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20 June 2002

PlanningNSW
Henry Deane Building
Level 4
20 Lee Street
SYDNEY NSW 2000

ATTENTION: MR C WILSON AND MR M ANDREWS

Dear Sirs

EPA CORRESPONDENCE DATED 4 JUNE 2002 REGARDING SECOND SUBMISSION OF ADDITIONAL INFORMATION

I refer to your facsimile of 14 June 2002 which incorporated correspondence from the Environmental Protection Authority (**"EPA"**) dated 4 June 2002 concerning comments on the additional information received by that agency on 20 May 2002 in relation to the Ashton Coal Mine Project.

In relation to the three (3) main issues raised by the EPA the following comments are offered:

1. EPA ISSUE – PROPOSED OPTION 2 AMENDMENTS

We note and concur with the EPA comments which is consistent with their position at the meeting held on 7 May 2002.

2. EPA ISSUE – PROPOSED SALINITY OFF-SET

The issue of "salinity off-sets" was raised by the Department of Land and Water Conservation (**"DWLC"**) at the conclusion of the meeting held on 7 May 2002. The attached paper entitled "*Report on Salinity and Green Off-Sets for the Ashton Coal Project*" was prepared in response to, and to satisfy the issues raised directly by DLWC.

We re-iterate that as the mine will intercept and utilise all groundwater during the 20 years of its operation, and during the estimated 30 years for the mine to fill with water (and therefore prior to potential upward migration of groundwater), the objective of this project is to provide a long term (greater than 50 years), program of tree, shrub and pasture species plantings to offset the predicted long term increase in salinity that may occur following closure of the mine.

The EIS document contains in Volume 3 a plan entitled "*Final Landform and Vegetation Patterns*" (Fig. 4.21) which provided for approximately 46,000 plants to be established across the Ashton Coal Mine Project site. Less than 10% of this number of trees is required to provide the necessary salinity off-set. We firmly believe that the initial plan adequately compensated and addressed salinity issues.

3. EPA ISSUE – MINE PLAN ALTERNATIVES

As we have consistently advised, the economics of this project are extremely sensitive to the amount of coal that can be recovered from the underground mine. This was re-iterated by White Mining Limited (**"WML"**) Managing Director, Mr Brian Flannery, at the meeting on 7 May 2002.

The alternative mine plans proposed by the EPA involve first workings only in the area of Bowmans Creek aquifer and result in the sterilisation of well over 50% of the coal in this area. The mine is not viable under this circumstance. We refer you to HLA's correspondence dated 28 March 2002, Section 4 regarding the assessment of operational alternatives.

We trust that this finalises all outstanding issues with the exception of archaeology. We note that NPWS received the final report on 18 June 2002 and that a copy has been forwarded to your office.

We are currently in the process of finalising our draft consent conditions as discussed at our recent meeting. These are expected to be submitted to your office early next week.

We look forward to discussing consent conditions with you in the immediate future.

Yours faithfully

IAN CALLOW
Project Manager

Encl

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Report on Salinity and Green Offsets for Ashton Coal Project

Prepared for

White Mining Limited
PO Box 699
Singleton NSW 2330

HLA-Envirosciences Project No U909-5

By

Dee Murdoch BSc Grad Dip Land Rehab
Land Rehabilitation Coordinator

20 June 2002

This document was prepared for the sole use of White Mining and the regulatory agencies that are directly involved in this project, the only intended beneficiaries of our work. No other party should rely on the information contained herein without the prior written consent of HLA-Envirosciences Pty Limited and White Mining.

CONTENTS

1.0 INTRODUCTION

This report assesses options to ensure that no net increase in saline groundwater discharge occurs into Bowmans Creek as a result of the proposed Ashton Coal Project. It is proposed to utilise trees, shrubs and pasture species to intercept groundwater at recharge and discharge locations, thereby reducing the net migration of salt through the aquifers and ultimately into the Hunter River.

The baseline data (DLWC gauging station 210130) for Bowmans Creek show that the salinity in the creek ranges historically (1993-2000) from in excess of 2000 µS/cm in low flow to less than 500 µS/cm in high flow. The management options listed in this report have been compiled to address the predicted worst case increase in salinity of the Hunter River of 14 µS/cm (HLA 2001 EIS Appendix H) which may result if no mitigation measures were implemented.

This report is in response to discussions held with representatives of the White Mining, Fisheries, EPA, PlanningNSW, DMR and DLWC who attended a meeting in Singleton on 7 May 2002 and requested White Mining to prepare strategies to:

- Ensure no net increase in salinity in the Hunter River with the option of planting suitable salt tolerant vegetation;
- Assess the impact of planting tree species that would soak up salinity in areas of longwall mining;
- Minimise the long term impacts of increased salinity in the Bowmans Creek alluvium;
- Minimise the predicted increase in salinity into the Hunter River and Bowmans Creek with regard to other land use in the catchment; and
- Address other environmental offsets.

The use of vegetation as a salinity management option is premised on the modification of current land use practices. These include the replacement of the existing shallow rooted introduced pasture species with deep rooted, high water usage, saline tolerant, tree, shrub and pasture species and increasing the area under tree and shrub species. These options would target high recharge areas or groundwater interception zones resulting in the lowering of the groundwater tables, reducing dryland salinity and minimising the saline discharge to Bowmans Creek and the Hunter River.

The use of the native trees and shrubs would also provide additional ecological and environmental benefits in the form of expanded native habitat, continuation of existing vegetative corridors and linkages and carbon sinks.

These additional benefits are consistent with the concept of Green Offsets which are defined by the NSW EPA (2002) as:

> *"action taken outside a development site (but near to it) that reduces pollution or environmental impacts. The developers either take the action themselves or pay for others to do it on their behalf.*
> *A green offset scheme ensures that there is a net environmental improvement as a result of the development."*

It should be noted that the actions applicable to the Ashton Coal Project would all occur within the Development Application boundaries.

The principles of offsets are:

- Environmental impacts must be avoided first by using all cost effective prevention and mitigation measures. Offsets are then only to address remaining environmental impacts;
- All standard regulatory requirements must still be met;
- Offsets must never reward ongoing poor environmental performance;
- Offsets will complement other government programs; and
- Offsets must result in a net environmental improvement.

The green offsets must be:

- Enduring;
- Quantifiable;
- Targeted;
- Located appropriately;
- Supplementary; and
- Enforceable.

2.0 OBJECTIVE OF THE PROJECT

As the mine will intercept and utilise all groundwater during the 20 years of its operation, and during the estimated 30 years for the mine to fill with water (and therefore prior to potential upward migration of groundwater), the objective of this project is to provide a long term (greater than 50 years), program of tree, shrub and pasture species plantings to offset the predicted long term increase in salinity that may occur following closure of the mine. This report provides details on the type, number and location of the recommended plantings.

3.0 DISCUSSION

3.1 Dryland salinity – definition, cause and vegetation management

Dryland salinity typically is the result of hydrological disequilibrium caused by extensive clearing of native vegetation. Native, deep-rooted, perennial vegetation has been replaced in dryland areas with annual, shallow rooted and water inefficient crops (e.g. wheat and barley) and pastures (e.g. clover and ryegrass) (RIRDC *et al*, 2000). Shallow-rooted crops and pastures can only use water in the upper horizons (<1.5m) of the soil profile and as with annual pasture growth rates are seasonally variable.

Recharge occurs in the higher parts of the landscape (recharge zone), and with time, groundwater moves down gradient, mobilising salt along the way. Where the groundwater surface converges with the land surface, for example, in stream channels, at break- of-slope, in areas of subsidence or in other low lying areas, water may discharge to the land surface bringing any dissolved salts with it (discharge zone). The transmission zone, which transmits water and dissolved salts between the recharge and discharge zones, is commonly included as part of the recharge zone.

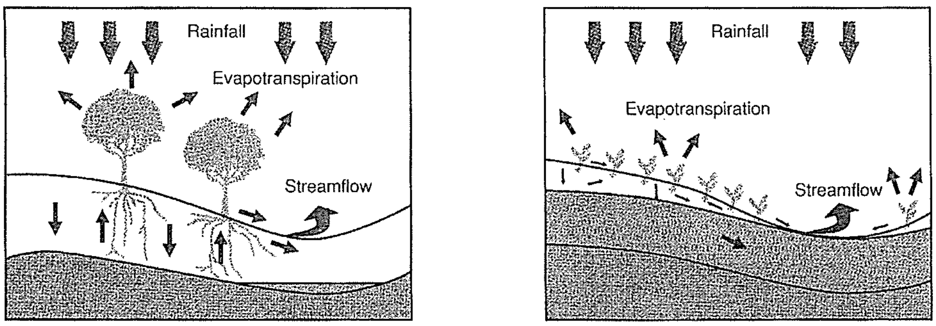
There are many actions, which can be implemented to manage and prevent the issue of salinisation in a catchment. These include changing of the cropping regime, the use of agro forestry, engineered solutions including piping, irrigation and associated drainage features. Whatever methodology is selected the optimum range of solutions encompass the management of the Development Application area rather than addressing the symptoms e.g. saline discharge areas.

The practical difficulty in identifying recharge areas arises from the fact that most focus for salinity control emanates from the study of the discharge area as these are the most visible on the landscape and have the most impact on land usage and productivity.

A fundamental element of the management of dryland salinity is the revegetation of both recharge and discharge areas, particularly recharge areas. The retention of existing native vegetation should therefore be advocated as the first preventive measure against the development of dryland salinity (RIRDC *et al*, 2000). To reduce the recharge the existing shrub and trees including native perennial pastures, in the upper catchment and salt prone areas should be retained.

Increased recharge is generally accepted as a major cause of secondary dryland salinity. In some dryland areas, especially those with winter rainfall patterns, recharge may have increased a 100 times since the clearing of native vegetation and the introduction of crops and pastures (RIRDC *et al*, 2000). Before the land was cleared for agriculture, evapotranspiration by native vegetation accounted for most of the incoming rainfall, whereas run-off and recharge comprised comparatively small components of the water balance. In most areas, water usage by native vegetation is able to maintain watertable levels below the ground surface. **Diagram 1** illustrates the impact of replacing native vegetation with shallow rooted plants and the resultant reduction in the evapotranspiration and storage components of the water balance and an increase in the run-off and recharge components. These increases in groundwater recharge rates have led to rising water tables, and, in many parts of the country, interception of groundwater systems with the ground surface.

Diagram 1. The effect of replacing deep-rooted vegetation with shallow rooted plants



	Before clearing	After clearing
Rainfall	650-750 mm	650-750 mm
Evapotranspiration	640-720 mm	580-660 mm
Streamflow	10-30 mm	70-90 mm
Salt input	0.01 kg/m²	0.01 kg/m²
Salt output	0.001-0.005 kg/m²	0.3-0.5 kg/m²

Source: Government of Western Australia, 1996

Although leakage can be difficult to measure, especially when comparing how much it varies under different management strategies, research clearly indicates that current agriculture is very "leaky", especially when compared to native forests and woodlands.

3.2 Issues associated with salinity management and green offsets

Aligning the use of vegetation to salinity management and green offsets creates a range of questions, which have been addressed in this report. These include:

- Where are the recharge areas?
- Where are the discharge areas?
- What species are suited to salinity control?
- Which species are summer growing?
- Which species are winter growing?
- What are the climatic conditions and when are the wet / dry times?
- What are the results on soil moisture and when is the soil wet and staying wet?
- What is the optimum time required for the maximum uptake of soil moisture to ensure the reduction in the incidence of discharge?
- What additional ecological benefits would be derived from a tree planting program on the project area?
- What are the disadvantages of the use of tree and shrub species in context of agricultural land productivity?
- Are there areas that are suited to the use of pasture species rather than tree and shrub species?
- How long are the plants growing and how does the uptake of water change over the life of the plant? and
- How long are the plants required?

Whilst opinions differ on the effectiveness of vegetation on salinity there is general consensus that to achieve a substantial change (to salinity) there needs to be significant changes in land use across the catchment. The real impact is that areas of land classified as land capability class II, III and IV historically would be returned to irrigated improved shallow rooted pasture and crops and better quality grazing country. However under the strategies recommended in this report, many of these areas of recharge and discharge would be planted to native trees and shrubs of a variety of species and life span.

The solution to salinity management is not simply a case of planting trees and shrubs. Rather, the landscape vegetation should be based on a long term plan which incorporates species selection, their life span, the harvesting of the vegetation (both pasture and trees) and a replanting program designed to ensure the continuation of the lowering of the water table. This program would continue until the tree and shrub community becomes self-sustaining, which would ensure an ongoing beneficial environmental impact on groundwater and salinity levels.

3.3 Rainfall and evaporation

Details of the rainfall and evaporation at the project site are provided in **Table 1**. The average annual and monthly evaporation exceeds rainfall, which indicates that a soil water balance deficit occurs most of the time and only a small percentage of the rainfall is available for runoff and deep percolation/recharge of the coal measures groundwater.

Table 1: Average Monthly and Annual Rainfall and Evaporation (mm)

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Rainfall*	80.3	69.7	58.4	43.9	41.2	47.7	43.7	36.7	42.1	51.7	57.1	66.8	639
Evaporation#	220	169	154	118	89	56	69	81	112	164	195	204	1630
Balance	-139.7	-99.3	-95.6	-74.1	-47.8	-8.3	-25.3	-44	-69.9	-112.3	-137.9	-137.2	-990.9

* BOM Jerrys Plains Meteorological Station

BOM Scone SCS Meteorological Station

(Source: HLA 2001)

3.3.1 Predicted changes to the groundwater

Longwall mining associated with the Ashton Coal Project will substantially alter the groundwater regime during mining and the potential exists for increased vertical permeability due to subsidence induced cracking or fracturing over the long wall panels. At the shallower northern end of the long wall panels there is a moderate to high risk of increased vertical hydraulic connection between the coal measures, which contain water with elevated salinity (8,500 µS/cm) and the overlying Bowmans Creek alluvial groundwater, which has salinity levels adjacent to Bowmans Creek of 900-2000 μS/cm and levels of 2000 – 6,000 μS/cm on the margins of the alluvium due to leakage from the underlying coal measures strata.

During the 20 years of mining groundwater levels will be drawn down by the depressurisation due to the dewatering activities in the mine. Once mining ceases, the mine workings will gradually fill with water over an estimated period of 30 years. The groundwater levels will then recover close to the premining state, in which there is upward vertical seepage or discharge from the coal measures groundwater under the low ground along the valley floor.

The rate of increase in upward seepage or discharge from the underlying mine workings is calculated to be about 0.022 ML/day. This additional seepage from the coal measures will mix with the alluvial groundwater and gradually flow back into Bowmans Creek downstream.

3.4 Characteristics of the aquifer

To ensure the vegetation program addresses salinity the following parameters were taken into consideration:

- The discharge capacity of the aquifer;
- How the recharge rates vary across the catchment;
- The scale of the groundwater systems – local, intermediate or regional; and
- The salinity of the groundwater.

3.4.1 Groundwater Hydrology

The main aquifers in the Ashton Coal Project area are in the coal seams and in the unconsolidated alluvium associated with Bowmans Creek, Glennies Creek and the Hunter River.

The permeability of the coal measures is low and is at least one order of magnitude lower than the unconsolidated alluvial aquifers. The main aquifers and groundwater in the coal seams and adjoining strata are saline with electrical conductivity (EC) in the range 5,000 μS/cm to 16,000 μS/cm. Water discharged from nearby mines (eg Cumnock) extracting the same seams ranges in salinity (EC) from 8,000 to 9,000 μS/cm.

A narrow strip of shallow alluvium (approximately 10m thick) occurs along Bowmans Creek, which contains basal sands and gravels that are saturated from about 4m to 6m below ground surface. This aquifer, which underlies three of the proposed long wall panels, stores about 750ML of water and has an underflow, or sustainable yield between 0.003 and 0.1 ML/day. This low sustainable yield severely limits its application for irrigation purposes.

Groundwater in the Bowmans Creek alluvium has a salinity which ranges from about 900 µS/cm near the creek to about 6,000 µS/cm near the margins of the alluvium, which is only suitable for stock watering at the higher limits and for irrigation of some moderately salt tolerant crops at the lower limits.

During the longwall mining subsidence will occur resulting in the flow of water from the alluvium into the underlying goaf with seepage predicted of 1 ML/day. After the seepage event the value will fall to a low value of around 0.1 ML/day (HLA 2001 Appendix H). The movement of groundwater will result in a reduction in salinity in the Bowmans Creek during this period. Experience indicates that the water inflows may reduce and groundwater levels recover within 10 years in most areas of the site, with the alluvium will be fully resaturated within 10-15 years post mining and underlying coal measures being completely saturated within 30 years.

Post the saturation of the alluvium and coal measures, groundwater will continue to seep into the alluvium at a rate of 0.022 ML/day, which when combined with the 0.09 ML/day from rainfall discharge, gives a excess seepage from the alluvium of 0.112 ML/day. This seepage will either form surface ponding in the lower parts of the subsided area or accede to the creek channel further south.

3.4.2 Post mining impact on stream flow salinity

For the case where the groundwater in the alluvium is in steady state, and assuming that complete mixing of waters occurs, the EC of the groundwater may rise from the current average of 1,200 µS/cm to about 1,700 µS/cm. Over time, the EC of ponded water will gradually increase due to evaporative processes, if these are larger than the ponded water's discharge rate towards the south.

It is estimated that the increase in salinity in Bowmans Creek due to the Ashton Project will be less than 70 µS/cm under low flow (2ML/day) conditions, assuming a worst case scenario that all the predicted mine water leakage (0.022ML/day) reaches the creek undiluted (8,500µS/cm).

In practice, the increase in salinity will be lower than 70µS/cm because not all the mine leakage will reach Bowmans Creek and there will be dilution from rainfall recharge over the alluvium. It is possible that the salinity may rise by between 100 µS/cm and 300 µS/cm for short periods during extreme low flows, but is unlikely that the stream would flow continuously at these times.

The estimated increase in salinity in the Hunter River, during low flows (150ML/day) under the same assumed worst-case scenario as a function of the Ashton Coal project is calculated to be less than 14 µS/cm. (HLA 2001 Appendix H)

3.5 Water use by trees and shrubs

The rate at which plants transpire water is a function of:

- Leaf area;
- The availability of water;
- Climatic conditions in context of rainfall and evaporation rates;
- The capacity of a plant to act as a conductive pathway (RIRDC et al 2000);
- Groundwater recharge whether it be via matrix flow (flow between soil particles) of preferential flow (along old roots structure and macroscopic structures);
- Quality of the groundwater; and
- Stand density or density of leaf area - Water use per tree is usually greater in widely spaced trees than in trees growing in a forest situation (Conservation Forests and Lands (1989) cited in RIRDC *et al* (2000)). This is the result of better access to soil water and a larger canopy providing an increased evaporative surface.

An indication of the potential water usage for nine species with differing ages, densities and annual rainfall is provided in **Table 2**.

Table 2: Water use measurements for nine species with differing ages, tree densities and annual rainfall

Species	Mean annual rainfall (mm)	Tree age (years)	Tree density (trees/ha)	Daily tree water use (l/tree/day)
E grandis	698	2	2150	14
E camaldulensis	Irrigated	2	1667	9
E cladocalyx	500	2.3	816	30
E leucoxylon (open grown)	625	6	200	18
E leucoxylon (densely grown)	625	6	200	34
E globulus	684	6	816	90
E leucoxylon	684	6	816	62
E camaldulensis	560	10	580	40
E regnans	Unknown	50	176	106
E regnans	Unknown	90	106	158
E regnans	Unknown	150	56	179
E regnans	Unknown	230	72	113
E fasciculosa	550	200	100	25
E fasciculosa	550	200	100	55
E wandoo	340	200	130	37
E salmonophloia	340	200	122	32

Based on: Bulman, 1995

The amount of water used by any plant is a function of the proximity of the groundwater to the plant roots, the age and health of the plant, planting densities, growth season of the plant and species selected. However these factors need to be considered in light of other factors of the green offsets. For example, it would not be practical to consider introducing plant species that are known to be invasive and have the potential to become a weed, or those species that offer little in the way of habitat value. Likewise due to the requirement for a long time frame for the salt uptake (50+ years) species must be long lived with self sustaining reproductive habits with growth during the cooler and wetter months of the year to ensure uptake of the winter rains, or significant autumn and summer growth to ensure the lowering of the water table pre winter " top up". By exploiting stored soil water as well as rainfall, strategically placed trees can consume more than double the amount of water provided by rainfall.

The specific details on the management of the vegetation in context of agro forestry and the harvesting, crop rotation of various species have not been covered in this report. However in those areas, which are predicted, to be saline and waterlogged the planting program is focused on the use on plant species, which would become ecologically sustainable.

Strategic placement, from the hydrological perspective, however requires information on where ready access to subsurface water occurs.

According to Bulman (1995), trees can be planted in:

- Well-drained recharge zones where trees can reach the watertable;

In general, trees and shrubs within recharge zones should be located in:

- Upper catchment areas. Areas of recharge are often ridgelines which have shallow soils overlying fractured rock;
- Areas with stony or deep sandy soils (areas of greater recharge);
- Areas where they can provide protection for stock or in addition to using soil water in their root zones) (Bulman, 1995);
- Recharge zones where the trees can not reach the watertable or unconfined aquifers; and
- Discharge zones where the watertable is close enough to the surface to evaporate and accumulate salt.

For the Ashton Coal Project the impact of the longwall underground mining on the groundwater and Bowmans Creek alluvium and the predicted saline seepage in the form of a discharge area has also been considered.

3.6 Water usage and pasture species

The selection of pasture species for the Ashton Project site will be a function of final land use, species suitability to the local conditions and the capacity of the selected species to grow in the potentially seasonally waterlogged and saline conditions.

Where trees are not a preferred option, the use of perennial pastures should be considered. They offer the following advantages:

- They are cost effective to establish and offer a quick return in terms of cultivation and grazing;
- Many perennial pasture species are high water users;
- Species selection can include cool and warm season species ensuring a balanced annual water usage at the site; and

- Depending on the species they may be suited to saline sites, in turn offering economic and environmental returns.

Previous studies (DLWC 2002 unpublished) have provided an indicative list of the preferred pasture species for the management of salinity. These include:

- Australian phalaris;
- Tall wheat grass;
- Victorian or Kangaroo Valley perennial ryegrass;
- Demeter fescue;
- Palestine strawberry clover;
- Trikkala or grosse sub clover;
- Paradana Balansa clover;
- Strawberry clover;
- Couch grass; and
- Wimmera ryegrass.

Consideration should also be given to the use of native grass species including *Microlaena* sp., *Elymus* sp. and *Danthonia* sp. especially considering their ability to grow during the cool season and the corresponding impact on groundwater usage in the cooler months.

4.0 VEGETATION MANAGEMENT ZONES FOR ASHTON COAL PROJECT

Whilst much has been written on the control of dryland salinity using native vegetation and the rate of water use of these species, much of this information is still in draft format or based on research scenarios. The recommendations of this report have been based on an extensive literature review and the recommended strategies extrapolated from these findings.

The selection of species and the management options have been based on the existing knowledge of the Ashton Coal Project site with particular reference to the groundwater, existing salinity levels and the associated modelling, soils, vegetative cover and proposed mining activities. Comprehensive details on the site layout of the project area, final number of plants required and species selection have also been provided.

4.1 Vegetation management zones

Based on the data available for the project area, the recommendations for vegetation management as a salinity control tool and a green offset would be based on a multi-strand approach. The main strands of this approach are:

- Zone 1- Hill slope tree belts – designed to reduce the flow moving down slope and used in areas of shallow surface soils especially dispersible surface soils layers;

- Zone 2 -Mixing of tree belts and agriculture – also benefit of adding to riparian and midslope corridors and habitat, include use of native deep rooted pasture species for non irrigated areas;

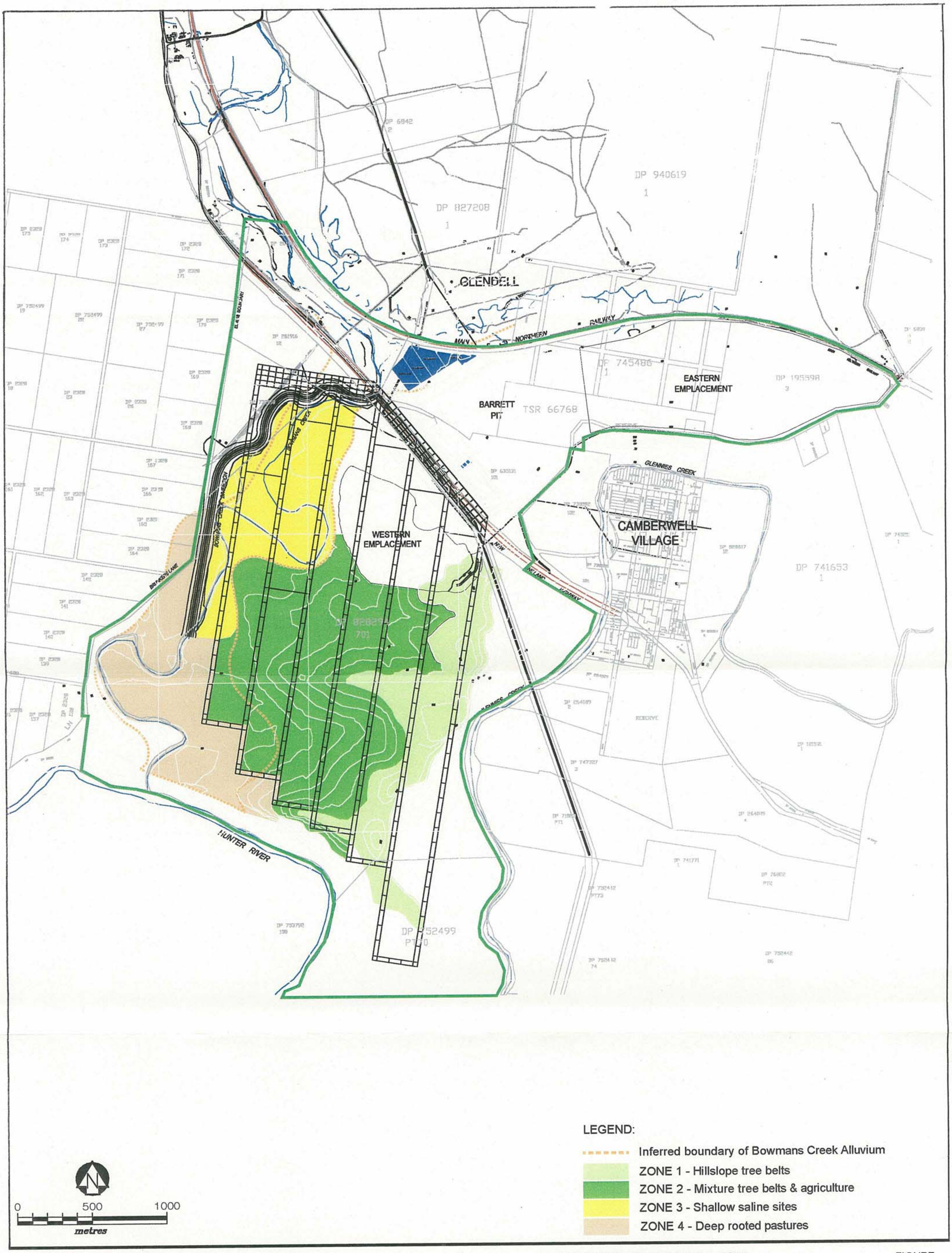
- Zone 3- Targeted plantings over known areas of shallow saline water tables especially in areas of predicted subsidence and the diversion of Bowmans Creek and the interface of the coal bearing areas and the alluvial soils; and

- Zone 4 - Use of deep-rooted pasture species in areas returning to irrigated pasture.

Information of each of these zones is provided in **Table 3** and on **Figure 1**.

4.2 Species selection

The plant communities selected for the various zones are listed below in **Table 3** and are aligned to the species list as provided in the HLA (2001) EIS for Ashton Coal Project Appendix J.



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PROPOSED VEGETATION MANAGEMENT ZONES GREEN OFFSET AND SALINITY

Ashton Coal Project

FIGURE **1**

DRAWN	PROJECT-FILE NUMBER	APPROVED	DATE	REVISED DATE
LJF	U909-5		June 2002	

Table 3: Vegetation zones and aligned plant communities

Zone	Area of each zone as per Fig 1	Depth to ground water	Existing land use problems	Current land use	Land use during operation	Land use post mining	Species selection as per Plant community from HLA EIS 2001	Management considerations	Green offsets
1	86.1 ha	Approx. 10m	Soil erosion – sheet and rill. Shallow dispersible soils.	Limited unimproved pasture – beef cattle	Unimproved pasture – beef cattle	Tree lots, agro forestry	Bull Oak open forest, Narrow Leaved Ironbark Woodland	Need to keep cattle off area whilst establishing trees.	Habitat, salinity, carbon credits, noise pollution, surface water movement, sediment and erosion control
2	185.7 ha	5-10m	Soil erosion – sheet and rill. Shallow dispersible soils.	Unimproved pasture – beef cattle	Unimproved pasture – beef cattle	Tree lots, agro forestry, Unimproved pasture – beef cattle	Bull Oak open forest, Narrow Leaved Ironbark Woodland and Treelot species	Spacing and dimensions of tree belts has still to be defined. Consider use of native pasture species for added habitat value.	Habitat, salinity, carbon credits, noise pollution, sediment and erosion control
3	83.8 ha	Above ground to 2m	Soil erosion – sheet, rill and tunnelling. Shallow dispersible soils. Saline scalds. Lack of native vegetation. Seasonal water logging.	Irrigated and improved pastures	Improved pastures	Native tree, shrubs, riparian habitat	River Oak Open Forest, plus *Casuarina glauca, Eucalyptus robusta, E.tereticornis* and *Callistemon sp.*	Use of non-endemic species should be considered due to their salt tolerance.	Riparian habitat, carbon credits, dryland salinity
4	99.2 ha	Above ground to 2m	Saline scalds. Lack of native vegetation. Seasonal water logging.	Irrigated and improved pastures	Improved pastures	Native and introduced perennial pastures	Native and introduced perennial pasture species	Requires regular maintenance, harvesting to ensure continual growth.	Dryland salinity control

4.3 Numbers of trees required

To calculate the number of trees required for the project area calculations are required on the following parameters:

- The amount of water to be evaporated;
- The density of trees in the plantation; and
- What is the acceptable delay before the control to recharge is achieved?

The vegetation program for the Ashton project site will be a mixture of species, which have a range of growing seasons including cool and warm season, pastures, shrubs and trees.

Based on the figures provided in **Table 1** and extrapolating this data the following calculations (**Table 4 and 5**) can be used to assess water uptake across the site. The groundwater information contained in the HLA 2002 EIS for the Ashton Coal Project (Appendix H) mentions that as a function of the recharge to the Bowmans Creek alluvium from the coal measures equal to 0.022ML/day and the recharge attributable to rainfall at 0.090 ML/day the total recharge of 0.1ML/day (100 000 litres /day) would need to be utilised by the proposed vegetation to restrict the potential movement of salt into Bowmans Creek and the Hunter River.

Table 4: Water usage for tree species based on 400 plants per hectare (5 m spacings)

Age of tree growth	Assumed water usage (Litre /day/tree)	Total water usage (Litres /ha/day)	Minimum area (ha) required to be planted to achieve 0.1 ML/day
0-5 years	30	12 000	8.333
5-10 years	60	24 00	4.166
10-30 years	100 l /day	40 000	2.500

(ML/day = Assumed water usage x 400)
(Minimum areas required = water required to be used (0.1 ML/day) /total water usage)

Table 5: Water usage for tree species based on 200 plants per hectare (10 m spacing)

Age of tree growth	Assumed water usage (Litre/day/tree)	Total water usage (litres/ha/day)	Minimum area (ha) required to be planted to achieve 0.1 ML/day
0-5 years	30	6 000	16.66
5-10 years	60	12 000	8.33
10-30 years	100	20 000	5.00

On the basis of the above calculations maximum area of say 17 hectares (16.66 ha) will need to be established with 200 plants/ha (total stems 3,400) to ensure the offset of the estimated increase in the salt load from the proposed Ashton Coal Project.

The use of the surface layers of the groundwater (<1.5m) by the pasture species has been viewed as additional to the groundwater used by the tree and shrubs species and would equate to 2000l/ha/day on a cropping regime of 3 tonne/ ha. These plantings would assist in further reducing localised dryland salinity issues and water logging.

Based on these figures, the project area could successfully be managed in terms of pasture, trees and shrubs species to ensure no impact to Bowmans Creek and the Hunter River in context of water and salinity discharge, over the life of the project (20 years) and in the long term (50 years and beyond).

4.4 Long term landscape

To ensure continuing success of the planting in context of salinity and groundwater control the selected plant species should have a minimum life span of which would be aligned to changes in the salinity of the alluvial groundwater which is predicted to occur within 30 years after cessation of mining.

Further information is required related to the details of managing the pasture and tree sites e.g. timing of harvesting of tree and pasture to maximise the uptake of moisture, selection of cool season crops.

4.5 Limitations of plant based options for salinity control

The utilisation of vegetation for the control of dryland salinity is not a guaranteed process. This can be attributed to a number of factors including:

- Lack of detailed information within a catchment can make predictions difficult and extrapolation of data from other areas can be questionable with management options needing to be tailored to the individual site and varied over time to ensure ongoing success;

- The processes controlling the groundwater can be broader than the project area;

- The time scale of remediation measures may make measurement of salinity difficult and management options must be planned and implemented for time scales of decades not months; and

- Changes in land use and the inherent reduction in traditional agricultural practices are required greater than the project area to ensure success.

However the studies on the catchment for the EIS have provided a comprehensive picture of the catchment area associated with the Ashton Coal Project and the results of these studies have been factored into the strategies for salinity management.

5.0 RECOMMENDATIONS

To address the long-term management of groundwater and salinity at the Ashton Coal Project approximately 3400 trees need to be planted in groundwater recharge zones. This is a minor proportion of plantings already proposed in the EIS.

The recommendations of this report and how they align to the final vegetation patterns of the EIS are detailed hereunder:

- Plant 50 ha of the 86.1 ha in Zone 1, i.e. 10,000 trees and shrubs. This is in accordance with the Final Landforms and Vegetation Patterns (Fig 4.21 EIS Vol 3 HLA 2001), which have a total area in the higher topography sections (south of the highway) of the project area of approximately 120 ha planted to Narrow leafed Iron Bark Woodland and Bull Oak Open Forest. Assuming rates of 200 plants/ ha this provides 24,000 stems;

- Plant 20 ha of the 185.7 ha of Zone 2 with a mixture of tree belts i.e. 4,000 trees and shrubs with the remainder (approximately 160 ha) of the zone planted to improved native and introduced deep rooted pasture. This area corresponds to the Final Landform and Vegetation Patterns (Fig 4.21 EIS Vol 3 HLA 2001), which has a total area planted to Narrow Leafed Iron Bark Woodland, Swamp Oak Open Forest and Bull Oak Open Forest of approximately 70 ha south of the New England Highway. Assuming 200 plants/ ha this provides 14,000 stems;

- Plant 25 ha of the 83.8 ha in Zone 3 to saline tolerant plants i.e. 5,000 plants. This area corresponds to the Final Landform and Vegetation Patterns (Fig 4.21 EIS Vol 3 HLA 2001), which has a total area planted to River Oak Open Forest of approximately 40 ha south of the highway. Assuming rates of 200 plants/ ha this provides 8,000 stems; and .

- Utilise Zone 4 (approximately 100 ha) for improved pastures, this area corresponds to the Final Landform and Vegetation Patterns (Fig 4.21 EIS Vol 3 HLA 2001), which has a total area planted to pasture of approximately 280 ha.

The main variation in the proposed vegetation patterns between the EIS and this report is in the alluvial plain, which adjoin the southern sections of Bowmans Creek. Under the EIS these are returning to River Oak Open Forest, though under this report they are to be retuned to deep-rooted pasture.

6.0 CONCLUSIONS

To adequately address the impact of salinity associated with the Ashton Coal project, it is predicted that a minimum of 3,400 plants over 17 ha would be established to a self-sustaining level. The plantings in the four Zones as illustrated in this report more than adequately compensates for this requirement with planned total of 95 ha being established with at least 19,000 plants

This vegetation program would accordingly ensure the ecologically sustainable interception of the predicted additional 0.1 ML/day of groundwater from entering Bowmans Creek 30 years after the cessation of mining and in doing so reduce the salt load entering the Hunter River from Bowmans Creek by at least 14μS/cm/day.

However the final landform and vegetation patterns outlined in the EIS provides for approximately 46,000 plants to be established across the site, covering 230 ha south of the New England Highway, with the additional benefit of the revegetation north of the highway and the establishment of the deep rooted pastures on the southern alluvial flats. This program more than adequately addresses the predicted salinity issues by the planting of several times more than the number of trees required under the off-set calculations.

The additional benefits in terms of green offsets of this large number of plants would include the enhancement of the riparian corridor along Bowmans Creek, significant habitat corridors across the project area and the development of major carbon sinks within the Development Application Area.

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Ashton Coal Project

20 June 2002

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