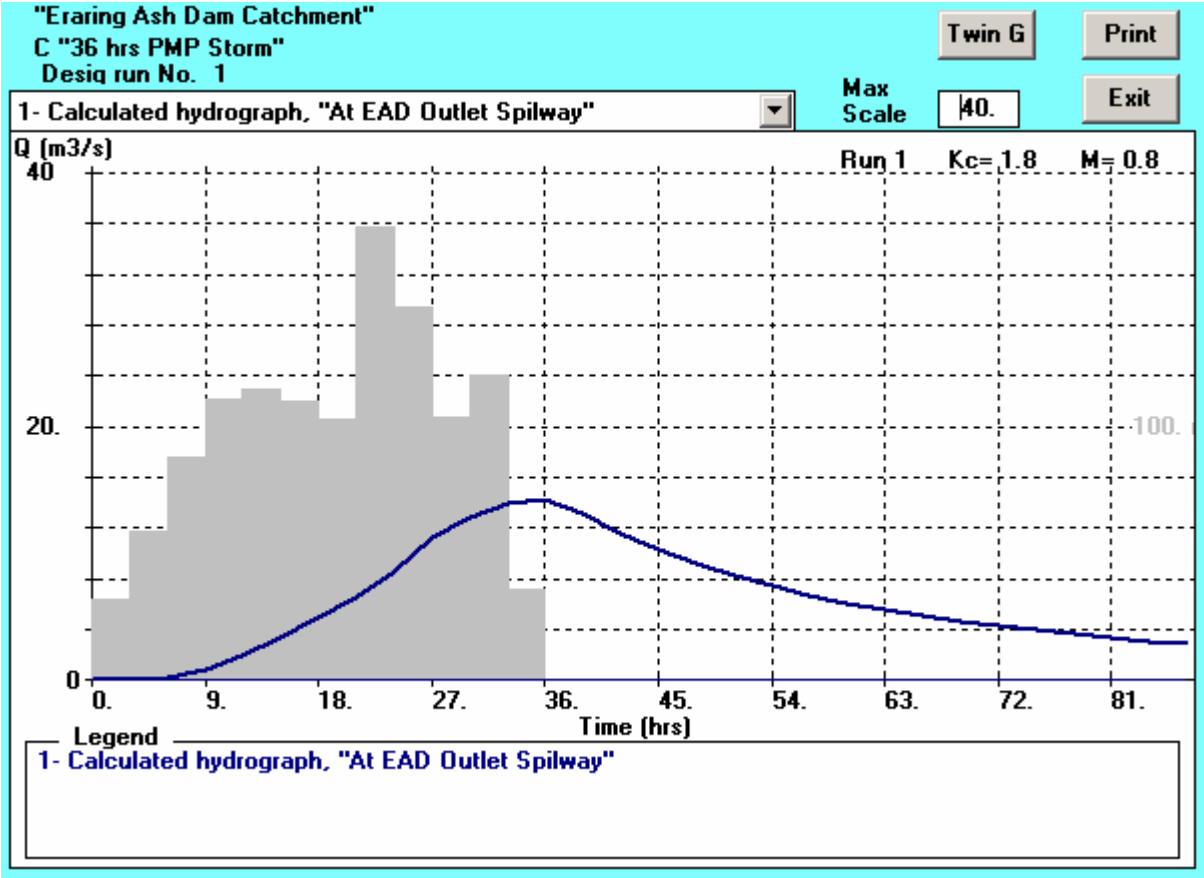


FIGURE 7 (a) - Scenario 1, Rainfall Excess and Outflow Hydrograph for the Critical PMP Design Storm of 36 hours

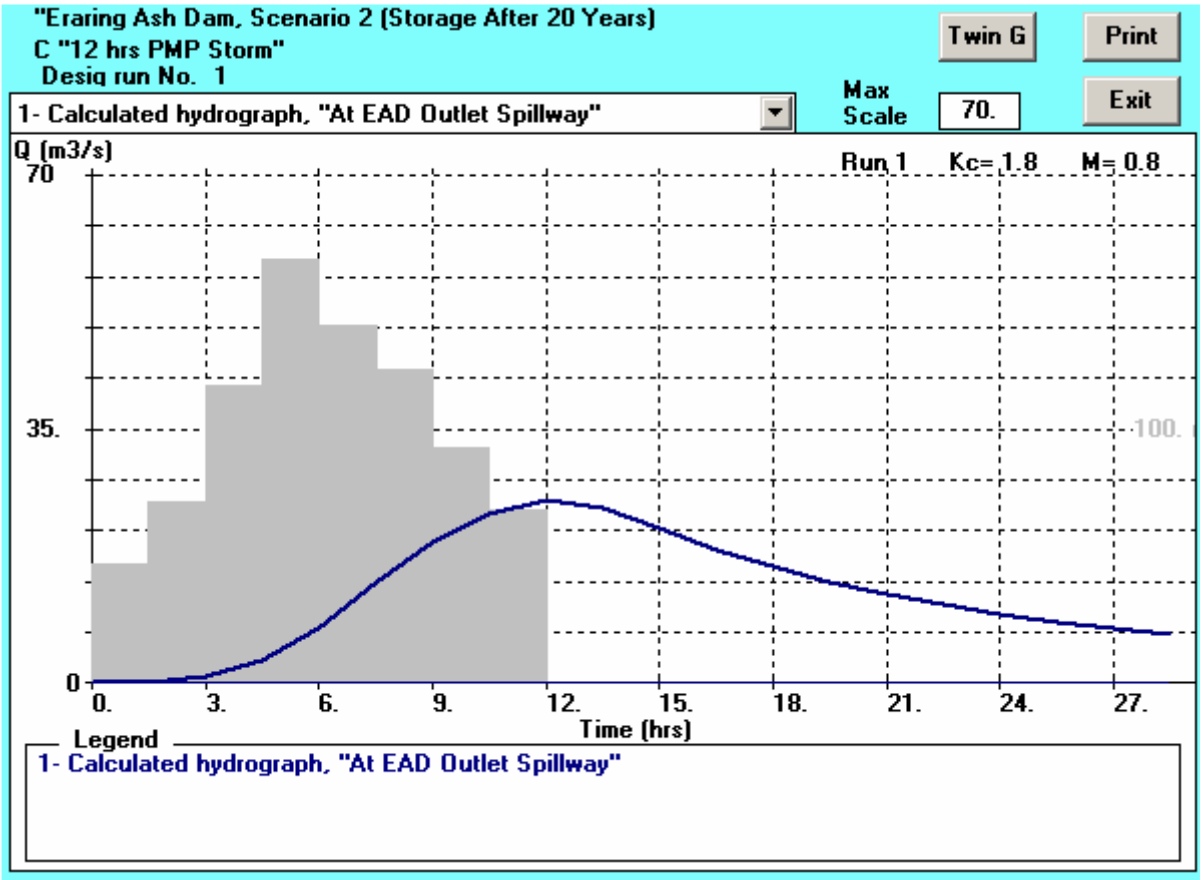


FIGURE 7 (b) - Scenario 2, Rainfall Excess and Outflow Hydrograph for the Critical PMP Design Storm of 12 hours

Figure 8 (a) - Eraring Ash Dam
Flood Frequency Curve - Scenario 1 (Current Storage)

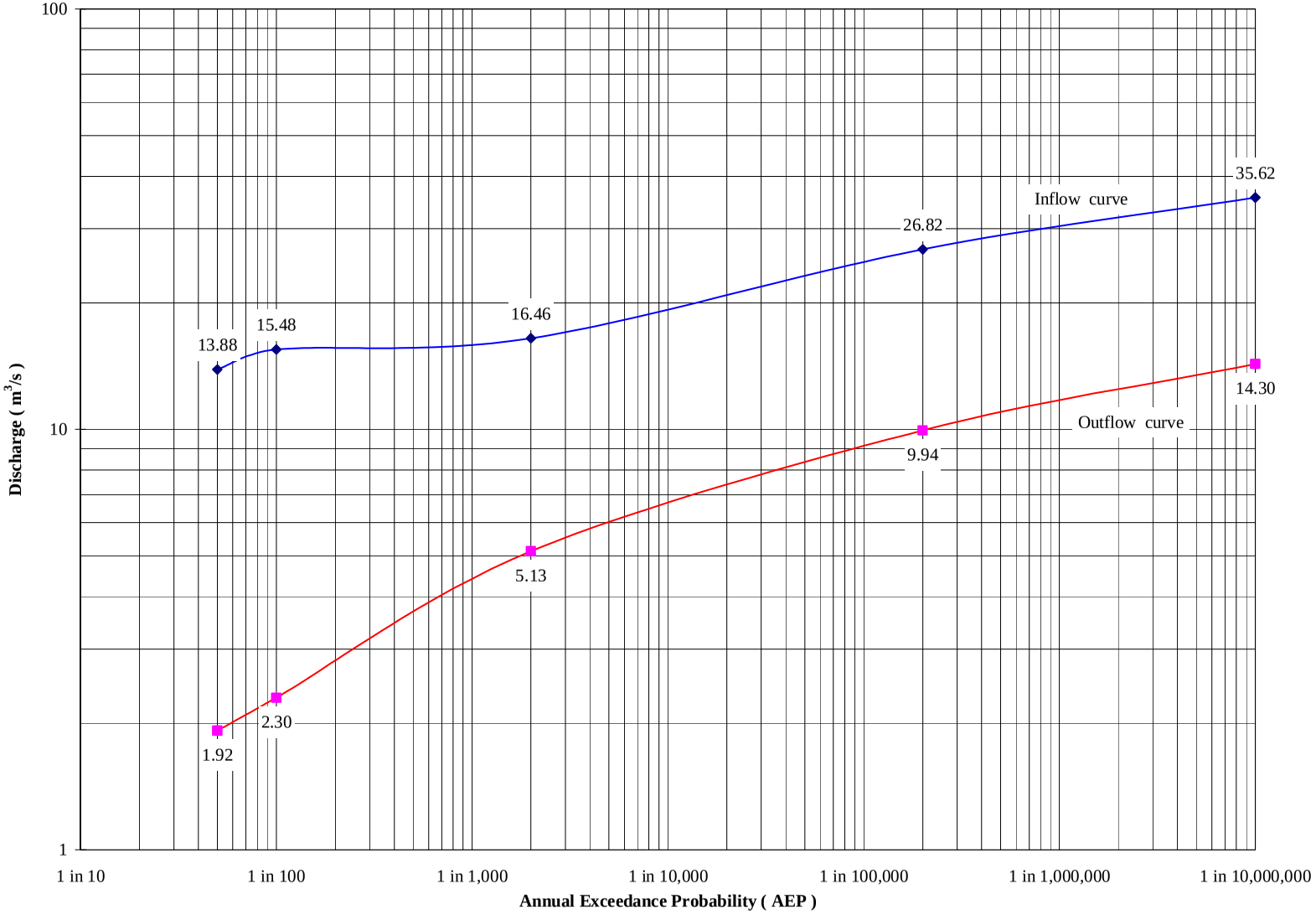


Figure 8 (b) - Eraring Ash Dam
Flood Frequency Curve - Scenario 2 (Storage after 20 Years)

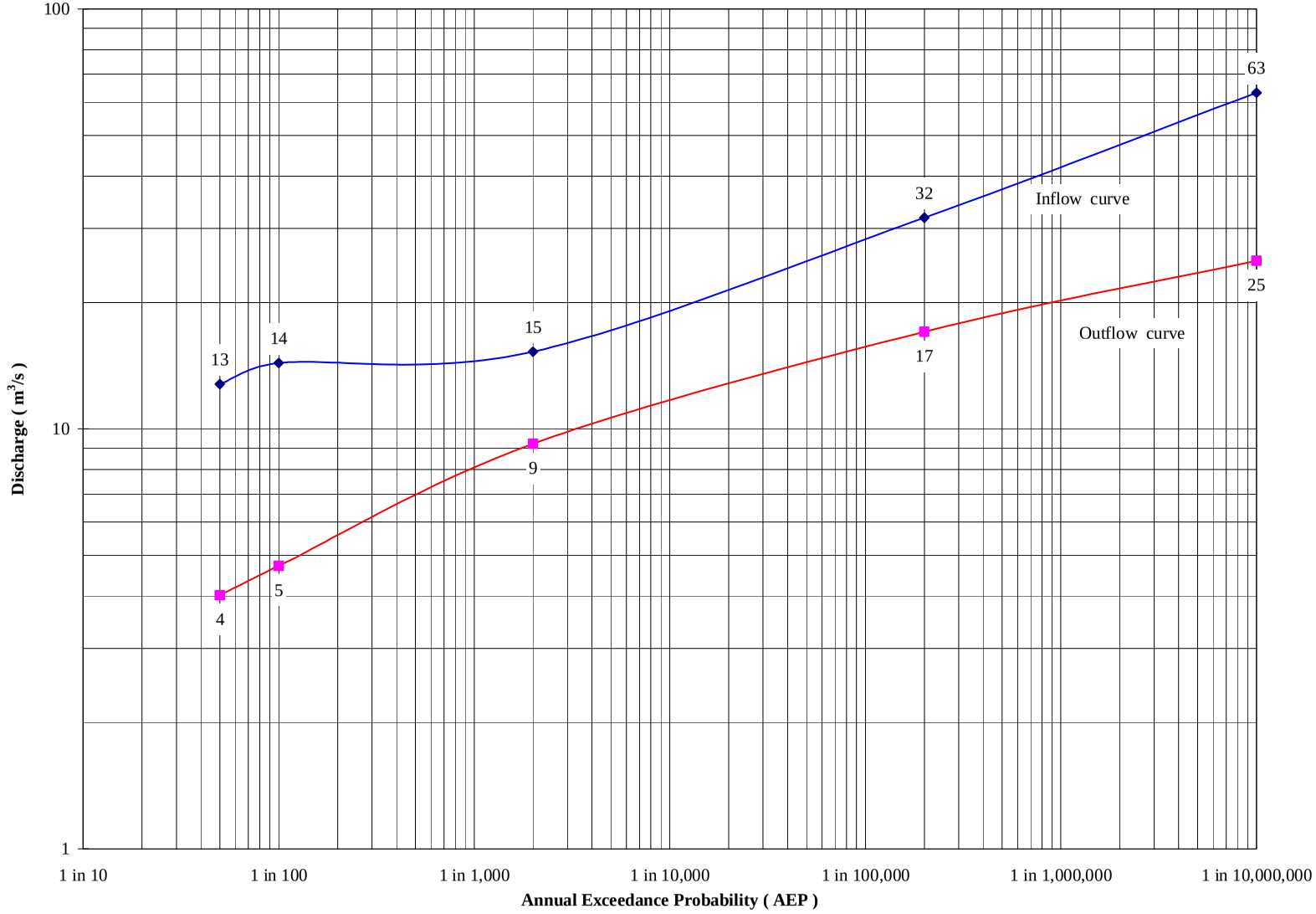


Figure 9 - Pipers Flat Dam
Flood Peak Outflow Discharges v's Duration For ARI of 50 Years - Scenario 1 (Current Storage)

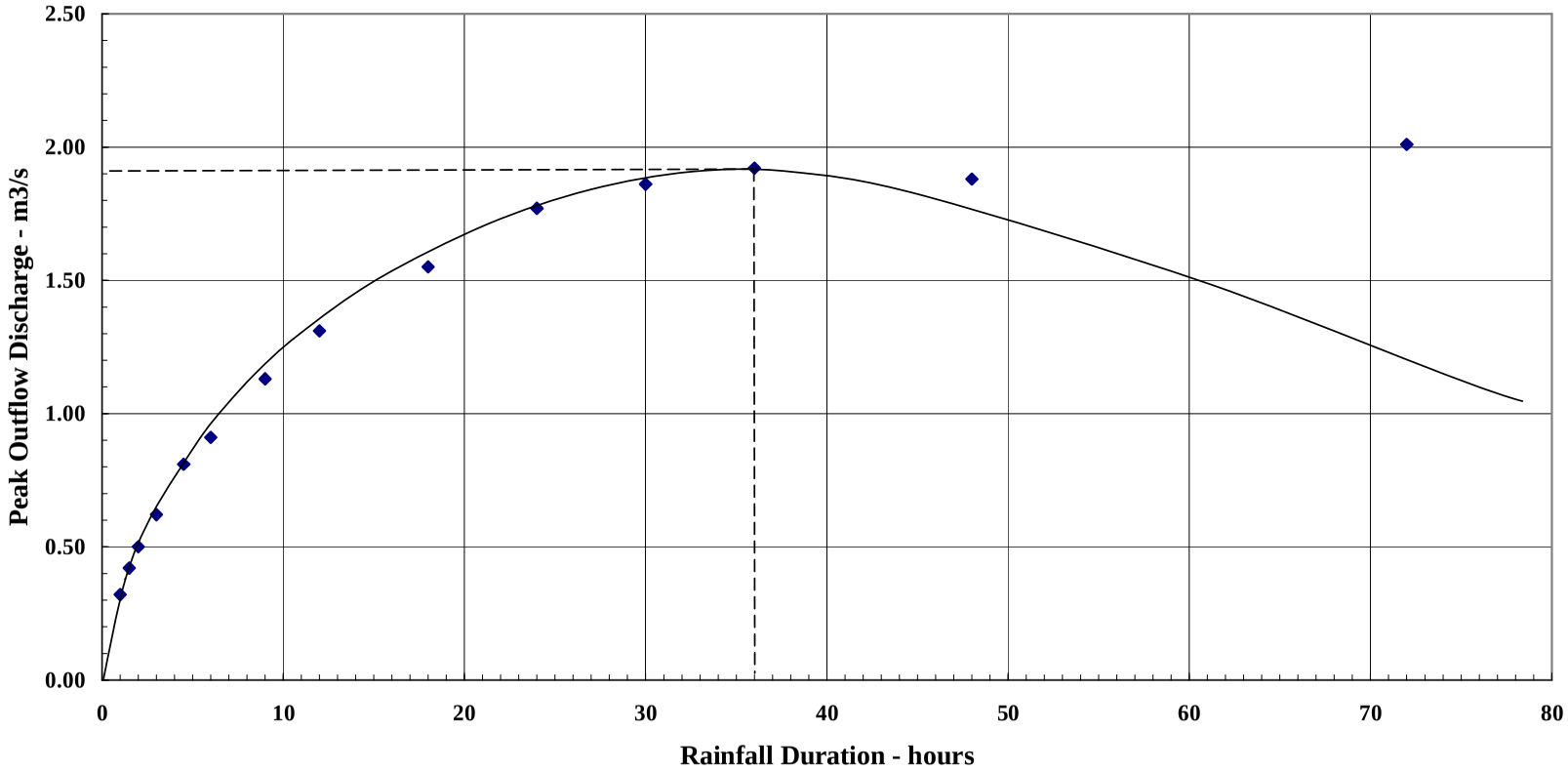


Figure 10 - Pipers Flat Dam
Flood Peak Outflow Discharge v's Duration For ARI of 100 Years - Scenario 1 (Current Storage)

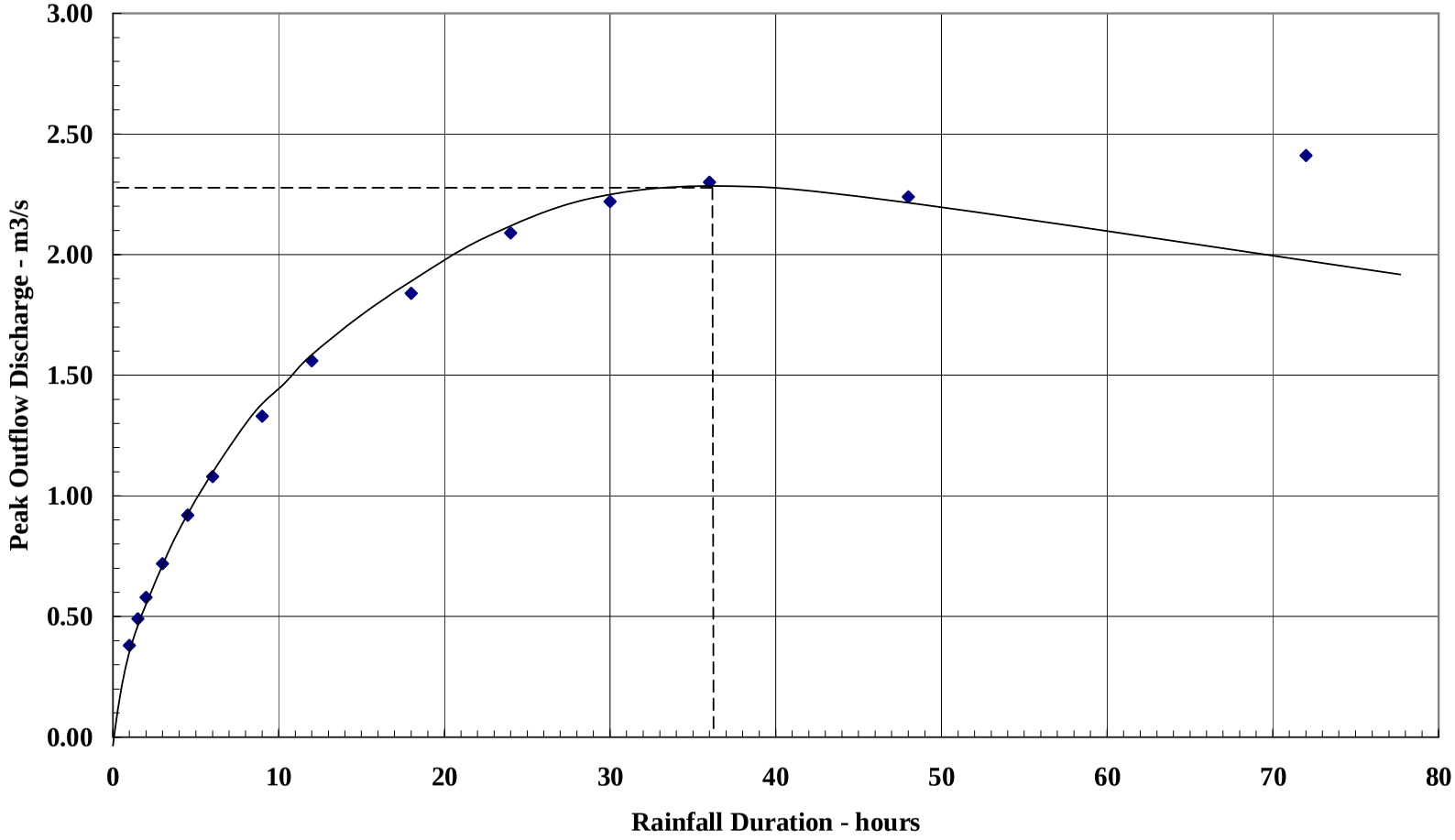


Figure 11 - Pipers Flat Dam
Flood Peak Outflow Discharges v's Duration For ARI of 50 Years - Scenario 2 (Storage after 20 years)

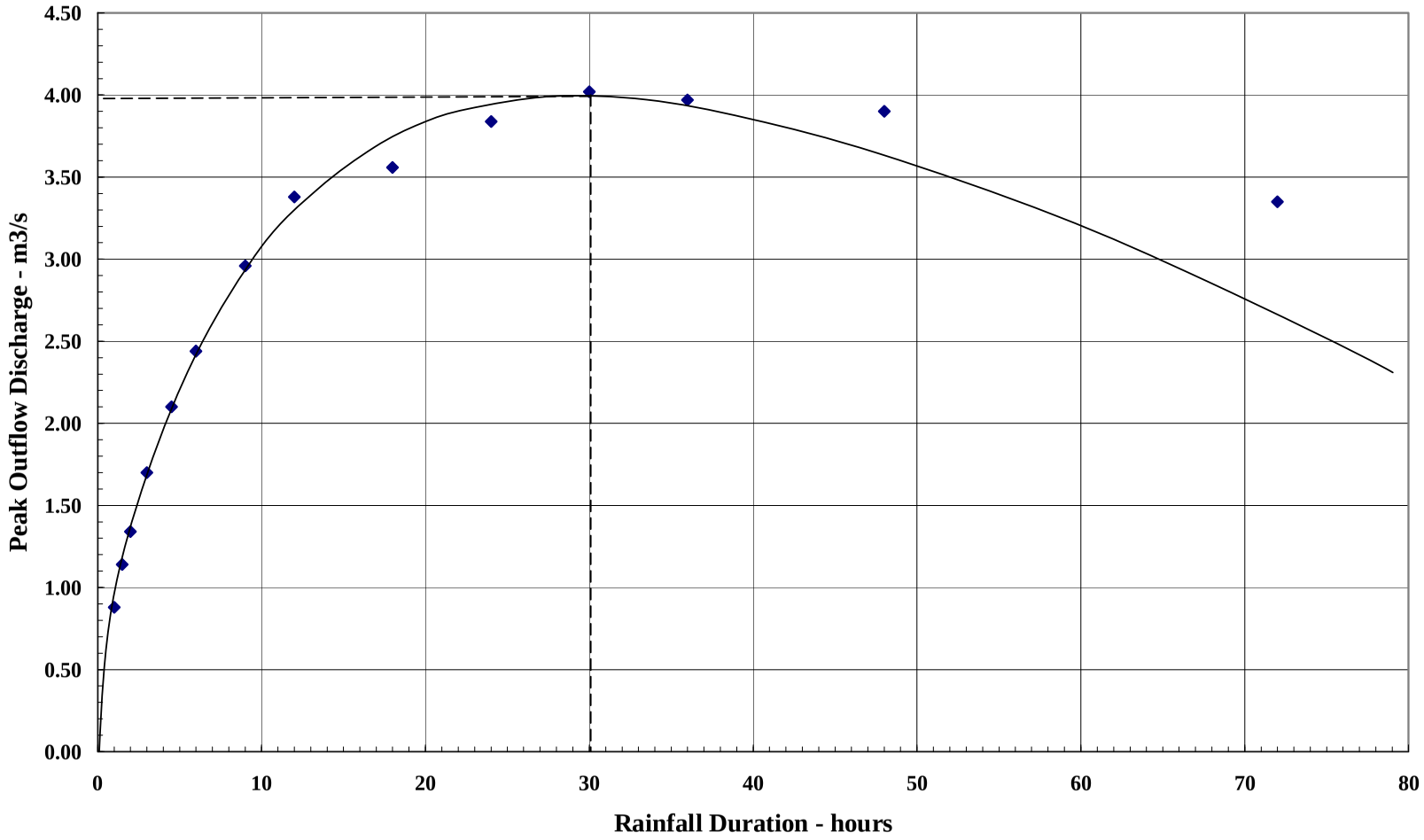
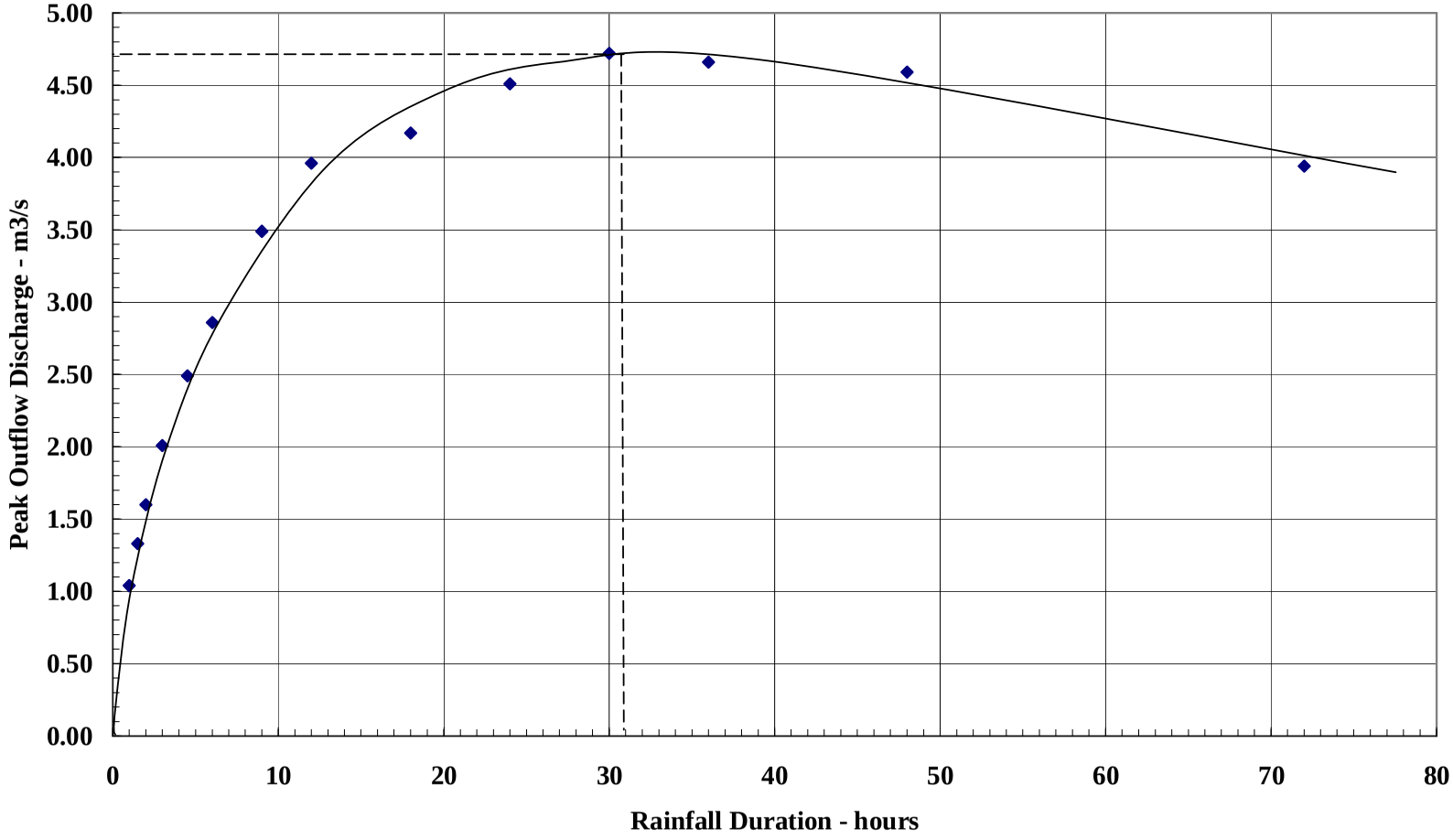


Figure 12 - Pipers Flat Dam
Flood Peak Outflow Discharge v's Duration For ARI of 100 Years - Scenario 2 (Storage after 20 years)



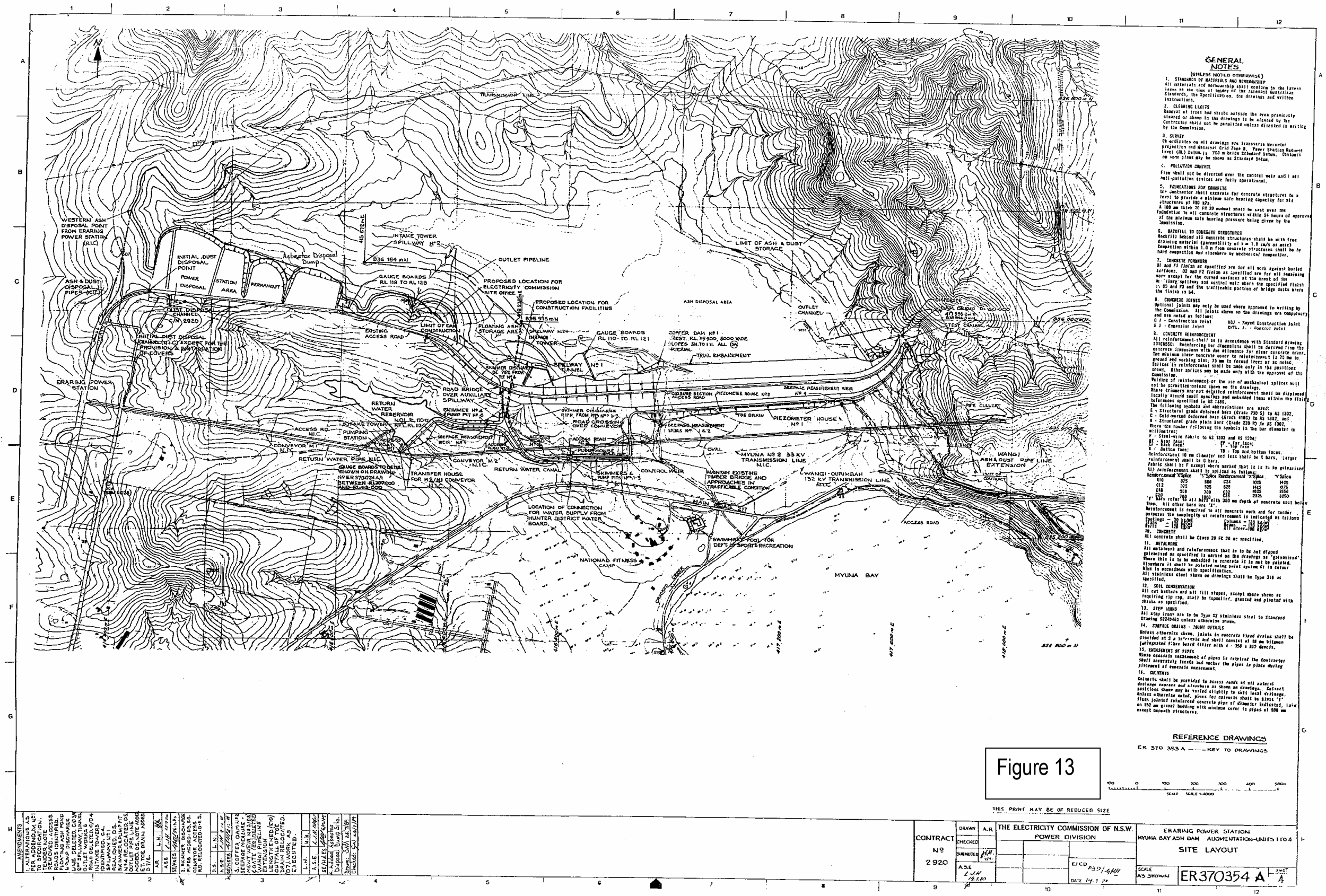

GENERAL NOTES
(UNLESS NOTED OTHERWISE)
1. STANDARDS OF MATERIALS AND WORKMANSHIP
All materials and workmanship shall conform to the latest issue at the time of tender of the relevant Australian Standards, the Specification, the drawings and written instructions.
2. CLEARING LIMITS
Removal of trees and shrubs outside the area previously cleared or shown in the drawings to be cleared by the Contractor shall not be permitted unless directed in writing by the Commission.
3. SURVEY
Co-ordinates on all drawings are Transverse Mercator projection and National Grid Zone 8. Power Station Datum Level (RL) Datum is 100 m below Standard Datum. Contours on some plans may be shown as Standard Datum.
4. POLLUTION CONTROL
Flow shall not be diverted over the control weir until all anti-pollution devices are fully operational.
5. FOUNDATIONS FOR CONCRETE
The Contractor shall excavate for concrete structures to a level to provide a minimum safe bearing capacity for all structures of 800 kPa.
A 100 mm thick 20 MPa mass concrete shall be cast over the foundation to all concrete structures within 24 hours of approval of the minimum safe bearing pressure being given by the Commission.
6. BACKFILL TO CONCRETE STRUCTURES
Backfill behind all concrete structures shall be with free draining material (permeability of k = 1.0 cm/s or more) Compaction within 1.0 m from concrete structures shall be by hand compaction and elsewhere by mechanical compaction.
7. CONCRETE FORMWORK
U1 and F1 finish as specified are for all work against buried surfaces. U2 and F2 finish as specified are for all remaining work except for the curved surfaces at the crest of the main spillway and control weir where the specified finish is U3 and F3 and the trafficable portion of bridge decks where the finish is U4.
8. CONCRETE JOINTS
Optional joints may only be used where approved in writing by the Commission. All joints shown on the drawings are compulsory and are noted as follows:
C J - Construction Joint KCJ - Keyed Construction Joint
E J - Expansion Joint CNTL. J. - Control Joint
9. CONCRETE REINFORCEMENT
All reinforcement shall be in accordance with Standard Drawing STD8555C. Reinforcing bar dimensions shall be derived from the concrete dimensions with due allowance for clear concrete cover. The minimum clear concrete cover to reinforcement is 75 mm to ground and working slab, 75 mm to formed faces or as noted. Splices in reinforcement shall be made only in the positions shown. Other splices may be made only with the approval of the Commission.
Welding of reinforcement or the use of mechanical splices will not be permitted unless shown on the drawings.
Where stirrups are not digitised reinforcement shall be displaced locally around small openings and embedded items within the fixing tolerances specified in AS 3600.
The following symbols and abbreviations are used:
S - Structural grade deformed bars (Grade 230 S) to AS 1302.
C - Cold-worked deformed bars (Grade 410C) to AS 1302, and
R - Structural grade plain bars (Grade 230 R) to AS 1302.
Where the number following the symbols is the bar diameter in millimetres:
F - Steel-wire fabric to AS 1303 and AS 1304;
U1 - Bottom face; U2 - Top face;
U3 - Both faces; U4 - Top and bottom faces.
Reinforcement 10 mm diameter and less shall be S bars. Larger reinforcement shall be C bars.
Fabric shall be F except where marked that it is to be galvanised.
All reinforcement shall be spliced as follows:
Reinforcement Splice Reinforcement Splice Reinforcement Splice
R10 375 S60 C24 1035 N25 1425
C12 375 S75 C28 1425 N32 1875
C16 500 S90 C32 1875 N40 2550
C20 700 S120 C36 2325 N50 3150
'N' Bars refer to all bars with 300 mm depth of concrete cast below them. All other bars are 'S'.
Reinforcement is required to all concrete work and for tender purposes the complexity of reinforcement is indicated as follows
Spacings - 150 mm Columns - 150 kg/m³
Walls - 100 kg/m³ Other - 75 kg/m³
10. CONCRETE
All concrete shall be Class 20 FC 20 as specified.
11. METALWORK
All metalwork and reinforcement that is to be hot dipped galvanised as specified is marked on the drawings as 'galvanised'. Where this is to be embedded in concrete it is not be painted. Elsewhere it shall be painted using paint system D1 in colour blue in accordance with specification.
All stainless steel shown on drawings shall be Type 316 as specified.
12. SOIL CONSERVATION
All cut batters and all fill slopes, except where shown as requiring rip rap, shall be topsoiled, grassed and planted with shrubs as specified.
13. STEP IRONS
All step irons are to be Type S2 stainless steel to Standard Drawing S2240405 unless otherwise shown.
14. SURFACE DRAINS - JOINT DETAILS
Unless otherwise shown, joints in concrete lined drains shall be provided at 3 m intervals and shall consist of 10 mm bitumen impregnated fibre board filler with 4 - 250 x 8.0 dowels.
15. EMBEDMENT OF PIPES
Where concrete encasement of pipes is required the Contractor shall accurately locate and anchor the pipes in place during placement of concrete encasement.
16. CULVERTS
Culverts shall be provided to access roads at all natural drainage courses and elsewhere as shown on drawings. Culvert positions shown may be varied slightly to suit local drainage. Unless otherwise noted, pipes for culverts shall be Class "2" flush jointed reinforced concrete pipe of diameter indicated, laid on 150 mm gravel bedding with minimum cover to pipes of 500 mm except beneath structures.
REFERENCE DRAWINGS
ER 370 353 A ——— KEY TO DRAWINGS
SCALE 1:4000
THIS PRINT MAY BE OF REDUCED SIZE
CONTRACT No 2920
DRAWN A.R.
CHECKED
SUBMITTED
A.S.E.
THE ELECTRICITY COMMISSION OF N.S.W.
POWER DIVISION
E/CO
DATE
ERARING POWER STATION
HYUNA BAY ASH DAM AUGMENTATION-UNITS 1 TO 4
SITE LAYOUT
SCALE AS SHOWN
ER370354 A
SHEET 4
AMENDMENTS
WESTERN ASH DISPOSAL POINT FROM ERARING POWER STATION (ALIC)
INITIAL DUST DISPOSAL POINT
POWER DISPOSAL
STATION AREA
PERMANENT
Asbestos Disposal Dump
ASH & DUST DISPOSAL PIPES (NTS)
INITIAL DUST DISPOSAL CHANNEL C/M 2920
INITIAL DUST DISPOSAL CHANNEL (N.T.C) EXCEPT FOR THE PROVISION & INSTALLATION OF COVERS
ERARING POWER STATION
INTAKE TOWER SPILLWAY No 2
OUTLET PIPELINE
GAUGE BOARDS RL 118 TO RL 128
PROPOSED LOCATION FOR ELECTRICITY COMMISSION SITE OFFICE
PROPOSED LOCATION FOR CONSTRUCTION FACILITIES
LIMIT OF ASH & DUST STORAGE
ASH DISPOSAL AREA
OUTLET CHANNEL
EXISTING ACCESS ROAD
LIMIT OF DAM CONSTRUCTION
FLOATING ASH STORAGE AREA
SPILLWAY No 1
GAUGE BOARDS RL 110 TO RL 121
COFFER DAM No 1
TRIAL EMBANKMENT
SPILLWAY CHANNEL
SKIMMER DISCHARGE PIPE FROM PIT No 4
ROAD BRIDGE OVER AUXILIARY SPILLWAY
SEEPAGE MEASUREMENT WEIR No 4
PIEZOMETER HOUSE No 2
RETURN WATER RESERVOIR NOL RL 110
SKIMMER No 2 PUMP PIT No 2
SKIMMER No 1 PUMP PIT No 1
ROAD CROSSING OVER CONVEYOR
TOE DRAIN
PIEZOMETER HOUSE No 1
INTAKE TOWER
PUMPING STATION
ACCESS RD. N.I.C.
CONVEYOR No 1 N.I.C.
SEEPAGE MEASUREMENT WEIR No 5
SEEPAGE MEASUREMENT WEIRS No 1 & 2
OVAL
RETURN WATER PIPE N.I.C.
GAUGE BOARD TO BE SHOWN ON DRAWING No ER378024 A/1 BETWEEN RL 100.000 AND RL 110.000
TRANSFER HOUSE FOR No 2/No 1 CONVEYOR N.I.C.
CONVEYOR No 2 N.I.C.
RETURN WATER CANAL
SKIMMERS & PUMP PITS No 1-5
CONTROL WEIR
MYUNA No 2 33 KV TRANSMISSION LINE N.I.C.
MAINTAIN EXISTING TIMBER BRIDGE AND APPROACHES IN TRAFFICABLE CONDITION
WANGI - OURIMBAH 132 KV TRANSMISSION LINE N.I.C.
WANGI ASH & DUST PIPE LINE EXTENSION
LIMIT OF CONTRACT
LOCATION OF CONNECTION FOR WATER SUPPLY FROM HUNTER DISTRICT WATER BOARD.
MAIN ROAD
SWIMMING POOL FOR DEPT. OF SPORTS & RECREATION
NATIONAL FITNESS CAMP
ACCESS ROAD
MYUNA BAY

Figure 13

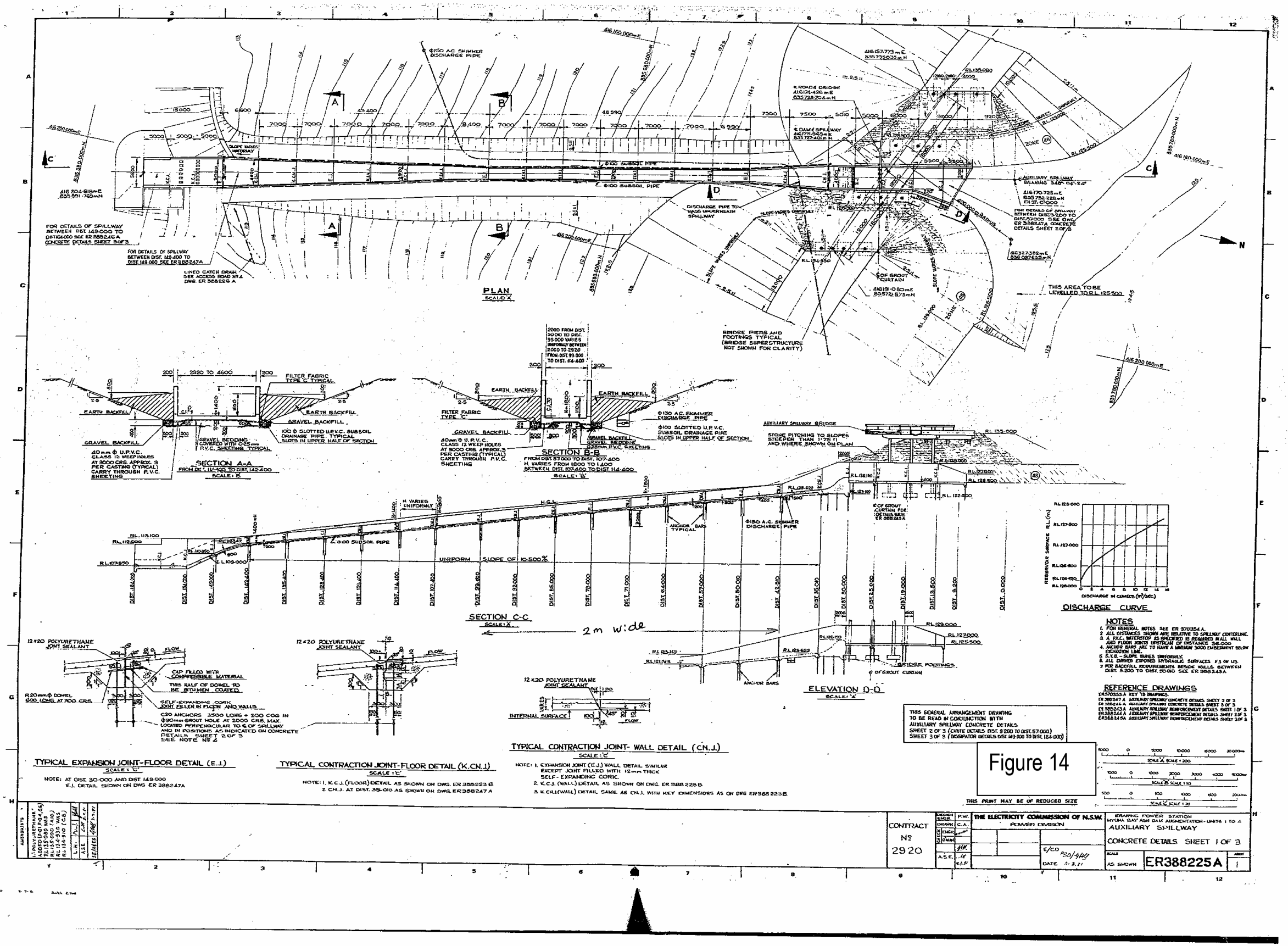
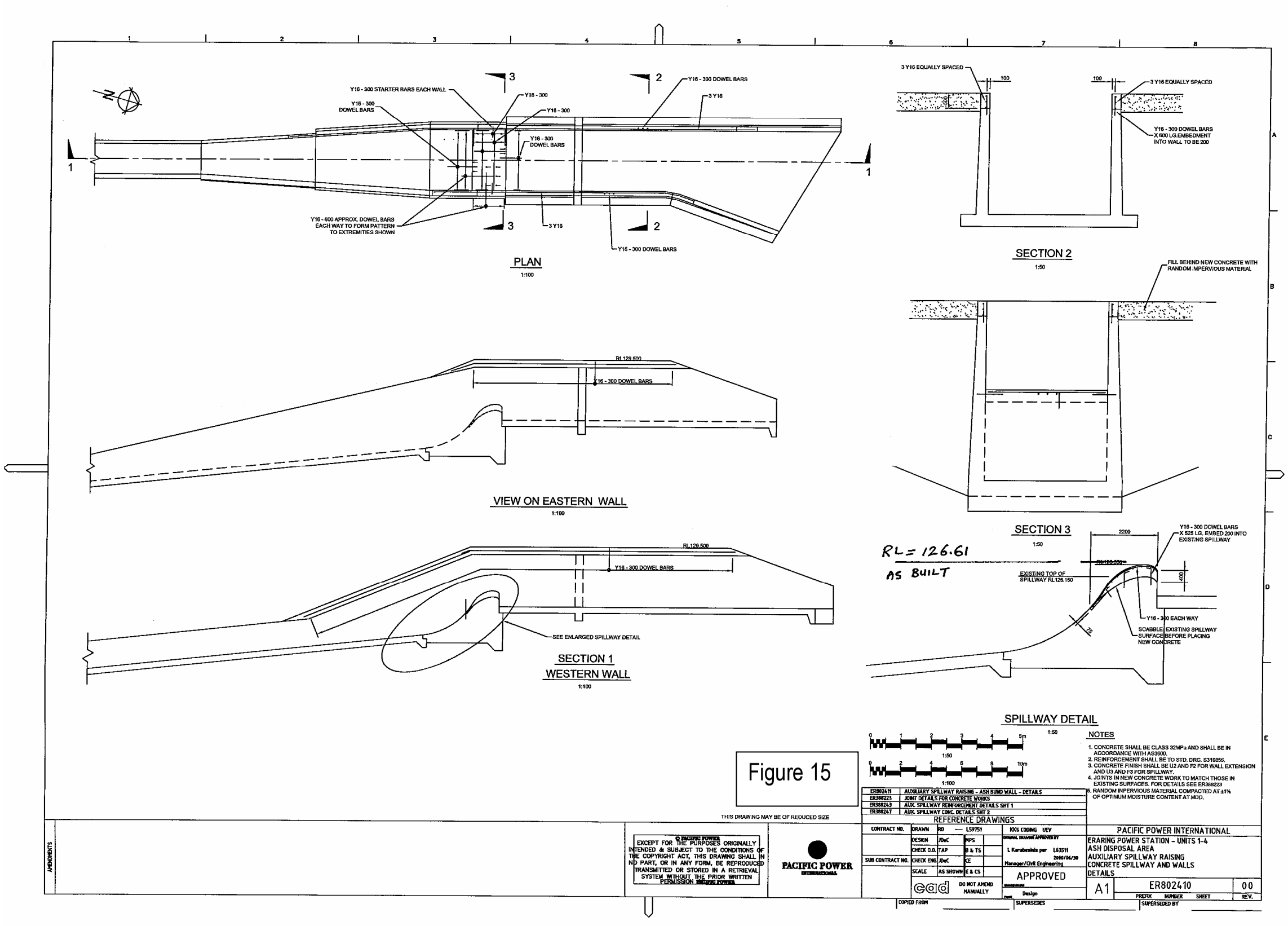

PLAN
SCALE 'A'
SECTION A-A
SCALE: B
SECTION B-B
SCALE: 'B'
SECTION C-C
SCALE: 'A'
ELEVATION D-D
SCALE: 'A'
DISCHARGE CURVE
NOTES
REFERENCE DRAWINGS
TYPICAL EXPANSION JOINT-FLOOR DETAIL (E.J.)
TYPICAL CONTRACTION JOINT-FLOOR DETAIL (K.CN.J.)
TYPICAL CONTRACTION JOINT- WALL DETAIL (CN.J.)
THIS GENERAL ARRANGEMENT DRAWING TO BE READ IN CONJUNCTION WITH AUXILIARY SPILLWAY CONCRETE DETAILS.
SHEET 2 OF 3 (CRESTE DETAILS DIST. 0 200 TO DIST. 57-000)
SHEET 3 OF 3 (DISSIPATOR DETAILS DIST. 149 000 TO DIST. 164-000)
THIS PRINT MAY BE OF REDUCED SIZE
THE ELECTRICITY COMMISSION OF N.S.W.
POWER DIVISION
CONTRACT Nº 2920
AUXILIARY SPILLWAY
CONCRETE DETAILS SHEET 1 OF 3
ER388225A

Figure 14


Y16 - 300 STARTER BARS EACH WALL
Y16 - 300 DOWEL BARS
Y16 - 300
Y16 - 300
Y16 - 300 DOWEL BARS
3 Y16
Y16 - 300 DOWEL BARS
Y16 - 600 APPROX. DOWEL BARS EACH WAY TO FORM PATTERN TO EXTREMITIES SHOWN
3 Y16
Y16 - 300 DOWEL BARS
PLAN
1:100
3 Y16 EQUALLY SPACED
100
100
3 Y16 EQUALLY SPACED
Y16 - 300 DOWEL BARS X 600 LG.EMBEDMENT INTO WALL TO BE 200
SECTION 2
1:50
FILL BEHIND NEW CONCRETE WITH RANDOM IMPERVIOUS MATERIAL
RL 129.500
Y16 - 300 DOWEL BARS
VIEW ON EASTERN WALL
1:100
SECTION 3
1:50
RL= 126.61
AS BUILT
2200
Y16 - 300 DOWEL BARS X 525 LG. EMBED 200 INTO EXISTING SPILLWAY
EXISTING TOP OF SPILLWAY RL126.150
400
Y16 - 300 EACH WAY
SCABBLE EXISTING SPILLWAY SURFACE BEFORE PLACING NEW CONCRETE
RL129.500
Y16 - 300 DOWEL BARS
SEE ENLARGED SPILLWAY DETAIL
SECTION 1
WESTERN WALL
1:100
SPILLWAY DETAIL
1:50
1:50
1:100
NOTES
1. CONCRETE SHALL BE CLASS 32MPa AND SHALL BE IN ACCORDANCE WITH AS3600.
2. REINFORCEMENT SHALL BE TO STD. DRG. S316856.
3. CONCRETE FINISH SHALL BE U2 AND F2 FOR WALL EXTENSION AND U3 AND F3 FOR SPILLWAY.
4. JOINTS IN NEW CONCRETE WORK TO MATCH THOSE IN EXISTING SURFACES. FOR DETAILS SEE ER386223
5. RANDOM INPERVIOUS MATERIAL COMPACTED AT ±1% OF OPTIMUM MOISTURE CONTENT AT MDD.
Figure 15
THIS DRAWING MAY BE OF REDUCED SIZE
ER802411 AUXILIARY SPILLWAY RAISING - ASH BUND WALL - DETAILS
ER386223 JOINT DETAILS FOR CONCRETE WORKS
ER386243 AUX. SPILLWAY REINFORCEMENT DETAILS SHT 1
ER386247 AUX. SPILLWAY CONC. DETAILS SHT 2
REFERENCE DRAWINGS
CONTRACT NO.
DRAWN RD — L59751
DESIGN JDwC NPS
CHECK D.O. TAP B & TS
SUB CONTRACT NO. CHECK ENG. JDwC CE
SCALE AS SHOWN E & CS
DO NOT AMEND MANUALLY
KKS CODING UEV
L Karabesinis per L63511 2000/06/30
Manager/Civil Engineering
APPROVED
Design
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SUPERSEDES
SUPERSEDED BY
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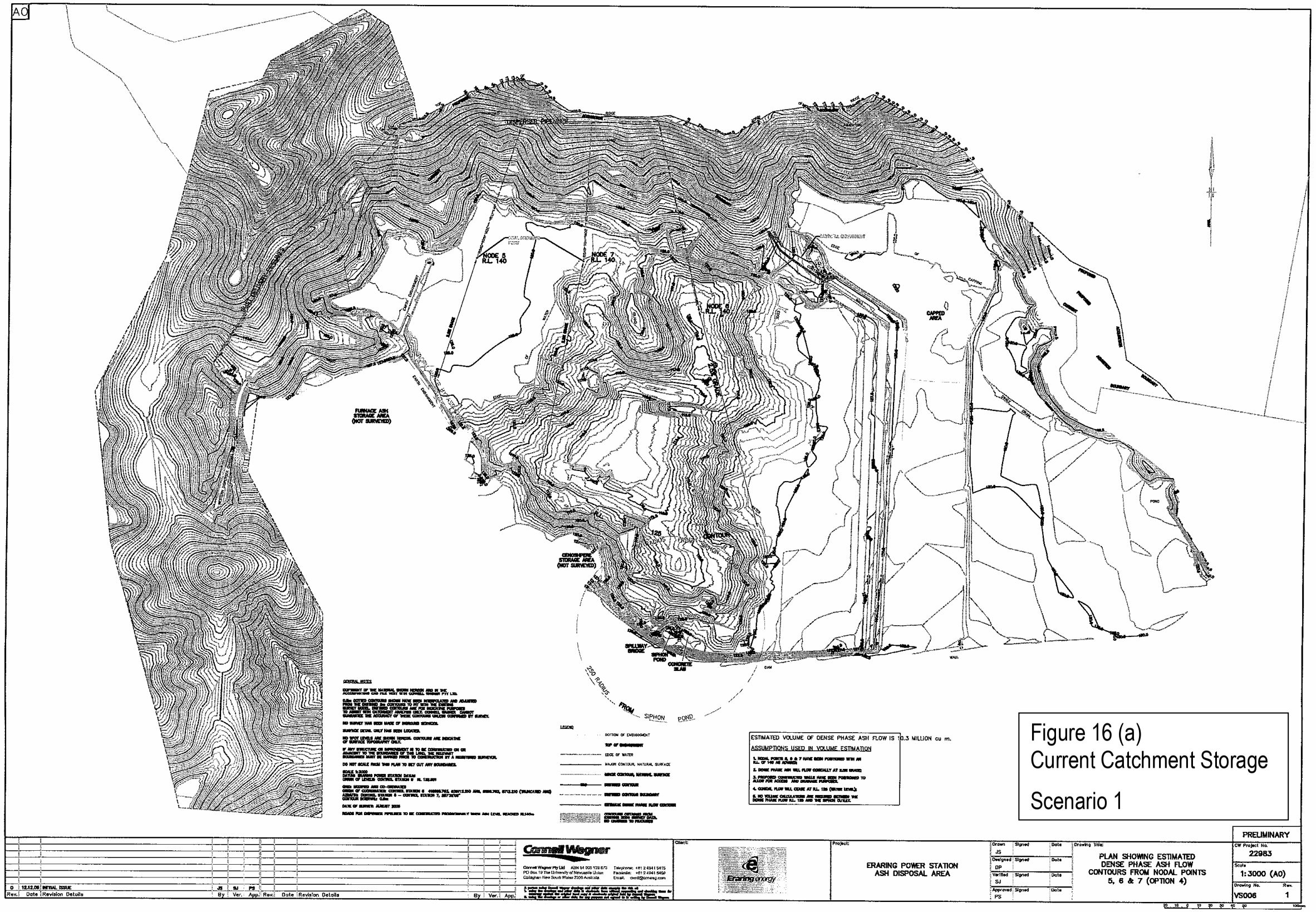
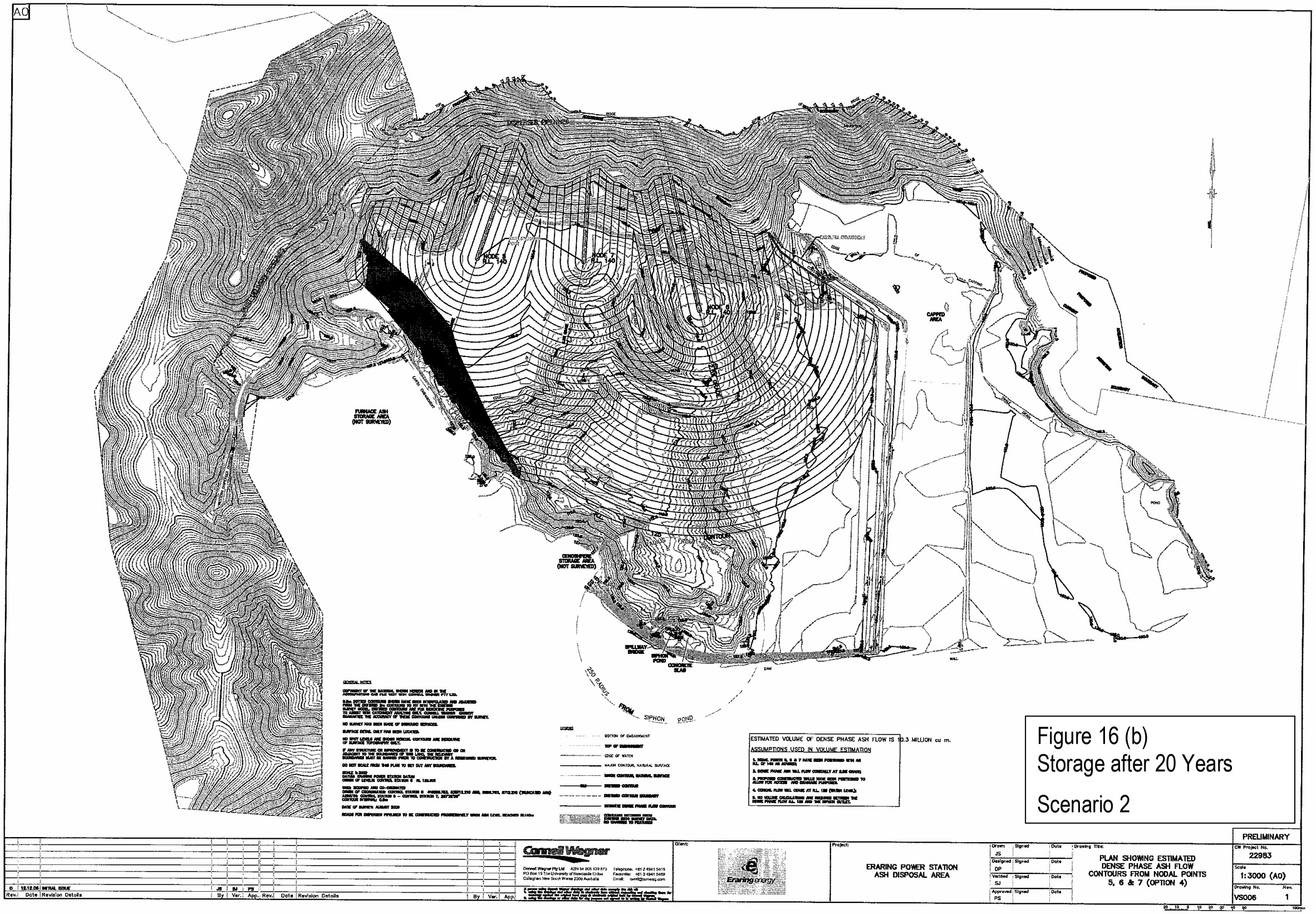
EXCEPT FOR THE PURPOSES ORIGINALLY INTENDED & SUBJECT TO THE CONDITIONS OF THE COPYRIGHT ACT, THIS DRAWING SHALL IN NO PART, OR IN ANY FORM, BE REPRODUCED TRANSMITTED OR STORED IN A RETRIEVAL SYSTEM WITHOUT THE PRIOR WRITTEN PERMISSION OF PACIFIC POWER
PACIFIC POWER
PACIFIC POWER INTERNATIONAL
ERARING POWER STATION - UNITS 1-4
ASH DISPOSAL AREA
AUXILIARY SPILLWAY RAISING
CONCRETE SPILLWAY AND WALLS
DETAILS
A1
ER802410
00
PREFIX NUMBER SHEET REV.
AMENDMENTS


A0
NODE 8
R.L. 140
NODE 7
R.L. 140
NODE 6
R.L. 140
CAPPED AREA
FURNACE ASH STORAGE AREA (NOT SURVEYED)
GENERATING STORAGE AREA (NOT SURVEYED)
128 CONTOUR
SPILLWAY BRIDGE
SIPHON POND
CONCRETE SLAB
220 RADIUS FROM SIPHON POND
DAM
WALL
POND
LEGEND
BOTTOM OF EMBANKMENT
TOP OF EMBANKMENT
EDGE OF WATER
MAJOR CONTOUR, NATURAL SURFACE
MINOR CONTOUR, NATURAL SURFACE
INFERRED CONTOUR
INFERRED CONTOUR BOUNDARY
ESTIMATE DENSE PHASE FLOW CONTOUR
CONTOURS OBTAINED FROM AERIAL PHOTOGRAPHY. NO CHANGES TO PRESENT
ESTIMATED VOLUME OF DENSE PHASE ASH FLOW IS 10.3 MILLION cu m.
ASSUMPTIONS USED IN VOLUME ESTIMATION
1. NODAL POINTS 5 & 6 & 7 HAVE BEEN POINTORED WITH AN R.L. OF 140 AS ABOVE.
2. DENSE PHASE ASH WILL FLOW CONICALLY AT 3.25H 1(V)AND
3. PROPOSED CONTRACTED WALLS HAVE BEEN POINTORED TO ALLOW FOR ACCESS AND DRAINAGE PURPOSES.
4. CONDIL FLOW WILL CEASE AT R.L. 128 (BELOW LEVEL)
5. NO VOLUME CALCULATIONS ARE REQUIRED BETWEEN THE DENSE PHASE FLOW R.L. 128 AND THE SIPHON OUTLET.
Figure 16 (a)
Current Catchment Storage
Scenario 1
0 12.12.06 INITIAL ISSUE JS SJ PS
Rev. Date Revision Details By Ver. App. Rev. Date Revision Details By Ver. App.
Connell Wagner
Connell Wagner Pty Ltd ABN 54 005 139 873
PO Box 19 The University of Newcastle Union
Callaghan New South Wales 2308 Australia
Telephone: +61 2 4941 5415
Facsimile: +61 2 4941 5459
Email: cw@cwneg.com
Client:
Eraring energy
Project:
ERARING POWER STATION
ASH DISPOSAL AREA
Drawn JS
Designed DP
Verified SJ
Approved PS
Signed
Date
Drawing Title:
PLAN SHOWING ESTIMATED
DENSE PHASE ASH FLOW
CONTOURS FROM NODAL POINTS
5, 6 & 7 (OPTION 4)
PRELIMINARY
CW Project No. 22983
Scale 1:3000 (A0)
Drawing No. VS006
Rev. 1


A0
NODE 5
RL 140
NODE 7
140
NODE 6
RL 140
CAPPED AREA
FURNACE ASH STORAGE AREA (NOT SURVEYED)
CONCRETE STORAGE AREA (NOT SURVEYED)
SPILLWAY BRIDGE
SIPHON POND
CONCRETE SLAB
DAM
WALL
POND
250 RADIUS FROM SIPHON POND
GENERAL NOTES
LEGEND
EDGE OF WATER
MAIN CONTOUR, NATURAL SURFACE
DISTURBED CONTOUR
DISTURBED CONTOUR BOUNDARY
ESTIMATE DENSE PHASE FLOW CONTOUR
ESTIMATED VOLUME OF DENSE PHASE ASH FLOW IS 10.3 MILLION cu m.
ASSUMPTIONS USED IN VOLUME ESTIMATION
Figure 16 (b)
Storage after 20 Years
Scenario 2
PRELIMINARY
Connell Wagner
Client:
Eraring Energy
Project:
ERARING POWER STATION
ASH DISPOSAL AREA
Drawn JS
Designed DP
Verified SJ
Approved PS
Drawing Title:
PLAN SHOWING ESTIMATED
DENSE PHASE ASH FLOW
CONTOURS FROM NODAL POINTS
5, 6 & 7 (OPTION 4)
CW Project No. 22983
Scale 1:3000 (A0)
Drawing No. VS006
Rev. 1
0 12.12.06 INITIAL ISSUE JS SJ PS

Appendix 1

RORB Data Input and Output files for Critical PMP Storm Duration of 36 hours (Scenario 1- Current Storage - Uniform Spatial Distribution)

Catchment Data File

```
"Eraring Ash Dam Catchment"
C Created at 11:32 on 29/03/:7
C  for: The Electricity Commision of N.S.W.    7/2/1992
C Reach Type Flag
0                          ,More than one reach type
C The Control Vector
 1,1,   0.390 ,-99              ,Sub-area A
 2,1,   0.220 ,-99              ,Sub-area B
 5,4,   0.260 ,-99              ,normal (reach) storage
 2,4,   0.220 ,-99              ,Sub-area C
3                          ,Store the current hydrograph
 1,4,   0.340 ,-99              ,Sub-area D
3                          ,Store the current hydrograph
 1,4,   0.300 ,-99              ,Sub-area E
 4                         ,Add in the last stored h'graph
 2,4,   0.130 ,-99              ,Sub-area F
 5,4,   0.600 ,-99              ,normal (reach) storage
 4                         ,Add in the last stored h'graph
3                          ,Store the current hydrograph
 1,4,   0.390 ,-99              ,Sub-area G
 2,4,   0.390 ,-99              ,Sub-area H
 4                         ,Add in the last stored h'graph
3                          ,Store the current hydrograph
 1,4,   0.470 ,-99              ,Sub-area I
 4                         ,Add in the last stored h'graph
 5,4,   0.130 ,-99              ,normal (reach) storage
 2,4,   0.170 ,-99              ,Sub-area J
16                          ,Existing special storage
"At EAD Spillway"
3,  0.000    ,  1 ,-99             ,Weir formula ;No drawdown;no. spillways
 1.000E-03,    4.0000
  2.050 ,-99                      ,Kw; End of weir data
C Elevation (H) - Storage (S) data for this special storage
1,  3 ,-99                        ,H - S relation: table;no. pairs in table
 0.000    ,  0.000
  3.45    ,  4.361E+06
  8.45    ,  1.221E+07 ,-99          ,Last pair of Elevation - Storage table
7                          ,7   Print calculated h'graph
"At EAD Outlet Spilway"
0                          ,0   Finished
C Sub-area Data
C
C Areas, km**2, of sub-areas A,B...
0.237,0.270,0.157,0.283,0.191,0.246,0.205,0.127,0.226
0.258 ,-99                        , 10 Sub-area(s)
C No impervious area (or runoff capacity indices zero for all sub-areas)
0 ,-99
```

Output File

```
 ** RORB Version 4.2 (PC), 1 May 1995 (C) Copyright Monash University **

This copy supplied to :
      PACIFIC POWER Services,  Sydney   17 December 2001

Run at: 15:49 on 24/ 4/2007
Data from file :input.dat
Output type  3


DATA CHECKS:
************
Next data to be read & checked:
    Item        Character data as read

Catchment name
"Eraring Ash Dam Catchment"
Reach type flag
Control vector & storage data
Code  Read     Name or Location
 No.  as:       as read:
 22   16.0  "At EAD Spillway"
 23    7.0  "At EAD Outlet Spilway"
Sub-area areas
Impervious flag
Storm identification
C "36 hrs PMP Storm"
Run type
    Desig
Storm parameters
Rainfall burst times
Pluviograph 1
  36 hrs
Reading of data completed
Data check completed



DATA:
****

"Eraring Ash Dam Catchment"


Time data, in increments from initial time
C "36 hrs PMP Storm"
Time increment (hours)=  3.00

                Start   Finish
Rainfall times:     0       12


End of hyeto/hydrographs:   12
Duration of calculations:   30



Pluviograph data (time in incs, rainfall in mm, in
                increment following time shown)

      1:36 hrs
  Time     1
    0    35.0
    1    62.0
    2    91.0
    3   114.0
    4   118.0
    5   113.0
    6   106.0
    7   182.0
    8   150.0
    9   107.0
   10   123.0
   11    39.0
```

Total1240.0

Desig run control vector

Step	Code	Description
1	1	Add sub-area 'A' inflow & route thru normal storage 1
2	2	Add sub-area 'B' inflow & route thru normal storage 2
3	5	Route hydrograph thru normal storage 3
4	2	Add sub-area 'C' inflow & route thru normal storage 4
5	3	Store hydrograph from step 4; reset hydrograph to zero
6	1	Add sub-area 'D' inflow & route thru normal storage 5
7	3	Store hydrograph from step 6; reset hydrograph to zero
8	1	Add sub-area 'E' inflow & route thru normal storage 6
9	4	Add h-graph ex step 7 to h-graph ex step 8
10	2	Add sub-area 'F' inflow & route thru normal storage 7
11	5	Route hydrograph thru normal storage 8
12	4	Add h-graph ex step 5 to h-graph ex step 11
13	3	Store hydrograph from step 12; reset hydrograph to zero
14	1	Add sub-area 'G' inflow & route thru normal storage 9
15	2	Add sub-area 'H' inflow & route thru normal storage 10
16	4	Add h-graph ex step 13 to h-graph ex step 15
17	3	Store hydrograph from step 16; reset hydrograph to zero
18	1	Add sub-area 'I' inflow & route thru normal storage 11
19	4	Add h-graph ex step 17 to h-graph ex step 18
20	5	Route hydrograph thru normal storage 12
21	2	Add sub-area 'J' inflow & route thru normal storage 13
22	16.0	Route thru existing storage, "At EAD Spillway"
23	7.0	Print hydrograph, "At EAD Outlet Spilway"
24	0	**********End of control vector**********

Sub-area data

Sub-area	Area km^2	Dist. km*
A	2.37E-01	1.39E+00
B	2.70E-01	1.00E+00
C	1.57E-01	5.20E-01
D	2.83E-01	1.37E+00
E	1.91E-01	1.33E+00
F	2.46E-01	1.03E+00
G	2.05E-01	1.08E+00
H	1.27E-01	6.90E-01
I	2.26E-01	7.70E-01
J	2.58E-01	1.70E-01

Total 2.200E+00
Av. Dist., km* 9.56E-01

* or other function of reach properties related to travel time

Normal storage data

Storage no.	Length km*	Rel. delay time	Type	Slope percent
1	.4	.408	Natural	
2	.2	.230	Natural	
3	.3	.000	Drowned	
4	.2	.000	Drowned	
5	.3	.000	Drowned	
6	.3	.000	Drowned	
7	.1	.000	Drowned	
8	.6	.000	Drowned	
9	.4	.000	Drowned	
10	.4	.000	Drowned	
11	.5	.000	Drowned	
12	.1	.000	Drowned	
13	.2	.000	Drowned	

* or other function of reach properties related to travel time

Special storage data

Storage: "At EAD Spillway"
Initial water level at cease to flow elevation
Spillway data:
Elevation(m)= .00 Length(m)= 4.0
Weir coeff. = 2.05
Elevation (m) - Storage (m^3) table

.00	0.000E+00
3.45	4.361E+06
8.45	1.221E+07

Loss model 1 selected

Rainfall, mm, in time inc. following time shown

Time Incs ment	Catch
0	35.0
1	62.0
2	91.0
3	114.0
4	118.0
5	113.0
6	106.0
7	182.0
8	150.0
9	107.0
10	123.0
11	39.0
Tot.	1240.

Rainfall-excess, mm, in time inc. following time shown

Time Incs ment	Catch
0	32.0
1	59.0
2	88.0
3	111.0
4	115.0
5	110.0
6	103.0
7	179.0
8	147.0
9	104.0
10	120.0
11	36.0
Tot.	1204.

```
ROUTING RESULTS:
****************
"Eraring Ash Dam Catchment"
C "36 hrs PMP Storm"
 Desig run No. 1

Parameters:   kc=    1.8  m=  .80
Loss parameters:          Initial loss (mm)   Cont. loss (mm/h)
                          .0                  1.00

Results of routing through special storage "At EAD Spillway"
 Peak elevation=   1.45 m
 Peak outflow =   14.28 m^3/s (spillway flow)
 Peak storage =    1.83E+06 m^3


*** Special storage :   "At EAD Spillway"

                    Hydrograph
                  Outflow   Inflow
Peak discharge,m^3/s    14.28    35.62
Time to peak,h          36.0     24.0
Volume,m^3          2.06E+06 2.65E+06
Time to centroid,h      44.9     21.0
Lag (c.m. to c.m.),h    25.6      1.6
Lag to peak,h           16.7      4.7

Time inc.=  3.00 h
Time     Discharge       Discharge, m^3/s   X:Outflow    O: Inflow
    Outflow  Inflow 0      7.1      14.2      21.4      28.5      35.6
incs. m^3/s   m^3/s I.........I.........I.........I.........I.........I
  0    .00     .00 *
  1    .07    6.00 *      O
  2    .26   11.89 *            O
  3    .87   17.65 *X                  O
  4   1.94   22.49 *  X                     O
  5   3.40   23.44 *   X                     O
  6   4.97   22.45 *     X                   O
  7   6.46   21.03 *      X                 O
  8   8.61   35.62 *        X                           O
  9  11.19   30.74 *           X                    O
 10  12.87   21.20 *             X         O
 11  14.01   24.27 *               X           O
 12  14.28    8.36 *        O      X
 13  13.10     .09 *             X
 14  11.59     .00 *           X
 15  10.35     .00 *           X
 16   9.26     .00 *         X
 17   8.28     .00 *        X
 18   7.47     .00 *       X
 19   6.75     .00 *      X
 20   6.13     .00 *      X
 21   5.58     .00 *     X
 22   5.09     .00 *     X
 23   4.66     .00 *     X
 24   4.28     .00 *    X
 25   3.93     .00 *    X
 26   3.63     .00 *   X
 27   3.36     .00 *   X
 28   3.10     .00 *  X
 29   2.87     .00 *  X
 30   2.68     .00 *  X
                I.........I.........I.........I.........I.........I

                0      7.1      14.2      21.4      28.5      35.6
```

```
*** Calculated hydrograph, "At EAD Outlet Spilway"

                    Hydrograph
                    Calc.
Peak discharge,m^3/s    14.28
Time to peak,h          36.0
Volume,m^3          2.06E+06
Time to centroid,h      44.9
Lag (c.m. to c.m.),h    25.6
Lag to peak,h           16.7

Time inc.=  3.00 h
Time    Discharge      Discharge, m^3/s   X:  Calc.   O:
     Calc.      0      2.9      5.7      8.6     11.4     14.3
incs. m^3/s   m^3/s I.........I.........I.........I.........I.........I
                *      20 R/fall 40 excess 60   mm   80       100
  0    .00      *================
  1    .07      *            =============
  2    .26      *X                   ===============
  3    .87      *  X                         ======
  4   1.94      *     X
  5   3.40      *        X
  6   4.97      *           X
  7   6.46      *              X
  8   8.61      *                 X
  9  11.19      *                      X
 10  12.87      *                          X
 11  14.01      *            ==============================X=
 12  14.28      *==================                     X
 13  13.10      *                           X
 14  11.59      *                        X
 15  10.35      *                     X
 16   9.26      *                   X
 17   8.28      *                 X
 18   7.47      *               X
 19   6.75      *              X
 20   6.13      *            X
 21   5.58      *           X
 22   5.09      *          X
 23   4.66      *         X
 24   4.28      *        X
 25   3.93      *       X
 26   3.63      *      X
 27   3.36      *     X
 28   3.10      *    X
 29   2.87      *   X
 30   2.68      *  X
                I.........I.........I.........I.........I.........I

                0      2.9      5.7      8.6     11.4     14.3


Finished
Max. real array storage =  561 words
Max. integer array storage = 127 words
Max. character array storage=  39 words
```

Appendix 2

Temporal Patterns for Floods of ARI 50 years and 100 years

TEMPORAL PATTERN, ERARING ASH DAM REGION, ZONE 1
ARI of 50 years (>30 years)
Design Storm Duration From 1 to 9 hours

ARI	Duration													Total
		Time increment (hour)	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.08	0.083	1.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	12
50 years	**1 hour**	Percentage of rainfall per increment %	4.3	7.3	16.1	11.6	21.7	10.0	9.0	6.0	5.2	3.5	3.0	2.3	100.0
		Rainfall depth within increment (mm)	2.71	4.60	10.14	7.31	13.67	6.30	5.67	3.78	3.28	2.21	1.89	1.45	63.0

ARI	Duration																										Total
		Time increment (hour)	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	2.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24
50 years	**2 hour**	Percentage of rainfall per increment %	2.4	5.2	3.3	4.9	9.1	5.2	16.7	11.9	5.3	3.3	3.4	4.3	4.3	2.4	2.4	3.4	2.4	1.2	1.2	2.5	1.2	1.3	1.3	1.4	100.0
		Rainfall depth within increment (mm)	2.06	4.47	2.84	4.21	7.83	4.47	14.36	10.23	4.56	2.84	2.92	3.70	3.70	2.06	2.06	2.92	2.06	1.03	1.03	2.15	1.03	1.12	1.12	1.20	86.0

ARI	Duration													Total
		Time increment (hour)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	3.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	12
50 years	**3 hour**	Percentage of rainfall per increment %	5.7	16.8	23.4	8.7	11.8	7.8	5.8	6.7	4.8	3.8	2.8	1.9	100.0
		Rainfall depth within increment (mm)	5.81	17.14	23.87	8.87	12.04	7.96	5.92	6.83	4.90	3.88	2.86	1.94	102.0

ARI	Duration																				Total
		Time increment (hour)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	4.5
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18
50 years	**4.5 hour**	Percentage of rainfall per increment %	1.6	5.4	9.8	7.6	17.8	12.9	4.7	3.4	6.8	5.6	4.5	3.7	3.8	2.7	3.8	2.7	1.6	1.6	100.0
		Rainfall depth within increment (mm)	1.95	6.59	11.96	9.27	21.72	15.74	5.73	4.15	8.30	6.83	5.49	4.51	4.64	3.29	4.64	3.29	1.95	1.95	122.0

ARI	Duration													Total
		Time increment (hour)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	12
50 years	**6 hour**	Percentage of rainfall per increment %	4.1	8.0	11.0	23.3	15.3	8.1	7.0	7.0	5.1	6.1	3.1	1.9	100.0
		Rainfall depth within increment (mm)	5.66	11.04	15.18	32.15	21.11	11.18	9.66	9.66	7.04	8.42	4.28	2.62	138.0

ARI	Duration																					Total
		Time increment (hour)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	9.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18	18
50 years	**9 hour**	Percentage of rainfall per increment %	2.4	6.3	4.4	4.5	3.4	10.5	2.8	4.7	7.4	17.6	13.1	6.5	5.4	3.5	2.4	2.5	1.3	1.3	100.0	
		Rainfall depth within increment (mm)	3.96	10.40	7.26	7.43	5.61	17.33	4.62	7.76	12.21	29.04	21.62	10.73	8.91	5.78	3.96	4.13	2.15	2.15	165.0	

TEMPORAL PATTERN, ERARING ASH DAM REGION, ZONE 1
ARI of 50years (>30 years)
Design Storm Duration From 12 to 72 hours

ARI	Duration																									Total
		Time increment (hour)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	12.0
50 years	**12 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24
		Percentage of rainfall per increment %	1.6	4.5	3.5	1.6	0.6	2.6	2.6	4.7	3.6	2.6	3.6	7.0	9.2	15.8	3.5	0.6	4.8	11.3	6.0	4.9	1.6	2.7	0.6	0.5	100.0
		Rainfall depth within increment (mm)	2.99	8.42	6.55	2.99	1.12	4.86	4.86	8.79	6.73	4.86	6.73	13.09	17.20	29.55	6.55	1.12	8.98	21.13	11.22	9.16	2.99	5.05	1.12	0.94	187.0

ARI	Duration																			Total
		Time increment (hour)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18.0
50 years	**18 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18
		Percentage of rainfall per increment %	1.5	3.4	2.4	4.4	6.3	6.3	18.4	6.0	12.9	8.0	10.0	5.4	4.5	2.5	3.5	1.5	1.5	1.5	100.0
		Rainfall depth within increment (mm)	3.39	7.68	5.42	9.94	14.24	14.24	41.58	13.56	29.15	18.08	22.60	12.20	10.17	5.65	7.91	3.39	3.39	3.39	226.0

ARI	Duration																										Total
		Time increment (hour)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24.0
50 years	**24 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24
		Percentage of rainfall per increment %	0.6	1.5	1.5	2.5	4.4	1.5	2.5	3.4	3.5	6.6	8.7	15.8	10.9	3.4	4.4	4.6	6.7	5.6	2.5	3.5	2.5	1.4	1.5	0.5	100.0
		Rainfall depth within increment (mm)	1.56	3.90	3.90	6.50	11.44	3.90	6.50	8.84	9.10	17.16	22.62	41.08	28.34	8.84	11.44	11.96	17.42	14.56	6.50	9.10	6.50	3.64	3.90	1.30	260.0

ARI	Duration																	Total
		Time increment (hour)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	30.0
50 years	**30 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	15
		Percentage of rainfall per increment %	1.3	3.3	4.3	7.2	4.3	15.3	8.1	9.9	22.4	12.6	5.2	2.3	2.3	1.3	0.2	100.0
		Rainfall depth within increment (mm)	3.76	9.54	12.43	20.81	12.43	44.22	23.41	28.61	64.74	36.41	15.03	6.65	6.65	3.76	0.58	289.0

ARI	Duration																				Total
		Time increment (hour)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	36.0
50 years	**36 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18
		Percentage of rainfall per increment %	1.5	3.4	2.4	4.4	6.3	6.3	18.4	6.0	12.9	8.0	10.0	5.4	4.5	2.5	3.5	1.5	1.5	1.5	100.0
		Rainfall depth within increment (mm)	4.68	10.61	7.49	13.73	19.66	19.66	57.41	18.72	40.25	24.96	31.20	16.85	14.04	7.80	10.92	4.68	4.68	4.68	312.0

ARI	Duration																										Total
		Time increment (hour)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	48.0
50 years	**48 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24
		Percentage of rainfall per increment %	2.6	3.6	2.6	4.6	3.6	6.6	9.9	3.1	13.0	19.4	7.7	4.6	5.7	1.6	1.7	2.7	1.6	0.6	1.6	1.6	0.4	0.4	0.4	0.4	100.0
		Rainfall depth within increment (mm)	9.13	12.64	9.13	16.15	12.64	23.17	34.75	10.88	45.63	68.09	27.03	16.15	20.01	5.62	5.97	9.48	5.62	2.11	5.62	5.62	1.40	1.40	1.40	1.40	351.0

ARI	Duration																			Total
		Time increment (hour)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	72.0
50 years	**72 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18
		Percentage of rainfall per increment %	2.7	3.4	6.0	3.7	24.8	7.9	12.8	4.8	9.9	0.2	1.6	0.2	17.5	1.7	0.7	0.7	0.7	0.7	100.0
		Rainfall depth within increment (mm)	10.94	13.77	24.30	14.99	100.44	32.00	51.84	19.44	40.10	0.81	6.48	0.81	70.88	6.89	2.84	2.84	2.84	2.84	405.0

TEMPORAL PATTERN, ERARING ASH DAM REGION, ZONE 1
ARI of 100 years (>30 years)
Design Storm Duration From 1 to 9 hours

ARI	Duration													Total
		Time increment (hour)	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.08	0.083	1.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	12
100 years	**1 hour**	Percentage of rainfall per increment %	4.3	7.3	16.1	11.6	21.7	10.0	9.0	6.0	5.2	3.5	3.0	2.3	100.0
		Rainfall depth within increment (mm)	3.01	5.11	11.27	8.12	15.19	7.00	6.30	4.20	3.64	2.45	2.10	1.61	70.0

ARI	Duration																										Total
		Time increment (hour)	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	2.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24
100 years	**2 hour**	Percentage of rainfall per increment %	2.4	5.2	3.3	4.9	9.1	5.2	16.7	11.9	5.3	3.3	3.4	4.3	4.3	2.4	2.4	3.4	2.4	1.2	1.2	2.5	1.2	1.3	1.3	1.4	100.0
		Rainfall depth within increment (mm)	2.30	4.99	3.17	4.70	8.74	4.99	16.03	11.42	5.09	3.17	3.26	4.13	4.13	2.30	2.30	3.26	2.30	1.15	1.15	2.40	1.15	1.25	1.25	1.34	96.0

ARI	Duration													Total
		Time increment (hour)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	3.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	12
100 years	**3 hour**	Percentage of rainfall per increment %	5.7	16.8	23.4	8.7	11.8	7.8	5.8	6.7	4.8	3.8	2.8	1.9	100.0
		Rainfall depth within increment (mm)	6.50	19.15	26.68	9.92	13.45	8.89	6.61	7.64	5.47	4.33	3.19	2.17	114.0

ARI	Duration																					Total
		Time increment (hour)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	4.5
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		18
100 years	**4.5 hour**	Percentage of rainfall per increment %	1.6	5.4	9.8	7.6	17.8	12.9	4.7	3.4	6.8	5.6	4.5	3.7	3.8	2.7	3.8	2.7	1.6	1.6		100.0
		Rainfall depth within increment (mm)	2.18	7.34	13.33	10.34	24.21	17.54	6.39	4.62	9.25	7.62	6.12	5.03	5.17	3.67	5.17	3.67	2.18	2.18		136.0

ARI	Duration													Total
		Time increment (hour)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	6.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	12
100 years	**6 hour**	Percentage of rainfall per increment %	4.1	8.0	11.0	23.3	15.3	8.1	7.0	7.0	5.1	6.1	3.1	1.9	100.0
		Rainfall depth within increment (mm)	6.31	12.32	16.94	35.88	23.56	12.47	10.78	10.78	7.85	9.39	4.77	2.93	154.0

ARI	Duration																					Total
		Time increment (hour)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5		9.0
		Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		18
100 years	**9 hour**	Percentage of rainfall per increment %	2.4	6.3	4.4	4.5	3.4	10.5	2.8	4.7	7.4	17.6	13.1	6.5	5.4	3.5	2.4	2.5	1.3	1.3		100.0
		Rainfall depth within increment (mm)	4.42	11.59	8.10	8.28	6.26	19.32	5.15	8.65	13.62	32.38	24.10	11.96	9.94	6.44	4.42	4.60	2.39	2.39		184.0

TEMPORAL PATTERN, ERARING ASH DAM REGION, ZONE 1
ARI of 100 years (>30 years)
Design Storm Duration From 12 to 72 hours

ARI	Duration																									Total
		Time increment (hour)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	12.0
100 years	**12 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24
		Percentage of rainfall per increment %	1.6	4.5	3.5	1.6	0.6	2.6	2.6	4.7	3.6	2.6	3.6	7.0	9.2	15.8	3.5	0.6	4.8	11.3	6.0	4.9	1.6	2.7	0.6	0.5	100.0
		Rainfall depth within increment (mm)	3.34	9.41	7.32	3.34	1.25	5.43	5.43	9.82	7.52	5.43	7.52	14.63	19.23	33.02	7.32	1.25	10.03	23.62	12.54	10.24	3.34	5.64	1.25	1.05	209.0

ARI	Duration																				Total
		Time increment (hour)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18.0
100 years	**18 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18
		Percentage of rainfall per increment %	1.5	3.4	2.4	4.4	6.3	6.3	18.4	6.0	12.9	8.0	10.0	5.4	4.5	2.5	3.5	1.5	1.5	1.5	100.0
		Rainfall depth within increment (mm)	3.80	8.60	6.07	11.13	15.94	15.94	46.55	15.18	32.64	20.24	25.30	13.66	11.39	6.33	8.86	3.80	3.80	3.80	253.0

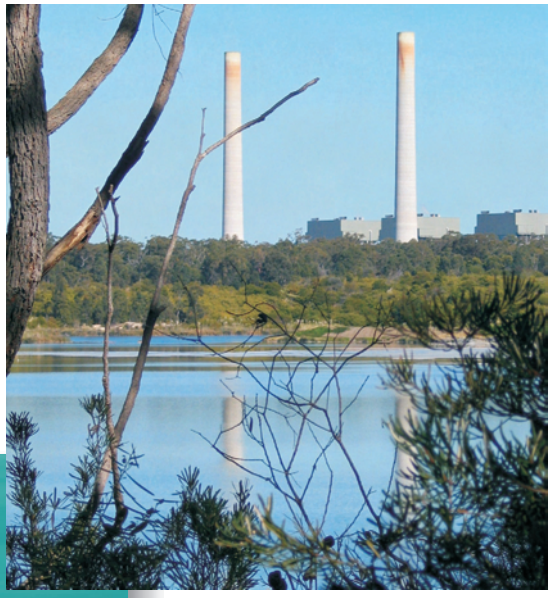
ARI	Duration																										Total
		Time increment (hour)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24.0
100 years	**24 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24
		Percentage of rainfall per increment %	0.6	1.5	1.5	2.5	4.4	1.5	2.5	3.4	3.5	6.6	8.7	15.8	10.9	3.4	4.4	4.6	6.7	5.6	2.5	3.5	2.5	1.4	1.5	0.5	100.0
		Rainfall depth within increment (mm)	1.75	4.38	4.38	7.30	12.85	4.38	7.30	9.93	10.22	19.27	25.40	46.14	31.83	9.93	12.85	13.43	19.56	16.35	7.30	10.22	7.30	4.09	4.38	1.46	292.0

ARI	Duration																										Total
		Time increment (hour)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	30.0
100 years	**30 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	15
		Percentage of rainfall per increment %	1.3	3.3	4.3	7.2	4.3	15.3	8.1	9.9	22.4	12.6	5.2	2.3	2.3	1.3	0.2	1.3	3.3	4.3	7.2	4.3	15.3	8.1	9.9	22.4	100.0
		Rainfall depth within increment (mm)	4.23	10.73	13.98	23.40	13.98	49.73	26.33	32.18	72.80	40.95	16.90	7.48	7.48	4.23	0.65	4.23	10.73	13.98	23.40	13.98	49.73	26.33	32.18	72.80	325.0

ARI	Duration																				Total
		Time increment (hour)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	36.0
100 years	**36 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18
		Percentage of rainfall per increment %	1.5	3.4	2.4	4.4	6.3	6.3	18.4	6.0	12.9	8.0	10.0	5.4	4.5	2.5	3.5	1.5	1.5	1.5	100.0
		Rainfall depth within increment (mm)	5.28	11.97	8.45	15.49	22.18	22.18	64.77	21.12	45.41	28.16	35.20	19.01	15.84	8.80	12.32	5.28	5.28	5.28	352.0

ARI	Duration																										Total
		Time increment (hour)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	48.0
100 years	**48 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	24
		Percentage of rainfall per increment %	2.6	3.6	2.6	4.6	3.6	6.6	9.9	3.1	13.0	19.4	7.7	4.6	5.7	1.6	1.7	2.7	1.6	0.6	1.6	1.6	0.4	0.4	0.4	0.4	100.0
		Rainfall depth within increment (mm)	10.30	14.26	10.30	18.22	14.26	26.14	39.20	12.28	51.48	76.82	30.49	18.22	22.57	6.34	6.73	10.69	6.34	2.38	6.34	6.34	1.58	1.58	1.58	1.58	396.0

ARI	Duration																				Total
		Time increment (hour)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	72.0
100 years	**72 hour**	Increment number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	18
		Percentage of rainfall per increment %	2.7	3.4	6.0	3.7	24.8	7.9	12.8	4.8	9.9	0.2	1.6	0.2	17.5	1.7	0.7	0.7	0.7	0.7	100.0
		Rainfall depth within increment (mm)	12.39	15.61	27.54	16.98	113.83	36.26	58.75	22.03	45.44	0.92	7.34	0.92	80.33	7.80	3.21	3.21	3.21	3.21	459.0



appendix e

aboriginal consultation

National Native Title Tribunal

Search Results

Prepared for HLA – Enviroscences Pty Ltd

Geospatial Job: GT2007/1414

Your Reference: S60555702

Search Area: As supplied by map to National Native Title Tribunal by HLA-Enviroscience Pty Ltd NSW

Requested by: Kate Tilden

Date: 15/8/2007

DISCLAIMER

This information product has been created to assist in understanding the spatial characteristics and relationships with native title matters and is intended as a guide only. Spatial data used has been sourced from the relevant custodians in each jurisdiction. The Registrar, the National Native Title Tribunal and its staff and officers and the Commonwealth, accept no liability and or give no undertakings, guarantees or warranties concerning the accuracy, completeness or fitness for purpose of the information.

NOTES FOR INTERPRETING THE RESULTS

The search is based on the external boundary of the application or agreement. To determine whether any search area is subject to claim, determination or agreement, you need to refer to the accompanying extracts and associated documents. An *"explanation of terms"* follows the search results.

Results of spatial analysis as at 15th August 2007

Indigenous Land Use Agreements

Search Area	Area (sqkm)	Overlap (sqkm)	% of Area within ILUA	Tribunal Number	Name	Agreement Status	Registration Date
Area A	1.434	1.43	100.00	NIA2000/001	Powercoal Pty Ltd Victor Perry Stephen Seiver and NSW ALC ILUA	Registered	29/08/2001

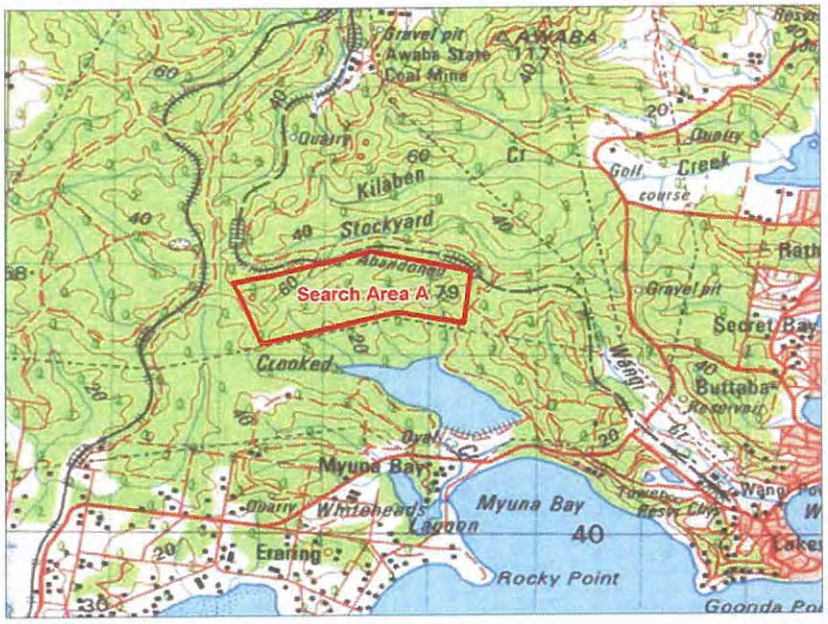
There is **NO** overlap with any determination of native title as per the **National Native Title Register**.
There is **NO** overlap with any registered application as per the **Register of Native Title Claims**.
There is **NO** overlap with any scheduled application as **filed with the Federal Court**.

Representative Aboriginal and Torres Strait Islander Body Area

Search Area	Area (sq km)	% of Area within RATSIB Area	Name
Area A	1.434	100.00	New South Wales - no recognised body (NSW Native Title Services)

Local Government Area

Search Area	Area (sq km)	% of Area within LGA	Name
Area A	1.434	100.00	Lake Macquarie City Council



MUD MAP

DATA STATEMENT

Prepared by Geospatial Services, National Native Title Tribunal.

New South Wales
Application boundary data compiled by the National Native Title Tribunal from data sourced from the Dept of Lands, Land and Property Information Division, NSW.
Local Government Areas data sourced from Public Sector Mapping Agency (August 2006).
Search area mapped by NNTT from map supplied by HLA-Envirosciences Pty Ltd (August 2007)

RATSIB data compiled by NNTT based on reference material sourced from AIATSIS and spatial data sourced from Geoscience Australia, Department of Natural Resources & Water (Qld) and Sinclair Knight Merz Pty Ltd.

EXPLANATION OF TERMS

National Native Title Register (NNTR)	Contains determinations of native title where native title does and does not exist in a particular area of land or waters.
Register of Native Title Claims (RNTC)	Contains claimant applications which have passed the Registration Test and those applications filed before 30/09/1998 that are still undergoing the Registration Test.
Schedule of applications – Federal Court	Contains active applications before the Federal Court.
Register of ILUAs	Contains indigenous land use agreements (ILUAs) that have been accepted for registration
Notified applications for indigenous land use agreements	Contains applications for ILUAs which have been notified but not yet registered
Area (sq km)	Total area of the Search Area (in sq km)
Tribunal Number	National Native Title Tribunal reference number (including identifier to record part applications)
Fed Court Number	Federal Court reference number
Name	Application or agreement name
Determination Date	Date on which the determination was made
Registration Date	Date on which the application was first placed on the Register of Native Title Claims with regard to its current 'registered' status or date on which an ILUA was registered
Reg Test Status	Registration test status (e.g. Accepted for registration, Currently identified for Reg. Test, Not currently identified for Reg. Test)
Application Type	Claimant, non-claimant or compensation
ILUA Status	In notification, notified, Registered

NATIONAL NATIVE TITLE TRIBUNAL

Extract from Register of Indigenous Land Use Agreements

NNTT number:	NIA2000/001
Short name:	Powercoal Pty Ltd, Victor Perry, Stephen Seiver & NSW ALC ILUA Area Agreement
ILUA type:	Area Agreement Certified
Date registered:	29/08/2001
AREA	
State(s)/Territories ILUA Covers:	NSW
ATSIC region(s) Or TSRA:	
Local Government Region(s):	Lake Macquarie City Council

Description of the area covered by the agreement:

The area covered by the agreement is located about 20km south west of Newcastle and in the vicinity of Lake Macquarie and covers an area of about 87 square km. Schedule 1 of the Area Agreement being a map of the area is attached.

PARTIES TO THE AGREEMENT

Applicant

Applicant Name:	Company Name:	Street Address:	Suburb/ Town:	State:	Postcode:
Powercoal Pty Ltd	c/- Clayton Utz	Level 18 - 333 Collins Street	Melbourne	VIC	3000

Other parties

Party Name:	Street Address:	Suburb/Town:	State:	Postcode:
Victor Perry on behalf of the Wonnarua People	c/- NSW Aboriginal Land Council			
Stephen Seiver	c/- NSW Aboriginal Land Council			
New South Wales Aboriginal Land Council	Level 9 - 33 Argyle Street	PARRAMATTA	NSW	2150

OPERATION PERIOD OF AGREEMENT

Start date: 28/05/99

End date: 28/05/2020

Statements to the effect of 24EB(1) or 24EBA(1) or (4):

Consent to Future Acts provided for by the agreement:
1. Subject to the Deed and to the Master Deed, Victor Perry (on behalf of the Wonnarua People) and Stephen Seiver consent to the doing of the Future Acts.
2. Subdivision P of Division 3 of Part 2 of the NTA is not intended to apply and does not apply to the doing of any of the Future Acts.
3. The non-extinguishment principle applies to the doing of the Future Acts.

Future Act is defined as a future act as defined in the NTA which consists of;
(a) the grant of a Mining Tenement;
(b) the grant or renewal by a Government Authority of any other right in respect of the surface area of the area of interest for the purposes of the mining operations;
(c) Mining operations; and
(d) any other act done by Powercoal for the purposes of the mining operations.

Mining operations are defined as 'the underground coal mining operations to be carried out by or under the direction of Powercoal within the area of interest, including, without limiting the generality of the foregoing, exploration, developing, designing, constructing, extracting, handling and transporting of coal and other products won from the underground coal mining operations within the area of interest and any rehabilitation work within the area of interest.

Mining Tenement is defined as a tenement granted to Powercoal under the Mining Act 1912

(NSW) to carry out Mining Operations in the area of interest.

Assignment provided for by the agreement: Powercoal is able to assign all or part of its rights under the Deed to another party, provided that other party assumes the obligations of Powercoal under the Deed.

SUBJECT MATTER DESCRIPTION

Agreement Subject Matter: mining

Nature of Activity: large mining

Description: Mining operations are defined as 'the underground coal mining operations to be carried out by or under the direction of Powercoal within the area of interest, including, without limiting the generality of the foregoing, exploration, developing, designing, constructing, extracting, handling and transporting of coal and other products won from the underground coal mining operations within the area of interest and any rehabilitation work with the area of interest.

Awabakal Traditional Owners Aboriginal Corporation

P.O.Box 253 Jesmond NSW 2299
Phone: (02) 49156 947
Mobile: 0412866357
Email: klbrauer@bigpond.com
ABN: 90 203 408 309

2 October 2007

Neville Baker
Principle Archaeologist
HLA-Envirosciences Pty Ltd
P.O. Box 726
Pymble NSW 2073

Re: Proposed Upgrade of the Eraring Power Station Ash Management Facility

Dear Neville,

The Awabakal Traditional Owners Aboriginal Corporation Aboriginal heritage assessment was carried out on the 4th September 2007. The site inspection was also attended by Shane Frost. A foot survey was conducted within the development area. The proposed Ash Dam upgrade is for an extension of the ash management facility initiated by Eraring Power Station. The previous assessment for the site was carried out on the 10th January 2006 by Scott Franks and Rob Lester. The primary objective of the preliminary Aboriginal Heritage assessment is to ascertain the presence of any areas of cultural or archeological significance within the study area.

We would like to affirm that the observation and information gathering process presented minimal visible evidence. However, it should not be assumed that no Aboriginal artifacts have survived within the proposed development area.

The principal vision and aims of the Awabakal Traditional Owners Aboriginal Corporation is to protect the cultural heritage of our Awabakal ancestral family. Naturally any evidence of our people's presence and lifestyle is held in high regard as a cultural reminder that unites us with our country and spirituality. The Proposed upgrade of the Eraring Power Station ash management regarded as the Ash Dam site falls into this category.

With regards to the proposed upgrade of the Eraring Power Station ash management facility regarded as the Ash Dam site, we recognise the environmental safeguards have been taken into consideration, but also recommend that any artifacts identified during the development requires certain actions to be carried out including the immediate ceasing of operations and notification to stakeholders. Also any Aboriginal artifacts exposed should be photographed and documented to provide a site specific information data collective.

An observation and a cultural and spiritual sensation within the study area was revealed on the day of the Aboriginal heritage Assessment. Kerrie had indicated to Shane Frost that she believed that she should not be in this area, and that it was a mens area. Contained and observed within the study area are particularly and predominantly marked trees that are aligned with Pulba Island. We therefore recommend that the marked trees are to be protected as a visual reminisce that speaks to the present day as a spiritual reminder of our cultural links to our country and Awabakal ancestors.

Our Awabakal cultural environment is a holistic one that interconnects our spirituality and land to our peoples past, present and future. The descendants of the Awabakal people believe now more than ever that it is essential to protect the cultural landscape of our ancestral family. We reserve the right and reluctance to share our cultural heritage with others in respect to aspects of the cultural significance that connects us to our country.

The archaeological assessment evaluated by HLA- Envirosciences Pty Ltd appears comprehensive.

Yours sincerely,

K. Brauer.

Kerrie Brauer
Secretary/Public Officer

Guringai Tribal Link
Aboriginal Corporation ABN 18 351 198 069
(Traditional Owners of the NSW Central Coast)

19 Coolabah Road,
Wyongah NSW 2259
Phone:(02) 4392 8743
Fax:(02) 4396 9525
Mobile: 0404 182 049
Email: guringai@kooee.com.au

30th August, 2007

Neville Baker

Principal Archeaologist

HLA-Envirosciences Pty.Ltd.

P.O.Box 726,

Pymble, NSW, 2072.

DearNeville,

RE: PROPOSED UPGRADE OF ERARING POWER STATION'S ASH MANAGEMENT FACILITY.

Thank you for inviting Guringai Tribal Link Aboriginal Corporation (GTLAC) to participate in the Indigenous Heritage Consultation at Eraring Power Station on 21st August, 2007.

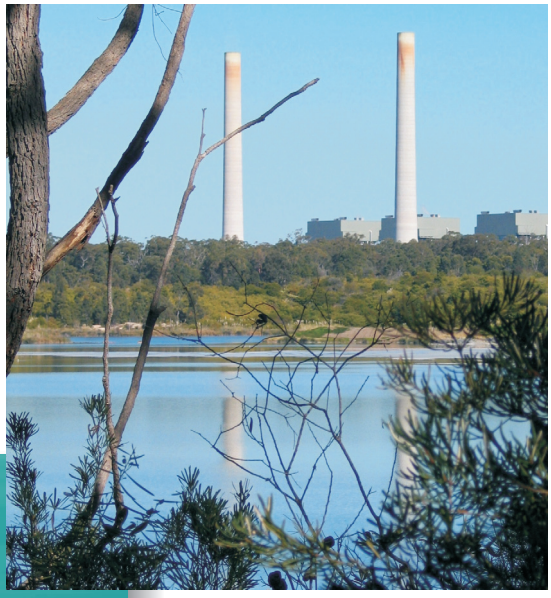
GTLAC have discussed this matter and are comfortable with the methodology for this project, as described by yourself and Garry Craig-Project Manager, at the above mentioned meeting.

Continued consultation is greatly appreciated.

MANUA OOMOOLYAN GOORI

Yours sincerely,

Tracey-lee Howie
Chairperson
Female Cultural
Heritage Officer
(contacts above)

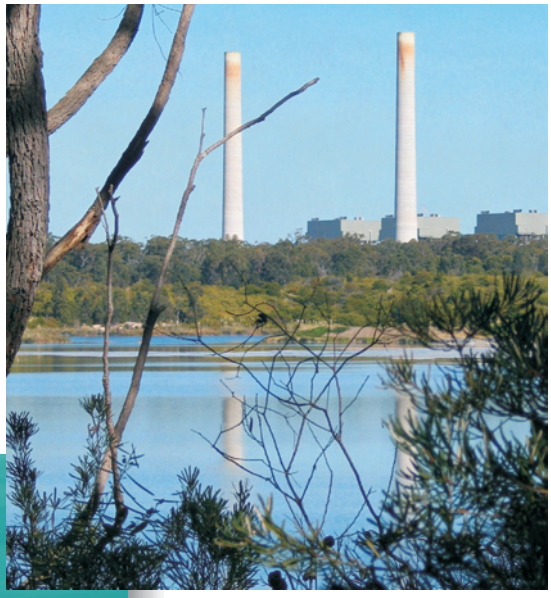


appendix f

archaeological terrain recording form

Archaeological Terrain Recording Form

Survey Area					
AMG Reference	Start……		End……		
Landform Unit	Crest	Ridge		Hillock	
	Simple Slope	Upper Slope		Mid Slope	
	Lower Slope	Flat		Open Depression	
	Closed Depression	Stream 1st	2nd	3rd	4th
Slope	Level	Very Gently Inclined		Gently Inclined	
	Moderately Inclined	Steep		Very Steep	
Exposure	Eroded	Aggraded		Human Action	
Geomorphological Agent	*Gravity:*	Collapse	Particle Fall		
	Precipitation:	Soil Creep	Mass Movement	Sheet Wash	
	Stream Flow:	Overbank	Channelled	Flood	Watertable
	Biological	Human	Animal		
Human Action:	Road	Residential	Earthworks	Industrial	Pastoral
	Other……				
Level of Disturbance	1	2	3	4	5	6	7	8
Exposure	No. of exposures……		Exposure area……		
Soil Type					
Soil Profile Exposed	Exposed:	A	A2	B	C	Vertical Profile:	Yes	No
Geology					
Locally Available Material	Silcrete	Mudstone	Quartz	Tuff	Quartzite
	Chert	FGS	Pet Wood	Sandstone	
Vegetation	Tall = trees>10m	Mid= shrubs+trees<10m		Low= grasses	
Groundcover	Dense= 70%	Mid-dense=30-70%		Sparse=10-30%	
	Very sparse= 10%	None			
Stone Artefacts	Absent	Present	Number……..		
Raw Materials Used	Silcrete	Mudstone	Quartz	Tuff	Quartzite
	Chert	FGS	Pet Wood	Sandstone	



appendix g

threatened species recovery plan *tetratheca juncea* and *acacia bynoeana*

Prepared for:

Eraring Energy

PO Box 5044
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Threatened Species Recovery Plan *Tetratheca juncea* and *Acacia bynoeana* Eraring Energy - Eraring NSW

HLA-Envirosciences Pty Limited (HLA ENSR)

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Threatened Species Recovery Plan *Tetratheca Juncea* And *Acacia Bynoeana* Eraring Energy - Eraring Nsw

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By

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CONTENTS

FIGURES

Figures Section

PLATES

Plates Section

TABLES

Body Report

Appendices

1.0 Introduction

This Threatened Species Recovery Plan (TSRP) was prepared by HLA-Envirosciences Pty Ltd (HLA ENSR), a subsidiary of ENSR Corporation, an AECOM Company and has been written in accordance with the framework of the following Eraring Management Plans:

- Land Management Plan;
- Biodiversity Management Plan; and
- Threatened Species Management Plan.

The TSRP has been compiled specifically for *Tetratheca juncea* and *Acacia bynoeana* which occur within the Eraring Power Station operational lands (the Site).

1.1 Background

Tetratheca juncea and Acacia bynoeana are listed as Vulnerable and Endangered species respectively under the *Threatened Species Conservation Act 1995 (NSW)* (TSC Act). Both species have a national conservation status of Vulnerable under the *Environmental Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act).

The daily operations of the Site and any possible future expansion may directly or indirectly impact upon the long term survival of individual plants and populations of these two species. This TSRP has been developed to mitigate possible impacts to these two species, and to provide measures to protect and promote the enhancement and sustainable reproduction of these species across the Site.

1.2 Objectives

The overall objective of this TSRP is to protect existing populations of the two mentioned species while establishing new populations that are stable, viable and self-perpetuating. This Recovery Plan provides a methodology for the protection of existing populations, as well as populations likely to be impacted by any future developments on the Site.

Specific objectives include:

- To gain an understanding of the biology, ecology, health and distribution of the species across the Site;
- To ensure existing populations are managed for conservation purposes and protected from habitat loss;
- To protect existing populations where possible from key threats;
- To develop and implement site specific habitat management and enhancement measures;
- Incorporate recommendations of the Bush Fire Management Plan (BFMP) which are relevant to the recovery of the species;
- To increase the numbers of mature individuals through targeted propagation and scientific monitoring;

- To provide a guide for onsite development to minimise potential impact upon the two species;
- To develop the awareness and involvement of the Eraring Staff to the location, appearance and conservation of the two species;
- To identify locations and methodology for the translocation of individual plants that are to be impacted by future developments; and
- To define the transplantation protocol for populations of the two species that will be impacted by development disturbance of the Site.

1.3 Site location and context

The Site is located between Morisset and Toronto, on the western foreshore of Lake Macquarie in the New South Wales Central Coast region.

The management area adjoins:

- Myuna Bay to the east;
- Northern Railway along the western boundary;
- Lake Eraring and Bonnells Bay to the south; and
- A mix of private and Crown lands to the north.

Principal landholders that adjoin the management area are as follows:

- NSW Department of Lands – Crown Lands to the north;
- Centennial Coal - Cooranbong Colliery to the west and Myuna Colliery to the southeast;
- Rail Services Australia – rail corridor which adjoins the Site;
- Transgrid and Energy Australia – electricity supply infrastructure;
- NSW Sport and Recreation – Myuna Bay Sport Recreation Centre;
- Private residents – rural properties of Myuna Bay and Eraring; and
- Private residents – residential properties of Dora Creek to the south.

The areas of native vegetation on the site are predominantly classified as open Eucalypt woodland and open Eucalypt forest. The areas of native vegetation are interspersed with various industrial installations including the Power Station itself, refuelling depots, water storage dams and the Ash Dam.

A diagrammatic representation of the Site is provided on **Figure F1.**

1.4 Licensing requirements – recovery of threatened species

Projects approved under Part 3A of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) do not require subsequent approvals or separate licensing to extract a threatened plant species for the purpose of propagation or translocation in relation to that project. This should be covered by the Consent Conditions issued for project approval.

This does not apply to Eraring lands outside of these Part 3A approvals, or areas which are the subject of development consent under Part 4 of the EP&A Act. Therefore a licence would be required under Section 132C of the *National Parks and Wildlife Act 1974* (NSW) (NP&W Act) to undertake an activity for scientific, educational or conservation purposes, that is likely to result in harm to a protected native

plant, or a plant that is a threatened species or is part of an endangered population or an endangered ecological community. A licence is also needed to collect voucher specimens for identification purposes, pick cuttings or whole plants, or to collect seed (NSW NPWS 2006: para. 1) (refer **Appendix A**).

The EPBC Act requires a permit for activities which may kill, injure, take, trade, keep or move a member of a listed threatened species or ecological community, a member of a listed migratory species, or a member of a listed marine species (Department of Environment and Water Resources 2007: para. 1) (see **Appendix B** and **Appendix C**).

1.5 Genetic considerations

Rare plants frequently occur in small populations that are often isolated from other similarly small populations. This isolation generally results in a combination of genetic bottlenecks and drift that leads to a reduction in overall viability (Ooostermeijer 2003). Specific changes can be related to the mating system of the natural population i.e. self compatible, self incompatible, mixed. For example isolation of plant species that are normally self-incompatible often results in a breakdown of this incompatiblity with the attendant inbreeding depression.

The implications of this for translocation are that the genetic changes brought about by isolation can result in a genetic incompatibility with the plants of other isolated populations (Ellestrand et al 1993). Consequently moving plants (or their propagules) from one isolated population to within pollination distance of another isolated population can result in a reduction of fitness leading ultimately to loss of both populations.

Habitat connectivity is a closely related matter. While plants themselves are physically located where they grow, mobility of pollinator and seed dispersal vectors is an important component in maintaining genetic diversity and facilitating the expansion of populations (Young et al 1996).

What are the consequences of this for rare plant management in the context of habitat destruction? It means that digging some rare plants up and moving them out of the way is not a simple answer. In the interests of the long-term (>75years) prospects for survival of the translocated plants and the population as a whole, the following should be considered:

- The accessibility of the recipient site to pollination and seed dispersal vectors;
- The likelihood that genetic material to and from the recipient site is within range of the next nearest population;
- Whether the target population is already isolated from genetic refreshment and should not be brought into contact with another isolated population; and
- An assessment should be made of the overall population structure in the locality to determine the level of genetic isolation present in sub-populations.

These considerations have been incorporated into the review of recovery strategies for both species as discussed in this TSRP.

2.0 Recovery plan: *Acacia bynoeana*

2.1 Conservation status

As of October 1999, under State legislation the NSW Scientific Committee, has made the determination to list the *Acacia bynoeana* in Schedule 1 (Endangered) of the TSC Act, upgrading the status of the species from the previous classification of Vulnerable. The TSC Act defines 'Endangered' as:

"A species, population or ecological community that is likely to become extinct or is in immediate danger of extinction."

Acacia bynoeana has a national conservation status of Vulnerable under the EPBC Act effective as of July 16, 2000. Under the EPBC Act development impacts upon the species must be addressed with the aim of minimising any potential impact.

2.2 Description

Acacia bynoeana Benth. is a small prostrate shrub which grows to 0.5m high. Golden yellow flowers are visible from September until March and seed pods mature from November to January (NSW NPWS 1999). The below description is provided from PlantNET (Botanic Gardens Trust 2007).

Family:

Fabaceae – Mimosoideae

Common Name:

Bynoe's Wattle, Tiny Wattle

Description:

Decumbent shrub to 0.5 m high; branchlets +/- terete, +/- hairy. Stipules +/- subulate, to 1.5 mm long.

Phyllodes narrowly elliptic to +/- linear, straight to slightly curved, usually 0.5-6 cm long (occasionally some phyllodes to 8 cm long), 1-3 mm wide, at first coarsely hairy and then +/- glabrous, 3 longitudinal veins prominent, apex +/- pungent-pointed; 1 minute gland at base; pulvinus to 1 mm long.

Inflorescences simple, 1 in axil of phyllodes; peduncles 2-6 mm long, hairy; heads globose, 10-25-flowered, 3-4 mm diameter, bright yellow.

Pods straight, raised over and +/- slightly constricted between seeds, 1-3 cm long, 3-4 mm wide, firmly papery and brittle, with raised pale anastomosing longitudinal veins, +/- minutely hairy; seeds longitudinal; funicle expanded towards seed.

A photo of the species as typically occurs across the Site is provided in **Plate 1**.

Plate 1: *Acacia bynoeana*

Photo T.M. Tame ©Royal Botanic Gardens & Domain Trust, Sydney Australia

2.3 Habitat

Acacia bynoeana is endemic to central eastern NSW and occurs in an area from the Hunter district on the Central Coast south to Berrima and Mittagong in the Southern Highlands (Morrison & Davies 1991). Significant populations occur within the Blue Mountains area.

Driscoll (2006) performed an audit on all available records sourced from the Atlas of NSW Wildlife and private records to determine 357 known locations. By looking at the population and plant numbers for all records, individual plants number between 1456 and 6691. *Acacia bynoeana* habitat occurs mainly in heath and dry sclerophyll forest (Harden, 1991); open woodland with dense to sparse heath understorey; open woodlands with a sparse shrub cover and a grass/sedge ground cover; and heathlands with sparse overstorey (Driscoll 2006).

The substrate is typically sand and sandy clay, often with ironstone gravels and is usually very infertile and well-drained. The species seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds (from grading) and recently burnt open patches (S. Douglas pers. comm.; Benson & McDougall 1996).

The recorded locations of *Acacia bynoeana* across the Site are illustrated on **Figure 1**.

Driscoll (2006) conducted an analysis of slope, aspect and altitude for all recorded locations of the species. The results indicated the species recorded occur mostly on flat to low relief topography (0° to

8°). The altitude analysis indicated that the majority of records are from 0 to 200m Australian Height Datum (AHD); however the range does extend to 1000m AHD.

2.4 Biology and ecology

Acacia bynoeana is known to flower from September to March with seed pods occurring from November to January (Benson and McDougall 1996; NSW NPWS 1999). Seeds are shed at maturity and there is apparently little local dispersal of seed, although the species can maintain a long-term soil-stored seedbank (Benson and McDougall 1996). The plant has a woody rootstock and Benson and MacDougal (1996) consider it likely that the species is able to re-sprout from the rootstock after fire.

Seeds produced fall beneath the plant upon the opening of the pods. Dispersal of the seed is thought to occur by ants harvesting the seeds for the aril (Whitney 2002 cited in Driscoll 2006).

Driscoll (2006) reports *that Acacia bynoeana* is also a clonal species that spreads vegetatively by underground stems.

2.5 Management issues

On a broad scale the main threats to *Acacia bynoeana* are habitat disturbance (including road, trail and powerline maintenance, and recreational vehicle use), clearing, weed invasion and frequent fire. Due to the fragmented nature of the populations, their small size, fire mitigation activities and the proximity of urbanisation, the species is susceptible to catastrophic events and localised extinction (NSW NPWS, 1999). These threats are relevant to the threatened species occurring across the Site.

Browsing by herbivorous animals is also a potential threat. Observations by Driscoll (2006) have noted that the European Hare may be responsible across several areas. This is due to an inconsistent browsing pattern across the observed area and the known presence of the Hares in areas where browsing is prevalent.

Table 1: *Acacia bynoeana* - Summary Table

Acacia bynoeana	
Flowering Time:	September to March
Seeding Time:	November to January
Soil Type:	Well drained sand and sandy clay
Slope:	Flat to low relief (0° to 8°)
Altitude:	0 to 200 m AHD
Vegetation Complex as per previously mapped vegetation communities:	Coastal Plains Scribbly Gum Woodland; Scribbly Gum Open Woodland; Coastal Plains Bloodwood-Apple Forest; and Coastal Sheltered Apple-Peppermint Forest.

3.0 Recovery plan: *Tetratheca juncea*

3.1 Conservation status

In New South Wales *Tetratheca juncea* is listed under Schedule 2 (Vulnerable) of the TSC Act. A 'Vulnerable' species is defined as a species:

> *"…likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate."*

Tetratheca juncea has a national conservation status of Vulnerable under the EPBC Act effective as of July 16, 2000. Under the EPBC Act development impacts upon the species must be addressed with the aim of minimising any potential impact.

3.2 Description

Tetratheca juncea is a low growing, usually leafless shrub with clumps of stems to one metre or more in length that bear deep lilac-pink or rarely white flowers. When present the narrow leaves are about 2cm long and lack a stalk (Thompson 1976, Harden 1992, Payne 2000). Plants are usually sprawling and are difficult to detect amongst other vegetation when not flowering. It may be readily distinguishable from other *Tetratheca* species with which it grows by its distinct winged stem and reduced leaves (NSW Department of Environment and Conservation 2005: para. 1). The below description is provided from PlantNET (Botanic Gardens Trust 2007).

Family:

Elaeocarpaceae

Common Name:

Black-eyed Susan

Description:

Prostrate shrub with stems to 1 m long; stems with 2 or 3 wings, glabrous with minute tubercles.

Leaves alternate, usually reduced to narrow-triangular scales, 3 mm long, otherwise +/- narrow-elliptic, to 20 mm long and c. 5 mm wide, glabrous, margins flat or recurved; sessile.

Flowers solitary or paired; peduncles 5-10 mm long, glabrous. Sepals 1-1.5 mm long, pink. Petals 7-11 mm long, deep lilac-pink. Ovary glabrous; ovules 4.

Fruit obovate, 6-8 mm long, often beaked, +/- stalked; seeds c. 4 mm long.

A photo of the species as typically occurs across the Site is provided in **Plate 2**.

Plate 2: *Tetratheca juncea*

Photo T.M. Tame ©Royal Botanic Gardens & Domain Trust, Sydney Australia

3.3 Habitat

Tetratheca juncea occurs naturally only in NSW. The species distribution is confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock (NSW Department of Environment and Conservation 2005:para. 2).

Driscoll (2003) used GIS analysis of 400 records compiled from Payne 2000, Bartier et al. 2001, and S. Bell & C. Driscoll (unpub) to demonstrate that *Tetratheca juncea* has been reported from 16 separate, and often widely differing, vegetation community types as defined in NSW NPWS (2000). These results indicate that within the range of its occurrence, *Tetratheca juncea* should be considered as possibly occurring in most common vegetation communities. A breakdown of occurrence in respective vegetation types has been outlined as follows:

- 60% of records were from within Coastal Plains Smooth Barked Apple Woodland (MU30);
- 14% from Coastal Plains Scribbly Gum Woodland (MU31); and
- 11% from Coastal Foothills Spotted Gum-Ironbark Forest (MU15).

It usually grows in low nutrient soils on hills and ridges and along creeks. The species prefers sites with good drainage and will grow in soils ranging from acidic to neutral (Payne 1998). Recorded locations of *Tetratheca juncea* across the Eraring Power Station site are illustrated on **Figure 2**.

The *Tetratheca* genera are known to form mycorrhizal association with soil fungi, allowing an exchange of nutrients between the two organisms. The fungus receives some of the carbohydrates photosynthesized by the plant and the plant obtains various inorganic nutrients and trace elements (Lepp, 2007 online).

3.4 Biology and ecology

Flowering of the *Tetratheca juncea* is sporadic, occurring mostly between July and December (Harden 1992). The species is capable of self pollination and even automatic seed set, however most seed is set where pollination occurs with pollen from another plant (Bartier et al. 2001). Studies conducted by Bartier et al. (2001) have indicated that the viability of the seed is low and that the seed stored in the soil is not long lived. Germination of seed is generally poor. Germination success can be increased when the seeds are treated with smoke (Bartier et al. 2001).

Tetratheca juncea is known to occur in fire prone environments, and is thought to be able to withstand a rapid hot fire – resprouting from rootstock, but not always able to withstand a prolonged slow fire (Benson and McDougal 2001).

3.5 Management issues

On a broad scale the main threats to *Tetratheca juncea* are considered to be habitat loss and degradation associated with land development (e.g. Great Lakes Council 2003, Karuah-Great Lakes Catchment Management Committee 2001, Lake Macquarie Council 2004, Wyong Shire Council 2003) and coal mining (Bartier 2001) although some developments have been shown likely to affect only a small proportion of plants in a given area (HWR Ecological 2002). Given the high occurrence of the species across the Site it is inevitable that future development will impact on some of the existing populations.

Weeds, which presumably compete with *Tetratheca juncea* plants for light and water, and may smother plant clumps, have been reported to be a potential threat in some areas (NSW NPWS 2003b) including the Wyong area (Wyong Shire Council 2003). Payne (2000) noted that invasion by competitive species such as Bladey Grass and Bracken may be encouraged by inappropriate fire regimes. Timber harvesting and inappropriate fire regimes are also considered threats to the species (Karuah-Great Lakes Catchment Management Committee 2001, NSW NPWS 2003b, Payne 1993, Payne 2000, Wyong Shire Council 2003).

Payne (2000) notes that the species appears to be sensitive to soil disturbance and vegetation clearance. Development activities involving clearing are likely to adversely affect the species through destruction of plants, loss/alteration of habitat, increasing fragmentation of subpopulations, and loss of connectivity between subpopulations. Where portions of subpopulations are retained and incorporated into residential design (Conacher Travers 2003, Lake Macquarie Council 2004), plants may still be at risk, for example from rubbish dumping (Wyong Shire Council 2003) or local recreational activities. *Phytophthora cinnamomi* has been declared a Key Threatening Process in NSW (NSW Scientific Committee 2003) with *Tetratheca juncea* being listed as a species with the potential to be adversely affected either through direct infestation or habitat degradation.

Tetratheca juncea has a limited geographic distribution that is precarious for the survival of the species. The species has a restricted extent of occurrence, is severely fragmented, and is subject to ongoing loss and fragmentation of habitat and a continuing decline in the number of subpopulations.

In summary, the key threats to the species on a broad scale include:

- Habitat loss and degradation (e.g. from land development, mining and timber harvesting activities);
- Competition from weeds;
- Inappropriate fire regimes; and
- Impacts from the plant pathogen *Phytophthora cinnamomi*.

Table 2: *Tetratheca juncea* - Summary Table

Tetratheca juncea	
Flowering Time:	July to September.
Seeding Time:	November to January.
Soil Type:	Acidic to neutral, well drained sandy soils,
Slope:	Various slope angles
Altitude:	30 to 70 m AHD (Eraring Site Specific).
Vegetation Complex as per previously mapped vegetation communities:	Coastal Plains Bloodwood Apple Forest; Coastal Plains Scribbly Gum Woodland; and Coastal Foothills Spotted Gum-Ironbark Forest.

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4.0 Recovery and management options

The following recovery and management options are designed to promote existing populations through responsible land management and to provide measures for the recovery of individual plants that may be potentially impacted.

4.1 Habitat protection

The locations of *Acacia bynoeana* and *Tetratheca juncea* across the Site have previously been recorded and are presented in **Figure 1** and **Figure 2** respectively. Habitat loss across the Site through degradation and development is a key threat to the long term survival of the species and the Site populations. By utilising the information accumulated for these species specific to the Site, Environmental Staff and Management can incorporate this knowledge into the decision making towards development plans and proposals.

Formal protection of habitat is possible through conservation covenants, and could be utilised as an off-set to future development projects.

A Fire Management Strategy (HLA 2007) (FMS) has been produced for the Site. Within the FMS a Site Management Strategy defines a Prescribed Burning Regime and Mechanical Hazard Reduction option for known locations of both *Acacia bynoeana* and *Tetratheca juncea*, as described below:

- *Acacia bynoeana*
  - No fire to occur more that once every seven years; and
  - No slashing, trittering or tree removal.
- *Tetratheca juncea*
  - No fire to occur more that once every seven years; and
  - Slashing only to 100cm and no trittering or tree removal.

4.2 Habitat rehabilitation and management of key threatening processes

4.2.1 Weed management and control

Weed competition has been listed as a Key Threatening Process to the survival and growth of individual plants and populations of both target species. Examples of the potential threats and management issues include:

- Inappropriate fire regimes may encourage the growth of some weed species;
- The control of weeds in sensitive habitats where the threatened species occur, present the risks of herbicide spray drift and non-target kills. The use of herbicides in these sensitive environments should only be used by licensed professionals and with all works aligned to the *Eraring Weed Management Plan* (HLA 2003);
- All weed control works are to be completed in consultation with the Site's GIS, which provides the basis for decision making aligned to the known location of both species;
- Prior to undertaking any works the grounds maintenance and weed control staff and contractors are to be provided training in the recognition of both species and information as to the known core locations of both species across the Site; and

- The weed control program must be reviewed when data is updated on the presence of new locations of both species to avoid impacting the species during the implementation of works.

4.2.2 Vertebrate pest management and control

Based on previous records of exotic herbivore species grazing on *Tetratheca juncea* protective structures such as tree guards or rabbit proof fencing could be installed to protect individual plants or sub-populations from the grazing pressures in areas where rabbits or the European Hare are known to occur over the Site.

4.2.3 Conservation covenants

Formal protection of habitat is possible through conservation covenants, and could be utilised as an off-set to future development projects. This would remove the threat of disturbance through development and habitat destruction.

4.2.4 Active management

Active management involves the manipulation or restoration of natural processes in order to increase recruitment in the target population. Depending on the potential risk to population, the level of manipulation can be determined. Low risk techniques aim to manipulate or restore natural processes in order to increase recruitment in the target population (Vallee et al. 2004). These techniques include hand pollination, regulated burning /slashing or clearing and soil disturbance. Higher risk techniques such as translocation may be required where the above actions are not sufficient. Translocation should be considered when all other options have failed or are considered inappropriate.

4.3 Translocation

Translocation[1] of any threatened species should be the last resort as an ameliorative or mitigating measure for development. Translocation should not be viewed as an alternative to *in situ* conservation. If translocation is proposed it should only occur if:

- All other measures have been taken to avoid and minimise impacts;
- It can be demonstrated there will be no irreparable harm to the species as a whole;
- It is to be implemented, managed, monitored and evaluated; and
- Adequate time and funding is available.

Important considerations include:

- Threatening processes which occur on Site and the impact that they pose to the known stands of the species;
- Availability of suitable recipient sites;

[1] Translocation is the deliberate transfer of plants or regenerative material from an *ex situ* collection or natural population to a new natural location. Methods include propagation via seed, division, cutting, tissue culture; direct seeding; transplantation; and the transfer of soil, leaf litter and brush.

- Population stability;
- Other means of increasing population size;
- Success of previous translocation efforts, with data provided from other studies;
- Potential for future disturbance to recipient sites; and
- Resource availability and cost.

For translocation to occur it would be necessary to obtain a Scientific Licence (NP&W Act) (**Appendix A**), approval from the local council and also a suitable host site for the plants.

4.3.1 Seed collection and propagation

The flowering and seed maturation periods of the two species have been provided above. Regular inspections of populations across the site are needed to determine the opportune time for seed collection, with preparation time provided when the species come into flower. It is important to ensure that multiple stands of both species are inspected to ensure geographical variations of the species do not provide a bias in data i.e. one stand in late flower whilst others are setting seed.

When collecting it is important not to over-collect from a single plant or population, thereby allowing for continued natural recruitment. FloraBank (1999) suggests that no more than 20 percent of the fruit from any one plant should be removed at a given time. However, special consideration should be given to areas across the Site which is going to be disturbed as a function of Site development. Assuming the timing of works is compatible with seed collection there may be merit in collecting all available seed.

Seed is to be thoroughly dried and cleaned prior to storage. Seed is to be stored in cool dark conditions to prolong the storage life of the seed. Should a substantial store of seed be collected it can be incorporated into a direct seeding program over proposed revegetation sites.

Collection should be an ongoing process over several years to build a bank of seed, with seed stored in an appropriate manner to ensure maintenance of viability. Once a sufficient store has been accumulated seed can be given to a selection of Nurseries accredited by the Nursery Industry Association for germination and production. Local NIASA Accredited Nurseries include:

- Merriwa Nursery - Merriwa;
- Scott's Tubes Pty Ltd - Mangrove Mountain;
- Royal Botanic Gardens - Sydney; and
- Riverdene Nursery - Gresford.

Both nurseries have sound track records in the propagation of native flora of the Hunter Region.

Where seed viability is known to be low seed treatment trials can be conducted to determine methods to improve germination rates. For example Driscoll (2006) has reported that *Acacia bynoeana* is assumed to germinate following a fire event, therefore the seed may respond favourably to smoke treatment or smoke water.

Research conducted by Bellairs et al. (2006) investigated the soil seed bank, seed viability, germination and seed dormancy of the *Tetratheca juncea*. Seed collected consisted of light brown and dark brown seed. The viability testing showed the light brown seed was immature. Viability of the dark brown seed was between 31 and 59 percent. Germination trials included smoke treatment and scarified seed treatments. At the conclusion of the experiment 49 percent of viable smoke treated seeds had germinated, compared to 30 percent for scarified treated seed and 20 percent for viable untreated seeds. Therefore the establishment of new populations of *Tetratheca juncea* from seed is possible, however germination is limited if the seeds are not treated.

4.3.2 Vegetative propagation

There are several proven methods for vegetative propagation including division, cuttings and tissue culture.

Division is possible for multi-stemmed plants with a fibrous root system. It involves the splitting of two or more plant sections and attached roots. Once divided the propagules are potted into a sterile potting mix and stored under controlled nursery conditions to enhance root and vegetative growth. The resultant plants are genetically identical to the parent plant. This method may be particularly suited to individual *Tetratheca juncea* plants that may be disturbed through proposed development.

A Cutting is a piece of plant material, which under controlled conditions will initiate root growth. The resultant plants are genetically identical to the parent plant. Based on previous works undertaken on Acacia species (pers comm. Dee Murdoch) cuttings should be taken from semi hard wood material of the parent plant. Hygiene is extremely important to avoid potential pathogen contamination. All equipment including hand tools, potting mix and pots need to be sterilised or disinfected. Cuttings should be approximately 75mm in length; leaf area is to be reduced. The bottom 15mm of the cutting is to be 'wounded' to promote root growth. A root promoting hormone is to be applied over the wound area and cutting base. Cuttings are to be set in potting mix and maintained and monitored under controlled nursery conditions. Moisture and temperature levels are very important to the success of cutting strike.

Tissue Culture is a form of micropropagation which involves the production of plants from small plant material grown aseptically in a container under laboratory conditions where the environment and conditions can be controlled. The media used is a nutrient rich agar to promote root and shoot growth. Hygiene is extremely important during collection and preparation. A research laboratory at the Agronomy and Soil Science branch of the University of New England is equipped to achieve plant production through tissue culture.

4.3.3 Direct transfer of topsoil and vegetative material

Areas proposed for development which occur in known location of either species will involve the mass disturbance of vegetation and topsoil. The topsoil is a source of organic matter and a potential source of seed of native flora. This topsoil seed bank can be utilised in offset revegetation areas. The stripped topsoil can be re-spread over areas prepared for revegetation, relocating the stored seed (and potentially other fungal bodies relevant to mycorrhizal associations) to a suitable environment (see **Section 4.4.1**). Such areas may include the revegetation zones occurring on the eastern sectors of the Ash Dam.

Cleared vegetative material can be selectively placed within the revegetation zones to provide faunal habitat, and organic matter to improve soil structure. This process also provides the opportunity to transport seed that may yet to be shed from the parent plant.

4.4 Translocation of adult plants

The translocation of adult plants should only be considered as a last resort or in areas which are going to be disturbed by Site development. Translocation involves several phases including site preparation, the collection and storage of plant material and implementation, whilst ensuring a thorough hygiene program during all stages of the process.

4.4.1 Site selection and preparation

Sites where the target species occurs or has previously occurred are most likely to support a translocated population. These sites should be considered first, see **Figure 1** and **Figure 2** for existing *Acacia bynoeana* and *Tetratheca juncea* locations across the Site. Alternatively areas of similar habitat

such as soil type, vegetation community, slope, aspect, etc. can be used to guide site selection (refer to **Table 1** and **Table 2**). The vegetation communities across the Site relevant to the two target species have been mapped and are shown in **Figure F3** and **Figure F4**. A more detailed site inspection will be required prior to site selection to ensure compatibility.

As an alternative to translocation of undisturbed areas, consideration should also be given to translocation to areas of degraded or reconstructed landscapes. In these instances considerable site preparation and a detailed management strategy is required to ensure long term success and eventual re-introduction to suitable habitat.

The revegetation areas of the eastern sectors of the Ash Dam are potential sites; however these areas would require site preparation and post management strategies to ensure success.

Site preparation includes the removal of threatening processes that may impact upon the success of plant survival. These include weed control, protection from herbivory and management of fire risks. An irrigation system may be required to ensure moisture levels remain adequate for plant survival.

4.4.2 Plant removal and transplant

Threatened plants identified to be impacted through proposed developments will require physical removal and relocation. Identified transplant sites should be prepared prior to relocation to limit the transport time between sites.

The “normal” process for plant removal would limit the disturbance to the plant and its root system. However as a function of the predicted gross disturbance to the areas of development it may be preferable to harvest a maximum quantity of vegetative and growing media material and in doing so optimising the chances of success post transfer. Ideally the entire root body and associated soil should be moved as a whole. Small individual plants can be removed by manual labour. Larger clumps of plants will require mechanical removal to limit disturbance and plant stress. Mechanical removal can occur via backhoe or front end loader.

4.4.3 After planting care

In order to maximise plant survival a maintenance program is required. Mulch can be used to reduce moisture loss and provide a barrier for weed establishment. Mulch is a good source of organic matter and can provide protection from frosts. Mulch needs to be sterile and free from weed seeds.

Watering can occur via an irrigation or dripper system. Maintaining moisture levels ensures the individuals are not experiencing unnecessary stress during the establishment period. Once established the watering regime can be adjusted to allow the plants to adapt to drier conditions. Soil wetting agents can be used to increase the moisture holding capacity of the soil, or hydro-crystals can be used to store moisture that is available for uptake by the plants.

Protection of transplant sites through fencing or tree guards will exclude herbivores from impacting on plant survival. Ongoing weed control will be necessary to ensure competition is minimal.

Monitoring of plant health for insect attack, pathogens and fungus are important to allow the effective treatment of plants to prevent avoidable attrition. Other preventative measures such as spraying replanted areas with Phosphonate can improve plant vigour and prevent the infection of *Phytophora cinnamomi.*

All relocation sites are to be recorded in the GIS system to ensure accurate long term monitoring. Reports should be provided annually on the success of translocation methods and recommendations made to assist in future translocation efforts. All works are to be recorded via a photographic record, the results of which are to be included in the ensuing project reports

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5.0 Recommendations

The report recommendations have been prioritised using the matrix provided in **Appendix D**.

Table 3: *Acacia bynoeana* Recovery Plan Recommendations

Time frame	Domain	Recovery Option	Priority
Immediate Action Pre December 2007	Across the Site	• Application for Scientific Licence NP&W Act 1974; • Site user education in the form of poster and feedback process; • Using GIS, the location of all known records of the species are reviewed prior to any ground disturbance – process incorporated in Ground Disturbance Permit; • Where plants are to be directly impacted by construction work – transplant; • Transplantation on site – as per vegetation community - 4 sites(1-4) to be selected as per **Figure 5**; • Transplant to rehabilitated Ash dam – 5 sites (A-D) sites to be selected as per **Figure 5**; • Seed collection as per Florabank guidelines (1999); • Research into seed availability and viability; and • Strategic use and management of topsoil resource.	High Medium High High High Medium High High High

Time frame	Domain	Recovery Option	Priority
Mid term January to December 2008	Domain 1 Attemperation Reservoir (following approval)	• Identify via GIS other sites where the species occur on lands adjoining Eraring holdings; • Investigate research potential with land owners of adjoining lands where the species has been recorded; • Stakeholder meeting with adjoining land owners; • Where plants are to be directly impacted by construction work – transplant; • Strategic use/ management of topsoil resource; and • Propagation by tissue culture and cutting – to include soft tip, semi-hard wood, hard wood and root material.	High Medium Medium High Medium High
Long term 2009 onwards	Other potential zones of disturbance	• Where plants directly impacted by construction work – transplant; • Strategic use and management of topsoil resource; • Ongoing propagation efforts and monitoring programs; and • Eraring to participate as a stakeholder in species conservation with adjoining landholders and State government departments.	High Medium High Medium

Table 4: *Tetratheca juncea* Recovery Plan Recommendations

Time frame	Domain	Recovery Option	Priority
Immediate Action Pre December 2007	Domain 1 Haulage Road – North of Ash Dam	• Application for Scientific Licence NP&W Act 1974; • Site user education via interpretive poster and feedback process; • Using GIS the location of all known records of the species are reviewed prior to any ground disturbance – process incorporated in Ground Disturbance Permit; • Transplantation on site – as per vegetation community – 5 sites (1-5) to be selected as per **Figure 6**; • Transplant to rehabilitated Ash dam - 5 (A-E) sites to be selected as per **Figure 6**; • Transplant to accredited nursery; • Propagation via division of *Tetratheca juncea;* and • Strategic use and management of topsoil resource.	High Medium High High High High High Medium
Mid term January to December 2008	Domain 1 Attemperation Reservoir (following approval)	• Repeat of transplantation as per above description; • Research into seed availability and viability; • Propagation by tissue culture and division; and • Strategic use and management of topsoil resource.	High High High Medium
	Domain 1 Ash Dam Expansion	• Seed collection and research into other propagation methods; • Identify plants directly impacted by construction work – transplant as per above description; • Strategic use and management of topsoil resource; and • Establish monitoring program for future success.	High High High High

Time frame	Domain	Recovery Option	Priority
Long term 2009 onwards	Other potential zones of disturbance	• Strategic use and management of topsoil resource; • Identify most effective propagation method; and • Ongoing monitoring of translocation efforts.	Medium High High

6.0 References

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Figures

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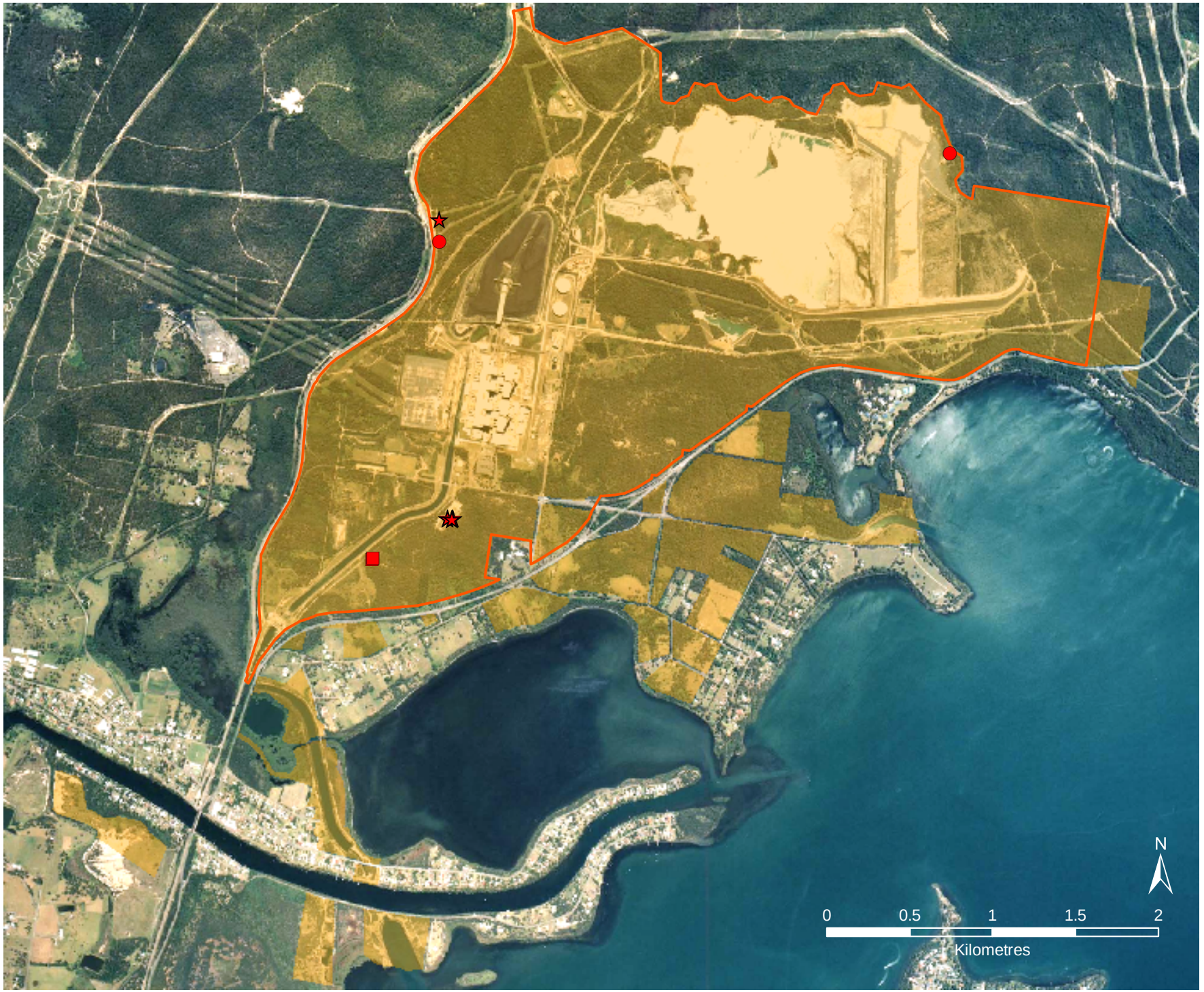

PROJECT FILE NAME	N4063941
DATE	10 SEPTEMBER 2007
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APPROVED	TD

Legend

Year of Survey & Location

- 2004 - *Acacia bynoeana*
- 2006 - *Acacia bynoeana*
- 2007 - *Acacia bynoeana*
- Eraring Operational Boundary
- Eraring Owned Lands

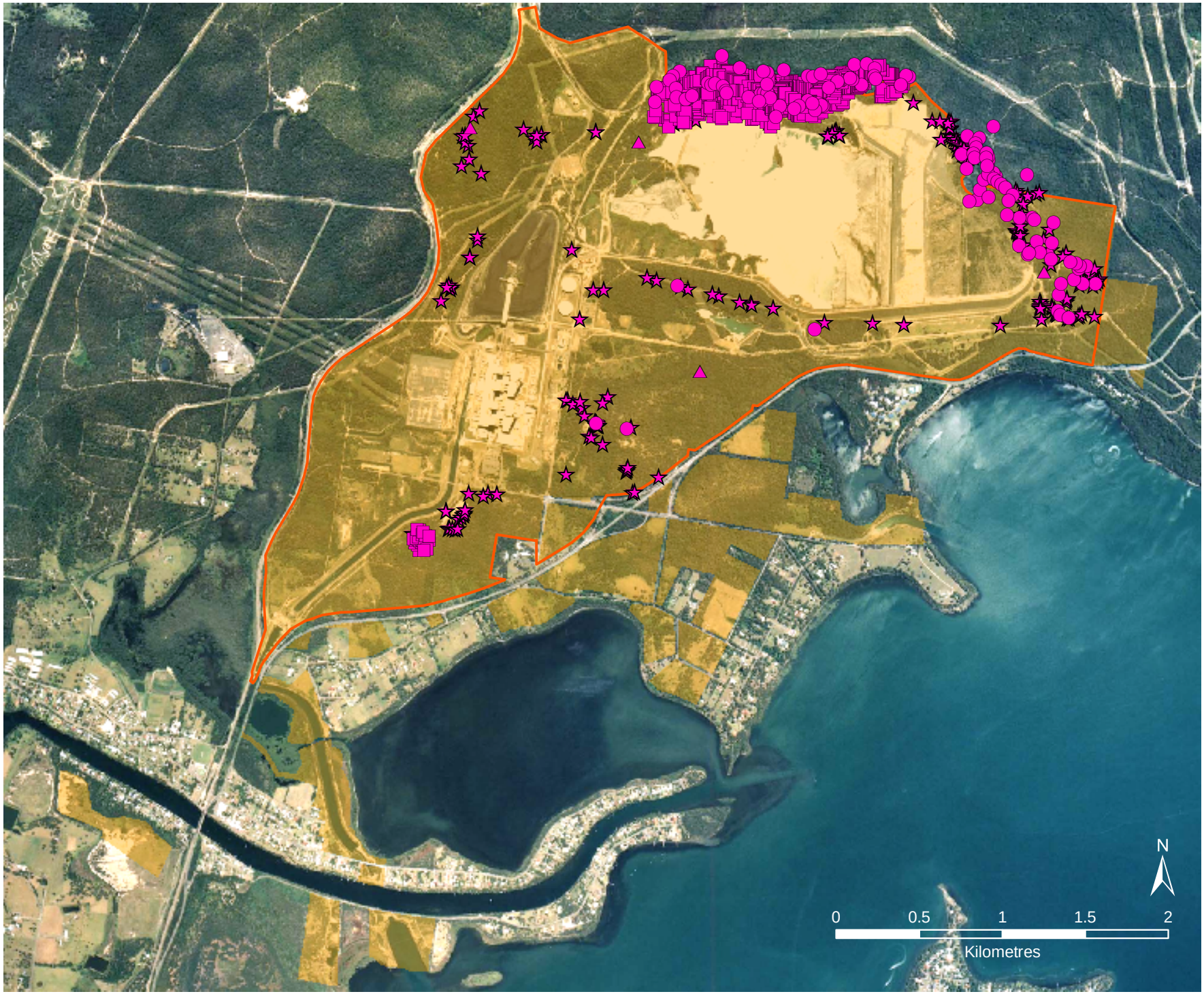
LOCATION OF *ACACIA BYNOEANA* SURVEY RESULTS 1999-2007

Eraring Energy

Threatened Species Recovery Plan *Tetratheca juncea* and *Acacia bynoeana* Eraring Energy Eraring, NSW

HLA

Figure 1



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DATE	10 SEPTEMBER 2007
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Legend

Year of Survey & Location

- 1999 - *Tetratheca juncea*
- 2004 - *Tetratheca juncea*
- 2006 - *Tetratheca juncea*
- 2007 - *Tetratheca juncea*
- Eraring Operational Boundary
- Eraring Owned Lands

LOCATION OF *TETRATHECA JUNCEA* SURVEY RESULTS 1999-2007

Eraring Energy

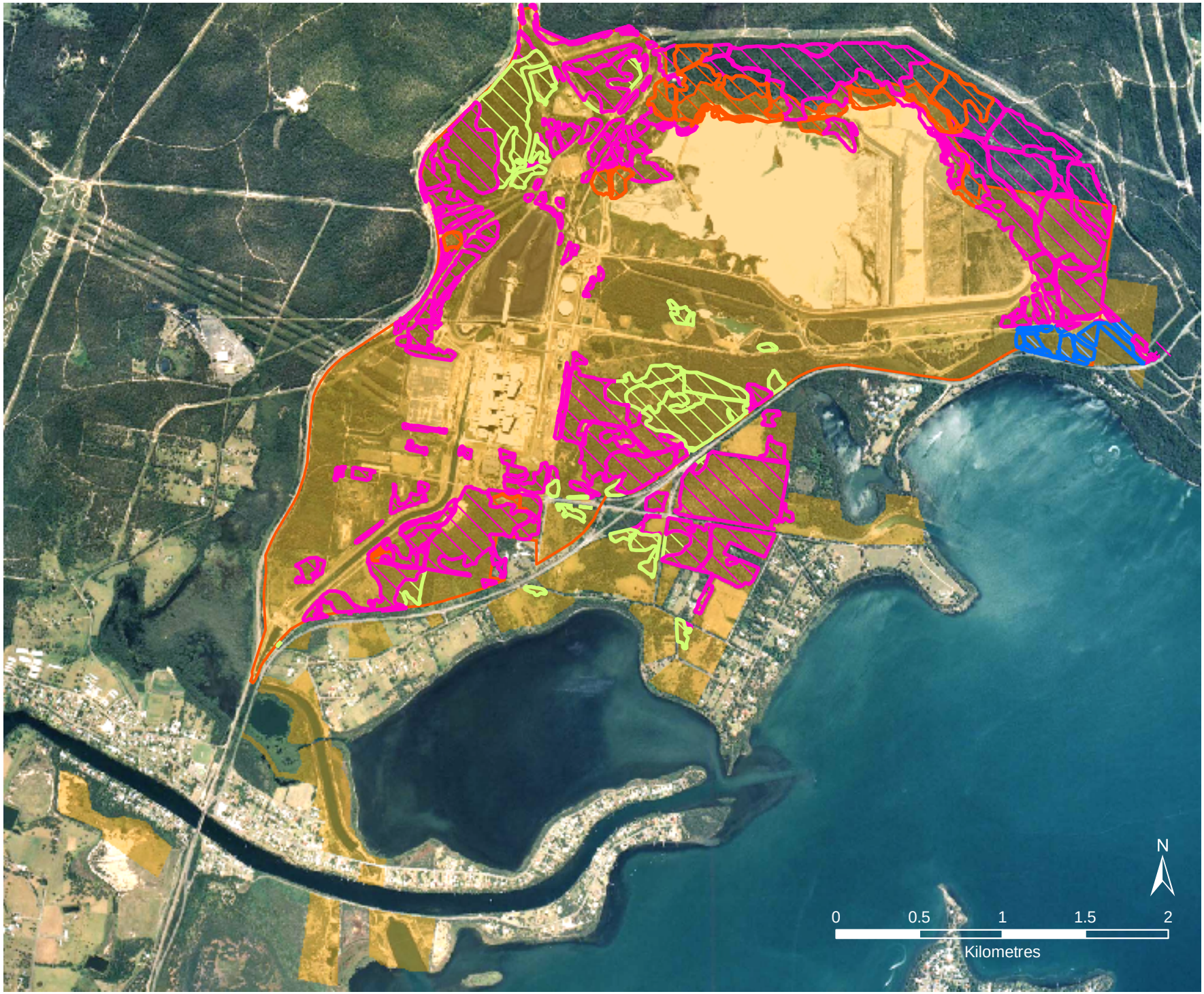
Threatened Species Recovery Plan *Tetratheca juncea* and *Acacia bynoeana* Eraring Energy

Eraring, NSW

HLA

Figure

2



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DATE	10 SEPTEMBER 2007
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Legend

***Acacia bynoeana* Habitat**

- Scribbly Gum Open Woodland
- Coastal Plains Scribbly Gum Woodland
- Coastal Plains Bloodwood-Apple Forest
- Coastal Sheltered Apple-Peppermint Forest
- Eraring Operational Boundary
- Eraring Owned Lands

AREA OF KNOWN VEGETATION COMMUNITY HABITAT FOR *ACACIA BYNOEANA*

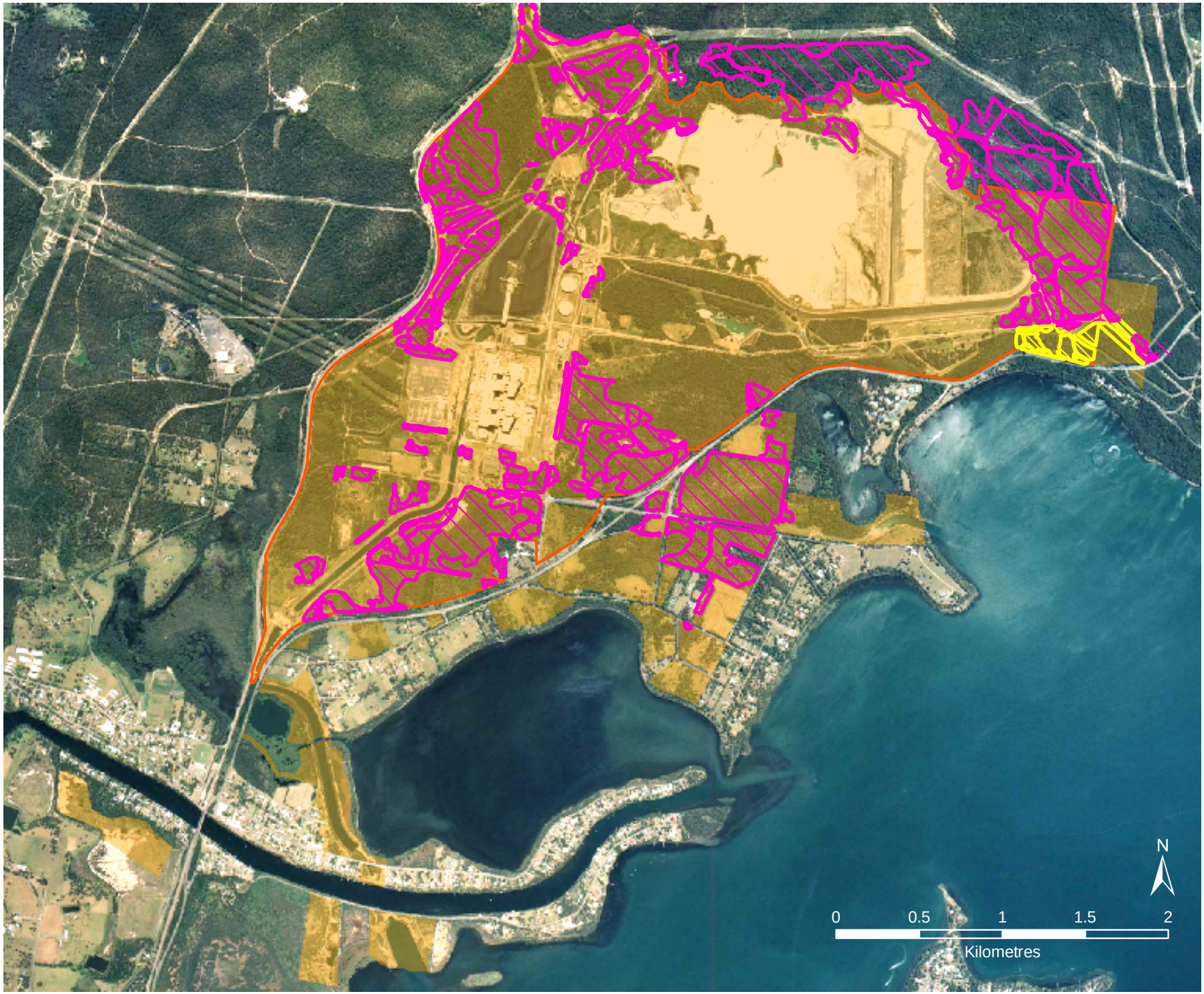
Eraring Energy

Threatened Species Recovery Plan *Tetratheca juncea* and *Acacia bynoeana* Eraring Energy Eraring Power Station, Eraring

HLA

Figure

3



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DATE	10 SEPTEMBER 2007
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Legend

***Tetratheca juncea* Habitat**

- Coastal Plains Bloodwood-Apple Forest
- Coastal Plains Scribbly Gum Woodland
- Eraring Operational Boundary
- Eraring Owned Lands

AREA OF KNOWN VEGETATION COMMUNITY HABITAT FOR *TETRATHECA JUNCEA*

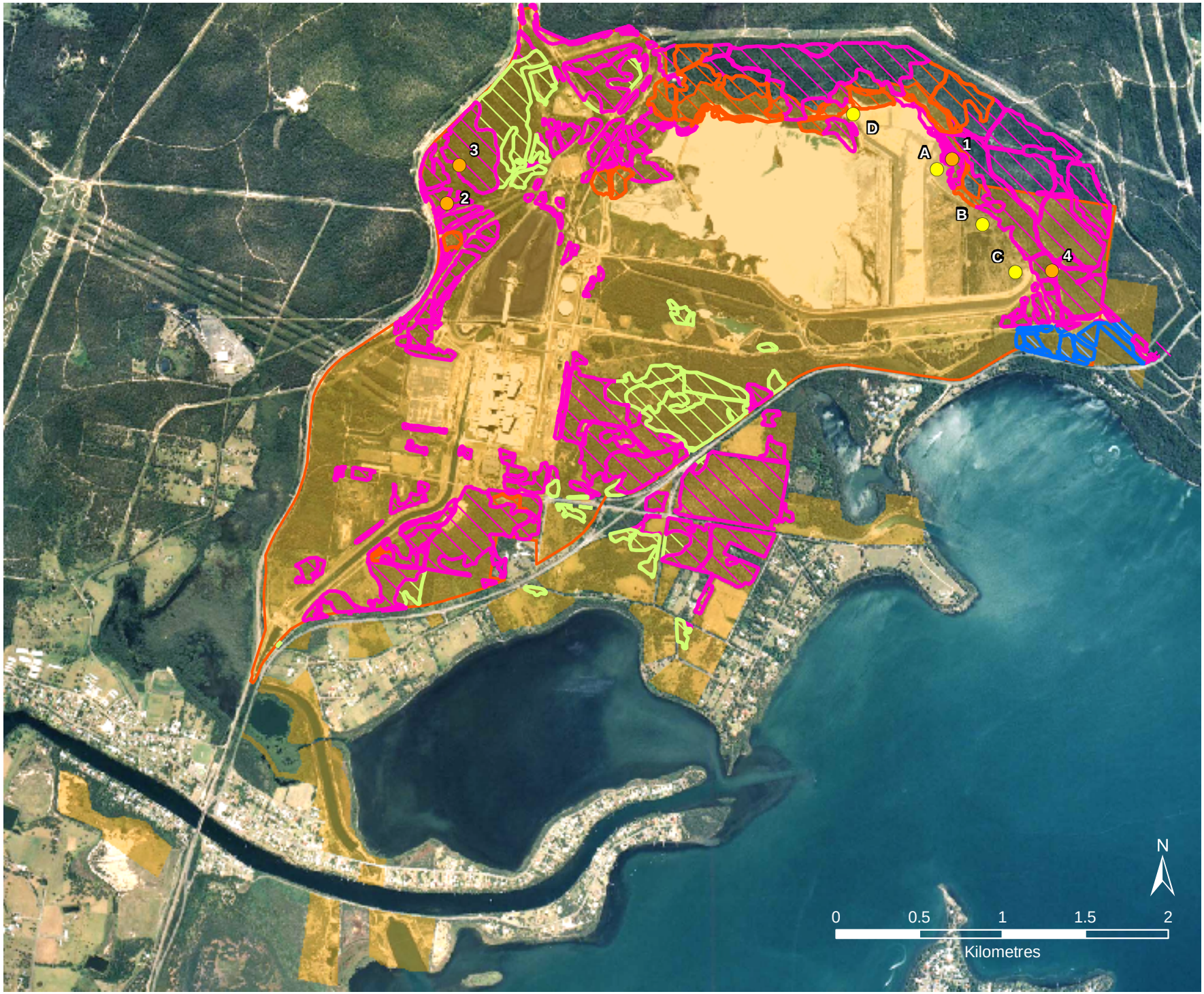
Eraring Energy

Threatened Species Recovery Plan *Tetratheca juncea* and *Acacia bynoeana* Eraring Energy Eraring, NSW

HLA

Figure

4



PROJECT FILE NAME	N4063941
DATE	10 SEPTEMBER 2007
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Legend

Translocation Site

- As per vegetation communities
- To rehabilitated Ash Dam

***Acacia bynoeana* Habitat**

- Scribbly Gum Open Woodland
- Coastal Plains Scribbly Gum Woodland
- Coastal Plains Bloodwood-Apple Forest
- Coastal Sheltered Apple-Peppermint Forest
- Eraring Operational Boundary
- Eraring Owned Lands

PROPOSED TRANSLOCATION SITE FOR *ACACIA BYNOEANA*

Eraring Energy

Threatened Species Recovery Plan

Tetratheca juncea and

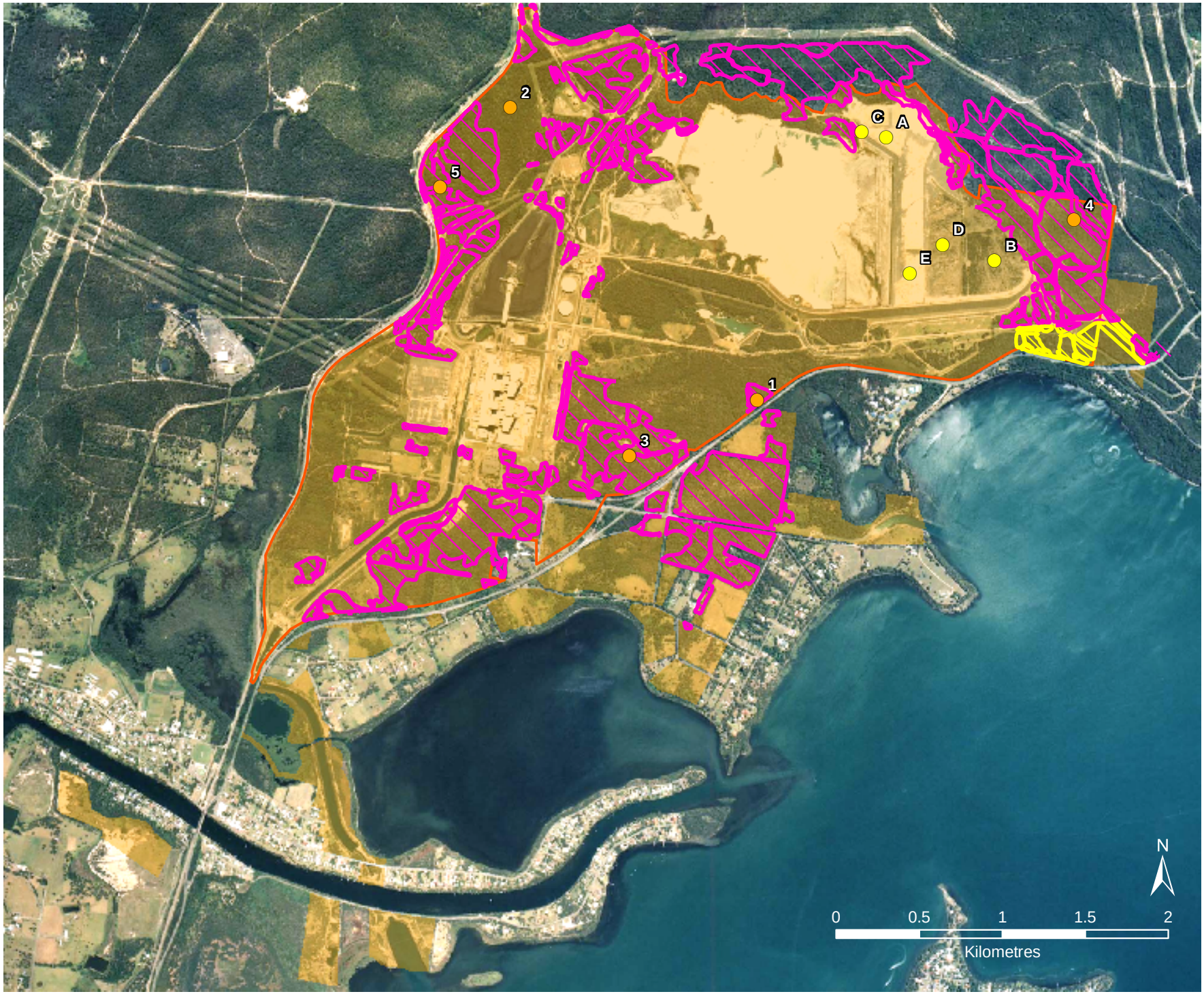
Acacia bynoeana Eraring Energy

Eraring, NSW

HLA

Figure

5



PROJECT FILE NAME	N4063941
DATE	10 SEPTEMBER 2007
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Legend

Translocation Site

- As per vegetation communities
- To rehabilitated Ash Dam

***Tetratheca juncea* Habitat**

- Coastal Plains Bloodwood-Apple Forest
- Coastal Plains Scribbly Gum Woodland
- Eraring Operational Boundary
- Eraring Owned Lands

PROPOSED TRANSLOCATION SITE FOR *TETRATHECA JUNCEA*
Eraring Energy
Threatened Species Recovery Plan
Tetratheca juncea and
Acacia bynoeana Eraring Energy
Eraring, NSW

HLA

Figure
6

Appendix A: Application for a Scientific Licence for the Purpose of Science, Education or Conservation, National Parks and Wildlife Act 1974 – Section 132C

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NSW Department of Environment & Conservation (DEC)
National Parks and Wildlife Service
Wildlife Licensing & Management Unit, PO Box 1967, Hurstville BC NSW 1481
Telephone: 02 9585 6540 Fax: 02 9585 6401
Email: wildlife.licensing@environment.nsw.gov.au
ABN 30 841 387 271

APPLICATION FOR A SCIENTIFIC LICENCE FOR THE PURPOSE OF SCIENCE, EDUCATION OR CONSERVATION

National Parks and Wildlife Act 1974
Section 132C

Version: February 2007

This box is for office use only
Application ID Number:

The New South Wales National Parks and Wildlife Service (NPWS) values the efforts of researchers, educators and conservation groups which contribute towards the conservation of the state's natural heritage and the NPWS seeks to work cooperatively with them. However, as a Scientific Licence may authorise the harming of fauna and picking of flora, it is necessary to have a clear and enforceable regulatory framework to accompany it.

NOTES FOR GUIDANCE *Please read the following notes carefully before completing this form.*

1. This application form is for people wishing to take action for scientific, educational or conservation purposes, that is likely to result in one or more of the following:
   (a) harm to any protected fauna, or to an animal that is of, or is part of, a threatened species, an endangered population or an endangered ecological community,
   (b) the picking of any protected native plant or of any plant that is of, or is part of, a threatened species, an endangered population or an endangered ecological community,
   (c) damage to critical habitat,
   (d) damage to a habitat of a threatened species, an endangered population or an endangered ecological community.

2. 'Harm' an animal is defined in Section 5 of the *National Parks and Wildlife Act 1974* (NPW Act) and includes hunt, shoot, poison, net, snare, spear, pursue, capture, trap, injure or kill.

3. 'Pick' a native plant is defined in Section 5 of the NPW Act and means gather, pluck, cut, pull up, destroy, poison, take, dig up, remove or injure the plant or any part of the plant.

4. 'Damage' is not defined in the legislation so dictionary definitions apply. For example, the Concise Oxford Dictionary defines damage as "loss of what is desirable" and "injury impairing value or usefulness," while the Macquarie Dictionary defines damage as "injury or harm that impairs value or usefulness."

5. 'Protected fauna' means all native animals (mammals, birds, reptiles and amphibians) of New South Wales, with the exception of dingoes.

6. 'Protected native plant' means a native plant of a species named in Schedule 13 of the NPW Act.

7. A 'threatened species,' an 'endangered population' and an 'endangered ecological community' are those species, populations and ecological communities listed on the Schedules of the *Threatened Species Conservation Act 1995* (TSC Act). These Schedules are regularly reviewed.

8. Up-to-date copies of NSW legislation in force can be accessed from the Parliamentary Counsel's Office website at www.legislation.nsw.gov.au

9. An applicant must be at least 18 years of age.

10. All sections of the application form must be completed in full unless considered by the applicant to be not applicable to the action proposed. However, failure to provide adequate information may delay the processing of your application. Please allow 4-6 weeks for your application to be processed.

11. Note: It is an offence carrying a maximum penalty of $3300 to make any statement or provide any information or other material in an application for a licence or certificate that the applicant knows, or ought reasonably to know, is false or misleading.

12. If insufficient space is available to answer any question(s) please attach a signed and dated statement.

13. Licences are issued under section 132C of the NPW Act. Section 132C came into effect in 2003 and replaces the need for separate licences under other provisions of the NPW Act and the TSC Act. Conditions that apply to all section 132C licences are shown in Part C of the application form. However, additional specific conditions may be applied to individual licences.

14. Section 120 of the NPW Act provides for the authorisation of a person to hold or keep in possession or under control any protected fauna for any specified purpose.

15. Authority granted under Clause 22 of the *National Parks and Wildlife Regulation 2002* may authorise a person to undertake research on land managed by the NPWS including research on, or the collection of, any animal, including invertebrates, plants, fungus, geological, hydrological, or other specimens or samples.

0. It is a condition of any licence issued that a full report of the actual work carried out under licence be submitted to the NPWS at the end of the licensing period and before any renewal will be granted. In cases where licences are issued for a period greater than one year annual reports are required. Additional reporting requirements contained in the application must be adhered to.

- Details of the animals, plants or other organisms captured, observed or collected under licence including species identification, precise locality (description and AMG/MGA coordinates or longitude/latitude) and date of trapping, observation or collection, are to be supplied in electronic format, preferably Microsoft Excel, to gis@environment.nsw.gov.au
- Alternatively, the electronically formatted data can be saved to disk and posted to the Wildlife Licensing & Management Unit at the above address. Such records will be incorporated into the NPWS Atlas of NSW Wildlife Database. A spreadsheet compatible with this database is available from the NPWS website at http://www.nationalparks.nsw.gov.au/images/scientific_licence_datasheet.xls
- Failure to submit a full report to the NPWS and/or information to the NPWS GIS Group will delay or prevent the renewal of a licence and may also incur an infringement notice for a breach of licence conditions ($300).

17. Applicants should note that a licence from the NPWS does not authorise access or power of entry onto any land. Consent from the property owner or manager must be obtained prior to entry onto their land.

18. Details of licences issued, including names and addresses of licensees, will be stored and processed on a computer database. This information will be used by the NPWS solely to undertake licensing functions. To do this the NPWS may need to discuss applications with third parties or disclose information about licensing decisions. In such cases, the NPWS will operate within the bounds of the *Privacy and Personal Information Protection Act 1998*.

19. Activities involving threatened species, populations and ecological communities will need to justify why the activity needs to be undertaken on/affecting that particular threatened species, population or ecological community. It will also need to demonstrate some clear conservation benefit(s) for that threatened species/entity.

20. An applicant who wishes to be licensed to undertake bird or bat banding activities must hold a current “A” or “R” Class permit from the Australian Bird and Bat Banding Scheme, or must have written notification that they will be issued a consent to band birds or bats upon the granting of a complementary State/Territory licence. Those persons licensed for banding purposes only (ie. not as part of a research project specifically licensed by the NPWS) are not required to submit an annual report. However, banders are encouraged to submit electronic copies of data for incorporation into the NPWS Atlas of NSW Wildlife Database. Enquiries regarding bat and bird banding licences should be directed to:
The Secretary, Australian Bird and Bat Banding Scheme, GPO Box 8, CANBERRA ACT 2601, Phone: 02 6274 2407.

21. An applicant who is undertaking work on animals may also have obligations under the *Animal Research Act 1985.* Applicants should contact the Animal Welfare Branch, NSW Department of Primary Industries on 02 6391 3324 for further information.

22. The NPWS may issue guidelines for the carrying out of certain actions that require a licence. Applicants will be required to follow any such guidelines that apply to their proposed action.

32. Licences are normally issued for a period not exceeding one year. The monitoring obligations of the NPWS mean the issuing of longer term licences will be considered where circumstances justify an extended period. A request to vary the original terms of the licence must be submitted in writing to the NPWS. Any approval given will be subject to an expiry date. Any licence issued may be revoked or may not be renewed should:

- the licence holder fail to abide by the conditions the licence was issued under; or
- information become available that implies the action is having an adverse impact on threatened species, populations or ecological communities.

PART A Personal Details and Experience

1. Full name of applicant: (Mr/Mrs/Ms/Miss/Dr/other) _____ Date of Birth _____

2. Name of Organisation/ Institution (if applicable) _____

   Position held within the Organisation/ Institution _____

3. Business Address _____

   _____ Postcode _____

4. Postal Address _____

   _____ Postcode _____

5. Phone (Business Hours) _____ (Mobile) _____

6. Fax _____ Email _____

7. Have you held a licence issued by the NPWS within the last 7 years?

   YES / NO If yes, please list the licence number and project title for each:

NPWS LICENCE NUMBER	PROJECT TITLE

8. Qualifications and experience.

) If the proposed licensee is an individual, please state their relevant qualifications and experience.

   _____

   _____

   _____

   _____

) If the proposed licensee is a group (government department, company, partnership or association) or will involve other persons whom you wish to act under this authority, please state the name, date of birth and relevant qualifications and experience of each officer/employee of the group who will carry out the actions.

NAME (IN FULL), AND DATE OF BIRTH	RELEVANT QUALIFICATIONS AND EXPERIENCE

9. Please provide the names, addresses and contact details for two referees who can verify your ability to undertake the action proposed. The NPWS may contact these referees to verify the statements you have provided.

- Name: _____

  Organisation and position: _____

  Address: _____

  Contact phone number and email: _____

- Name: _____

  Organisation and position: _____

  Address: _____

  Contact phone number and email: _____

PART B Details of proposal

10. Please nominate the purpose of your work (more than one box may be ticked).

☐ Science – research purposes

☐ Science – field surveys for environmental assessment purposes

☐ Education

☐ Conservation

11. Please indicate whether the action proposed is likely to affect one or more of the following [Please tick the relevant box(es)].

☐ Habitat of a threatened fauna species, an endangered fauna population or an endangered ecological community

☐ Habitat of a threatened flora species, an endangered flora population or an endangered ecological community

☐ Declared critical habitat* for an endangered species, population or ecological community

* Critical habitat means habitat declared to be critical habitat under Part 3 of the TSC Act. View the critical habitat register: www.nationalparks.nsw.gov.au/npws.nsf/Content/Critical+habitat+protection+by+doctype.

12. If the action proposed is likely to damage or adversely affect critical habitat, either directly or indirectly, please specify the amount to be affected. _____ (ha). Please provide a detailed outline of the likely impacts on critical habitat in an attachment.

13. Project title for the action proposed: _____

_____

14. Please state the duration of the action proposed. From: _____ To: _____

15. Describe the action proposed, including:

) the objectives and significance of your work;

_____

_____

_____

_____

) the equipment and methods proposed to be used (including method of acquiring/trapping/killing fauna, if applicable).

_____

_____

_____

_____

_____

_____

16. Please indicate whether the action proposed involves permanent or semi-permanent tagging, banding, microchipping or radio tracking etc. (please tick relevant box).

☐ Bird banding ☐ Bat banding ☐ Not applicable

☐ Other, please specify. _____

NOTE: It is a condition of this licence that any banding or other forms of permanent marking or tagging that is undertaken (with the exception of non-research bird and bat banding activities) requires that the NPWS is provided with details of the marking method, marker number and the basic specimen details (date, species, location, species number).

17. Does the action proposed involve the translocation, propagation, introduction, re-introduction or moving of a species in any way, specifying the species involved? YES / NO. If yes, please provide details below.

_____

_____

_____

_____

NOTE: Translocations for threatened fauna must be in compliance with the NPWS Policy for the Translocation of Threatened Fauna in NSW, and for threatened flora should follow the Australian Network for Plant Conservation's guidelines for the Translocation of Threatened Plants in Australia (1997). Proposed rehabilitation activities must be in compliance with the NPWS Rehabilitation of Fauna Policy. The NPWS has prepared guidelines for bush restoration and all rehabilitation of vegetation communities is to be undertaken in accordance with those guidelines. Please make reference to relevant recovery plans or threat abatement plans, where applicable.

18. Please provide details about the protected fauna, protected native plants, threatened species, endangered populations or endangered ecological communities to be affected by the action proposed.

SCIENTIFIC NAME	COMMON NAME	NSW CONSERVATION STATUS (PROTECTED, VULNERABLE, OR ENDANGERED)	ESTIMATED NO. OF INDIVIDUALS OR PROPORTION AND TYPE OF PLANT MATERIAL THAT WILL BE AFFECTED BY THE ACTION	SPECIFIC LOCATION, INCLUDING LAND TENURE DETAILS

19. Please provide details of the types and condition of habitats in and adjacent to the land to be affected by the action proposed.

20. Please provide a list of any known records of threatened species in the same or similar known habitats in the locality.

For questions 21-26, if using NPWS approved guidelines to support your application for the relevant action(s) proposed please state in your answer “using the NPWS approved guideline for ……forms part of this application.” If not using NPWS approved guidelines, questions 21-26 must be answered in detail.

21. Please provide an assessment of whether a viable local population of any species (protected and/or threatened) is likely to be adversely affected by the action proposed or to be placed at an increased risk of extinction.

22. Please provide an assessment of the likely nature and intensity of the effect of the action proposed on the different stages of the life cycle for each species (protected and/or threatened) to be affected by the action proposed.

23. Please provide an assessment of whether the life cycle of a species of an endangered population is likely to be disrupted such that the viability of the population is likely to be adversely affected or placed at an increased risk of extinction.

24. Please provide an assessment of whether the action proposed is likely to disrupt, modify or remove an endangered ecological community such that the local occurrence of the community is adversely affected and/or placed at an increased risk of extinction, or any component species of the community is likely to be placed at an increased risk of local extinction.

25. Please provide an assessment of whether, and outline how, the action proposed is consistent with an approved recovery plan or threat abatement plan.

26. Please provide an assessment of whether the action proposed is of a class of action that is recognised as a key threatening process*, or is likely to result in the operation of, or increase the impact of a key threatening process.

* Key threatening process (KTP) means a threatening process specified in Schedule 3 of the TSC Act. A list of KTPs can be viewed on the DEC Threatened Species website www.threatenedspecies.environment.nsw.gov.au

27. If the action proposed is to be carried out on land managed by the NPWS, please justify why NPWS managed land has been chosen over alternative locations.

28. If the action proposed is for scientific and/or conservation purposes and will affect a threatened species, endangered population or endangered ecological community, please describe how the action will contribute to the conservation of the relevant threatened species, population or ecological community.

29. If plant material is to be removed from the site, please describe the proposed arrangements for deposition of the material (for example, specimens will be forwarded to a herbarium, institution).

30. If animals are to be removed from the site of capture, please describe where they are to be taken, arrangements for their keeping/housing and for how long. If animals will be subsequently released, please describe procedures for release, including where and when the release is to take place.

31. Please provide details of applications made or proposed to be made to other Australian States or Territories in connection with this action proposed (project).

1 Additional information:

PART C Conditions of issue of Scientific Licence

1. The *National Parks and Wildlife Act 1974* and Regulations thereunder shall be strictly observed and complied with.
2. Collections or research shall, as far as is possible, be carried out away from the view of the public.
3. An authorised officer may suspend or cancel this licence if conditions are not complied with.
1. A full report of the actual work carried out under licence shall be submitted to the NSW National Parks and Wildlife Service (NPWS) at the end of the licence period and before any renewal will be granted. In addition, details of the animals, plants or other organisms captured, observed or collected including species identification, precise locality (description and AMG/MGA coordinates or longitude/latitude) and date of trapping, observation or collection, are to be supplied in electronic format, preferably Microsoft Excel, to gis@environment.nsw.gov.au. Alternatively, the electronically formatted data can be saved to disk and posted to the Wildlife Licensing & Management Unit. Such records will be incorporated into the NPWS Atlas of NSW Wildlife Database. A spreadsheet compatible with this database is available at http://www.nationalparks.nsw.gov.au/images/scientific_licence_datasheet.xls. Failure to submit a full report to the NPWS and/or information to the DEC GIS Group will delay or prevent the renewal of a licence and may also incur an infringement notice for a breach of licence conditions ($300).
5. It is a condition of this licence that where the activity involves some form of permanent/semi-permanent marking, banding or tagging that the marking details (e.g. tag number, date, location, species) are to be provided to NPWS with any renewal application.
6. A copy of the final report, and/or any scientific papers relating to this work, is to be forwarded to the Director-General (marked “attention Wildlife Licensing & Management Unit”) when the study is completed.
7. The proposed activities must not contravene the statutory requirements of other authorities, e.g. NSW Department of Primary Industries.
8. The licensee must obtain the permission of the owner, manager or occupier of lands upon which research is conducted.
9. Specimens taken under this licence must not be sold. Specimens shall not be given to or lent to other persons without the prior written approval of the Director-General. Specimens or samples taken from specimens of threatened species collected under this licence are not to be sold, bartered, given or promised to others where this precludes the future use of this material/specimen such that it impedes future research efforts on the species concerned. The lodgement of such material in a collection or with another institution is to be with NPWS approval of the conditions of such lodgement.
10. The licence must be carried at all times whilst work is being undertaken in the field. Where multiple names are listed, photocopies will suffice provided some other proof of identity can be provided eg. Drivers licence.
11. Only the person/s named on the licence, or authorised to operate under the terms and conditions of the licence, may undertake the work. This licence is not transferable.

With respect to research/collection in NPWS managed land

12. The licensee shall contact the Manager of the relevant NPWS Area Office or relevant NPWS managed land prior to each visit to NPWS managed land and shall comply with any instructions given with respect to access etc.
13. Unless otherwise approved by an authorised officer, in writing, all vehicles must only use public roads.
14. Unless otherwise approved by an authorised officer, in writing, or by this licence, a person shall not carry, discharge or have in their possession any prohibited weapons (as defined in the *National Parks and Wildlife Act 1974*) in NPWS managed land.
15. Unless otherwise approved by an authorised officer, in writing, or by this licence, a person shall not use any animal, firearm, explosive, net, trap, hunting device or instrument or means whatever for the purpose of harming, taking or killing any animal that is within NPWS managed land.
16. Unless otherwise approved by an authorised officer, in writing, or by this licence, a person shall not carry or have in their possession any explosive, net, trap or hunting device within NPWS managed land.
17. A person shall not be accompanied by a dog within NPWS managed land.
18. The licensee shall indemnify and keep indemnified, so far as the law allows, Her Majesty Queen Elizabeth II, the Minister administering the *National Parks and Wildlife Act 1974*, the Government of New South Wales, the Director-General of the National Parks and Wildlife Service, and the National Parks and Wildlife Service and its servants, agents or contractors (herein jointly and severally referred to as "the NPWS"), FROM AND AGAINST all lawful suits, claims, demands, proceedings, costs, (including solicitor - client costs) and expenses of any nature whatsoever which the NPWS may suffer or incur in connection with loss of life, personal injury or damage to property from an occurrence in connection with any land, premises, vehicle or other mode of conveyance or other item under the care, control or management of the NPWS, and arising either directly or indirectly from any negligent or wrongful act or omission of the licensee in the course of an operations or activities pursuant to the licence or otherwise.

PART D Declaration

- I have read and understood the notes for guidance on this form.
- I understand that failure to comply with any conditions attached to a licence granted in respect of this application may constitute an offence.
- I understand that additional specific conditions may be applied to a licence, following assessment of a licence application.
- I declare that all information provided by me in this application is true and correct to the best of my knowledge and belief.

Note: It is an offence carrying a maximum penalty of $3300 to make any statement or provide any information or other material in an application for a licence or certificate that the applicant knows, or ought reasonably to know, is false or misleading.

_____ _____

Signature of Applicant *Date*

PART E Payment is no longer required for licences issued under section 132c

Please forward this application form to:

Wildlife Licensing & Management Unit, Department of Environment & Conservation, PO Box 1967, Hurstville BC NSW 1481.

Enquiries: Ph. 02 9585 6540 Fax. 02 9585 6401

Email: wildlife.licensing@environment.nsw.gov.au

Appendix B: EPBC Act 1999 General Permit Application for: Threatened Species and Ecological Communities (Section 201)

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Australian Government

Department of the Environment and Water Resources

Environment Protection and Biodiversity Conservation Act 1999.

General Permit Application for:

- **Threatened species and ecological communities (section 201)**
- **Migratory species (section 216)**
- **Whales and dolphins (section 238)**
- **Listed marine species (section 258)**

TIME SAVER

If the person completing this form is representing a small business (i.e. a business having less than 20 employees), please provide an estimate of the time taken to complete this form.

Please include:

– the time taken spent reading the instructions, working on the questions and obtaining the information; and

– the time spent by all employees in collecting and providing this information.

Hours ☐ Minutes ☐

Purpose of this form

This form is for an activity which will affect any species or ecological community listed under the EPBC Act in the above categories where that activity is within a Commonwealth Area, and for whale/dolphins where the activity is within the waters of the Australian Whale Sanctuary, or internationally.

Complete this form in addition to either Supplementary Form A, B or C described in question 1 on the next page. Please return it, along with the relevant Supplementary Form to the Department of the Environment and Water Resources.

Note that it is a requirement of the *Environment Protection and Biodiversity Conservation Act 1999* that details of this application (which may include the applicant's name) and any supplementary forms (A, B or C) be provided to persons or bodies registered with the Department of the Environment and Water Resources under section 266A of the Act, for the purposes inviting submissions from those persons or bodies regarding permit applications.

Do not use this form for permits in:

- The Great Barrier Reef Marine Park. These permits are available at: www.gbrmpa.gov.au/corp_site/permits/
- A Commonwealth park or reserve (e.g. Kakadu National Park). These permits are available at: www.environment.gov.au/epbc/permits/parks/

Additional information

Please ensure that you have read the following information sheet:
Permits required for activities affecting EPBC Act listed species in Commonwealth Areas including the Australian Whale Sanctuary

This information sheet is available at *http://www.environment.gov.au/epbc/permits/index.html.* Further information is also available by contacting the Department on phone: (02) 6274 1111 or email: epbcwild@environment.gov.au.

Incomplete information

Applications that are incomplete or contain insufficient information cannot be assessed. Delays will occur whilst further information is sought from the applicant.

If you need more space

If there is insufficient space on this form to fully address any of the questions please attach additional pages and list these attachments at question 10.

1 Which of the following best describes the purpose of this application?

Research on whales/dolphins	☐ ⇒	You will also need to complete Supplementary Form A for Whales and Dolphins (cetaceans). *Now go to 2*
To conduct an activity that will have an incidental impact on whales/dolphins E.g. whales and dolphins are not the purpose of the activity but they will be indirectly affected	☐ ⇒	You will also need to complete Supplementary Form A for Whales and Dolphins (cetaceans). *Now go to 2*
Whale and Dolphin watching	☐ ⇒	You will also need to complete Supplementary Form B for Whale and Dolphin Watching. *Now go to 2*
To kill, injure, take, trade, keep or move a listed species or ecological community in Commonwealth areas	☐ ⇒	You will also need to complete Supplementary Form C *Listed species / ecological community, listed migratory species or listed marine species.* *Now go to 2*
Import/export of whale/dolphin parts or products	☐ ⇒	Please contact the Cetacean Research and Policy Section on 02) 6274 1111.

2 Period of permit requested
Permits are usually not issued for more than 5 years.

Start date:	End date:

3 The permit holder can be a group such as a business, company, or corporation?

Is the proposed permit holder a group?

No ☐ ⇒ *Go to next question*

Yes ☐ ⇒ *Give details below*

Group Name
Street address:
Postal address:
Telephone No.:
Fax No.:
Email address:

Now go to 5

4 Is the proposed permit holder an individual?

No ☐ ⇒ *Go to next question*

Yes ☐ ⇒ *Give details below of each individual to whom the permit would be issued.* If insufficient space, attach a separate list.

1	Name:
	Residential address:
	Postal address:
	Telephone No.:
	Fax No.:
	Email address:

2	Name:
	Residential address:
	Postal address:
	Telephone No.:
	Fax No.:
	Email address:

3	Name:
	Residential address:
	Postal address:
	Telephone No.:
	Fax No.:
	Email address:

5 Applicant details (if different from proposed permit holder(s)

Name:
Residential address:
Postal address:
Telephone No.:
Fax No.:
Email address:

6 Give the relevant qualifications and experience of all people who will carry out the activities. If insufficient space, attach a list.

1	Name:
	Qualifications and experience:

2	Name:
	Qualifications and experience:

3	Name:
	Qualifications and experience:

7 Have you applied for or obtained any other approvals, permits or licences relating to this activity under Commonwealth, State or Territory legislation?

No ☐ ⇒ *Go to next question*

Yes ☐ ⇒ *Attach copies*

8 Have you previously held a permit from the Australian Government to conduct this activity?

No ☐ ⇒ *Go to next question*

Yes ☐ ⇒ *Give details below*

Permit number	Date permit expired

9 Offences

A proposed permit holder is taken to have been convicted of an offence if, within 5 years before the application is made, the proposed permit holder:

- has been charged with, and found guilty of, the offence but discharged without conviction; or
- has not been found guilty of the offence, but a court has taken the offence into account in passing sentence on the proposed permit holder for another offence.

Section 6 of the *Crimes Act 1914* deals with being an accessory after the fact. Sections 7 and 7A and subsection 86(1) of the *Crimes Act 1914* and sections 11.1, 11.4 and 11.5 of the Criminal Code deal with attempts to commit offences, inciting to or urging the commission of offences by other people and, conspiracy to commit offences.

Part VIIC of the *Crimes Act 1914* includes provisions that, in certain circumstances, relieve persons from the requirement to disclose spent convictions and require persons aware of such convictions to disregard them.

Has the proposed permit holder been <u>convicted</u> of, <u>or subject to proceedings</u> for an offence under any of the following?

a. offences under the *EBPC Act* or *Regulations*

b. a law of the Commonwealth or a State or Territory about the protection, conservation or management of native species or ecological communities;

c. section 6, 7 or 7A, or subsection 86(1), of the *Crimes Act 1914* (Commonwealth) or sections 11.1. 11.4 or 11.5 of the *Criminal Code Act 1995* (Commonwealth) in relation to an offence under a law mentioned in (a) or (b) above; or

d. a provision of a law of a State or Territory that is equivalent to a provision mentioned in (c) above.

No ☐

Yes ☐ ⇒ *Attach details*

10 *Attachments*

Indicate below which documents are attached.

Additional permit holders
See question 4 ☐

Additional qualifications details
See question 6 ☐

Copies of other approvals/permits
See question 7 ☐

Details of offences
See question 9 ☐

Other supporting documentation
List all additional documents below ☐

Titles of all attached documents *(include the document title, the specific section(s) and the page number(s) on which the information appears)*

11 Declaration

I declare that the information contained in this application Is correct to the best of my knowledge.

Signature of applicant

Name of person signing

Date

Appendix C: Supplementary Form C - Threatened Species and Ecological Communities

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Australian Government

Department of the Environment and Water Resources

Supplementary Form C —

- **Threatened species & Ecological Communities**
- **Migratory species**
- **Listed marine species**

(use Form A for Cetaceans)

Use this supplementary form if you are applying for a permit to kill, injure, take, trade, keep or move a listed species or ecological community, a listed migratory species, or a listed marine species in a Commonwealth Area. You will also need to complete "The General Permit Application Form".

If you are proposing to take or send specimens out of Australia it is likely that you will also need an export permit. Import permits may also be necessary for taking specimens into an overseas country. For more information on imports and exports contact the Wildlife Trade Assessments Section on 02 6274 2880.

Please note that it is a requirement under subsection 200(3) of the Environment Protection and Biodiversity Conservation Act 1999 that details of this application (which may include the applicant's name) be provided to persons or bodies registered with the Department of the Environment and Water Resources under section 266A of the Act, and to whom notice of applications is to be given, for the purpose of inviting submissions from those persons or bodies regarding permit applications.

1 Under which section(s) of the EPBC Act are you applying for this permit?

It will help you complete your application if you know which list in the EPBC Act the affected species/ecological community appears on.
Search the lists at: www.environment.gov.au/cgi-bin/sprat/public/sprat.pl
Please note some species appear on more than one list. For example the Green Turtle *Chelonia mydas is a listed threatened species, a listed migratory species, and a listed marine species.*

Select all that apply

Section 201 — Listed threatened species and ecological communities ☐

Section 216 — Listed migratory species ☐

Section 258 — Listed marine species ☐

2 On the next page list details of species or ecological communities that will be affected by the action.
Use the following codes to enter details in columns 3, 4 and 5.

Column 3 Conservation status of threatened species or ecological communities under EPBC Act

- EW Extinct in the wild
- EX Extinct
- CE Critically endangered
- EN Endangered
- VU Vulnerable
- CD Conservation dependent

Column 5 Type of effect

- DE Death
- IN Injury
- TR Trading
- TA Taking
- KE Keeping
- MO Moving

Details of species or ecological communities that will be affected by the action.

Common name of listed species/ecological communities, listed migratory species, or listed marine species.	Scientific name of species Common and scientific names are available at the Department's website: www.environment.gov.au/cgi-bin/sprat/public/sprat.pl	Conservation status under EPBC Act	Estimated number that will be affected. For ecological communities, provide estimate of the affected area	Type of effect

Where the project is of less than 1 km2 in size, provide the location as a single pair of latitude and longitude references. Latitude and longitude references should be used instead of AMG and/or digital coordinates.

Locality:

Latitude: degrees: minutes seconds:

:

Longitude degrees: minutes seconds:

:

Where the project area is greater than 1 km2, or any dimension is greater than 1 km, provide additional coordinates to enable accurate identification of the location of the project area.

Attach a map to show the boundaries of the area in which the action will be conducted.

3 Provide an attachment describing the action addressing the following points.

A. The objectives and purposes of the action;

B. The equipment and methods used;

4 What are the likely short and long term impacts of the proposed action on the species or the ecological community?

5 Describe the steps that will be taken to minimise impacts on the listed species/ecological community, including contingency plans in the case of events that may adversely affect members of the species/ecological community.

6 Attach a description of any research relevant to the affected species or communities that will be carried out in the course of or in conjunction with the proposed action, including:

A. a copy of the research proposal;

B. the names of the researchers and institutions involved in or supporting the research; and

C relationship of the researchers to the permit applicant, including any funding being provided by the permit applicant.

7 Will the action involve invasive techniques?

No ☐ ▶ *Go to next question*

Yes ☐ ▶ If permit relates to mammals, birds, reptiles or amphibians, attach evidence that the proposed methods have been approved by an independent Animal Ethics Committee (this may include a State or Territory ethics committee, even if the action is conducted in a Commonwealth area).

A permit can only be issued under one of the following criteria: the action

- *will contribute significantly to the conservation of a listed species/ecological community (go to Question 8); or*
- *will be incidental to, and not the purpose of the action (go to Question 12); or*
- *is of particular significance to indigenous tradition (go to Question 15); or*
- *is necessary to control pathogen(s) (go to Question 18).*

8 Are you applying on the basis that the action will contribute significantly to the conservation of a listed species/ecological community?

No ☐ ▶ *Go to 12*

Yes ☐ ▶ *Go to next question*

9 Why do you believe that the action will contribute significantly to the conservation of listed species/ecological communities, listed migratory species or listed marine species?

10 Will the proposed action implement the recommendations of any recovery plan or wildlife conservation plan in force for the species or ecological community that may be affected by the action?

Commonwealth recovery plans that are in force are available at

www.environment.gov.au/biodiversity/threatened/recovery/list-common.html

Commonwealth wildlife conservation plans that are in force are available at www.environment.gov.au/biodiversity/migratory/waterbirds/shorebird-plan/plan.html

State and territory recovery plans are available from state and territory environmental agencies.

No ☐ ▶ *Go to next question*

Yes ☐ ▶ Describe how this will be implemented.

11 Will the proposed action respond directly or indirectly to recommendations of any national or international organisation responsible for management of the affected species?

No ☐ ▶ *Go to next question*

Yes ☐ ▶ Describe how the proposed action will respond.

12 Are you applying on the basis that the impact of the action will be incidental to, and not the purpose of, the action?

No ☐ ▶ *Go to 15*

Yes ☐ ▶ *Go to next question*

13 Why do you believe that the impact of the action will be incidental to and not the purpose of the action?

14 Why do you believe that the taking of the action will not adversely affect the:

i. survival or recovery in nature of the species or ecological community?

ii. conservation status of a listed species or ecological community?

15 Are you applying on the basis that the action is of particular significance to indigenous tradition?

No ☐ ▶ *Go to 18*

Yes ☐ ▶ *Go to next question*

16 Explain why do you believe that the proposed action will be of particular significance to indigenous tradition?

17 Why do you believe that the proposed action will not adversely affect the:

i. survival or recovery in nature of the listed species or ecological community; or

ii. conservation status of the listed species or ecological community.

18 Are you applying on the basis that the action is necessary to control a pathogen(s), and is conducted in a way that will, as far as is practicable, keep to a minimum any impact on listed species/ecological communities, listed migratory species or listed marine species?

No ☐ ▶ *Continue to Payment Section*

Yes ☐ ▶ *Go to next question*

19 Why do you believe that the action is necessary for the control of pathogen(s)?

20 Explain how the action will be conducted in a way to minimise impacts on the species/communities affected.

If you have answered NO to Questions 8, 12, 15 and 18, it is unlikely that a permit can be issued under the EPBC Act.

21 Fees

The following fees apply:

- permits relating to listed threatened species or ecological communities - $100
- permits relating to listed migratory species - nil
- permits relating to listed marine species – nil

Please note that exemption from fee payment may apply under circumstances as set out in EPBC Regulation 18.04.

22 Are you paying by credit card

No ☐ ▶ *Go to 23*

Yes ☐ ▶ Complete the following details

Card: Visa ☐ Bankcard ☐ MasterCard ☐

Card number

Expiry date (month/year)

Card holder's name as shown on card

Amount

Cardholder's signature

23 Attachments

Indicate below which documents are attached.

Description of proposed action
See question 3 ☐

Description of relevant research
See question 6 ☐

Evidence of approval of invasive techniques
See question 7 ☐

Cheque for payment of fee
See question 21 ☐

24 Declaration

I declare that the information contained in this supplementary form is correct to the best of my knowledge.

Signature of applicant

Name of person signing

Date

Send this application and fee to:

Wildlife Trade Assessments
Department of the Environment and Water Resources

Australian Government

GPO Box 787
CANBERRA ACT 2601

Fax: 02 6274 1921
Email: wta@environment.gov.au

Appendix D: Priority Matrix

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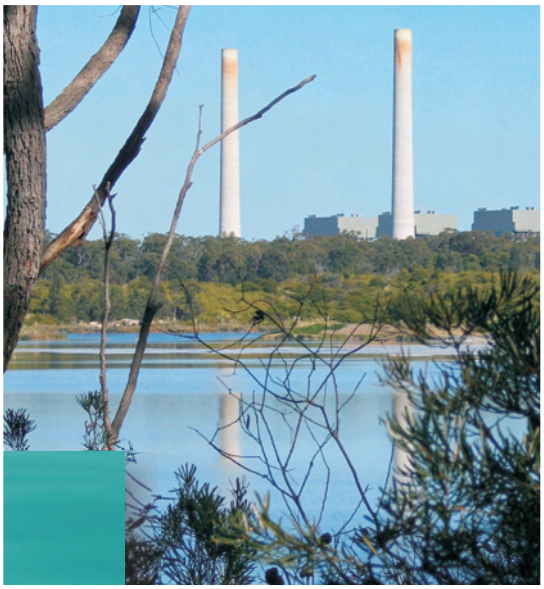
URGENCY OF ACTION	POTENTIAL SURVIVAL IMPACT			
		1 Low	**2 Moderate**	**3 High**
	1 Ongoing	2 LOW	3 LOW	4 MEDIUM
	2 Moderate	3 LOW	4 MEDIUM	5 HIGH
	3 Immediate	4 MEDIUM	5 HIGH	6 HIGH



HLA-Envirosciences Pty Limited (HLA ENSR), part of ENSR, an AECOM company.
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