NSW GOVERNMENT | Planning & Environment

Dr Cameron Collins
President
Hunter Thoroughbred Breeders Association
PO Box 538
Scone NSW 2337

Dear Dr Collins

Mount Pleasant Coal Mine - MOD 3 (DA 92/97)

I am writing in response to your letters of 2 July and 3 July 2018 requesting that copies of the Deed of Agreement (Deed) between MACH Energy (MACH) and Bengalla Mining Company (BMC) and the 1997 DUAP Report, titled *Upper Hunter Cumulative Impact Study and Action Strategy*, be made available to the Independent Planning Commission (IPC) and other interested parties.

I can confirm that the Department has not furnished a copy of the Deed to the IPC and is not able to do so. I am sure you would appreciate that the Deed between MACH and BMC is a document of a commercial nature which only involves these two parties. Accordingly, the Department has not sought a copy of the Deed, other than in respect of the high-level summary presented in the Department's MOD 3 Assessment Report. The Department is of the view that the commercial details contained in the Deed do not have any significant bearing on the assessment of the MOD 3 application, except that its execution resolved the concerns expressed by BMC and its joint venture partners, thus resulting in the withdrawal of their objections. This has been confirmed to the Department both by BMC and by MACH.

I can also confirm that the Department has an original hard copy of the 1997 *Upper Hunter Cumulative Impact Study Report*. A copy of the 2005 report titled *Coal Mining Potential in the Upper Hunter Valley – Strategic Assessment*, is also available. The Department will forward digitised copies of both reports to the HTBA. Should the IPC seek access to either document, it will of course be provided.

Should you have any further enquiries, please contact Howard Reed, Director Resource Assessments on 9274 6308.

Yours sincerely

3/7/2018

Oliver Holm
Executive Director
Resource Assessments and Compliance

CC: Independent Planning Commission

Upper Hunter

UPPER HUNTER CUMULATIVE IMPACT STUDY
AND ACTION STRATEGY

Department of Urban Affairs and Planning

Upper Hunter

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AND ACTION STRATEGY

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Foreword

Craig Knowles

Minister for Urban Affairs and Planning and

Minister for Housing

The Upper Hunter Region of NSW has experienced continued growth in a number of areas. Natural resource development, mining, energy and related activities, and substantial agricultural and tourist development make the Upper Hunter Region a significant contributor to the State's economy while being an attractive place to live or visit. Clearly there is a need to assess the varied and combined effects of these activities on the Region and plan for their sustainable co-existence.

The Upper Hunter Cumulative Impact Study and associated action strategy are unique in establishing an innovative approach for sustainable development and resource planning and management. Rather than one-off studies, cumulative impact studies measure the interaction of several activities across the region and across time. It is a sophisticated tool for assessing and planning for impacts.

This report includes significant commitments by State Government agencies, local government and the community to the sustainable management of this diverse and important area of NSW. I commend the report to the community of the Upper Hunter Region and to the broader NSW community as a model for strategic planning, assessing, measuring and managing complex interactions.

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INTRODUCTION

The Upper Hunter Region of NSW has experienced continued growth particularly in natural resources development, mining, energy and related activities. The region accommodates significant agricultural activity, and urban and rural settlement. The Upper Hunter has also major potential for increased tourism. The region is environmentally and economically highly significant to the State and nation.

The sustainable co-existence of various activities and land uses, particularly from an environmental and planning perspective, has increasingly been questioned in recent times. Intensification of open-cut coal mining activities in particular has brought these concerns into focus.

Traditionally, the environmental impact assessment and decision-making processes for major resource and other developments have been undertaken on a project-by-project basis. The need to consider the cumulative impacts of various projects, land uses and activities was recommended by recent Commissions of Inquiry into major coal mining developments. Cumulative impact considerations are also warranted to ensure that assessment and decision making for individual projects and activities are undertaken within a broader context.

Cumulative impact assessment is at an early stage of practical implementation both nationally and internationally. This study for the Upper Hunter Region should therefore be seen as establishing an ongoing process which will benefit strategic planning and more informed decision making.

STUDY AIMS AND OBJECTIVES

All individual disturbances in the environment caused by natural and human activities have the potential to act in unison to create cumulative impacts, which in some cases may be greater than the sum of their individual impacts. These individual impacts can be additive in space or time or they may interact. The Upper Hunter Cumulative Impact Study considers the cumulative impacts of various major land uses and activities (both current and projected).

The aims of the study are:

- to establish the effects of cumulative impacts of various existing and major proposed land uses and activities
- to establish a regional framework for the assessment of the environmental impacts of individual development proposals and activities
- to provide the basis for coordinated environmental monitoring and enhanced environmental management practices
- to assist future strategic land use and development planning at both the local and regional levels.

The broad approach adopted to achieve the above aims includes:

- an identification phase comprising a qualitative review of all potential cumulative relationships between various land uses and activities and the environment, using a set of environmental indicators
- a second phase which examines the cumulative relationship for selected indicators of air and water quality, using quantifiable methods
- a final phase of strategic assessment and analysis leading to recommendations and broad directions for future actions.

In undertaking the study, the Department of Urban Affairs and Planning aimed to ensure close involvement by all stakeholders at an early stage and throughout the study. The study was conducted in liaison with a Community Consultative Committee comprising representatives of relevant Government agencies, industry and the key environmental and community groups. A Local Government Consultative Committee comprising representatives of the relevant councils in the study area (Singleton, Muswellbrook, Scone, Murrurundi and Merriwa) provided the key forum for Local Government input and consultation. The study benefited from an early issue identification stage through a public forum which identified water quality and quantity, and air quality as being the key issues of concern to the stakeholders in the region.

Key Investigations

The following specialised investigations have been conducted and are available separately in detailed reports:

- the *Upper Hunter Cumulative Impact Study Identification Report* which develops a range of trigger mechanisms and cumulative impact environmental indicators for the Upper Hunter Region
- the *Cumulative Air Quality Study* which quantifies the relevant cumulative impacts due to atmospheric emissions in the Upper Hunter Valley, with emphasis on coal mining activities
- the *Upper Hunter Cumulative Study Water Catchment Analysis* which reviews and analyses water quality and quantity trends and parameters of relevance to cumulative impact considerations
- *GIS mapping*, highlighting up-to-date land use
- *An Economic Assessment of the Upper Hunter*, which updates employment and economic trends for the region
- A *Regional Profile for the Upper Hunter*, which provides an outline of land uses and activities and associated parameters
- *Upper Hunter Cumulative Freight Transport Study*, which provides a strategic regional perspective of the road and rail network.

Summary of Key Findings

- Air quality meets community health standards, although dust from blasting creates temporary nuisances which need to be addressed.
- Good environmental management practice in agriculture and riparian activities could be strengthened, particularly in sensitive areas.
- Decline in water quality is an issue of most concern. Recent initiatives in total catchment management (TCM) will help address this situation.
- The region possesses an extensive monitoring network, however, it may be necessary to review data collection to make it consistent with cumulative impact principles.

The assessment of cumulative impacts is limited by the existing environmental monitoring network and data which generally aim to monitor the impact of individual sites on specific parameters rather than assess cumulative impacts. Available data suggests that at this time there are no major

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cumulative impacts which warrant additional regulatory intervention or major restrictions on development. While this finding is generally valid within the limitations and constraints of the analysis, cumulative impacts on water quality highlight the need for further investigations.

The assessment also highlights the need to strengthen cumulative impact considerations in future decision making, planning and environmental management.

The study has developed a system of triggers and indicators which could be used for the assessment of individual projects and in the decision-making process, to ensure that cumulative impact considerations are taken into account. The EIS process should benefit from such environmental triggers.

In relation to water quality, the study found that of the range of potential cumulative impacts arising from land use change, decline in water quality resulting from agriculture, rural settlement and—to a certain extent—urban development, are of main concern. The study found that the potential for cumulative impacts to affect water quality is particularly significant. A number of recent initiatives that relate to total catchment management, and particularly the Hunter River Salinity Trading Scheme, are addressing the cumulative impact on water quality from various activities.

Phosphorous levels from the use of fertilisers and effluent discharges from sewage treatment plants are increasing, although there are plans to recycle waste water. Nitrate levels in ground water in some parts of the Upper Hunter exceed recommended levels for human consumption. Bacteriological contamination has also a significant potential cumulative impact. Notwithstanding that the study results do not entirely reflect the outcome of the recent initiatives, the need to ensure a review of monitoring adequacy and consistency is warranted.

Air quality meets community health standards, with SO_2 and NO_2 cumulatively well within acceptable standards. Ambient levels of dust for current and future coal mining developments have been established. The affected areas are localised around mines and, according to established standards, there are no adverse impacts on the health of residents or on other activities. The study, however, recognises that there is a nuisance amenity issue from dust episodes, caused by both mining (particularly during blasting) and agricultural activities. Research into these episodes is needed and strengthening of coordinated monitoring needs review.

Many of the activities and issues addressed in the study as potential significant contributors to water quality cumulative impacts in particular are matters for which no planning consents or approvals are required, or are the responsibility of various stakeholders under a variety of legislative and regulatory instruments. Therefore, implementation of the majority of strategic actions necessary to improve environmental conditions in the Upper Hunter will rely upon a range of non-statutory approaches such as promotion of best practice, community action, agency action and support, community awareness and education, and research and monitoring. The study represents a strategic approach to the management of the Upper Hunter, proposing a range of actions to achieve improved environmental outcomes for the area.

Strategic Directions

The Upper Hunter Cumulative Impact Study provides for an ongoing program for cumulative impact considerations to be better integrated with the planning and development assessment and control processes, and environmental management and monitoring. The study demonstrates the need to strengthen the integration of cumulative impact considerations in decision making. Recent initiatives in water management (quality and quantity) will assist in mitigating water quality deterioration, particularly from existing activities.

There are four broad strategic directions for the development of an ongoing program for cumulative impact consideration and improved environmental outcomes:

1. Strengthening the Planning Process

The outcomes of the study should be used as the basis for environmental assessment and development control. For example, the environmental triggers and indicators should be used in the preparation of future EISs. The GIS and groundwater vulnerability data will assist in the preparation of locational requirements for various activities. The cumulative air and water quality studies should assist the review of planning strategies and practices at both the regional and local levels.

2. Strengthening Environmental Monitoring and Data Bases
The study outcomes, particularly the air and water investigations, provide the opportunity to review and, where appropriate, strengthen environmental monitoring infrastructure in the Region. While extensive monitoring is being undertaken within the region, the study provides the opportunity to examine the relevance and consistency of data and associated details to cumulative impact concepts.

3. Strengthening Environmental Management Practices
Of particular relevance are the development and implementation of best practice guidelines and mechanisms relevant to agriculture and associated activities, particularly in environmentally sensitive areas; and waste disposal and mine rehabilitation. The study's outcomes provide an opportunity to reconsider existing practices in order to account for cumulative impacts where appropriate.

4. Improve Coordination, Liaison and Participation
Various initiatives for improved information and consultative mechanisms are recommended to strengthen and build upon existing mechanisms (e.g. Hunter Catchment Management Trust, State of the Environment Reporting, State of the Rivers and Estuaries Report), the aim being to strengthen cumulative impact considerations.

Within this strategic context the following Cumulative Impact Action Strategy containing 39 actions has been developed.

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UPPER HUNTER CUMULATIVE IMPACT ACTION STRATEGY
There is a broad-based commitment among the major public bodies and community stakeholders to an ongoing process of environmental management in the Upper Hunter to ensure that cumulative impacts are either avoided or minimised and that trends in key environmental indicators are monitored. The Study's strategic directions have been refined into a series of actions which the relevant government agencies have agreed will receive attention within their corporate responsibilities.

These actions are not meant to comprise a comprehensive list of works or programs relating to all identified current or emerging environmental or resource development problems. Such would continue to be addressed through the normal channels and processes relevant to those single-issue problems. Where cumulative environmental interactions are involved, new or improved stakeholder actions are required as set out below which consider these interactions and their heightened potential for additive, compounding or synergistic effects. The Action Strategy, therefore, promotes an integrated cumulative impact framework for the Upper Hunter, and is not to be regarded as the totality of the NSW Government's environmental program for the area in all its various facets.

The study's strategic directions have been refined into a program of 39 actions.

A responsible stakeholder agency is nominated for the principal carriage of each action, with other *associated stakeholders* indicated where their involvement is critical. These stakeholders will need to further define the specific dimensions and specifications of the task, where necessary, so that the action is clear in terms of its aims and tasks and well targeted to produce achievable outcomes for the Upper Hunter. In some cases, public agencies may need to seek additional resources for work which may be beyond their traditional core functions. The *timing* indicated in the Action Strategy is for the commencement of the work, not its completion, and is shown either as I: Immediate (to commence within 6 months of the adoption of the Action Strategy); S: Short Term (within one year); M: Medium Term (within 3 years), or P: involving an ongoing process where actions arise as needed.

A central feature of the Action Strategy is its reliance on an open and transparent review process involving key local government and community reference groups to evaluate progress on all actions in an annual report which is to be made available to all stakeholders and the community. In this way, the actions can be adjusted over time in the light of experience and changing circumstances.

The Department of Urban Affairs and Planning will be the lead agency for overseeing implementation of the Strategy and will convene the Consultative Committee responsible for the preparation of an Annual Progress Report.

STRENGTHENING THE PLANNING PROCESS

Objective: Decisions in environmental plan making, development control, and the formulation of agency resource management policies will be enhanced by consideration of cumulative environmental impacts.

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
1. Prepare a sub-regional planning strategy for the area to: strengthen the framework for environmental planning and the coordination of actions taken by various stakeholders within that agreed framework; to promote improved practices for land and water management based on cumulative impact considerations; and to facilitate an effective link between total catchment management and the environmental planning system.	DUAP	Local Councils; Relevant government agencies; Industry associations; Community	I	Preparation of Upper Hunter sub-regional planning strategy
2. Examine the specific cumulative environmental impacts of four new coal mining proposals in the Muswellbrook/Scone area to assist in the environmental assessment of these projects. The key issues to be examined include: road and rail traffic impacts; coal transport systems and infrastructure; socioeconomic factors; visual amenity; noise; vibration and blasting; air quality; and water quality. The four proposed mines are: • Kayuga open cut • Mount Pleasant open cut • Mount Arthur open cut • Muswellbrook/Sandy Creek underground mine.	DUAP	Muswellbrook Council; DMR; DLWC; EPA; Community; Mining companies	I	Preparation of Muswellbrook Cumulative Impact Study

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
3. Ensure cumulative impact considerations are fully taken into account in the issuing of Director-General's requirements in the preparation of environmental impact statements by using the cumulative impact triggers, where appropriate, identified in the Study.	DUAP		I	Cumulative impact considerations addressed in EIS preparation
4. Consider the Upper Hunter Cumulative Impact Study and, when available, The State of the Rivers Reporting and the Healthy Rivers Commission Inquiry into the Hunter River, in local planning and development assessment processes. Councils will report their progress as part of the annual review process indicated in Action No. 30.	Local Councils		I	Report on how cumulative impacts are being considered in local planning and development assessment processes
5. Re-examine urban and rural settlement strategies with a view to ensuring that residential development is well located having regard to the findings of this study, particularly in regard to cumulative water quality considerations.	Local Councils	DUAP; Community; Other government agencies	S	Preparation of Urban and Rural Settlement Strategies for each LGA within the sub region
6. Prepare a landscape master plan for the area subject to mining, to coordinate landscaping between existing mines and for incorporation in Environmental Management Plans prepared for future mines, in order to lessen the visual impact of development during the construction and mining phases and ensure appropriate post mining rehabilitation.	DMR	Local Councils; Minerals Council; Community	S	Preparation of Landscape Master Plan

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
7. Consider cumulative impacts in developing water allocation and catchment management plans.	DLWC	HCMT; Local Councils; Community	M	Report on how cumulative impact considerations are being incorporated into Water Allocation and Catchment Management Plans
8. Consider the groundwater vulnerability maps prepared by DLWC when preparing local environmental plans and assessing development applications.	Local Councils	DLWC	P	Annual Reports on the practical application of this data base in decision making

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STRENGTHENING ENVIRONMENTAL MONITORING AND DATA BASES

Objective: Cumulative environmental impact considerations should be further explored and developed as a practical means of understanding long-term environmental trends, with appropriate environmental indicators and data bases developed.

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
9. Further develop tools and techniques for cumulative impact assessment as an extension of this study, with special focus to be given to the development of an accessible environmental data base (based on cumulative impact parameters and indicators) relevant to the assessment of long term environmental trends and cumulative environmental impacts and indicators.	DUAP	EPA	M	Prepare a review report on the ongoing development of cumulative impact assessment techniques
10. Review current monitoring systems for the Upper Hunter and develop a coordinated consistent approach to routine environmental monitoring in the Upper Hunter to enable the detection of long term trends and cumulative impacts.	EPA (noise and air) DLWC (water)	HCMT; Local Councils; Industry; Community	I	Design and implementation of a coordinated, consistent, routine environmental monitoring program for the Upper Hunter
11. Review performance of conditions of consent for coal mining projects with regard to environmental monitoring and independent auditing.	DUAP	Local Councils	S	Prepare review reports on an ongoing basis
12. Clarify the issues involved in the community's concerns regarding nuisance dust.	EPA	Local Councils; NSW Agriculture; Mining industry	S	Preparation of review report

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
13. Develop criteria for triggering modification of mining operations during adverse weather conditions such as high winds, in order to minimise local dust impacts.	DMR	EPA; Mining industry	S	Preparation of operational guidelines
14. Undertake research into: • the relative contribution of diffuse sources of salinity; • existing status of dryland salinity; • changes in groundwater regimes as a result of changes in land management, land use and development; • the impact of increased diffuse salinity releases on streams and the riverine environment; and • the impacts of present and predicted changes in groundwater regimes on dryland salinity and land use practices.	DLWC		S	Preparation of Salinity Research Action Plan
15. Review the existing dust monitoring network, emphasising objectives, data gathered, location of monitoring sites and with particular regard to providing evidence of cumulative impact trends.	EPA	Mining industry; DMR	M	Preparation of a review report and implementation of new procedures as appropriate
16. Maintain the GIS mapping system developed for this study as the basis for monitoring, analysis and educational processes associated with cumulative impact assessment. Relevant databases (reports) need to be developed and maintained with suitable maps.	DLWC	EPA; DMR; HCMT; DUAP	M	Preparation of GIS action implementation plan

STRENGTHENING ENVIRONMENTAL MANAGEMENT PRACTICES

Objective: Best practice guidelines for mining and for agricultural activities, many of which are outside the sphere of regulation, and technical goals for environmental performance should be better defined for cumulative impact mitigation measures and should be widely understood and promoted throughout the Upper Hunter community.

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
17. Develop site specific blasting guidelines to assist mining companies reduce the probability of blasting dust passing directly over residential areas and incorporate those blasting procedures into development consent conditions provided for future mines.	DMR	EPA; Mining industry, Local Councils; DUAP	I	Preparation of Blasting Guidelines
18. Distribute to industry and the community results of recently completed research from the small number of open cut mines with a spontaneous combustion problem and preparation of a management plan for the control of spontaneous combustion.	DMR	Mining industry; Community	S	Preparation of spontaneous combustion management plan
19. Continue the implementation of Load Based Licensing and model licences in relation to different operations such as coal mines, sewage treatment plants and power stations, to ensure consistency and effective regulation of licensed premises.	EPA	DMR; Local Councils; Mining industry; Macquarie Generation	S	Model Load Based Licences for different operations
20. Prepare site selection criteria for waste disposal associated with land uses with high potential to influence groundwater nitrate levels.	DLWC	EPA	S	Preparation of waste disposal site selection criteria

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
21. Develop water allocation plans for unregulated streams and consider these in the siting of land use activities, to ensure that existing water supplies and environmental flow provisions are protected.	DLWC	Local Councils	M	Preparation of Water Allocation Plans for unregulated streams
22. Continue to develop Regional Air Quality Management Strategies which will enhance ambient air quality within the region and the Greater Sydney airshed.	EPA	Local Councils; Community	M	Report on the preparation of a Regional Air Quality Management Strategy
23. Continue to implement the Hunter River Salinity Trading Scheme (HRSTS) so that the cumulative impact of coal mines and other point sources on salinity levels in the Hunter River is managed to avoid detrimental environmental effects.	EPA	DLWC; Mining industry; Power industry	P	Preparation of progress reports on the implementation of the HRSTS
24. Continue liaison with the State Stormwater Committee to: • develop the strategic policy framework for stormwater management; • provide examples of stormwater treatment technology; and • provide best practices for use on construction and other sites where land is disturbed, soil erodes and water is polluted.	EPA	Local Councils; HCMT	M	Preparation of an implementation report for the Upper Hunter

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
25. Continue development of best practice guidelines for stabilisation and rehabilitation of areas exposed by mining.	DMR	Mining industry	P	Preparation of Best Practice Guidelines
26. Continue the development of best practice guidelines relating to water management in the catchment. Such guidelines should: • promote controlled stock access to streams and drainage lines and develop off stream shade and watering points to minimise the potential for effluent to be deposited into the drainage system; • establish surface runoff controls on farms to minimise the potential for manure from grazing areas to be transported to the drainage system; • establish the use of groundwater vulnerability mapping as a tool to ensure activities are located where waste disposal can be suitably carried out. Other tools to assist land selection include Land Capability and Suitability Mapping and Acid Sulphate Soils Mapping; and • continue the development of Surface Water Quality and River Flow Objectives.	DLWC	NSW Agriculture; HCMT; Farmers	P	Preparation of Best Practice Guidelines for water management

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
27. Develop best practice guidelines to minimise nutrient generation potential. Such guidelines to: • establish riparian buffer zones; • adopt best management practices in terms of fertiliser usage and application; • control and minimise streambank erosion; and • implement a communication strategy so that information can be disseminated to the general public and other interested parties.	DLWC	NSW Agriculture; HCMT; Farmers	P	Preparation of Best Practice Guidelines to minimise nutrient generation
28. Continue to develop educational material on dryland salinity and to work with Landcare/Rivercare groups to address rural diffuse sources of water quality problems.	DLWC	HCMT; Landcare and Rivercare groups; Farmers	P	Preparation of community Education material

IMPROVED COORDINATION, LIAISON AND PARTICIPATION

Objective: Ongoing work on cumulative environmental impact assessment should be based on improved awareness and involvement of the Upper Hunter community and all relevant public authorities and stakeholders, who should assist each other cooperatively with shared information and a common objective to improve environmental quality in the Upper Hunter.

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
29. Maintain Local Government and Community Consultation Committees, established for the purposes of the Upper Hunter Cumulative Impact Study, as key reference groups to meet at least every six months to assist with preparation of an annual report, to incorporate updated information and knowledge and review progress on actions.	DUAP	All committee members	I	Establishment of Committees to review and monitor implementation of the Action Plan
30. Monitor and report annually on progress made on the actions arising from this study. The primary aim is to ensure the integration of initiatives being undertaken within government (both at the state and local levels).	DUAP	All Stakeholders	M	Annual reports indicate progress made on Actions and evaluate the integration of initiatives
31. Make the study and final report and subsequent annual reports available to agencies, consent authorities, the Office of Commissioners of Inquiry For Environment and Planning, the Hunter Catchment Management Trust and to the community.	DUAP		I	This study and subsequent reports to be widely available to the community and decision makers

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
32. Brief the Healthy Rivers Commission that the Upper Hunter Cumulative Impact Study is available to assist the Commission in its charter.	DUAP		I	DUAP to brief the Healthy Rivers Commission on this study
33. Continue to publish the State of the Environment Reports every two years by the EPA and annually by local councils. These reports should include an assessment of the impact of development approvals on issues such as air and water quality, using quarterly air and water quality reports. Relevant cumulative impact information is to be included in such reports.	EPA/Local Councils		I	SOE reporting, to include cumulative impact considerations
34. Coordinate working parties for the introduction of interim water quality and river flow objectives for submission to government.	EPA	DLWC	I	Convene working parties
35. Publish regularly plain English reports on the state of the catchment, such as: • the State of the Rivers and Estuaries Report for the Hunter; and • Window on Water: The State of Water in NSW.	DLWC	EPA; Local Councils	M	Plain English reports published regularly on the state of the catchment

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
36. Implement a demonstration program for establishing and monitoring the success of a range of different agricultural pursuits on rehabilitated mining land. The pilot program should be developed to assess the rehabilitation of mining land on different soil regimes and geological regimes.	DMR	Mining industry; NSW Agriculture	M	Demonstration program implemented on agricultural uses of rehabilitated mining land
37. Develop a demonstration program for the rehabilitation of degraded agricultural land.	DLWC	NSW Agriculture; Landholders	M	Demonstration program on rehabilitation of degraded agricultural land
38. Develop a user friendly and publicly available comprehensive information system designed to assist education and decision making in relation to cumulative impacts and strengthen existing systems.	EPA/DLWC/ DUAP	HCMT; DMR; Local Councils; NSW Minerals Council	M	Information system which educates and assists understanding of cumulative impacts
39. Promote sustainable agricultural practices through programs such as Farming For the Future, Prograze and Industry Codes of Best Practice to enable landholders to recognise and deal with on site and off site impacts associated with agriculture in the Upper Hunter.	NSW Agriculture	DLWC; HCMT; NPWS; Landholders	P	Prepare Action Plan for the promotion of sustainable agricultural practices

1. Introduction

The Upper Hunter region of New South Wales is an area of significant economic and employment generating activities including: agriculture, mining and extractive resources, energy, service industries and urban and rural settlement. The region makes a major contribution to the State and National economies. With only 0.8% of the State's population, the area produces 56% of the coal production of NSW and the same percentage of overseas coal exports ($1.6 billion), 40% of the State's electricity output, and 2.4% of the total NSW value of agricultural products.

In recent years the expanded development of coal resources has generated concerns within sections of the community that certain land use activities are incompatible and that the environmental impact assessment process for major projects has not properly addressed the combined effects of major developments. The need for cumulative impact assessment in the Upper Hunter was recommended by Commissions of Inquiry into the Bengalla and Bayswater No. 3 open cut coal mining projects.

Consideration of development applications and environmental impact statements allows for relevant cumulative impact aspects of development to be considered where appropriate and relevant. However, the extent and nature of past developments in the area, together with the need to provide an improved environmental planning context for the assessment of future developments, warrant consideration of cumulative impacts.

There is a recognition by Government that community concerns and perceptions need to be scientifically evaluated. There is also a recognition as to the need to address cumulative impact issues when undertaking strategic planning, development approval and environmental management decisions.

The Upper Hunter Cumulative Impact Study develops an integrated approach by Government and the community in this important and emerging policy area. It does not replace the need for project specific environmental assessment required by the *Environmental Planning and Assessment Act 1979*. However, it will provide a credible source of information to assist the preparation of environmental impact statements for specific development proposals and to guide the environmental management of existing and future activities and land uses.

1.1 THE STUDY AREA

The Study Area (figure 1) includes the Local Government Areas (LGA) of Singleton, Muswellbrook, Scone, Murrurundi, and Merriwa. The area reflects a very strong sense of regional identity within the community.

The study focuses on the Upper Hunter Valley as a catchment unit, but includes some parts of the Goulburn Valley which are outside the core LGAs. The general study area covers approximately 18 000 sq. km, and includes part of the Liverpool Plains and the northwestern part of Murrurundi, which are outside the Hunter River catchment. This is to ensure potential cumulative impacts in adjoining areas are considered where relevant. Air quality investigation has focused on the air shed around the main coal fields, but has taken into account potential effects from aluminium smelters in the Lower Hunter.

1.2 CUMULATIVE IMPACT

All individual disturbances in the environment created by natural and human activities have the potential to act in unison to create cumulative impacts, which in some cases may be greater than the sum of their individual impacts. These individual impacts can be additive in space or time, or they may interact together.

Cumulative impact can arise when:

- individual impacts occur so close in time that the effects of one are not dissipated before the next one occurs (*time crowded effects*).
- individual impacts are so close in space that their effects overlap (*space crowded effects*);
- there is some time or distance from the initial impact, or a chain of events occurs (*indirect effects*);
- repetitive, often minor, impacts erode environmental conditions (*nibbling effects*); or
- different types of disturbances (especially pollutants) interact to produce an effect which is greater or different than the sum of the separate effects (*synergistic effects*).

This study examines the cumulative impacts of major activities within the Upper Hunter. This is a far more complex task than the environmental impact assessment process traditionally directed to the effects of a single proposed project on the surrounding environment.

The focus is on the capacity for individual impacts to combine to create cumulative impacts, which in some cases may be greater than the sum of their individual impacts. Purely localised impacts associated with a particular development or activity are not relevant to the assessment of cumulative impacts and are not therefore addressed in this study.

In an area as large and diverse as the Upper Hunter, the many relationships between activities and the environment create a complex range of potential cumulative impacts. Influences on the environment arise both from human activities, such as land uses and traffic movements, and from natural processes, such as geological weathering and climate variations. Identifying the relevant agents of change and the environmental indicators which measure that change, provides an understanding of the nature and significance of the relationships and their potential to contribute to cumulative impacts.

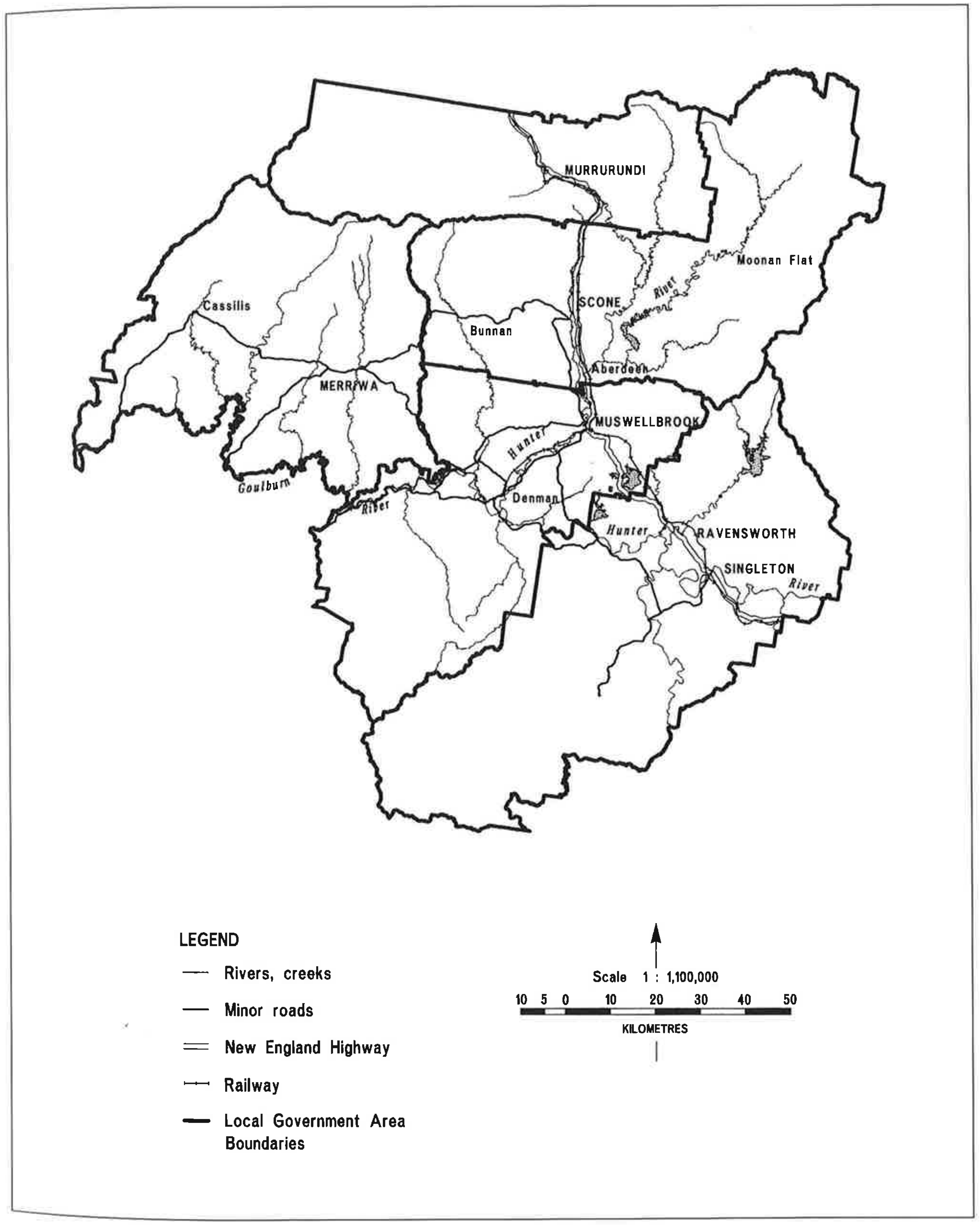
1.3 STUDY OBJECTIVES/INVESTIGATIONS

The study aims to assist the overall understanding of cumulative environmental impacts associated with major activities and land uses within the Upper Hunter. Significant activities including resource development, agriculture, infrastructure, service industries and urban/rural settlement are examined in regard to their implications for key environmental components such as air, water, land/soil and general environmental amenity.

The principal *objectives* are to:

- establish cumulative impacts of various activities and land uses;
- establish a regional framework for the assessment and consideration of

FIGURE 1. STUDY AREA



environmental impacts associated with future development proposals and activities;
- provide a basis for coordinated monitoring of environmental indicators and enhanced environmental management practices, including an information base; and
- facilitate future strategic land use and development planning at the local and regional levels

The following investigations were undertaken in order to achieve the above objectives:

- an environmental/socioeconomic profile of the Upper Hunter;
- identification of potential cumulative impacts;
- detailed study of key air and water impacts;
- land use mapping and assessment of trends;
- study of road and rail networks;
- strategic assessment of the economic and sustainable use of resources;
- triggers to guide cumulative impact assessments for future proposals; and
- a review of monitoring and management practices.

1.4 METHODOLOGY

Previous work, both internationally and within Australia, indicates that the practical application of cumulative impact assessment techniques is in its early stages of development. Much of the work is highly theoretical, based upon complex methodologies and extensive computer modeling. To apply this research to a practical situation such as the Upper Hunter would require the development of a specific model, the preparation of considerable baseline data and a range of agreed environmental indicators and thresholds.

The study has found that there is considerable further work required to refine cumulative impact assessment techniques for practical applications.

Given the nature of data available and the extent of analysis undertaken for this project, the methodology adopted for this study should be seen as the first step in an ongoing process to refine techniques for studying cumulative impacts. The study breaks new ground within Australia.

The methodology adopted for the study comprised three phases:

(i) Stage 1 — Identification phase comprising a qualitative review of the potential cumulative relationships between various activities and land uses and the environment in the Upper Hunter Region.

The *Upper Hunter Cumulative Impact Study — Identification Report*, Department of Urban Affairs and Planning April 1996 (separately available).

(ii) Stage 2 — Analysis of the more significant potential impacts using quantitative techniques. The most relevant environmental impacts of a cumulative regional nature were examined, including air quality, water quality, catchment conditions and economic and social conditions.

The following studies were commissioned by the Department of Urban Affairs and Planning and are separately available:

a) *Air Quality Study: Cumulative Impacts Due to Atmospheric Emissions in the Upper Hunter Valley*, NSW 1996, Nigel Holmes & Associates Pty Ltd

b) *Upper Hunter Cumulative Impact Study Water Catchment Analysis 1996*, Umwelt (Australia) Pty Ltd

c) *Upper Hunter Cumulative Impact Study — Landuse Survey*, 1995 Department of Land and Water Conservation

d) *An Economic Assessment of the Upper Hunter 1995*, The Hunter Valley Research Foundation

e) *Upper Hunter Regional Profile* 1996, Department of Urban Affairs and Planning

f) *Upper Hunter Cumulative Freight Transport Study*, 1996

(iii) Stage 3 — Strategic Assessment of the findings of stages (i) and (ii) to provide an overview of the existing state of the environment regarding cumulative impacts; establish a framework for the assessment of future activities; establish enhanced environmental management practices; to

facilitate strategic planning at the local and regional levels; and to strengthen coordination between various government agencies and improved consultation with the community and other stakeholders.

1.5 PUBLIC CONSULTATION

A range of initiatives were taken during 1995 and 1996 to involve local government, community, business, environmental and scientific groups in the preparation of this study and to keep the broader community informed of progress. This was a primary objective in undertaking the study, so that all stakeholders could participate in the process at an early stage.

Public Forum

The study commenced with the holding of a public forum held in Singleton in February 1995, the aim of which was to identify the key environmental issues of most concern to the community and to discuss appropriate boundaries for the study area and proposals for public consultation.

Over 100 people attended the forum with representatives from the mining industry, vignerons, dairy farmers, environmental and community groups, members of the public, local government and state agencies.

The forum considered the main issues to be:

- water quality and quantity: particularly in relation to salinity, nutrients, nitrates and bacteria in the water;
- air quality: principally dust, odours, emissions from power stations, effects of Nitrogen oxides and Sulphur dioxides on health, agricultural spray drift and acid rain;
- land degradation: due to chemical residues, salinity, soil erosion, rising water table etc;
- land use conflicts: incompatibility of certain land uses;
- transport systems: rail and road, particularly the conveyance of coal;
- loss of biodiversity: the need for protection of native flora and fauna;
- visual amenity;
- acoustics: truck and train noise;
- community consultation: community to be kept informed and be involved with the study;
- rural population densities: population increase, rural diversification.

Local Government Consultative Committee

Established so that aspects of the study which are of particular concern and/or interest to the five Upper Hunter councils can be discussed within a local government forum comprising one councillor and one staff member from each council, convened by the Department of Urban Affairs and Planning.

Community Consultative Committee

Established to provide a forum for the community to have detailed input to the study. Membership comprises:

- Department of Urban Affairs and Planning (Chair)
- Hunter Catchment Management Trust
- Hunter Environment Lobby
- Hunter Valley Vineyard Association
- Hunter Valley Water Users Association/Dairy Farmers Association
- Minewatch NSW Incorp.
- NSW Coal Association
- Scone–Parkville Environmental Watch
- Singleton and Upper Hunter Business Enterprise Centre
- Upper Hunter Water Quality Forum
- Singleton Shire Council
- Muswellbrook Shire Council
- Environment Protection Authority
- Department of Mineral Resources
- NSW Agriculture
- Department of State Development
- Department of Business and Regional Development
- Pacific Power
- Department of Water Resources.

Community Information

In addition, information to the community was provided through newsletters, individual community briefings and media briefings/ interviews.

1.6 PUBLIC EXHIBITION OF OVERVIEW REPORT

As indicated above, the Department of Urban Affairs and Planning has endeavoured to involve all stakeholders as much as possible in preparing this study and strategy. Opportunities for community input have been provided throughout the process of preparing the study and views expressed by the community through submissions have formed an important consideration in framing the strategy. A detailed report on the public exhibition and analysis of submissions received is available in appendix H. In summary:

- The *Upper Hunter Cumulative Impact Study — Overview report*, 1996 was released for public discussion and input from 12 September to 2 December 1996. Twenty three submissions were received: 5 from community members; 6 from independent organisations; and, 12 from local and state government agencies.

- Views expressed in the submissions varied widely and opposing views on some issues were evident. Many issues raised were general environmental concerns, or of a localised nature, not regional cumulative impact issues.

- A number of key aspects of the study attracted widespread support. Many respondents expressed support for the undertaking of such a study to ensure cumulative impacts are being assessed and managed better.

- The Upper Hunter reflects a strong sense of regional identity within the community. A number of submissions indicated that there are many perceived virtues that make various areas of the region special places to live and work.

- A number of issues were commonly raised, these included the need for regional air and water quality monitoring; impacts on community amenity such as dust, noise and spontaneous combustion; air quality; water quality and quantity; land use conflicts and the desire for plain English reporting.

This study and the Upper Hunter Cumulative Impact Action Strategy have been finalised in the light of community views as expressed through all stages of the process. Wherever possible, this document either responds to key issues or provides a framework within which major issues can be dealt with on an ongoing basis.

2. Regional Overview

This chapter presents an overview of the natural environment, socioeconomic characteristics, land use and land use trends within the Upper Hunter. More detailed information is available in the *Upper Hunter Regional Profile 1996*, Department of Urban Affairs and Planning and *An Economic Assessment of the Upper Hunter 1995*, Hunter Valley Research Foundation.

2.1 THE NATURAL ENVIRONMENT

2.1.1 Landform and Geology

Geological Units (figure 2) and landform slopes (figure 3) have significant implications for economic activity and environmental management.

The study area is generalised into a number of landform units:

- Liverpool and Mount Royal Ranges — The Liverpool Range in the north, and the Mount Royal Range and Barrington Tops in the northeast form the headwaters of the Upper Hunter. This area consists of Carboniferous rocks with basalt caps and granite intrusions, and forms part of the Great Dividing Range.

- Merriwa Plateau and Goulburn Valley —The Merriwa Plateau is derived from weathered basalt. South of this, the Goulburn Valley is cut into softer sandstone forming broad open valleys. A sandstone escarpment and plateau forming the Wollomi National Park defines the southwestern part of the Study Area.

- Northeastern foothills — The north eastern part of the Study Area is a hilly and low mountainous area derived from hard sedimentary rocks and lava. It extends from the Mount Royal and Barrington Tops to the central part of the Hunter Valley.

- Central Lowlands — This area extends from Murrurundi to Branxton and was formed from relatively weak Permian sediments. This area is the most likely to be affected by development activity and contribute to water quality decline.

2.1.2 Soils

Deep fertile alluvial soils form a ribbon along the flood plains, in places several kilometres wide. The flood plains are usually devoted to intensive cultivation and dairying. On the Merriwa Plateau, cracking clay soils derived from weathered basalt have been extensively used for agriculture. In many areas these soils show widespread signs of tunnel erosion. Basalt derived soils tend to be relatively high in phosphorous and can be a significant contributor of phosphorous into the drainage system. Skeletal soils in the southern sandstone plateau and in the eastern mountain area are infertile and shallow. Podsolic and solenetic soils in steeply sloping areas derived from carboniferous rocks are highly susceptible to erosion when cleared of native vegetation and subjected to inappropriate cattle grazing practices.

Of recent concern is the possible development of alluvial areas. Coal mining proposals to date have generally avoided the alluvial floodplains of the Hunter River and its tributaries. Open cut mining on the alluvial soils is generally considered by the community as inappropriate because of land use conflict with intensive cropping on the irrigated prime agricultural land.

In 1993, consent was granted for a very small scale open cut extension at Hunter Valley No. 1 mine to take coal from a floodplain in an area with poor gravelly soils. This particular project, assessed on its merits following detailed hydrogeological studies and with regard to safeguards and rehabilitation, does not set a precedent for the approval of mining in alluvial areas.

2.1.3 Climate

Sub-humid conditions generally prevail throughout the Upper Hunter. Evaporation is approximately double precipitation with moisture deficits in most months. Singleton has an average annual rainfall of 706 mm, and Muswellbrook 619 mm.

Prevailing winds follow the north west-south east axis of the valley. The area experiences surface level and upper air inversions, which can lead to fog, reduced dispersion of gases and fine particulate matter and enhance the transmission of noise. These climatic characteristics are common for all inland areas of New South Wales.

2.1.4 Hydrology and Water Supply

Variable rainfall results in extremes in streamflow characteristics. At times, all tributaries and the Hunter River cease to flow. Flooding occurs along the Hunter River and the lower courses of the major tributaries.

Dams on the Hunter River at Glenbawn and on Glennies Creek regulate river flows. The Goulburn River and other tributaries are unregulated. Whilst water is drawn from unregulated streams, due to stress during drought periods an embargo has been placed on further water licenses from unregulated streams.

The total volume of groundwater in the Hunter Valley is estimated to be approximately 30 million megalitres of which approximately 30% is of good quality. The main sources of good quality groundwater are the unconsolidated sediments, with fluvial clay, silt, sand and gravel deposits being the most extensively developed. Ground water is used extensively for irrigation, town water supply, commercial stock and domestic purposes.

Of recent concern is the possible contamination of groundwater with nitrates from point sources such as intensive animal production activities, fertiliser application and urban development. Such contamination has the potential to decrease the value of groundwater resources. A groundwater vulnerability map (figure 4) has been prepared by the Department of Land and Water Conservation which indicates the hydrogeological setting which makes groundwater susceptible to contamination from a surface source. Five classes of vulnerability ranking indicate the relative assessment of the potential for groundwater to be exposed to contamination from a surface source.

2.1.5 Natural Vegetation and Fauna

Clearing for agriculture along the valley has left scattered remnant savanna woodland and low scrub woodland. Eucalypt forest, and some patches of rainforest, are found in the higher parts of Liverpool Range, Mount Royal Range and Barrington Tops. Dry sclerophyll forest

FIGURE 2. GEOLOGICAL UNITS

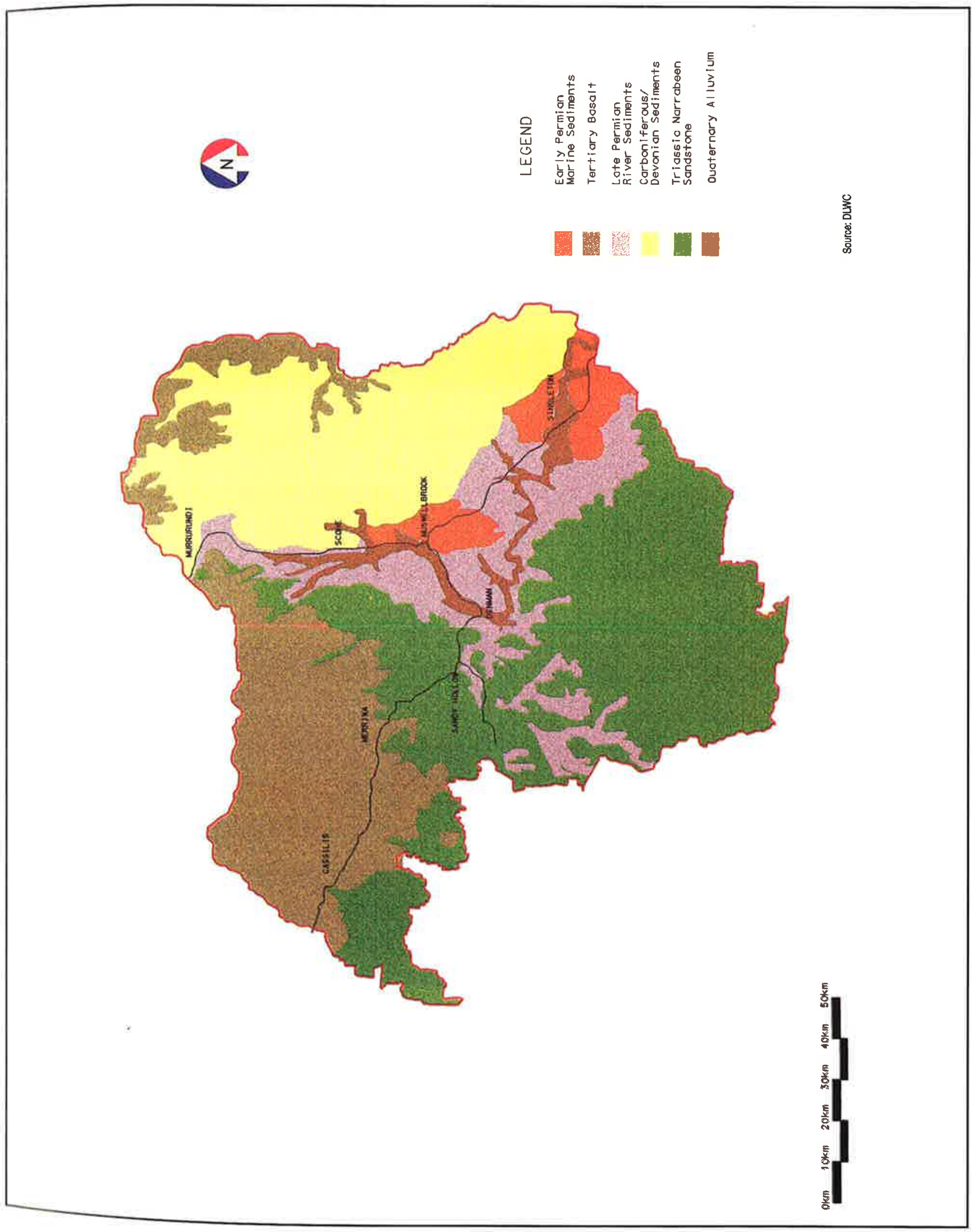


FIGURE 3. LANDFORM SLOPES

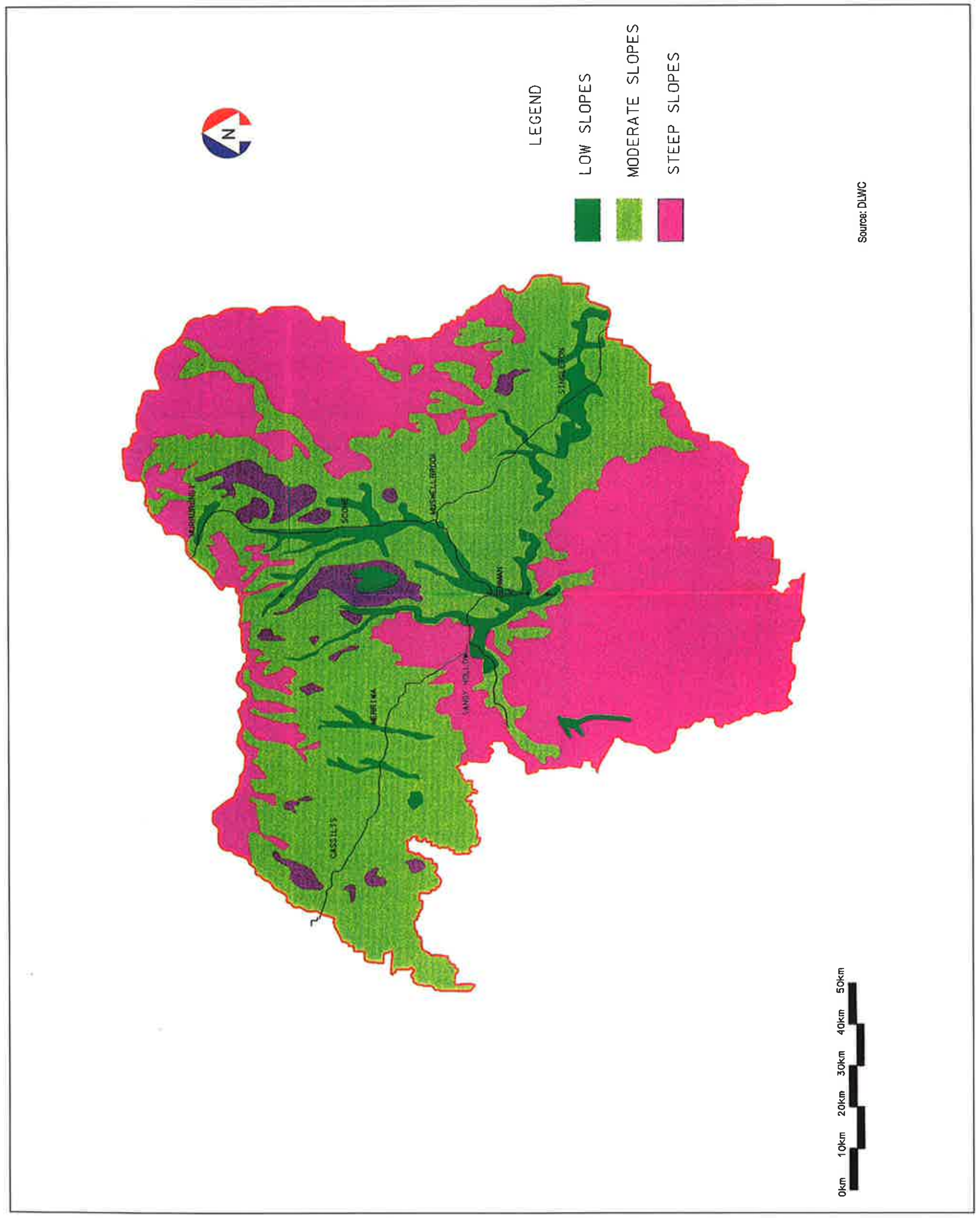


FIGURE 4. GROUND WATER VULNERABILITY

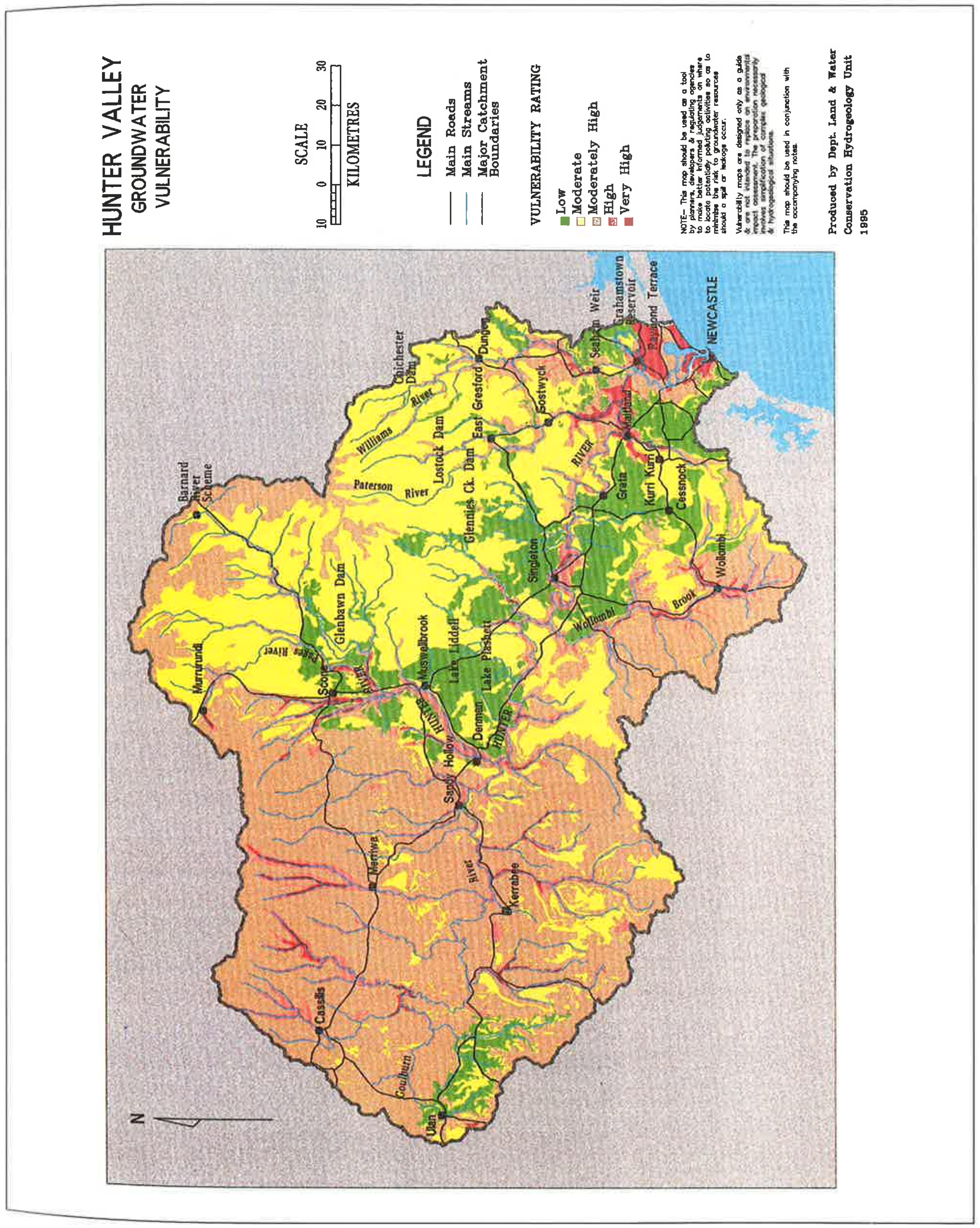


FIGURE 5A. GROWTH RATE IN EMPLOYMENT AND LABOR FORCE 1986–1991

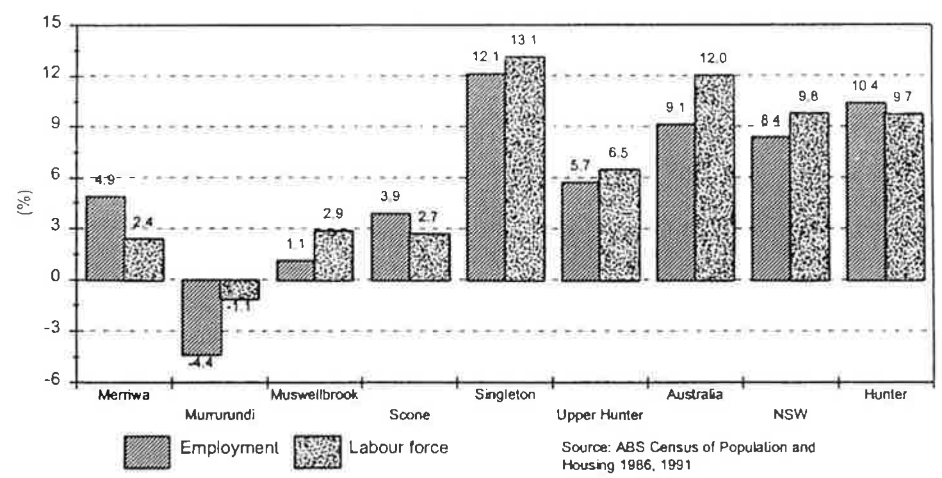
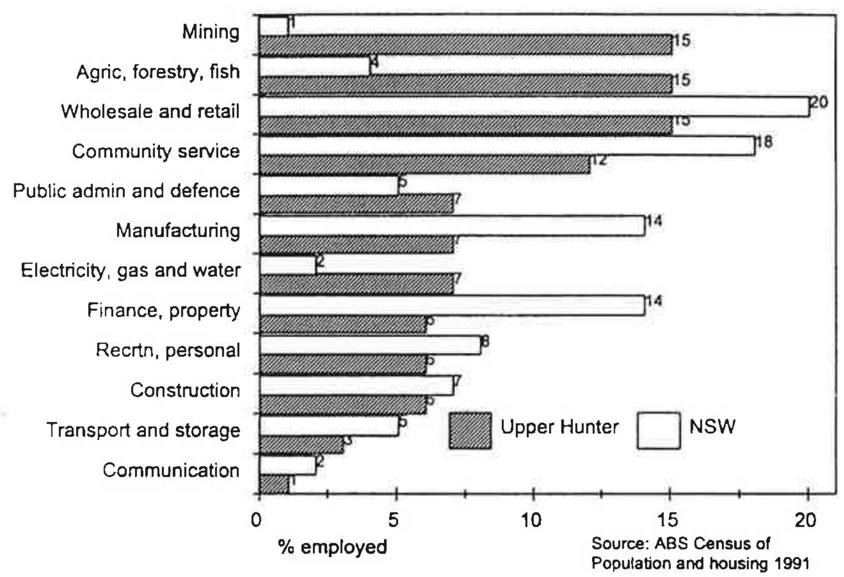


FIGURE 5B. EMPLOYMENT BY INDUSTRY, 1991



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characterises the southern sandstone plateau of the Wollomi National Park and Goulburn River National Park. Vegetated areas are indicated in figure 6, Land Use, as timbered land. Timber comprises areas of tree growth with an assessed canopy cover of greater than fifty percent.

Except within the National Parks, State Forests and areas of freehold land comprising steep slopes, extensive clearing associated with agricultural production has either removed or severely modified habitat areas.

The degree of loss of tree cover in the Upper Hunter and the general lack of information about remnant vegetation distribution and significance has prompted the Hunter Catchment Management Trust to commence the Hunter Remnant Vegetation Project.

This project aims to:

- develop and implement a public awareness and consultation program;
- determine the distribution and ecological significance of remnant native vegetation in the Hunter Valley and identify potential corridors which may link them;
- encourage participation in the survey, and continuing conservation and appropriate management of remnants by government agencies, local government, community groups and individual landholders;
- work with landholders to develop strategies for the appropriate management of remnants; and
- develop resource information, based on data obtained, to assist land managers in the conservation and management of the remnants.

The valley floor (an area of 316,000 ha) was selected as the study area as it has experienced the greatest loss of native vegetation in the Hunter catchment. No comprehensive information exists for vegetation in the Hunter Valley, although good information exists for a range of environmental attributes such as geology, soils, land use and salinity. A representative number of remnants will be surveyed, involving the identification of floristics, vegetation communities, regional and national significance and assessment of potential threatened fauna habitat.

The project will use the DLWC Hunter GIS (developed for the UHCIS) and provide important information to fill a current data gap It will allow future land management decisions to be based on sound knowledge, rather than on predicted information.

2.2 DEMOGRAPHIC CHARACTERISTICS

2.2.1 Population

The estimated resident population of the study area in 1994 (table 1) indicated that population had grown from the 1991 census (47,816 persons) to 51,070 persons, with all areas in general maintaining their proportional share of total population.

TABLE 1. ESTIMATED POPULATION OF UPPER HUNTER LOCAL GOVERNMENT AREAS, 1994

LGA	Population	% of Upper Hunter
Merriwa	2 490	4.9%
Murrurundi	2 450	4.8%
Muswellbrook	15 930	31.2%
Scone	10 150	19.9%
Singleton	20 050	39.3%

Source: ABS Estimated Resident Population, Preliminary 1994

The 1991 Census (most recent figures available) indicated that over half the population resided in the urban centres of Singleton (11 861), Muswellbrook (10 140) and Scone (4 290).

Population projections by the Department of Urban Affairs and Planning indicate that population growth in the Upper Hunter is expected to slow somewhat in the future, to reach between 55,800 and 63,400 by the year 2021.

2.2.2 Employment

Total employment in the Upper Hunter grew by 5.7% from 20,174 in 1986 to 21,329 in 1991. This rate of growth was below the levels recorded in NSW and the Hunter Region. However, the Upper Hunter had a lower unemployment rate for every age group in 1991 in comparison with both the State and the Hunter.

Figure 5(a) indicates growth rates in employment and the labour force between 1986–1991. It shows Singleton had the highest rate of employment growth, whilst other areas showed moderate rates of growth, except for Murrurundi which decreased.

The largest employment sectors in the Upper Hunter are mining, agriculture/forestry, wholesale and retail, and community services. The area employs proportionally more people in the mining, agriculture/forestry, public administration and defence, and the electricity, gas and water sectors compared with the rest of NSW in 1991 (figure 5(b)). This may reflect resource and market advantages for both

TABLE 2. AREA AND PERCENTAGE OF LAND USES

Landuse	Area (ha)	Percent
Grazing	874,750	47.8
Timber	769,500	42.0
Cropping	153,750	8.4
Mining	14,700	0.8
Water Bodies	6,000	0.3
Urban	4,450	0.2
Vineyard	4,250	0.2
Recreation	1,350	0.1
Quarrying	650	0.2
Utilities	450	
Industrial	300	
Vegetables	300	
Orchards	250	
Intensive Animal Production	250	
Total	**1,830,950**	**100.0**

Source: Department of Land and Water Conservation 1995

agriculture and mining which are specific to the Upper Hunter.

The coal mining industry makes the most significant contribution to the Upper Hunter economy in terms of employment and income generation. The number of people employed in Upper Hunter mines in 1994–1995 totalled 5278 and is predicted to further increase as production continues to expand over the next decade.

Employment in agriculture is strongly linked to climatic conditions and market prices. Employment in the horse industries is predicted to continue increasing. A 1995 survey by the Hunter Valley Bloodhorse Breeders Association indicates that 350 full time and 271 part time workers were employed in the equine industry in the Upper Hunter, an activity which is particularly important to the Scone area, rapidly developing as an area of national/international significance.

2.3 ACTIVITIES AND LAND USE

As part of the Cumulative Impact Study, a land use survey was undertaken by the Department of Land and Water Conservation (DLWC) in 1995 using aerial photography and computer mapping. This was follbwed by extensive field checking. Table 2 shows the area and percentage of each of the land uses. Figure 6 indicates the general distribution of land uses within the study area.

2.3.1 Agriculture

Agriculture has been an extensive land use over 14 decades and has significantly changed the natural character of large parts of the study area. Consequently, it has important implications for the management of the region's land and water resources.

Major agricultural commodities produced in the Upper Hunter are beef cattle, dairy products and wool. Other significant products and activities include piggeries, goats, lucerne and pasture grown for hay, wheat, sorghum and grapes.

Table 3a shows the area of agricultural land within each local government area. Table 3b and 3c show current information (1994/95 ABS) on the gross value of production for major Upper Hunter agricultural enterprises and the relative economic contribution of this for the Hunter and NSW.

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TABLE 3A. AREA OF AGRICULTURAL LAND 1995/96 (HECTARES)

LGA	Area of each LGA (ha)	Agricultural Land (ha)	% of U. Hunter Ag. Land
Merriwa		235 900	23
Murrurundi		194 800	19
Scone		322 500	31
Muswellbrook		123 300	12
Singleton		162 500	15
Total	**1 830 950**	**1 039 000**	**100**

TABLE 3B. GROSS VALUE OF AGRICULTURAL PRODUCTION BY LOCAL GOVERNMENT AREAS 1994/95

Shire/City	Gross value of production ($ million)	% of Upper Hunter
Merriwa	22.2	13.8
Murrurundi	27.4	17.1
Scone	43.2	26.9
Muswellbrook	31.8	19.8
Singleton	36.1	22.4
Total	**160.8**	**100**

While Murrurundi and Merriwa have the greatest economic reliance on agriculture, it remains a significant land use and economic input of all local government areas in the Upper Hunter. The region is well suited for beef cattle production, and grazing remains the most dominant land use in all local government areas. Agricultural enterprises such as cropping, wool and vineyards have more specific resource/market requirements and tend to be aggregated in particular areas. The diversity of soils, topography and climate in the Upper Hunter is an important feature of the region and provides a significant and unique advantage for agricultural production.

Crops

There is considerable variation in the area of crops in the Upper Hunter over the record period, most likely attributed to seasonal fluctuations. A reduction in the area of crops has occurred since 1991. This may be due to drought conditions. Murrurundi has consistently the highest area under crops within the study area, despite being the smallest LGA. Crops are also a dominant form of agriculture in the Merriwa. Muswellbrook, Scone and Singleton have comparably small areas of crops.

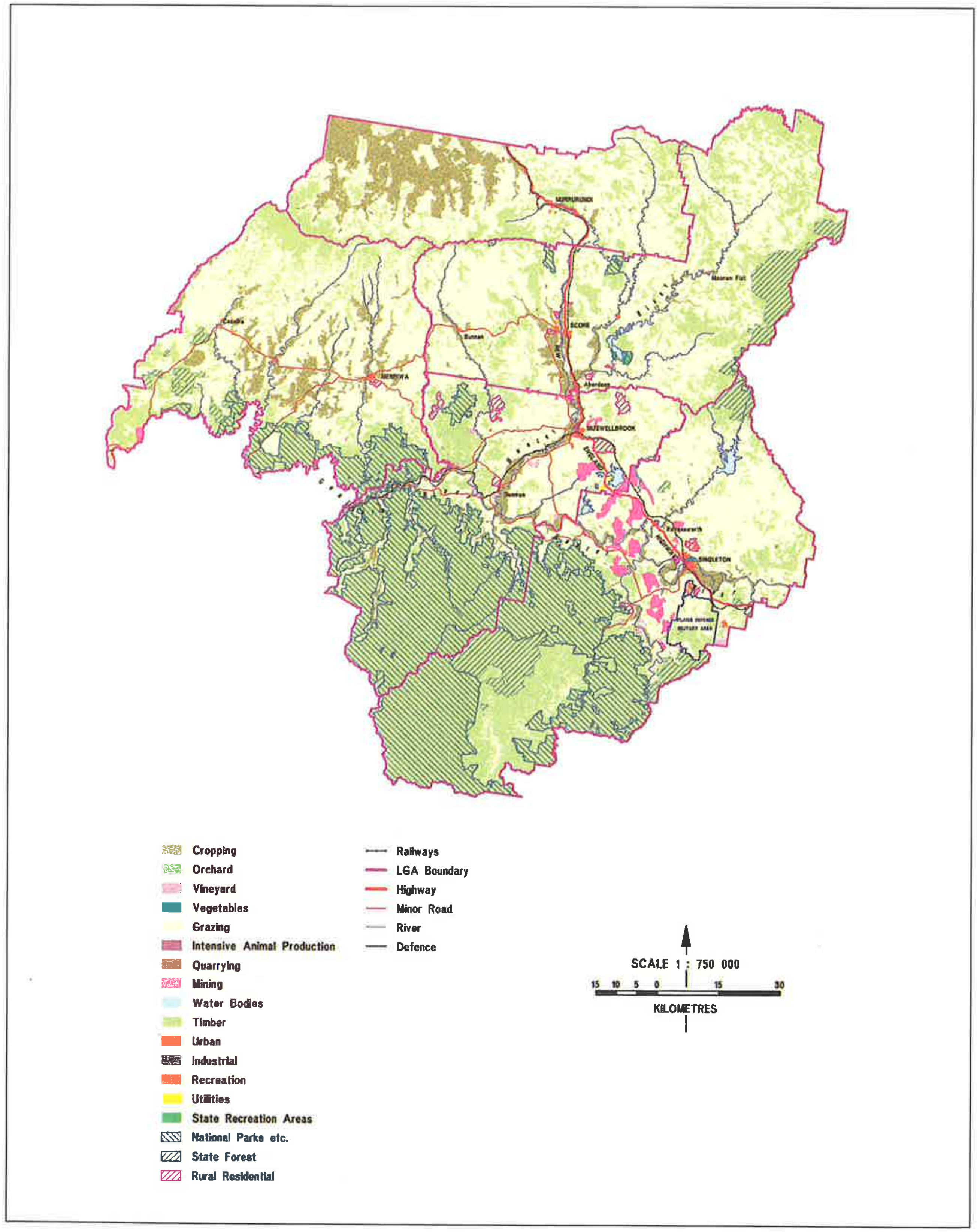
Grazing

Pastoral activities include grazing of sheep, beef cattle, dairy cattle, and horses. DLWC land use

TABLE 3C. GROSS VALUE OF PRODUCTION OF KEY AGRICULTURAL SECTORS (1994/95 ABS)

Product	Predominant Local Government Area	Upper Hunter Gross Value of Production ($)	% of Hunter GVP	% of State GVP
Beef Cattle	All LGAs	64 577 000	70	6
Milk	Muswellbrook, Singleton	40 860 000	50	9
Wool and sheep meat	Merriwa, Murrurundi	14 385 000	99	1
Wheat, barley sorghum, oil seeds	Merriwa, Murrurundi	10 066 000	100	2
Lucerne, hay	Muswellbrook, Scone Singleton	9 231 000	86	10
Pigs	Scone	5 362 000	85	2
Grapes	Muswellbrook, Singleton	4 538 000	69	1
Eggs and poultry	Scone	3 143 000	2	0.6
Goats	Scone, Singleton	692 000	81	7
All other		7 906 000		
All products		**160 760 000**	**44**	**2**

FIGURE 6. LAND USE



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mapping estimates approximately 47.8% (874 750 ha) of natural and improved pastures are used for grazing. An undefined portion of the 42% of the Upper Hunter mapped as timber land would also be open forest or woodland with a grassy understorey used for grazing.

Dairy production is an important economic industry in the Upper Hunter and continues to increase in value. The gross value of milk production has increased by 47% from $28 million in 1989/90 to $41 million in 1994/95. The gross value of milk production from the Upper Hunter in 1994/95 comprised 50% of the total for the Hunter and 9% of the State total.

The production of lucerne hay has also greatly increased over recent years in the Upper Hunter. In 1994/95 the gross value of production of cut hay comprised $9.2 million representing 10% of the State total. Part of this increase may be associated with extended local drought conditions and increased market demand for supplementary fodder.

Intensive Animal Husbandry

Intensive animal husbandry including cattle feedlots, piggeries and poultry sheds occupies approximately 250 hectares in the Upper Hunter. These industries are presently concentrated predominantly within Scone Shire, where they provide a significant additional economic value. Although these activities occupy a relatively small area, appropriate management is essential to avoid the potential for very high localised water quality and odour impacts.

Vineyards

The total area of vineyards within the Upper Hunter is estimated by DLWC to be 4250 hectares which comprises 0.2% of the study area. There are currently 50–60 vineyards in the study area which are predominantly located within Broke–Fordwich, Jerrys Plains, Denman and Sandy Hollow. The vineyards are usually for large scale grape production, irrigated from the Hunter and Goulburn Rivers.

The gross value of grape production in 1993–94 was $4.6 million and contributed 67% to the total grape production for the Hunter Region. The majority of grape production goes into the production of premium table wines. Strong growth in the industry is expected in the medium term.

2.3.2 Tourism

In 1993–94, Tourism NSW estimated that the area attracted approximately 315,000 visitors who spent around $56 million. Visitor attractions include natural features, mining and power generation, farming, the vineyards and historical buildings. The equine industry and its associated events are also major draw cards for visitors.

The Upper Hunter Tourism Strategy identifies major opportunities for new tourism markets based on historical interest, the environment, adventure and education.

2.3.3 Forestry

The majority of State Forests within the Upper Hunter are located within the Singleton LGA. Forest management in the Singleton area has been closely associated with the coal mining industry with forestry operations producing timber for use in mines. This demand has lessened due to changing mining techniques. None of these forests are currently used for intensive timber production.

2.3.4 Quarrying

Approximately 650 hectares or less than 0.1% of the Upper Hunter comprises quarrying activities. The majority of quarrying in Muswellbrook LGA is gravel extraction from the Hunter and Goulburn Rivers. Council records indicate there are 14 approved sand/gravel extraction operations.

2.3.5 Coal Mining

Employment in mining in 1991 equalled that of the agricultural, wholesale and retail sectors, comprising 15% of the Upper Hunter workforce. The number of people employed in Upper Hunter mines (the Hunter Coalfield) in 1994–95 totalled 5278. The wages bill for mine workers is estimated to be about $350m per annum. For NSW the proportion of people employed in mining was only 1% while for the Hunter Region as a whole, the corresponding level was 5%. At the June 1995 quarter, over one-fifth of the current investment of $4.3 billion for the Hunter Region was invested in the mining sector, most of which was in the Upper Hunter.

Production from the Upper Hunter in 1994–95 represented some 53% of total coal production in New South Wales. Approximately 90% of the area's coal output comes from open cut mines. The extent of land affected by open-cut mining in the Upper Hunter in 1994 is summarised in Table 4. Table 5 shows current and projected underground coal mining activities. Table 6 shwos current and projected open cut coal mining activities. Coal development locations are shown in figure 7.

It is expected that potential expansion of NSW export thermal coal requirements will be primarily sourced from the Hunter Coalfield for the next 20 years.

Coal supply has been assessed for the Hunter Coalfield for the next 40 years based on published data and environmental impact statements for existing and proposed mining developments. Production projections for current, proposed and future open cut and underground mining developments were undertaken by Beckett (1995) and are shown in figure 8. Future Coal Production.

In Singleton Shire, medium term expansion by open cut and underground mining is likely in the established mining district between Broke and Ravensworth, and a new underground mine approved at Nardell.

Most major proposed new coal mining developments are located in the vicinity of Muswellbrook (Mount Pleasant, Mount Arthur North, Kayuga, Muswellbrook/Sandy Creek).

Most of the resource in the Muswellbrook/Scone area is covered by Assessment Lease A102 which is held by the Department of Mineral Resources on behalf of the people of NSW. Reserves are allocated for development in line with market demand for coal. Allocations to date include the Bengalla, Mount Pleasant, Dartbrook, Kayuga and Sandy Creek deposits. Much of the unallocated resource is only suitable for underground mining in the longer term, with limited open cut potential in the medium term (5–10 years).

A new mine, Bengalla, was approved in 1996. The only mining development in Scone local government area is underground coal mining by Dartbrook, a mine which straddles the boundaries of Scone and Muswellbrook Shires. The proposed Kayuga (Open Cut) mine whilst entirely within the Muswellbrook Shire may have potential environmental impacts across the Scone Shire boundary. From the information available, there is only limited potential for open-cut mining in the southern area of Scone shire. There are however underground mining resources with long term potential for possibly a small mine west of Aberdeen.

TABLE 4. OPEN CUT MINING IN THE UPPER HUNTER, 1994

Mine	Total colliery holding area (ha)	Cumulative total area disturbed (ha)	Total area rehabilitated (ha)
Bayswater	683.6	486.3	102.1
Camberwell	915	306	83.5
Cumnock	228	103.3	8.8
Drayton	1602.5	855	152.3
Howick	2246	1068.5	175.7
Hunter Valley	3650	1219.3	370.2
Lemington	1650	820.6	232.1
Liddell	1016	677.4	65.7
Mount Owen	1314	0	0
Mount Thorley	1740	788.5	158.5
Muswellbrook	1023	355.4	65.7
Ravensworth	820	1221	396.9
Rix's Creek	1065	181.3	84.7
Saxonvale-Bulga	3258	1050.8	207.6
Swamp Creek	1050	433.1	410.8
United	590	73.4	43.2
Wambo	3360	435	136.3
Warkworth	2955	889.1	136.3
Total	29136.1	10964	2830.4
% Upper Hunter Region (total area 18,218 km²)	1.6%	0.6%	0.16%

2.3.6 Power Generation
Bayswater and Liddell thermal power stations are located in the Muswellbrook LGA generating approximately 40% of the State's total power.

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TABLE 5. HUNTER VALLEY UNDERGROUND COAL DEPOSITS

Status	Mine	Mine Life (Years)	Recoverable Reserves (Mt)	Raw Prod. (Mtpa) 1994–95	Start Date	Finish Date
CURRENT UNDERGROUND MINES	South Bulga	42	160	3.80		2037
	Cumnock	40	60	1.50		2035
	Wambo	42	96	2.25		2037
	Muswellbrook No. 2	33	10	0.30		202
	United	100	150	1.50		2095
	Dartbrook	47	143	3.00		2042
UNDERGROUND PROPOSALS	Glennies Creek	37	94	2.50	2000	2037
	Mitchels Flat	27	68	2.50	2010	2037
UNDERGROUND DEPOSITS	Nardell	50	150	3.00	2000	2050
	Liddell	74	185	2.50	2005	2079
	Muswellbrook Extns.	50	100	2.00	2005	2055
	Wambo Extension	80	200	2.50	2008	2088
	Castle Rock	30	75	2.50	2010	2040
	Mt Thorley	100	250	2.50	2013	2113
	East Denman	40	100	2.50	2016	2055
	West Bulga	100	250	2.50	2018	2118
	West Scone	30	75	2.50	2019	2049
	Wollombi	30	75	2.50	2020	2050
	South Bulga Extns.	26	100	3.80	2023	2049
	Lemington East	94	235	2.50	2024	2118

Liddell Power Station was completed in 1974 and has a capacity of 2000 megawatts. Drinking water and process water requirements for the power station are drawn from the Hunter River. Cooling water is obtained from Lake Liddell.

Bayswater Power Station was completed in the mid 1980s and currently produces in the order of 34% of the State's power with an output of 2640 megawatts. The cooling system causes partial evaporation of cooling water and a consequent increase in cooling water salinity levels.

2.3.7 Sewage Treatment Plants and Waste Disposal Areas
Primary sources of potential water pollution from urban development, apart from general urban runoff, include waste water (sewage) and solid waste disposal areas.

Sewage treatment plants are located at Singleton, Muswellbrook, Denman, Scone, Aberdeen, Murrurundi and Merriwa, servicing urban populations. Other townships and rural areas are serviced by septic tanks using either pump out or on site disposal. Within the Shires of Muswellbrook and Scone, agreements have been reached to recycle sewerage. When implemented this will result in a nil discharge of treated effluent to the river system.

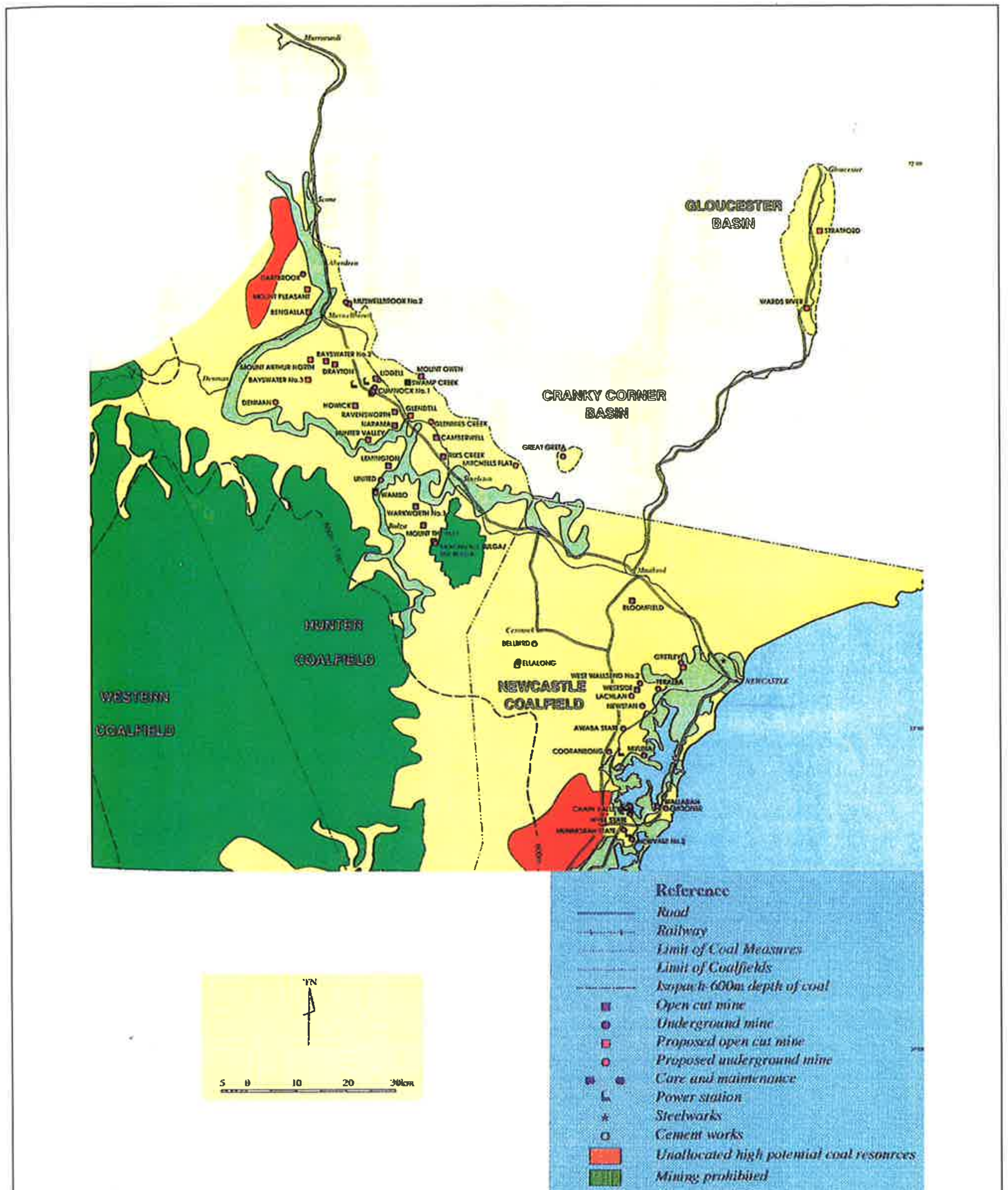
Solid waste disposal depots are located at Singleton, Muswellbrook, Denman, Murrurundi, Merriwa, Ulan, Cassilis, Scone and Aberdeen.

TABLE 6. HUNTER VALLEY OPEN-CUT COAL DEPOSITS

Status	Mine	Mine Life (Years)	Recoverable Reserves (Mt)	Raw Prod. (Mtpa) 1994–95	Start Date	Finish Date
CURRENT OPEN-CUT MINES	Bayswater No. 2	5	10	1.95		2000
	Ravensworth	6	24	4.00		2001
	Liddell	9	10	1.04		2004
	Cumnock South	11	10	0.85		2006
	Camberwell	16	46	2.75		2011
	Muswellbrook	16	20	1.30		2011
	Lemington	17	57	3.34		2012
	Drayton	17	64	3.77		2012
	Rixs Creek	17	26	1.50		2012
	Mt Thorley	19	142	7.40		2014
	Wambo	20	30	1.50		2015
	Saxonvale-Bulga	26	130	5.00		2021
	Narama	27	57	2.06		2022
	Howick	32	136	4.23		2027
	Mt Owen	35	107	3.00		2030
	Hunter Valley	37	275	7.43		2032
	Warkworth	51	230	4.50		2046
OPEN-CUT DEVELOPMENT PROPOSALS	Bayswater No. 3	46	207	4.50		2042
	Bengalla	69	450	6.50	1997	2066
	Mount Pleasant	33	250	7.50	2028	2028
	Mt. Arthur North	60	334	5.50	2065	2065
OPEN-CUT DEPOSITS	Howick Extension	30	203	6.77	1998	2028
	Dartbrook (opencut)	19	40	1.5	1998	2017
	Kayuga					
	Ravensworth No. 3	20	50	2.50	2004	2024
	Castle Rock	20	30	1.50	2009	2029
	Ashton	26	40	1.50	2010	2036
	Mt Arthur South	30	75	2.50	2012	2042
	Lemington East	20	40	2.00	2013	2033
	Glendell	23	70	3.00	2015	2038

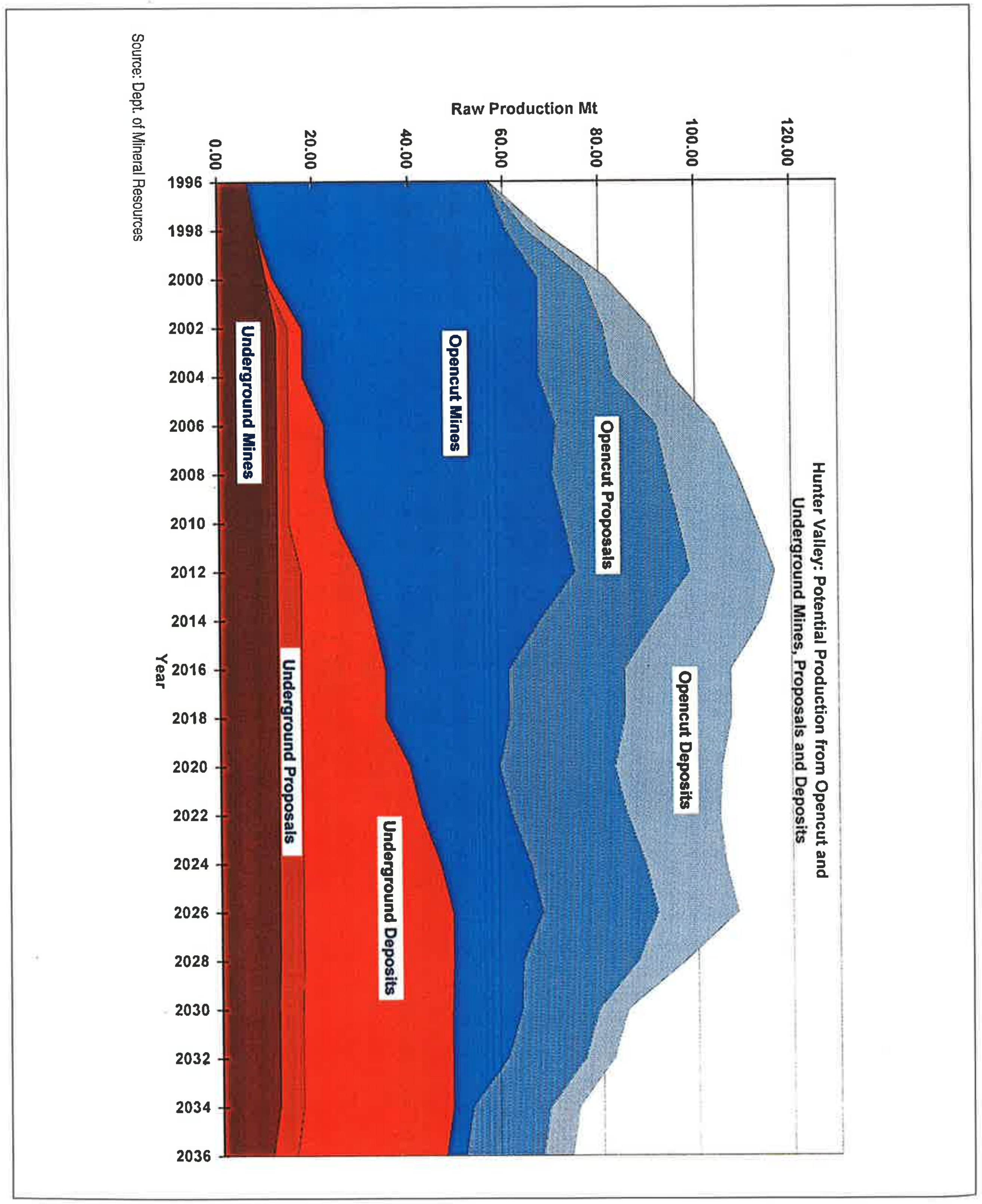
UPPER HUNTER CUMULATIVE
IMPACT STUDY AND ACTION STRATEGY

FIGURE 7. COAL DEVELOPMENT AREAS



Source: Dept. of Mineral Resources

FIGURE 8. FUTURE COAL PRODUCTION



UPPER HUNTER CUMULATIVE
IMPACT STUDY AND ACTION STRATEGY

2.4 OVERVIEW OF LAND USE TRENDS

Major land use trends provide a context for a discussion on cumulative impacts in the Upper Hunter. These trends are summarised as follows:

- Although the number of farms and total employment in agriculture have been declining over recent years, agriculture will retain its importance in all local government areas. Merriwa and Murrurundi are likely to remain dominated by broad acre cropping and grazing, while other areas are likely to experience growth in more intensive forms of agriculture. The most discernible of these are increased vineyard activity continuing to expand in the Singleton–Muswellbrook areas as well as growth in the equine sector concentrated in Scone.

- The beef cattle and wool sectors are nationally expected to remain depressed in the immediate future, however, ABS data for 1994/95 show a 2.5% increase in the gross value of production (GVP) for beef in the Upper Hunter from the previous year. The combined GVP for wool and sheep meat for the same period increased by 12.3%.

- Good growth prospects remain for milk production associated with improved farm productivity and a limited expansion of dairy holdings.

- Increased areas of grapes continue to be established in the Upper Hunter and are expected to significantly increase production when mature. The GVP shown in recent ABS figures, however, appears to have been depressed by extended drought conditions.

- The horse industry is also expected to continue to increase in association with substantial recent investment, however, the economic value of this is not readily identifiable.

- Coal production is likely to continue its expansion, peaking early next century and continuing for some time subject to demand and environmental sustainability of mining. After this time, the coal production rates in the Upper Hunter appear to depend on the economics of underground recovery compared to mining coal reserves at Gunnedah. Coal mining will dominate economic activity in the Upper Hunter well into the future.

- Non-coal resource extraction will remain moderate serving local demand. This may alter if existing sources closer to the Newcastle market such as coarse aggregate and sands for building become depleted or uneconomic.

- Population growth in the Upper Hunter is dominated by Singleton and Muswellbrook with more moderate growth in Scone, Merriwa and Murrurundi. The total population is predicted to increase from 47 800 in 1991 to between 55 000/64 000 by 2021. Continued employment opportunities and regional demographics are likely to be the primary influence of population growth. As part of this population growth, pressure for rural residential settlement is likely to increase.

- There are no plans for power stations with a capacity similar to Liddell or Bayswater. However, with the introduction of greater competition, smaller operations such as the Redbank proposal may become more common, depending on the economics of using latent energy sources to supplement electricity supply.

- There is potential for increased tourism in the Upper Hunter.

- Service industries are likely to remain dominated by mining sector needs, with some diversification into financial services. The local manufacturing sector has potential to expand especially for the export of finished products outside the Hunter Region.

3. Planning Framework

3.1 STATE ENVIRONMENTAL PLANNING POLICIES

State Environmental Planning Policies are prepared under the Environmental Planning and Assessment Act 1979 to address matters considered to be of environmental significance for the State.

Whilst there are several policies which have implications for the Upper Hunter, within the context of this study there are two in particular which have relevance to major economic activity:

- *State Environmental Planning Policy No. 34 — Major Employment Generating Industrial Development*
  This Policy makes the Minister for Urban Affairs and Planning the consent authority for industrial developments which would result in at least 100 post construction full time jobs (20 jobs in the case of intensive livestock operations) or have a capital investment value of $20m or more. It does not apply to retail, commercial, residential or tourism developments.

- *State Environmental Planning Policy No. 45 — Permissibility of Mining*
  This policy commenced on 4 August 1995 and ensures that where provisions in local environmental plans allow mining, subject to meeting certain requirements, then mining will be permitted with consent without having to meet those requirements. The policy does not permit mining where explicitly prohibited by a local environmental plan.

3.2 HUNTER REGIONAL ENVIRONMENTAL PLAN 1989

The Hunter Regional Environmental Plan 1989 addresses social, economic, settlement, accessibility, natural resources and ecological issues as they relate to the use of land for public and private purposes.

The Plan sets out a comprehensive framework for local planning and control of development, through statements of desired outcomes and objectives for landuse, natural resource management and environmental protection. These objectives and the policies which implement them, are statutory requirements which consent authorities, councils in preparing local environmental plans and public authorities carrying out activities, must consider before making decisions. They aim for balanced development and improved environmental outcomes through coordinated actions and recognised best practices.

For the Upper Hunter, the plan projects population growth and includes a settlement strategy to accommodate urban growth primarily in Singleton and Muswellbrook, with lesser growth in Scone, Denman and Aberdeen.

Among the plan's major provisions are those which guide incompatible landuses away from coal resources, minimise adverse environmental impacts from mining, require assessment of proposals subject to environmental impact statements so that consents do not result in significant deterioration of environmental quality, and require councils to consider adequate measures for watercourse setbacks and soil erosion control in any consent decision. The plan cites a number of relevant public authority manuals and reports which give technical advice and standards for use in zoning and development approval matters.

While the plan has provided a consistent framework over many years for the management of environmental change in the Upper Hunter, it is now widely agreed by stakeholders that there is a need to prepare a targeted sub-regional planning strategy for the Upper Hunter, to integrate traditional planning with catchment management initiatives, promote improved practices for land and water management, and to provide an improved framework for cumulative environmental planning.

The development of a new planning strategy with the assistance of relevant government agencies, local councils, the community and commercial interests, must recognise that all persons using land or undertaking an activity within the area, whether or not that activity requires development consent or approval, have a responsibility to improve the way activities are carried out in order to improve environmental conditions.

3.3 LOCAL PLANNING

Local Environmental Plans (LEPs) are an important vehicle for local councils in implementing strategic planning objectives and providing a degree of certainty about the future environment of particular localities. They are also a means of implementing state and regional policies at a local level.

Comprehensive LEPs are in place for each local government area: Muswellbrook LEP 1985; Scone LEP 1986; Merriwa LEP 1992; Murrurundi LEP 1993; and Singleton LEP 1996.

Under these plans all development proposals requiring consent or approval must be examined to take into account to the fullest extent possible all matters affecting or likely to effect the environment. This provides the opportunity to examine environmental impacts and longer term consequences. Regulatory or licensing requirements under other government legislation may impose other environmental obligations on certain projects.

The Upper Hunter Cumulative Impact Study provides additional information and techniques for local councils to improve their decision making.

3.4 DRAFT HUNTER VALLEY STRATEGIC WATER MANAGEMENT PLAN

The Draft Hunter Valley Strategic Water Management Plan published by The Department of Land and Water Conservation (DLWC) in December 1996, provides an indication of the status of water resources, identifies key water management issues and provides a regional framework for water management by government bodies and community groups. This is an important step towards implementing a cumulative impact assessment approach since water quality is a key concern in the Upper Hunter. The Water Management Plan identifies seven main issues for action:

- sharing stream flow;
- maintaining water quality;
- protecting against salinity;
- maintaining the riparian zone;
- sharing and protecting groundwater;
- meeting the water needs of the estuary interface; and
- minimising the effect of flooding.

The Plan proposes strategies to address these issues supported by a range of management, promotion and research activities. These have been examined in light of this study and it would appear that the strategies address most cumulative impact concerns regarding environmental conditions, research and information needs. The plan will assist DLWC, the Hunter Catchment Management Trust, Councils and the Environment Protection Authority in managing and monitoring land use within the catchment.

3.5 HUNTER RIVER SALINITY TRADING SCHEME DRAFT OPERATION MANUAL

The Hunter Valley is a significant area of saline seepage. Salinity is being addressed on a catchment wide basis under the coordination of the Hunter Catchment Management Trust and is a primary concern of the Department Land and Water Conservation and the Environment Protection Authority (EPA). A more extensive river salinity monitoring network is now in place to improve river management.

The contribution made to the salinity of the Hunter River by coal mining operations has been recognised by the EPA in the introduction of new licensing arrangements and the Hunter Salinity Trading Scheme, introduced in January 1995.

The aim of the Scheme is to reduce salinity levels in the Hunter and improve the quality of irrigation water particularly during periods of low flow. Licenses of coal mine operations in the Hunter Valley prohibit all discharges during periods of low flow (which occurs 90% of the time). During high flow conditions, the daily total of salt which may be discharged is capped to sustain a level suitable for all agricultural uses.

Under flood flows, the volume of saline discharges is insignificant compared with the volume of flow. This presents the best opportunity to discharge excess salty water with minimum impact. Accordingly, there is no longer a limit on saline discharges in these conditions.

3.6 THE HEALTHY RIVERS COMMISSION

The New South Wales Government has indicated its determination to ensure ecologically sustainable development of the State's rivers. To this end it has initiated some major reforms in the policies and procedures governing water management throughout the State including institutional arrangements and processes for public consultation. Establishment of the Healthy Rivers Commission is one element of the water reforms.

The Commissioner for Healthy Rivers is to make recommendations to Government on:

- suitable objectives for water quality, flows and other goals central to achieving ecologically sustainable development in a realistic time frame;
- the known or likely views of stakeholder groups on the recommended objectives;
- the economic and environmental consequences of the recommended objectives; and
- strategies, instruments and changes in management practices needed to implement the recommended objectives.

The Commissioner may conduct an inquiry for the Hunter River, in which case the Cumulative Impact Study will be available to assist the Commission address its terms of reference.

3.7 HUNTER CATCHMENT MANAGEMENT TRUST

The Hunter Catchment Management Trust is a statutory body charged with implementing the NSW Government's Total Catchment Management (TCM) Policy within the catchment of the Hunter River. Its activities relate to the sustainable use of the essential natural resources, soil, water and vegetation and the mitigation of the effects of flooding. To this end, the Trust uses survey and other information on the condition of these resources and operates programs for their conservation or where degradation occurs, their rehabilitation.

The long term (i.e. cumulative) effects of unsustainable land-use activities cannot be better indicated than by the condition of a catchment's natural resources. The diversity and amount of cover of natural vegetation, the degree to which soils have eroded and the concentrations of pollutants in waterways are excellent indicators of catchment health.

These natural elements do not occur in isolation but within an integrated system operating within a natural hydrologic unit, a river catchment. This is the physical basis of the TCM concept. TCM however is not a purely physical process. The Trust's role is one of facilitating and coordinating the many groups from both community, industry and government to achieve mutually developed goals for natural resource conservation and flood mitigation. As well it helps coordinate the development of policies for such things as erosion and sediment control, vegetation management, water quality and floor mitigation. The Trust helps fund such ventures on a selective basis, dependent on its assessment of priority areas and/or issues within the Hunter Catchment.

4. Supporting Studies

A number of specialised investigations were undertaken as part of the study and are separately available:

- Regional Profile
- Identification Report
- Air Quality Study
- Water Quality Analysis
- Economic Assessment
- Land Use Survey 1995
- Freight Transport Study.

A brief outline of each investigation follows, with selected executive summaries provided in the Appendices.

4.1 REGIONAL PROFILE

The Department of Urban Affairs and Planning has prepared *A Profile of the Upper Hunter Region* describing the area in terms of its natural characteristics, landscapes, settlement pattern, natural resources and pressures for change. The profile provides a more detailed reference for the information contained in sections 2.1 and 2.2.

4.2 IDENTIFICATION REPORT

The identification report *(Upper Hunter Cumulative Impact Study — Identification Report*, April 1996, DUAP*)* develops a methodology for the assessment of cumulative impacts and systematically examines the many relationships between various activities and different environmental indicators in the Upper Hunter. Through this examination evaluations were made of the potential for activities to contribute to cumulative impacts, as well as the characteristics of that potential impact.

Influences on the environment arise from activities which are either human, such as land use, or natural such as geological processes, climate and the like. The choice of land uses and indicators provide for a balanced overview of relationships in the Upper Hunter environment as they relate to cumulative impacts (table 7). The most important attributes of the study area requiring examination were considered to be:

- air quality;
- water quality;
- catchment conditions; and
- social conditions.

Appendices B1–B4 provide an overview of potential causes, potential effects and environmental conditions associated with each of the environmental indicators selected to best represent conditions in the Upper Hunter.

Appendix C presents a framework developed to evaluate the potential relationships between activities and the environment, from which cumulative impacts might arise:

- changes to the environment potentially caused by land uses and other influences and thus alert to possible *sources* of an environmental deterioration
- the sensitivity of land uses and other receptors to changes in the environment and thus alert to possible consequences of environmental changes, and
- interactions between environmental indicators alerting to possible synergistic or compounding effects on these environmental qualities.

TABLE 7. SELECTED ACTIVITIES AND ENVIRONMENTAL INDICATORS

Activities (land uses and natural) that may influence the environment in the Upper Hunter	**Environmental indicators selected to best represent conditions in the Upper Hunter**
Agriculture • Crops • Horticulture • Viticulture • Grazing • Horse Studs • Intensive Livestock Conservation of Valued Ecosystems Extractive Industry • Sand • Hard Rock Flood Mitigation Works Forestry • Native • Plantations Geology (Natural geological processes) Infrastructure • Roads • Rail • Airfields • Power Transmission • Utilities Land Clearing Meteorological influences Mining • Open-Cut Coal • Underground Coal Natural Hazards • Bush Fires • Flooding • Drought Power Generation Recreation and Tourism Rural Residential Urban • Residential/Commercial • Industrial	Water Resource Management Air: ***Particulate matter*** Sulphur Dioxide Nitrogen Oxides Fluoride Greenhouse Gases: Carbon Dioxide and Methane Other Vehicle Emissions: Lead, Carbon Monoxide, VOCs Odour Water: Water Supply Bacteriological Nutrients: Phosphorus and Nitrogen Water Salinity Water Acidity Toxicity Turbidity Water Table Movement Catchment: Land Stability Erosion Soil Structure Decline Soil Salinisation Soil Acidification Soil Contamination Biodiversity Social: Noise and Vibration Visual Amenity Transport and Traffic Housing and Services Waste Management and Disposal Employment and Worth Resource Sterilisation

Note: Appendices B1–B4 outline potential causes/potential effects and environmental conditions in relation to each of the above environmental indicators.

4.3 AIR QUALITY STUDY

The specialist report *Cumulative Impacts Due to Atmospheric Emissions in the Upper Hunter Valley, NSW* was undertaken by Nigel Holmes & Associates (1996). A summary of this study is provided in Appendix D. The purpose of this report is to review existing information about air quality in the Hunter Valley to determine how much the cumulative effects of emissions from industry (in particular mining) and agriculture are affecting air quality currently and in the near future. The pollutants covered include sulphur dioxide (SO_2), nitrogen dioxide (NO_2), fluorides and particulate matter (dust).

The main focus of the air quality study has been on coal mine development and consequently the focus has been on dust. However, emissions from other industries such as power generation, aluminium production, transport and agriculture have also been examined.

There is no single parameter that describes air quality. It cannot be described by referring to the concentration of a single pollutant. To provide a comprehensive picture of existing air quality requires review of a range of parameters. Some of these involve matters for which reasonably reliable scientific information is readily available, for example the health effects of air pollution, others involve subjective assessment such as the impact of atmospheric emissions on visibility and general amenity.

In assessing the potential for cumulative effects to give rise to environmental problems a number of different approaches have been adopted. In some cases, for example with fluorides, it has been sufficient to simply review existing air quality monitoring data. In other cases, such as particulate matter and SO_2 it has been necessary to review air quality data and to undertake computer based modelling to account for significant developments that are not yet in operation.

Due to existing data collection methods, air quality in the Upper Hunter has been measured at various locations, using a range of methods without a consistent or coordinated approach.

4.4 WATER QUALITY ANALYSIS

The Upper Hunter Cumulative Impact Study — Water Catchment Analysis was undertaken by Umwelt (Australia) Pty Ltd (1996). It attempted to detect long-term changes in water quality and determine if these changes could be attributed to land use. The study also attempted to draw conclusions regarding water quality parameters such as colour, turbidity, conductivity, phosphorous, nitrogen, algae, bacteria and pesticides. A summary of this study is provided in Appendix E.

To enable water quality information to be reviewed in the context of climatic variation (i.e. drought periods or prolonged wet periods), data spanning the past 10–20 years was reviewed.

Analysis of the available water data information (i.e. HYDSYS from the DLWC) indicated that over the past 20 year period, significant variations have occurred in the water quality and that these variations appear to be principally driven by fluctuations in climatic conditions.

After climatic fluctuations are taken into consideration there are no apparent long term trends in surface or ground water quality in the Upper Hunter. The absence of detectable changes in water quality could be a result of the relative scarcity of the water quality data that is required to allow minor long term changes in water quality to be detected in an environment that exhibits extreme variability in response to natural climatic conditions.

The potential for cumulative impacts to affect water quality in the Upper Hunter is significant, particularly with regard to salinity, phosphorous, nitrates, bacteria and water availability.
The nature of catchment processes and the dominance of non-point sources of pollution make monitoring and regulation of water quality difficult. Land degradation is also a cumulative impact issue because of its relationship with water quality and the potential loss of regional agricultural productivity.

4.5 ECONOMIC ASSESSMENT

The Hunter Valley Research Foundation prepared *An Economic Assessment of the Upper Hunter 1995*. The report provides a more detailed reference for the information contained in

sections 2.3 and 2.4. An Executive summary is included as Appendix G.

The purpose of this report was to review available data and information to determine the economic significance of land uses and services within the Upper Hunter, identify any economic sensitivities of land uses and services, and to provide an economic profile.

While there is a considerable amount of information available regarding the economy of the Hunter Region in total, there are marked differences between the economic structure of the Upper Hunter and Hunter Region as a whole. For this reason, information collected and presented in this report profiles the Upper Hunter and compares it with the regional and State economies where appropriate.

All information used to compile the report was in the form of secondary data sources — no primary data was collected. There are a number of limitations in using such secondary sources not the least being that the information is invariably out of date. For example, much of the analysis conducted for this study relied on Australian Bureau of Statistics (ABS) Census of Population and Housing data. The most recent census was carried out in 1991 and therefore any changes to the social and demographic structure of the Upper Hunter since then have not been accounted for. Some of the specific limitations of particular sources, as well as information "gaps" are noted in the final section of the document.

The report details the social profile of the Upper Hunter, followed by an economic profile including the primary, secondary and tertiary sectors and analysis of the labour force. Where possible, trends over time have been discussed and some commentary provided regarding future implications of changes in various sectors.

4.6 LAND USE SURVEY 1995

A key component of the Cumulative Impact Study is the preparation of an up to date landuse map for the Upper Hunter, as a reference for future cumulative impact assessment.

Data collected in the early 1980s during the Hunter Valley Erosion Survey, based upon aerial photographs was inadequate for the study's requirements. The Department of Land and Water Conservation (DLWC) was therefore commissioned to undertake a new landuse study showing 1995 landuses.

4.6.1 Methodology

The study was undertaken by aerial photograph interpretation (API) and mapping onto 1:100,000 topographic maps. The latest aerial photographs were used, followed by extensive field checking to make the necessary corrections.

The maps were then digitised into DLWC's Information System (GIS) for storage, interpretation, enhancement and final outputs. Additional regional information, e.g. roads, railways, rivers, towns etc. were imported into the GIS from various sources to enhance the final map outputs.

The landuse map produced was finally compared with 1995 Satellite Images to update the boundaries and confirm the presence of various landuses.

4.6.2 Landuses

The following land uses were mapped, with criteria used to assign an area of land to a particular landuse: cropping; grazing; water bodies; recreation; urban; industrial; utilities; quarrying; mining; intensive animal production; orchards; vegetables; vineyards; and timber.

Figure 6, Land Use and table 2, Area and Percentage of Land Uses 1995, are products of this exercise.

4.6.3 Availability of Information

The information is available in digital format for GIS systems compatible with the Land and Water Conservation GIS, from the Hunter Regional Office of Land and Water Conservation.

The landuse database for the Hunter Valley will be progressively upgraded to 1:25000 scale accuracy as part of their Natural Resource Inventory Program. Additional landuse data can be added as it becomes available.

This GIS landuse mapping is an important product of the Upper Hunter Cumulative Impact Study. It provides key baseline information which can benefit effective planning, environmental assessment and management, natural resources management, and decision making for major development proposals.

The Department of Urban Affairs and Planning will seek to further develop this data base as an effective resource for decision making at both the regional and local levels.

4.7 UPPER HUNTER CUMULATIVE FREIGHT TRANSPORT STUDY

The Upper Hunter Cumulative Freight Transport Study — stage 1, and a Supplementary Report was undertaken by TEC Consultants Pty Ltd, 1996. The study focuses on the major rail and road systems within the Upper Hunter, and, includes the major rail and road links between Narrabri and Newcastle which feed through the Region.

This strategic study establishes a regional perspective of the road and rail networks and provides future road and rail network performance analyses.

In addition, analyses were carried out to assess the performance of the road and rail networks under different scenarios relating to different levels of coal production, coal mine employee traffic, production of other non-coal developments including grains, and general road traffic growth, for the years 1998 and 2016. The results of the analyses can assist councils and the road and rail service providers to plan future infrastructure development strategies.

4.7.1 Road Network

The results indicate that the road from Narrabri through Murrurundi to Scone would operate satisfactorily where traffic would generally be unaffected by the presence of other vehicles and be able to select desired speed and manoeuvres within the traffic stream along most of its length in both 1998 and 2016. Road traffic would increase south of Scone where traffic would be restricted in its freedom to select desired speed and manoeuvres within the traffic stream without the assistance of separate overtaking lanes in 1998 and 2016. In towns, traffic is restricted to the urban speed limits and should not be affected by the presence of other traffic. The eastern bypass for Muswellbrook, currently being studied by the RTA, would remove significant through traffic from the town.

4.7.2 Rail Network

The study indicates that in 1998 the rail network would operate comfortably within its estimated capacity under most conditions (i.e. excluding accidents or other events outside normal operating conditions). However, in 2016 this capacity would be exceeded on three short sections immediately north, west, and south of Muswellbrook. The degree by which these sections could exceed their capacity over normal operating conditions is estimated as between 10% and 32%. The study indicates that in that year most of the network would be operating at greater than 75% of capacity, with some sections south of the Liddell Siding operating just below full capacity.

4.7.3 Sensitivity Analysis

Sensitivity analyses of road and rail network performance with respect to four different sets of development related parameters were carried out. The results revealed that performance of the main regional roads between the Northwest and Branxton would not be affected by variations in coal production levels, as coal will be transported by rail and not by road.

When compared to the road network, the rail network would experience a much greater impact if the coal production level is varied. In general the estimated rail capacity would not be exceeded under normal operating conditions in 1998 even in the event of a 30% increase in coal production (the 'worst' scenario considered). However, in 2016, the system would operate satisfactorily for a 30% decrease in coal production (the 'best' scenario considered) under normal operating conditions. Under the 'worst' scenario, the system from Mauls Creek, north of Gunnedah, to Branxton would experience operating levels of 87% to 135% of capacity under normal operating levels.

5. Study Findings

The assessment of cumulative impacts is restricted by the existing monitoring network which is generally targeted towards monitoring the impact or individual sites or specific parameters rather than assessing cumulative impact. This has made it more difficult to identify the extent to which cumulative impacts are taking place. Although the limitations imposed by the existing data base do not seriously compromise the analysis, there is a case for reviewing the monitoring system of the Upper Hunter. This is provided for in the Action Strategy.

Following the evaluation of the potential for activities to contribute to cumulative impacts, the most important attributes of the Upper Hunter requiring examination were considered to be air quality, water quality, catchment conditions and social conditions. This section presents study findings in relation to these attributes.

5.1 AIR QUALITY

In summary the study found that:

> Air quality meets community health standards. Cumulative emissions of sulphur dioxide and nitrous oxides are within established standards. The study has modelled cumulative dust emissions from existing and proposed coal mines. Dust affected areas have been identified as being mostly around mines. No adverse health impacts, or effects on vegetation from dust emissions could be detected. However, dust from blasting creates temporary nuisances which need to be addressed.

Environmental indicators chosen to represent air quality conditions in the Upper Hunter were:

- total suspended particulates (TSP)
- sulphur dioxide (SO_2)
- nitrogen oxides (No_x)

- fluoride
- greenhouse gases: carbon dioxide and methane
- other vehicle emissions: lead, carbon monoxide and volatile organic compounds (VOCs)
- odour.

5.1.1 Potential Cumulative Impacts Relating to Air Quality
The main air pollutants that have a potential to create cumulative impacts in the Upper Hunter are particulates, SO_2 and possibly NO_x. The potential for odour generation may also be significant.

5.1.2 Potential Interactions between Air Quality Indicators
Fine particulates can act as carriers of gaseous pollutants into the lungs and onto materials and vegetation. This is recognised in ambient air quality standards for SO_2 which take into account standards for particulates. NO_x are also acid gases and there is potential for them, particularly nitrogen dioxide, to also have synergistic effects in combination with fine particulates. However, particulates from mining and agriculture in the Upper Hunter comprises coarse particle sizes, and are not dangerous to health.

SO_2 can also act synergistically with fluoride and the potential for fluoro-toxicity is increased where both particulates and gaseous fluorides are released into the atmosphere. However, emission levels within the study area are well below the levels required for this effect.

5.1.3 Sulphur Dioxide
The Liddell and Bayswater Power Stations are by far the major sources of SO_2 in the Upper Hunter. Sulphur dioxide emission rates depend on the sulphur content of the coal used.

Analysis of monitoring data collected since 1988 shows that the EPA's long-term goals for ambient/background SO_2 concentrations are met within a significant margin of safety. In relation to short term concentrations, under rare meteorological conditions, power stations may produce concentrations above the NHMRC and WHO air quality goals. However the areas affected and the very low frequency of these events mean that SO_2 concentrations do not pose an environmental concern.

Sulphur dioxide (SO_2) is measured by Pacific Power at Singleton, Ravensworth, Mount Arthur North, Muswellbrook and Lake Liddell.

Analysis of data from 1989–1992 shows the following long term averages:

TABLE 8. SO_2 AVERAGE CONCENTRATIONS

NHMRC Goal 60 (µg/m³)	
Monitoring Location	**Result**
Singleton	3.0 (µg/m³)
Ravensworth	8.5 (µg/m³)
Mount Arthur North	4.5 (µg/m³)
Muswellbrook	6.0 (µg/m³)
Lake Liddell	8.5 (µg/m³)

(NHMRC — National Health and Medical Research Council µg/m³ micrometres per cubic metre; one million micrometres would add up to one metre)

The existing concentrations are well below the goal in both the major towns and at receptors where concentrations are likely to be highest.

Short-term air quality refers to pollutant concentrations measured over one hour or shorter periods. This is the period of time where humans are most aware of air quality impacts.

Eleven short term exceedances have been recorded by Pacific Power over the last six years. Of these, ten exceeded the goal for less than one hour. The data indicates that these events were due to prevailing weather conditions rather than any abnormal emission conditions.

Table 9 shows the percentage of time that monitored concentrations fell within the 1 hour NHMRC goal for SO_2 of 700 µg/m³ and also the percentage of time that concentrations were below the stricter World Health Organisation (WHO) 1-hour goal of 350 µg/m³.

The WHO 1-hour goal is based on a concentration level designed to protect an exercising asthmatic with a protection factor of two, therefore, it is unlikely that there are any health effects due to SO_2 emissions from Bayswater or Liddell at current emission levels.

Even with the operations of the proposed Redbank Power Plant, the study found that the

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TABLE 9. PERCENTAGE OF TIME 1-HOUR SO_2 CONCENTRATIONS ARE BELOW THE AIR QUALITY GOALS

Monitoring Location	WHO goal (350 µg/m³)	NHMRC (700 µg/m³)
Singleton	>99.99	100.00
Ravensworth	>99.99	100.00
Mount Arthur North	>99.90	99.99
Muswellbrook	99.90	99.99
Lake Liddell	99.80	99.98

TABLE 10. MONTHLY AVERAGES FOR FLUORIDE

Location	Monthly Average	Sensitive Vegetation Goal	Very Sensitive Vegetation Goal
Mount Arthur	0.3 µg/m³	0.84 µg/m³	0.4 µg/m³

current and projected levels of SO_2 remain at acceptable limits.

While there is some community concern about the potential for acid rain in the Hunter Valley, studies undertaken by the CSIRO, Pacific Power and the EPA indicate that acid rain levels are well below internationally accepted levels.

(Source: EPA, 1994, *Rainfall quality in the Upper Hunter Valley*, NSW EPA, Bankstown, NSW).

5.1.4 Nitrogen dioxide
The major emission sources of NO_x are the power stations and internal combustion engines used for road transport and mining. The study found that the nitrogen dioxide concentrations are within the EPA's goals at all monitoring sites in the Upper Hunter.

Nitrogen dioxide is measured at the same sites SO_2 is monitored. Neither the EPA's 1-hour goal (320 µg/m³) nor the annual average goal (103 µg/m³) have been exceeded at any of the monitoring sites.

Diesel-powered mining equipment and traffic on main roads and urban areas are significant sources of NO_2. The monitoring measures the contribution from all these sources. The Muswellbrook monitor is near the New England Highway and urban area. The Ravensworth monitor is close to both the New England Highway and the Ravensworth open cut mine. Therefore a range of land uses is covered.

The NHMRC goal for NO_2 has not been exceeded at any of the Pacific Power monitoring sites in the Hunter Valley.

5.1.5 Fluoride
Emission of fluorides occur from power stations and aluminium reduction plants. Fluoride concentrations are monitored by Pacific Power at Mount Arthur North and Ravensworth. Data for the period January 1988 and July 1992 show that the maximum seven-day average concentration was 0.73 µg/m³ (at Mount Arthur North) and the majority (more than 99 percent) of seven-day averages are below 0.4 µg/m³. The EPA's seven-day average goals for fluorides are 1.7 µg/m³ and 0.8 µg/m³ for sensitive and very sensitive vegetation respectively.

The fluoride levels reported to the EPA have always been well within the Australian and New Zealand Environment Council's (ANZECC) goals for 'very sensitive vegetation', such as grape vines.

Monitored levels of fluoride in the Upper Hunter indicate that the concentration levels are well below levels of concern even for sensitive vegetation. There is no foreseeable significant growth in fluoride emissions within the Upper Hunter.

Overall the study found that current and projected cumulative levels of SO_2, NO_2 and Fluorides are well below acceptable limits.

5.1.6 Particulate Matter
Airborne particulate matter (dust) is a complex mixture of organic and inorganic material with a range of particles sizes. The sources of suspended matter can be crustal material from natural sources such as dust storms and wind erosion, land uses such as agriculture and mining and combustion processes including power stations, motor vehicles, incinerators and domestic fuel burning.

The most significant sources of dust in the Upper Hunter are from open cut coal mines and agriculture. Particulate matter emissions from present mining operations are estimated to be in the order of 52,000 tpa and are estimated to rise to 72,000 tpa by the year 2000. Agriculture contributes directly and indirectly to dust levels and its effects can be greater on a receptor than the combined effects of other causes in certain locations or situations. These effects are localised in most conditions and can occur indirectly through land degradation and drought. Agricultural activities are estimated to presently contribute approximately 23 000 tpa, a figure which is not expected to change in the near future.

The health effects of particles are largely related to the extent to which they can penetrate the respiratory tract. It is the very fine particles which are of concern to human health. The analysis of the effects of dust emissions on health indicates no adverse effects on community health would be expected in the Upper Hunter due to dust emissions from coal mines. There is a large body of data which shows that only a small percentage (3–6%) of the dust generated from mines is in the fine particle category.

The prime focus on mining dust is its capacity to cause nuisance effects rather than health effects. It is generally accepted that dust deposition levels above 4g/m²/month are unacceptable at residences and is probably the point at which amenity begins to be affected.

A wide area of the valley is estimated to experience a dust deposition level due to mining of between 0.1 and 2g/m²/month, which can be considered to be outside the level of concern. There has been an increase in dust deposition and concentration levels over the past decade, partly due to an increase in mining activity and partly due to adverse drought conditions.

In regard to existing mines, figure 9 indicates levels of dust fallout. The area affected by levels above 4g/m²/month covers approximately 68 km², land which is generally owned or controlled by mining companies.

Figure 10 shows predicted average dust deposition levels taking into account all mines operating in the year 2000. It indicates that the area affected by levels above 4g/m²/month increases to 89 km², a 30% increase over the existing situation. The major change relates to new mines operating near Muswellbrook, where dust levels can be expected to increase to levels currently experienced by Singleton.

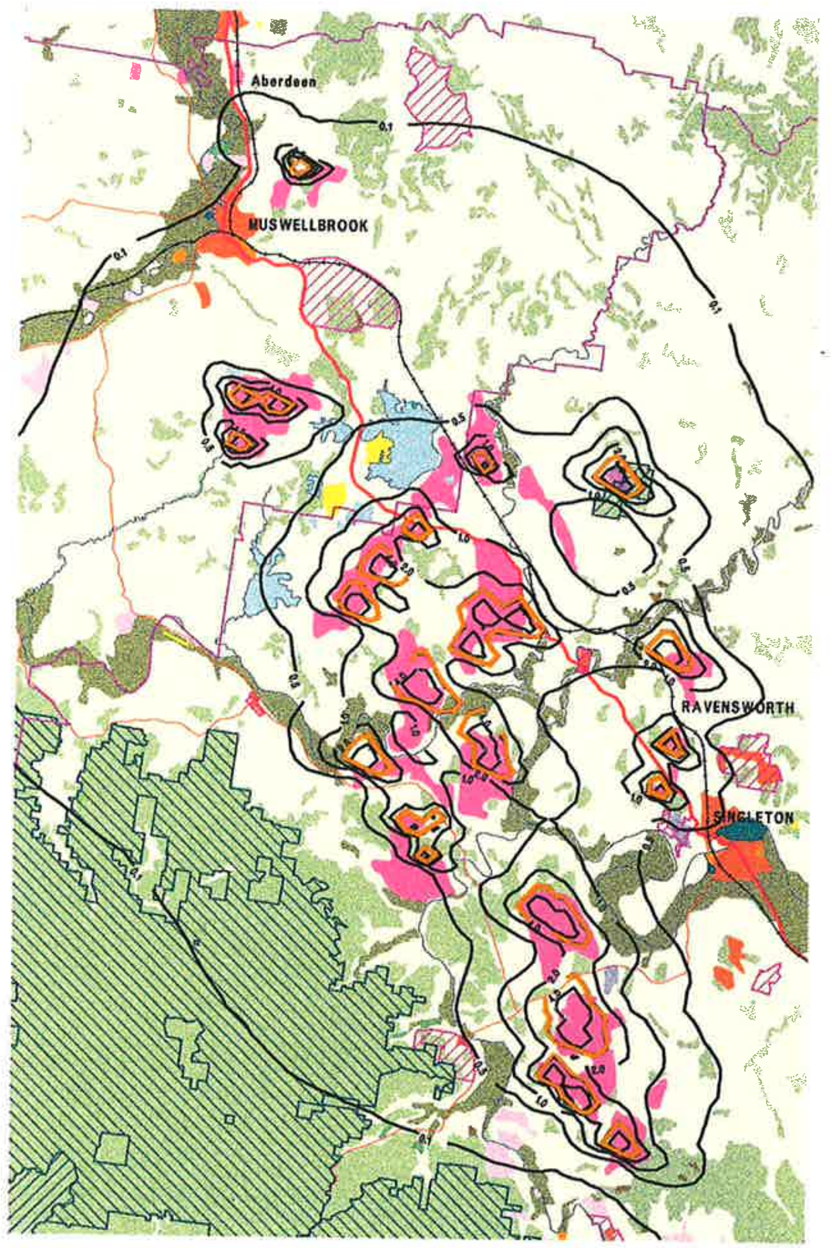
The study concludes that dust levels in the Hunter valley due to mining would not be expected to adversely effect vegetation nor to contribute significantly to regional scale visibility degradation. However visible plumes of dust from blasting and dust haze associated with individual mines under certain commonly occurring conditions are an aesthetic concern for the community.

5.1.7 Roadway Emissions
Roadside concentrations of motor vehicles emissions in the Upper Hunter are likely to remain well within acceptable limits. Increased emissions due to an approximate 25% increase in traffic growth between 1994–2016 is expected to be offset by lower emissions per vehicle in response to technology change.

5.1.8 Greenhouse Gases
While greenhouse gases are emitted by the combustion of fossil fuels, both within the Upper Hunter from power generation and externally with export coal, there is no cumulative impact issue specific to the region.

Processes for considering Greenhouse issues are not fully developed across the nation at this stage and are being considered at both the National and State level. The EPA has been actively participating in the National Greenhouse Gas

FIGURE 9. MODELLED EXISTING ANNUAL DUST DEPOSITION LEVELS DUE TO MINING IN THE UPPER HUNTER (g/m²/month)



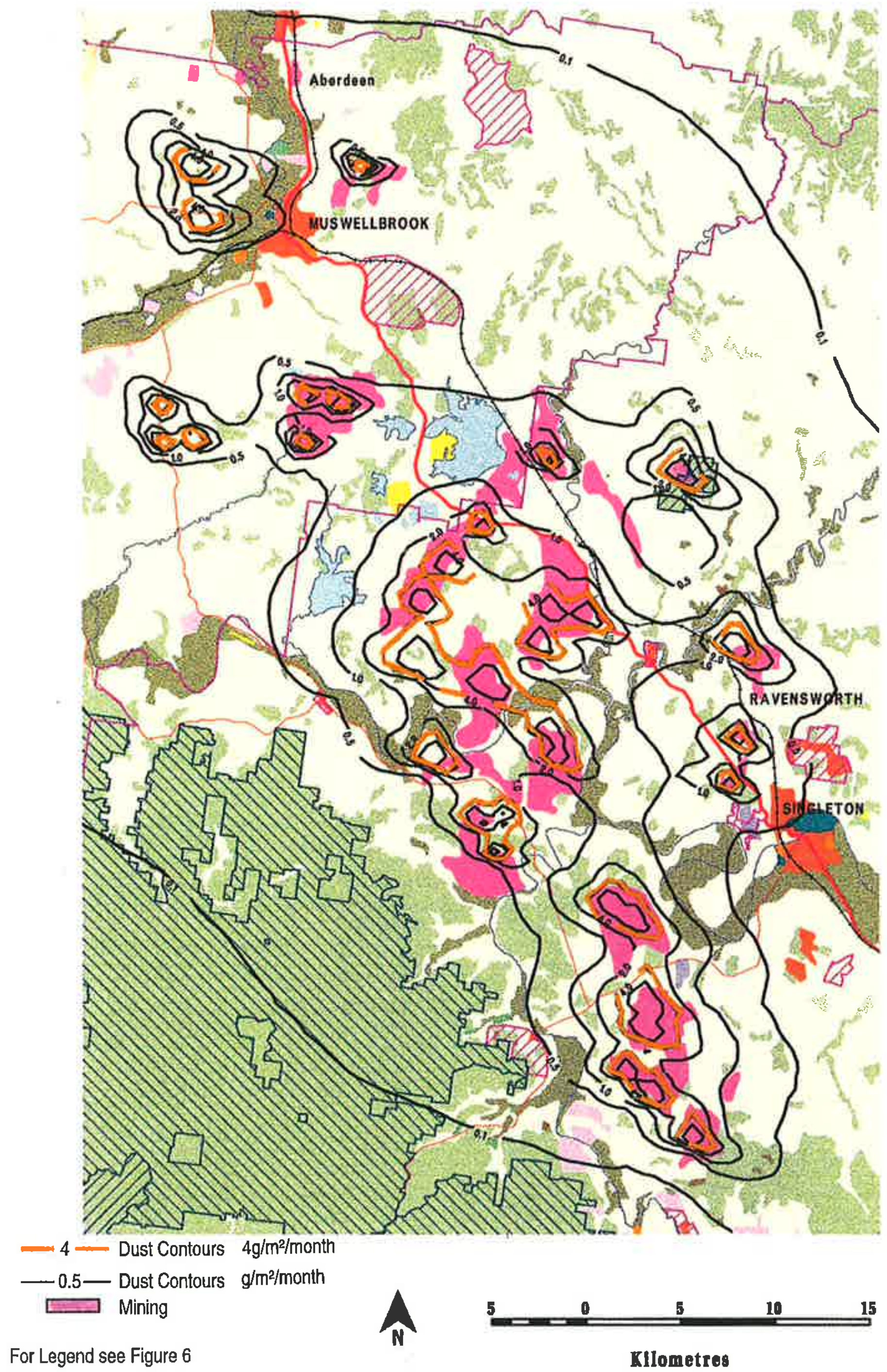
— 4 — Dust Contours 4g/m²/month
—0.5— Dust Contours g/m²/month
Mining

For Legend see Figure 6

N

5 0 5 10 15
Kilometres

FIGURE 10. MODELLED FUTURE ANNUAL DUST DEPOSITION LEVELS (YR2000) DUE TO MINING IN THE UPPER HUNTER (g/m²/month)



Inventory Committee and the development of the Inventory Workbook which will assist assessment at the national level. The EPA is also an active player in implementation of the National Greenhouse Response Strategy along with other relevant state agencies.

The Government's Greenhouse Statement (June 1997) outlines a number of initiatives in energy, land management, transport and waste management to encourage energy savings, promote renewable energy technologies and reduce greenhouse gas emissions.

5.1.9 Odour

Human responses to odours depend on their intensity, detectability, character and unpleasantness. The potential for odour generation most often arises from animal intensive industries such as cattle feedlots and the spontaneous combustion of coal associated with mining. Where odours are generated, the area of sensitivity can be significant depending upon topographic and climatic conditions. At present odour issues tend to be localised impacts associated with individual activities and are not cumulative in nature.

Extensive research has been carried out in recent years on open cut spontaneous combustion in the Hunter Valley and a Code for the prevention of spontaneous combustion has been jointly prepared by the Department of Mineral Resources and the mining industry. Long term effort must be maintained in order to manage this issue.

5.2 WATER QUALITY

In summary the study found that: among potential cumulative impacts arising from land use change, decline in water quality is an issue of main concern. Recent initiatives in total catchment management will help address this situation.

The Department of Land Water Conservation runs two State-wide surface water quality programs:

- the Key Sites Program, which focuses on three significant water quality issues that effect both water users and the health of aquatic environments — salinity, suspended solids and nutrient enrichment. The main objective is to determine water quality trends through time in terms of electrical conductivity, turbidity and total phosphorous concentration at selected sites; and
- the Storages Monitoring Program, comprising sampling at departmental storages to address a mix of short-term objectives such as public health and algal status as well as long term objectives such as the success of catchment management practices.

The results of these programs are published in the Department of Land and Water Conservation's *Window on Water*. Relevant extracts for the Hunter Catchment from the latest publication is provided in Appendix I.

5.2.1 Potential Cumulative Impacts relating to Water Quality

Environmental indicators chosen by this study to represent water quality conditions in the Upper Hunter were:

- water availability
- bacteria
- nutrients: phosphorus and nitrogen
- water salinity
- water acidity
- toxicity
- turbidity
- water table movement.

5.2.2 Potential Cumulative Impacts Relating to Water Quality

The main components of water quality which have the potential to cause cumulative impacts are water availability (flow and volume), bacteria, nutrients, salinity, turbidity and water table movements. Agricultural activities, coal mining and power generation have significant potential for cumulative water quality effects.

5.2.3 Potential Interactions between Water Quality Indicators

Water quality interactions comprise the compounding effects of water flow and/or volume with bacteriological contamination as well as nutrient, toxic and salinity content.

Other examples include the relationship of flows with algae, dissolved oxygen and eutrophication as well as the potential for turbidity through erosion, soil loss and sedimentation. Water flow and volume is also a significant factor in freshwater biodiversity while toxicity has implications for food chain bioaccumulation.

The Australian and New Zealand Environment Council (ANZECC) has highlighted the potential of certain mixtures of heavy metals for synergism where combined toxicity is greater than the sum of individual toxicities. If all toxicants are present at close to their guideline values, significant combined effects could be expected. Also, the pH of water can affect the toxicity of other compounds. However, there is as yet no evidence that these conditions exist in the Upper Hunter.

5.2.4 Water Availability

There is enough water available from the regulated sections of the Hunter River system to meet projected future demands. At present only some 50% of available stored water resources are being utilised. This situation may change as knowledge increases of flows needed to maintain an ecologically sustainable river system.

In unregulated sections of the Hunter River system there are likely to be shortages in water availability for further development. At present the unregulated reaches of the system are under stress during dry conditions. At the time of this study a moratorium was imposed on the issue of any new licences in unregulated sections of the river.

In relation to water availability, it may be necessary that new development such as vineyards, horticulture, and intensive animal husbandry activities need to be restricted to regulated sections of the Hunter system.

5.2.5 Bacteria

Bacteriological contamination is a significant potential cumulative impact due to the high levels recorded and its potentially serious human health consequences. Additional work is required to identify the sources of bacterial contamination of waterways in order that management and planning initiatives can be accurately targeted.

The water quality study identified that parts of the Upper Hunter system are not suitable for human consumption without further treatment and in some areas not suitable for primary recreation. This is likely to be the case with many river systems and is not specific to the Upper Hunter. The study found that if nothing is done to maintain and/or increase water quality, then potential future development will only increase bacteria in the river system and further reduce the recreational amenity of the river system.

5.2.6 Phosphorus

High natural concentrations of phosphorus occur in stretches of the river system particularly in tributaries that drain basalt derived soils, i.e., upper sections of the Hunter River, Glennies Creek and the northern tributaries of the Goulburn River.

Other sources of increased nutrients which have potential to cause cumulative impacts are:

- high levels of fertiliser usage and effluent discharge from dairies and other agricultural industries; and
- contribution of point sources of nutrients such as sewage treatment plants (depending on level of treatment) to river flow during low flow conditions.

5.2.7 Nitrates

Nitrates are a potential problem in groundwater in some parts of the Upper Hunter alluvium where recommended levels for human consumption have been exceeded. The possible contamination of groundwater with nitrates, mainly from point sources such as intensive animal production activities, requires research to identify whether there is a correlation between nitrate levels and the existing land uses.

Groundwater vulnerability mapping for the study area undertaken by DLWC is an important resource in undertaking locational decisions for land uses likely to increase groundwater nitrate levels. The groundwater vulnerability map developed by the DLWC for the Hunter area should be used as tool to make better informed judgements on the potential for development to pollute groundwater. It identifies the hydrogeological setting which makes groundwater susceptible to contamination from a surface source.

5.2.8 Salinity

Major causes of salinity are land clearing affecting dryland salinity, discharge of saline water from mining, and to a lesser extent as leachate from rehabilitated areas. Increased

salinity levels in groundwater and surface water are caused by over pumping of the alluvial aquifer. Introduction of The Hunter River Salinity Trading Scheme (HRSTS) is designed to avoid potential problems from mine water discharge.

In the Hunter Valley, salinity is the most significant factor for groundwater quality.

5.2.9 Water Acidity

While the potential exists for the increased acidity of waters, the natural alkaline nature and high buffering capacity makes the Hunter River and its major tributaries insensitive to acid inputs. Potential problems may still arise in smaller tributaries in sensitive catchments. There also appears to be little evidence of water toxicity from agricultural activities, while no major industrial sources exist.

5.2.10 Pollution Sources

Point sources of water quality impacts centre on the treatment and disposal of wastes. Primary effects derive from intensive livestock operations and sewage treatment plants from urban areas which may result in increased levels of nutrients and bacteria. Leachate from mining, domestic and industrial waste emplacements also have the capacity to contribute to a variety of water quality impacts. Saline waste waters from mines is more likely to be controlled through new licences restricting releases to high water flows (through the Hunter River Salinity Trading Scheme).

Another primary source of water quality impacts occurs from the disturbance of soils through agricultural activities, land clearing, extractive industries and mining. These may occur directly by removing or disturbing terrestrial vegetation, increasing the erodability of certain soils (in particular, basaltic) resulting in increased turbidity and nutrients. Modification of the benthic zone of waterways from in-stream extraction and flood mitigation works can also reduce their capacity to assimilate nutrients. Indirect processes which disturb the water table, and thereby bring salts nearer to the surface soils, include the removal of deep rooted native vegetation, poor irrigation practices and altering or disturbing groundwater aquifers.

5.3 CATCHMENT CONDITIONS

Environmental indicators chosen to represent catchment (terrestrial) conditions in the Upper Hunter are:

- land stability
- erosion
- soil structure decline
- soil salinisation
- soil acidification
- soil contamination
- biodiversity.

5.3.1 Potential Cumulative Impacts Relating to Catchment Conditions

The main potential for cumulative impacts on catchment (terrestrial) conditions concern erosion (predominantly hill slope), solid structure decline and soil salinisation. Erosion and salinisation have significant implications for water quality.

5.3.2 Potential Interactions between Catchment Indicators

Terrestrial interactions include the loss of nutrients from soil and the build up of nutrients in waters from soil erosion and run-off. Erosion itself is related indirectly and directly to water table rises and salinisation/acidification as well as structural decline. These also play a role in land stability.

Other interactions relate to potential impacts on habitat (vegetation) from excess emissions of certain gaseous pollutants and rising salinity as well as the effects on biodiversity from land degradation, soil contamination, enhanced greenhouse effect, and the effects of changes in water flows on freshwater habitats.

The cumulative impact of surface erosion and soil loss is a regional problem which can result in loss of fertility and good quality agricultural land, changes in types of crops produced, increased use of fertilisers, and resulting degradation of water quality through increased turbidity, salinity, acidity and sedimentation of the region's waterways.

5.3.3 Agricultural Activities

Impacts from agricultural activities are chiefly controllable though good land management practices but require a high level of compliance to be successful. Similar impacts arise from processes which remove or degrade vegetation including land clearing, extraction, forestry and mining operations although net benefits may arise from well targeted rehabilitation programs.

Soil salinisation is an indirect result of the removal, replacement or degradation of deep rooted native vegetation. Together with poor irrigation practices, altering or disturbing groundwater aquifers, often leads to rises in the water table bringing salts to surface soils and saline seepages. In these circumstances evaporation from the surface soils results in the crystallisation of salt leading to dryland salinity.

While the potential exists for soil acidification from agricultural activity supplemented by deposition, there is no evidence of it occurring to a serious degree. Potential problems may still arise in smaller sensitive catchments. There also appears to be little evidence of widespread serious soil contamination from agricultural practices, while no major industrial sources exist. However, bioaccumulation of toxicants in the food chain is a subject for further research involving evaluation of the interactive influence or chemical, physical and environmental stresses.

5.3.4 Biodiversity
The maintenance of biological diversity and ecological systems and processes is one of the core objectives of ecologically sustainable development. The preservation of valued ecosystems both outside and inside protected areas such as national parks and nature reserves is an important function in conserving biodiversity. The environment of the Upper Hunter has been significantly disturbed mainly through land clearing and agricultural conversion so as to severely disrupt habitats and the potential for widespread habitat re-establishment. However, such constraints do not preclude taking action to minimise the distribution of exotic plants and feral animals or to develop recovery plans for endangered plants and animals, habitats and ecosystems (see also section 2.1.5).

5.3.5 Sensitive Landuses
Landuses most sensitive to a deterioration in catchment conditions are predominantly agricultural because of their effect on productivity. Other land uses maybe sensitive through the relationship with terrestrial conditions and water quality, while a wide range of land uses are sensitive to the destructive forces of erosion. Residential development is very sensitive to any toxic contamination of the soil by direct contact or indirectly through bioaccumulation in the food chain.

5.4 SOCIAL CONDITIONS
Environmental indicators chosen to best represent social conditions including amenity and economic conditions in the Upper Hunter were:
- noise and vibration
- visual amenity
- transport and traffic generation
- housing and services demands
- waste management and disposal
- employment and worth
- resource availability.

5.4.1 Potential Cumulative Impacts Relating to Social Conditions
The main potential for cumulative impacts on the social environment concern potential amenity impacts from noise, vibration and visual disruption largely relating to open cut coal mining, road and rail noise, and the economic benefits associated with the development of natural resources. Air quality impacts such as particulates and odour can compound amenity impacts.

5.4.2 Potential Interactions between Social Indicators
Although many of the impacts from operations such as open cut mining and extractive industries are temporary, they take place over long timeframes.

Transport generation has a compounding effect on noise as well as potential traffic congestion and air quality impacts. Impacts on visual amenity may derive from particulates, mining and agriculture. Socioeconomic interactions exist between productivity and its effects on employment and income. This in turn affects the demand for housing, services and resource availability. Waste from urban development and livestock has the potential to contaminate surface and groundwaters, and cause odours.

Acquisition of buffers around coal mines and power stations may lead to social dislocation within existing communities.

5.4.3 Noise and Vibration
A detailed assessment of cumulative impacts relating to noise has not been carried out as part of this study. Offensive noise occurs when sound or vibration is likely to be harmful, offensive or to interfere unreasonably with people's comfort.

Noise may be considered to be cumulative if several sources of noise in an area contribute to increasing background noise levels. Acceptable levels of noise associated with major development proposals are assessed using the EPA's Environmental Noise Control Manual by evaluating the potential sources of noise in the context of the existing acoustic environment.

The EPA's broad environmental noise objectives are designed to be consistent, effective and equitable by ensuring that:
- the noise from any single source does not intrude greatly above the prevailing background level; and
- the background noise level does not exceed the level appropriate for the particular locality and land use.

In the Upper Hunter, noise assessments consider the surrounding land use as rural. This designation restricts the noise levels to those normally associated with a rural locality rather than a more industrial area. It is questionable whether continuing to regard the background noise context as 'rural' in view of the predominance of industrial mining activities in certain areas is appropriate.

Increasing ambient noise levels can be anticipated as a result of expanded mining activities in Singleton and Muswellbrook.

5.4.4 Visual Amenity
From a broad perspective the current scenic quality of the Upper Hunter is good, its developed areas along the course of the Hunter River and New England Highway benefiting from views of the high ground framing the sides of the valley to the north, west and south.

However, open cut mining operations and the Liddell and Bayswater Power Stations cause localised visual impacts on the area bounded by Singleton, Muswellbrook and Denman.

Scenic quality is an important attribute to regional tourism, and whilst power generation and coal mining contribute to visitor numbers, the overall reduction in visual amenity has contributed to sometimes negative perceptions of the region. Although air quality is within accepted standards, the high visibility of resource developments, emissions from power stations and dust from coal mining leads to a perception that the area is polluted.

The impact on the visual quality of the area can be described as cumulative in the sense that this particular part of the Upper Hunter is undergoing continual change. The intensity of change and reduction in scenic amenity will continue as new mining operations commence. While landscape buffers will progressively reduce visual intrusions, further development can be expected to increase visible dust levels. These effects are mostly temporary, but occur over relatively long time scales. Restoration of mines takes place progressively, however, landscape rehabilitation can take up to seven years or more to mature. Some aspects of resource development will remain as long term elements in the landscape. Final voids which are left at completion of mining may in some cases be filled and revegetated, or tuned into artificial lakes. Power stations also have long term impact on the visual environment.

Dust and night lighting also have a cumulative impact on the visual environment. A more coordinated approach to the development, assessment and end use of individual mining proposals would assist in reducing these impacts.

5.4.5 Transport and Traffic Generation
Road traffic movements are increasing along the New England Highway as are rail movements along the Main Northern Railway. The predicted increases in rail traffic will largely come from expected increases in coal production around Muswellbrook and Singleton.

The Government's policy of promoting the movement of coal by rail will assist in the reduction of cumulative impacts. The Upper Hunter Cumulative Freight Transport Study indicates that the road and rail network has the capacity/potential to meet projected requirements.

In regard to the development of associated infrastructure for new mines such as coal handling facilities, opportunities taken by mine operators to share and coordinate the provision of essential facilities can greatly assist in reducing the potential cumulative impacts of noise and visual intrusion.

5.4.6 Housing and Services
Increased demand for housing and public services is mainly related to growth in the mining industry, although the impacts are reduced by the characteristics of mine location and the place of residence of employees, which sees significant numbers of employees travelling to work from outside the area. Local councils have generally anticipated the demand for housing and services within their areas, taking into account coal mining projections.

5.4.7 Waste Management and Disposal
Waste disposal needs vary according to the land use or activity involved.

Intensive animal industries can generate significant quantities of effluent waste which in most cases can be successfully disposed of on site. Power generation wastes comprise furnace and fly ash residue which are pumped to a closed system disposal area. Coal mining wastes are associated with coal washery refuse and overburden for disposal on site in association with land rehabilitation.

Domestic solid waste is the subject of landfill disposal by local councils with varying degrees of recycling. Urban centres operate secondary/tertiary sewage treatment plants. Liquid hazardous wastes are collected and treated by a number of approved methods, with disposal at municipal waste depots strongly discouraged.

5.4.8 Employment and Worth
Employment and income is essentially geared to the direct, indirect and induced effects of continuing agricultural, commercial, industrial and tourist development. A strong dynamic regional economy is essential for the long term viability of local communities.

5.4.9 Resource Availability
For national and regional economies that substantially depend upon the development of natural resources for the generation of wealth, it is important that resource availability is maximised. For the Upper Hunter, where major resources include coal and prime agricultural soils, the potential sterilisation of resources is a significant issue.

In particular, resources may be sterilised by the location of rural and urban settlement, requiring the provision of substantial buffer areas to mitigate noise, odour and other impacts.

5.5. CUMULATIVE IMPACT ASSESSMENT GUIDELINES
The study presents a framework for the strategic assessment of potential cumulative impacts, further details of which are provided in the Identification Report and summarised in Appendix C — Cumulative Impact Assessment Guidelines. The appendix contains a series of matrices which summarise:

- potential changes to the environment caused by land uses and other influences
- sensitivity of land uses and other receptors to changes in the environment
- possible interactions between environmental indicators comprising interactive (synergistic) and compounding effects.

The significance of these relationships to cumulative impacts in the Upper Hunter is qualitatively rated major, moderate and minor for the sole purpose of providing a guide to the relative importance of each.

Appendix C also provides some examples how these matrices may be used to assist in identifying likely areas of concern for government agencies, councils and industry involved in strategic policy formulation and planning, in the preparation of project specific environmental impact statements, and in assessing development applications.

The Identification Report provides a very useful tool which can be refined as further practical applications of cumulative impact assessment techniques are implemented. It is stressed that the tables and matrices are based on qualitative and subjective judgements and need to be considered in the light of specific data relating to each circumstance.

6. Study Conclusions

The Upper Hunter Cumulative Impact Study is an important contribution to the practical application and development of cumulative impact assessment techniques and to the understanding of cumulative impacts arising from land use practices and land use change in the Upper Hunter. The study makes an important contribution to the public knowledge of environmental interactions occurring within the area and achieves a substantive first step in what is seen as an *ongoing process*, in regard to planning, environmental assessment, consultation, monitoring, improved data base, land management, educational and research activities within the study area to achieve improved environmental outcomes.

Mining and power industries within the study area are concentrated and visibly intrusive compared with other forms of land uses such as agriculture and as such have become a focus for community concern. However, the principal finding of this study, is that based on current knowledge, and within the limitations of the current data set there are no significant cumulative impacts associated with these industries to warrant the introduction of major regulatory changes to restrict or limit their continuation.

The main air pollutants that have the potential to create cumulative impacts are particulate matter, sulphur dioxide and nitrogen oxides. Of these, particulate matter (dust) is the most significant issue, the major sources of which are mining and agriculture. Dust deposition and concentration analysis reveal an upward trend attributed to increases in mining and in recent years, lower rainfall. The proposed expansion of mining to the west and north of Muswellbrook will lead to increased dust levels in that area. However, no adverse effects on community health are expected due to the larger particle sizes associated with mining, which largely fall on land owned by the mining operations. There will be however broader issues of nuisance and amenity that need to be addressed.

The potential for cumulative impacts to affect water quality and land degradation is significant and largely relates to agricultural and human settlement activities. The most significant potential impacts of these activities relate to salinity, phosphorous, nitrates, bacteria and water availability.

The study concludes that a range of planning, cumulative impact assessment, data collection, monitoring, coordination, land management, education, demonstration program and research initiatives are required to benefit the study area both in the short and the long term. An Action Strategy has been developed to further develop cumulative impact assessment techniques and achieve improved environmental outcomes for the Upper Hunter.

6.1 PLANNING AND ENVIRONMENTAL ASSESSMENT

An improved planning and environmental assessment framework based upon cumulative impact considerations should make a significant contribution to improved decision making within the study area. Key elements include:

- a strengthened regional context promoting sound environmental planning, coordination of actions and improved land/water management practices (Action 1)
- re-examination of urban and rural settlement strategies, particularly with regard to cumulative water quality considerations (Action 5)
- local planning to have careful regard to the findings of the Upper Hunter Cumulative Impact Study when assessing local planning and development assessment (Action 4)
- a focussed examination of the cumulative environmental impacts of new coal mining proposals in the Muswellbrook/Scone area (Action 2)
- the cumulative impact triggers developed in this study being central to requirements for the preparation of environmental impact statements and for strengthening cumulative impact considerations in project assessment (Action 3).

6.2 CUMULATIVE IMPACT ASSESSMENT

The study provides the first step in an ongoing process to develop tools and techniques for cumulative impact assessment and the development of a geographic information system (GIS) for the Upper Hunter. A strong commitment is required to:

- further develop tools and techniques for cumulative impact assessment (Action 9);
- promote the use and application of cumulative environmental triggers and indicators developed in this study (Actions 7 and 8); and
- further develop the GIS mapping system as the basis for data collection, monitoring and education processes associated with cumulative impact assessment (Action 16).

6.3 IMPROVED COORDINATED MONITORING

Both the air quality and water quality consultants recommended the need for quality data and improved coordination of monitoring to assist the further evaluation as to whether long-term trends or cumulative impacts are occurring. These recommendations will be evaluated by relevant government agencies and stakeholders with a view to refining monitoring of environmental indicators and systems to ensure a consistent set of targeted parameters are monitored in a consistent and regular manner (Action 10). There may be a need for monitoring infrastructure adjustments to optimise input to cumulative impact considerations.

6.4 CONSULTATION, REPORTING AND COORDINATION

Given the ongoing nature of developing cumulative impact assessment techniques and the many other actions arising from this study which are directed towards achieving improved environmental outcomes for the Upper Hunter, it is considered necessary to put in place a process for ongoing review, involving all relevant stakeholders in the preparation of an annual report on progress made on the actions arising from this study. Both the Local Government and Community Liaison Committees established for the purposes of this study are seen as key

reference groups and should play an important role in this process (Actions 29 and 30).

It is noted that there are a range of initiatives within the area being undertaken by government and industry. It is important to ensure that the Upper Hunter Cumulative Impact Study is widely made available to achieve an integrated approach to cumulative impact assessment (Actions 3, 4, 31 and 32).

6.5 REVIEW GOALS AND IMPACT MITIGATION MEASURES

The study has identified the need to undertake further work in regard to nuisance dust, the cumulative impact of noise in the Muswellbrook/Scone area, site selection criteria for waste disposal associated with land uses with high potential to influence groundwater nitrate levels, in addition to recognising existing programs run by agencies aimed to mitigate cumulative impacts (Actions 12, 13, 15, 17, 20, 22, 23, 24, 25, 33 and 35).

6.6 LAND MANAGEMENT

Many of the impacts identified by the study relate to either existing activities or those which do not require a planning consent, including many agricultural activities. In this regard, it is recognised that water quality is more widely influenced by agriculture than any other land use in the Upper Hunter. Agricultural activities also make a significant contribution to dust levels.

Planning and environmental management of agricultural pursuits occurs to a much lower extent than those activities that require planning consent. The study has highlighted the need for improvements to a wide range of environmental management techniques which can assist in addressing cumulative impacts, to be achieved through best practice guidelines, education, improved information dissemination, demonstration programs and research (Actions 14, 26, 27, 28, 36, 37, 38 and 39).

7. Action Strategy

UPPER HUNTER CUMULATIVE IMPACT ACTION STRATEGY

There is a broad-based commitment among the major public bodies and community stakeholders to an ongoing process of environmental management in the Upper Hunter to ensure that cumulative impacts are either avoided or minimised and that trends in key environmental indicators are monitored.

The study presents four strategic directions for the development of an ongoing program for cumulative impact consideration and improved environmental outcomes:

- strenthening the planning process
- strengthening environmental monitoring and databases
- strengthening environmental management practices
- improving cordination, liaison and participation.

The Study's strategic directions have been refined into a program of 39 actions which the relevant government agencies have agreed will receive attention within their corporate responsibilities. These actions are not meant to comprise a comprehensive list of works or programs relating to all identified current or emerging environmental or resource development problems. Such would continue to be addressed through the normal channels and processes relevant to those single-issue problems.

Where cumulative environmental interactions are involved, new or improved stakeholder actions are required as set out below which consider these interactions and their heightened potential for additive, compounding or synergistic effects. The Action Strategy, therefore, promotes the integrated strategic cumulative impact framework for the Upper Hunter, and is not to be regarded as the totality of the NSW Government's environmental program for the area in all its various facets.

Each of the 39 separate actions is grouped within one of the *policy areas* identified in the strategic directions.

A responsible stakeholder agency is nominated for the principal carriage of each action, with other *associated stakeholders* indicated where their involvement is critical. These stakeholders will need to further define the specific dimensions and specifications of the task, where necessary, so that the action is clear in terms of its aims and tasks and well targeted to producing achievable outcomes for the Upper Hunter. In some cases, public agencies may need to seek additional resources for work which may be beyond their traditional core functions. The *timing* indicated in the Action Strategy is for the commencement of the work, not its completion, and is shown either as I: Immediate (to commence within 6 months of the adoption of the Action Strategy); S: Short Term (within one year); M: Medium Term (within 3 years), or P: involving an ongoing process where actions arise as needed.

A central feature of the Action Strategy is its reliance on an open and transparent review process involving key local government and community reference groups to evaluate progress on all actions in an annual report which is to be made available to all stakeholders and the community. In this way, the actions can be adjusted over time in the light of experience and changing circumstances.

The Department of Urban Affairs and Planning will be the lead agency for overseeing implementation of the Strategy and will convene the Consultative Committee responsible for the preparation of the Annual Progress Reports.

7.1 STRENGTHENING THE PLANNING PROCESS

Objective: Decisions in environmental plan making, development control, and the formulation of agency resource management policies will be enhanced by consideration of cumulative environmental impacts.

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
1. Prepare a sub-regional planning strategy for the area to: strengthen the framework for environmental planning and the coordination of actions taken by various stakeholders within that agreed framework; to promote improved practices for land and water management based on cumulative impact considerations; and to facilitate an effective link between total catchment management and the environmental planning system.	DUAP	Local Councils; Relevant government agencies; Industry associations; Community	I	Preparation of Upper Hunter sub-regional planning strategy
2. Examine the specific cumulative environmental impacts of four new coal mining proposals in the Muswellbrook/Scone area to assist in the environmental assessment of these projects. The key issues to be examined include: road and rail traffic impacts; coal transport systems and infrastructure; socioeconomic factors; visual amenity; noise; vibration and blasting; air quality; and water quality. The four proposed mines are: • Kayuga open cut • Mount Pleasant open cut • Mount Arthur open cut • Muswellbrook/Sandy Creek underground mine.	DUAP	Muswellbrook Council; DMR; DLWC; EPA; Community; Mining companies	I	Preparation of Muswellbrook Cumulative Impact Study

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
3. Ensure cumulative impact considerations are fully taken into account in the issuing of Director-General's requirements in the preparation of environmental impact statements by using the cumulative impact triggers, where appropriate, identified in the Study.	DUAP		I	Cumulative impact considerations addressed in EIS preparation
4. Consider the Upper Hunter Cumulative Impact Study and, when available, The State of the Rivers Reporting and the Healthy Rivers Commission Inquiry into the Hunter River, in local planning and development assessment processes. Councils will report their progress as part of the annual review process indicated in Action No. 30.	Local Councils		I	Report on how cumulative impacts are being considered in local planning and development assessment processes
5. Re-examine urban and rural settlement strategies with a view to ensuring that residential development is well located having regard to the findings of this study, particularly in regard to cumulative water quality considerations.	Local Councils	DUAP; Community; Other government agencies	S	Preparation of Urban and Rural Settlement Strategies for each LGA within the sub region
6. Prepare a landscape master plan for the area subject to mining, to coordinate landscaping between existing mines and for incorporation in Environmental Management Plans prepared for future mines, in order to lessen the visual impact of development during the construction and mining phases and ensure appropriate post mining rehabilitation.	DMR	Local Councils; Minerals Council; Community	S	Preparation of Landscape Master Plan

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
7. Consider cumulative impacts in developing water allocation and catchment management plans.	DLWC	HCMT; Local Councils; Community	M	Report on how cumulative impact considerations are being incorporated into Water Allocation and Catchment Management Plans
8. Consider the groundwater vulnerability maps prepared by DLWC when preparing local environmental plans and assessing development applications.	Local Councils	DLWC	P	Annual Reports on the practical application of this data base in decision making

7.2 STRENGTHENING ENVIRONMENTAL MONITORING AND DATA BASES

Objective: Cumulative environmental impact considerations should be further explored and developed as a practical means of understanding long-term environmental trends, with appropriate environmental indicators and data bases developed.

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
9. Further develop tools and techniques for cumulative impact assessment as an extension of this study, with special focus to be given to the development of an accessible environmental data base (based on cumulative impact parameters and indicators) relevant to the assessment of long term environmental trends and cumulative environmental impacts and indicators.	DUAP	EPA	M	Prepare a review report on the ongoing development of cumulative impact assessment techniques
10. Review current monitoring systems for the Upper Hunter and develop a coordinated consistent approach to routine environmental monitoring in the Upper Hunter to enable the detection of long term trends and cumulative impacts.	EPA (noise and air) DLWC (water)	HCMT; Local Councils; Industry; Community	I	Design and implementation of a coordinated, consistent, routine environmental monitoring program for the Upper Hunter
11. Review performance of conditions of consent for coal mining projects with regard to environmental monitoring and independent auditing.	DUAP	Local Councils	S	Prepare review reports on an ongoing basis
12. Clarify the issues involved in the community's concerns regarding nuisance dust.	EPA	Local Councils; NSW Agriculture; Mining industry	S	Preparation of review report

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
13. Develop criteria for triggering modification of mining operations during adverse weather conditions such as high winds, in order to minimise local dust impacts.	DMR	EPA; Mining industry	S	Preparation of operational guidelines
14. Undertake research into: • the relative contribution of diffuse sources of salinity; • existing status of dryland salinity; • changes in groundwater regimes as a result of changes in land management, land use and development; • the impact of increased diffuse salinity releases on streams and the riverine environment; and • the impacts of present and predicted changes in groundwater regimes on dryland salinity and land use practices.	DLWC		S	Preparation of Salinity Research Action Plan
15. Review the existing dust monitoring network, emphasising objectives, data gathered, location of monitoring sites and with particular regard to providing evidence of cumulative impact trends.	EPA	Mining industry; DMR	M	Preparation of a review report and implementation of new procedures as appropriate
16. Maintain the GIS mapping system developed for this study as the basis for monitoring, analysis and educational processes associated with cumulative impact assessment. Relevant databases (reports) need to be developed and maintained with suitable maps.	DLWC	EPA; DMR; HCMT; DUAP	M	Preparation of GIS action implementatior plan

7.3 STRENGTHENING ENVIRONMENTAL MANAGEMENT PRACTICES

Objective: Best practice guidelines for mining and for agricultural activities, many of which are outside the sphere of regulation, and technical goals for environmental performance should be better defined for cumulative impact mitigation measures and should be widely understood and promoted throughout the Upper Hunter community.

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
17. Develop site specific blasting guidelines to assist mining companies reduce the probability of blasting dust passing directly over residential areas and incorporate those blasting procedures into development consent conditions provided for future mines.	DMR	EPA; Mining industry, Local Councils; DUAP	I	Preparation of Blasting Guidelines
18. Distribute to industry and the community results of recently completed research from the small number of open cut mines with a spontaneous combustion problem and preparation of a management plan for the control of spontaneous combustion.	DMR	Mining industry; Community	S	Preparation of spontaneous combustion management plan
19. Continue the implementation of Load Based Licensing and model licences in relation to different operations such as coal mines, sewage treatment plants and power stations, to ensure consistency and effective regulation of licensed premises.	EPA	DMR; Local Councils; Mining industry; Macquarie Generation	S	Model Load Based Licences for different operations
20. Prepare site selection criteria for waste disposal associated with land uses with high potential to influence groundwater nitrate levels.	DLWC	EPA	S	Preparation of waste disposal site selection criteria

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
21. Develop water allocation plans for unregulated streams and consider these in the siting of land use activities, to ensure that existing water supplies and environmental flow provisions are protected.	DLWC	Local Councils	M	Preparation of Water Allocation Plans for unregulated streams
22. Continue to develop Regional Air Quality Management Strategies which will enhance ambient air quality within the region and the Greater Sydney airshed.	EPA	Local Councils; Community	M	Report on the preparation of a Regional Air Quality Management Strategy
23. Continue to implement the Hunter River Salinity Trading Scheme (HRSTS) so that the cumulative impact of coal mines and other point sources on salinity levels in the Hunter River is managed to avoid detrimental environmental effects.	EPA	DLWC; Mining industry; Power industry	P	Preparation of progress reports on the implementation of the HRSTS
24. Continue liaison with the State Stormwater Committee to: • develop the strategic policy framework for stormwater management; • provide examples of stormwater treatment technology; and • provide best practices for use on construction and other sites where land is disturbed, soil erodes and water is polluted.	EPA	Local Councils; HCMT	M	Preparation of an implementation report for the Upper Hunter

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
25. Continue development of best practice guidelines for stabilisation and rehabilitation of areas exposed by mining.	DMR	Mining industry	P	Preparation of Best Practice Guidelines
26. Continue the development of best practice guidelines relating to water management in the catchment. Such guidelines should: • promote controlled stock access to streams and drainage lines and develop off stream shade and watering points to minimise the potential for effluent to be deposited into the drainage system; • establish surface runoff controls on farms to minimise the potential for manure from grazing areas to be transported to the drainage system; • establish the use of groundwater vulnerability mapping as a tool to ensure activities are located where waste disposal can be suitably carried out. Other tools to assist land selection include Land Capability and Suitability Mapping and Acid Sulphate Soils Mapping; and • continue the development of Surface Water Quality and River Flow Objectives.	DLWC	NSW Agriculture; HCMT; Farmers	P	Preparation of Best Practice Guidelines for water management

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
27. Develop best practice guidelines to minimise nutrient generation potential. Such guidelines to: • establish riparian buffer zones; • adopt best management practices in terms of fertiliser usage and application; • control and minimise streambank erosion; and • implement a communication strategy so that information can be disseminated to the general public and other interested parties.	DLWC	NSW Agriculture; HCMT; Farmers	P	Preparation of Best Practice Guidelines to minimise nutrient generation
28. Continue to develop educational material on dryland salinity and to work with Landcare/Rivercare groups to address rural diffuse sources of water quality problems.	DLWC	HCMT; Landcare and Rivercare groups; Farmers	P	Preparation of community Education material

7.4 IMPROVED COORDINATION, LIAISON AND PARTICIPATION

Objective: Ongoing work on cumulative environmental impact assessment should be based on improved awareness and involvement of the Upper Hunter community and all relevant public authorities and stakeholders, who should assist each other cooperatively with shared information and a common objective to improve environmental quality in the Upper Hunter.

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
29. Maintain Local Government and Community Consultation Committees, established for the purposes of the Upper Hunter Cumulative Impact Study, as key reference groups to meet at least every six months to assist with preparation of an annual report, to incorporate updated information and knowledge and review progress on actions.	DUAP	All committee members	I	Establishment of Committees to review and monitor implementation of the Action Plan
30. Monitor and report annually on progress made on the actions arising from this study. The primary aim is to ensure the integration of initiatives being undertaken within government (both at the state and local levels).	DUAP	All Stakeholders	M	Annual reports indicate progress made on Actions and evaluate the integration of initiatives
31. Make the study and final report and subsequent annual reports available to agencies, consent authorities, the Office of Commissioners of Inquiry For Environment and Planning, the Hunter Catchment Management Trust and to the community.	DUAP		I	This study and subsequent reports to be widely available to the community and decision makers

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
32. Brief the Healthy Rivers Commission that the Upper Hunter Cumulative Impact Study is available to assist the Commission in its charter.	DUAP		I	DUAP to brief the Healthy Rivers Commission on this study
33. Continue to publish the State of the Environment Reports every two years by the EPA and annually by local councils. These reports should include an assessment of the impact of development approvals on issues such as air and water quality, using quarterly air and water quality reports. Relevant cumulative impact information is to be included in such reports.	EPA/Local Councils		I	SOE reporting, to include cumulative impact considerations
34. Coordinate working parties for the introduction of interim water quality and river flow objectives for submission to government.	EPA	DLWC	I	Convene working parties
35. Publish regularly plain English reports on the state of the catchment, such as: • the State of the Rivers and Estuaries Report for the Hunter; and • Window on Water: The State of Water in NSW.	DLWC	EPA; Local Councils	M	Plain English reports published regularly on the state of the catchment

ACTION	RESPONSIBLE STAKEHOLDER	ASSOCIATED STAKEHOLDERS	TIMING	OUTCOME
36. Implement a demonstration program for establishing and monitoring the success of a range of different agricultural pursuits on rehabilitated mining land. The pilot program should be developed to assess the rehabilitation of mining land on different soil regimes and geological regimes.	DMR	Mining industry; NSW Agriculture	M	Demonstration program implemented on agricultural uses of rehabilitated mining land
37. Develop a demonstration program for the rehabilitation of degraded agricultural land.	DLWC	NSW Agriculture; Landholders	M	Demonstration program on rehabilitation of degraded agricultural land
38. Develop a user friendly and publicly available comprehensive information system designed to assist education and decision making in relation to cumulative impacts and strengthen existing systems.	EPA/DLWC/ DUAP	HCMT; DMR; Local Councils; NSW Minerals Council	M	Information system which educates and assists understanding of cumulative impacts
39. Promote sustainable agricultural practices through programs such as Farming For the Future, Prograze and Industry Codes of Best Practice to enable landholders to recognise and deal with on site and off site impacts associated with agriculture in the Upper Hunter.	NSW Agriculture	DLWC; HCMT; NPWS; Landholders	P	Prepare Action Plan for the promotion of sustainable agricultural practices

Appendices

APPENDIX A. GLOSSARY

alluvium — sediments deposited by rivers, creeks and lakes made up of clay, silt, sand, gravel and cobble beds.

biological diversity — the variety of life in all its forms, including ecosystem diversity, species diversity, and generic diversity.

bloom — an unusually dense and visible growth of organisms (algae or phytoplankton) in water, resulting from proliferation caused by increased nutrients.

conservation — the management of human use of organisms or ecosystems to ensure such use is sustainable.

cumulative impact assessment — cumulative impact assessment (CIA) is identifying, analysing and assessing all likely (past), existing and reasonably foreseeable future effects on the environment (and land uses) arising from impacts which are:

- **time crowded** — cumulative effects that occur because individual impacts are so close in time that the effects of one are not dissipated before the next one occurs.
- **space crowded** — cumulative effects that occur when individual impacts are so close in space that their effects overlap.
- **synergistic** — different types of impact interact to produce an effect which is greater or different than the sum of the separate effects.
- **indirect effects** — cumulative effects occur at some time or distance from the initial impacts or come about through a chain of events.
- **nibbling** — cumulative effects that occur as the result of repetitive, often minor impacts.

dryland salinity — salinity which occurs in rain fed (non-irrigated) areas due to the mobilisation of soil salts. Or, accumulation of salt in soil and water of non-irrigated areas; caused by clearing trees and vegetation on outflow zones for saline watertables: the uptake of water by plants is reduced allowing the watertable with soluble salts to rise.

ecologically sustainable development — using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.

ecosystem — any system in which there is an interdependence upon and interaction between living organisms and their immediate physical, chemical and biological environment.

effect — a direct effect caused by an action occurs at the same time and pace as the action. An indirect effect caused by an action can occur later in time or at a distance from the action. Indirect effects may be induced by physical, biological or socio-economic changes to the environment. May be taken as being synonymous with 'impact'.

environment — all aspects of the surroundings of human beings, whether affecting human beings as individuals or in social groupings incorporating physical, biological, cultural, economic and social factors.

environmental impact assessment — a process for the orderly and systematic evaluation of a proposal, including its alternatives and objectives and its effect on the environment, including the mitigation and management of those effects.

environmental impact statement — a document prepared by the proponent to present the case for the assessment of a proposal as part of the environmental impact assessment process required under the *Environmental Planning and Assessment Act 1979*.

environmental planning instrument — a State Environmental Planning Policy, regional environmental plan, or local environmental plan prepared under the *Environmental Planning and Assessment Act 1979*.

environmental significance — a phrase used for initiating the Environmental Impact Assessment process if a proposal appears likely to have a significant effect on the environment. It requires consideration of, inter alia, the character of the receiving environment, the magnitude and spatial extent of impact, the duration and intensity of change, the resilience of the environment to cope with change, and the confidence of prediction of change.

extractive material — sand, soil, stone, gravel, rock, sandstone, or similar substances that are not prescribed minerals within the meaning of the *Mining Act 1992*.

groundwater — subsurface water contained in a saturated zone of soil and/or geological strata. Groundwater may be confined or unconfined. When confined, the groundwater is beneath relatively impermeable rocks and is under considerable pressure (e.g. borewater). Unconfined groundwater has a free water table (e.g. as in a surface well).

impact — see *effect*.

integrated resource management — management that concentrates on the linkages among water, land, vegetation, wildlife and other resources. Such management focuses on ecological processes, typically the hydrological cycle, and recognises that particular resource uses have implications for interrelated resources and alternative uses.

IQQM (integrated quantity/quality model) — a daily generalised integrated water quality/quantity simulation modelling suite suitable for water resources management planning purposes at the river basin scale, and capable of addressing water quality and environmental issues as well as water quantity issues.

irrigation salinity — caused by rising water tables bringing high concentrations of salts within root zones of plants, killing and stunting vegetation; caused by poor irrigation practices where more water is applied than can be used by the crop and the clearing of deep-rooted vegetation such as trees.

limits of acceptable change — this is a concept which is an aid to the management of use impacts and not of use itself. It tackles resource management problems from the perspective of the extent to which change is acceptable. It is used to establish the maximum damage level for a resource that society is prepared to accept and to define the maximum level of use consistent with that damage level.

particulate — discrete aggregations of solid matter larger than the surrounding air.

precautionary principle — a principle of ecologically sustainable development providing that, where there are threats of serious or irreversible damage, the lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

proponent — a person, corporate body, organisation or Government agency responsible for implementing a proposal, or as is designated as the proponent.

proposal — any project, policy, program, plan, or other activity which may fall within the scope of environmental impact assessment legislation.

regulated river — river whose flow is largely controlled by dams and weirs, (in NSW, legal definition is; rivers proclaimed under section 22c of *NSW Waters Act 1912*).

resource — anything that is used directly by people. A renewable resource can renew itself or be renewed at a constant level. A non-renewable resource is one whose consumption necessarily involves its depletion.

regional carrying capacity — the maximum rate of resource consumption and waste discharge that can be sustained indefinitely in a defined impact region without progressively impairing bioproductivity and ecological integrity.

riparian zone — associated with a river. The biotic zone dominated by the presence of a river. Of, pertaining to, or situated or dwelling on, the bank of a river.

salinisation — the accumulation of salts in the soil to a level that causes degradation of the soil.

salinity — the amount of sodium chloride or dissolved salts in a unit of water. It can be measured in parts per hundred (percent), parts per thousand, milligrams per litre or in units of electrical conductivity (microseimens per centimetre at 25°C or 'EC units'). In these different scales sea water has a salinity of 3.5%, 35 parts per thousand 0/00), 35,000mg/L and 50,000 EC units.

state of the environment reporting — reports that provide an assessment of the conditions of the environment, pressures on the environment, and the responses of the environment to those pressures. A requirement of the *Local Government Act 1993*.

strategic environmental assessment — the application of the techniques of project specific environmental impact assessment to policies, plans and programs which may have sector, regional or indirect impacts.

synergistic — by acting together, separate elements produce a greater effect than would be produced if they acted separately.

threatened species — means a species listed in the relevant schedules of the *Threatened Species Conservation Act 1995*.

total catchment management — the coordinated and sustainable use and management of land, water, vegetation and other natural resources on a water catchment basis so as to balance resource utilisation and conservation.

toxic wastes — any discarded material, commonly from industrial or commercial processes, capable of causing injury or deaths to living organisms.

turbidity — a measure of water clarity and an indicator of suspended material—usually fine clay or silt particles—which is unsightly and can block sprays and pipes.

unregulated river — river whose flow is not controlled or mostly not controlled by dams or weirs.

water table — the upper level of the unconfined groundwater, where the water pressure is equal to that of the atmosphere and below which the rocks or soils are saturated. It is taken as the level at which water stands in the wells that penetrate the water body.

APPENDIX B CONTAINS
B-1 AIR QUALITY INDICATORS
B-2 WATER QUALITY INDICATORS
B-3 CATCHMENT CONDITIONS INDICATORS
B-4 SOCIAL CONDITION INDICATORS

APPENDIX B-1. AIR QUALITY INDICATORS

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Total Suspended Particulate (TSP) - Airborne solid or liquid particles of less than 100 micrometres (µm)	• Open-cut coal mining, hard rock quarrying including the extraction, movement, stockpiling and transport of the resource, overburden & wastes (Coarse dust). • Agricultural activities including land clearing, ploughing, harvesting, spreading of fertilisers (aerial dressings) & unprotected soils (Coarse dust). • Power generation, transportation & some industrial processes (Fine particles). • Natural sources including wind blown dust, bush fire smoke, pollen and bacteria	• Reduction in visibility. Smaller particles of less than 2.5 µm (PM2.5) may be responsible for haze by scattering light. • Soiling of materials. • High deposition rates of dust can affect the growth of vegetation although it has been suggested that even high deposition rates may only reduce photosynthetic response by a very small amount. • Toxicity to grazing animals. • Particles of less than 10 µm (PM10) when inhaled can penetrate into the lungs and may cause respiratory problems.	• Long term monitoring of particulates has shown that high dust levels generally do not persist for any significant distance away from the centre of mining activity. • Monitoring has recorded dust fallout levels below the EPA guideline of 4g/sq.m/month (annual average). • SPCC (1986) data indicates that less than 6% of TSP produced in open cut mines is in the fine particle size category.
Sulphur Dioxide (SO_2) - a colourless pungent gas	• Combustion of fossil fuels and smelting of mineral ores containing sulphur. • Natural sources include the decomposition and combustion of organic matter. • The Liddell and Bayswater Power station emissions are the main source of sulphur dioxide. • Minor quantities will result from motor vehicle emissions. • Some emissions could occur from the spontaneous combustion of coal mining waste, however minimised through management practices. • Industry outside the study area such as aluminium smelters at Kurri Kurri and Tomago	• Irritation to the respiratory system contributing to diseases such as chronic bronchitis. • In combination with water vapour, high levels of sulphur dioxide may corrode material & damage the tissue of fauna & flora. Acute injury can occur to plants when exposed to high concentrations over short periods & chronic injury may result from long term exposure at lower levels. • A slight potential for sulphates to contaminate surface and ground waters should deposition increase dramatically.	• Levels of sulphur dioxide near power stations are well below established long-term objectives.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Nitrogen Oxides (NO_x) - Primarily comprise of nitrous oxides, nitric oxides and nitrogen dioxide. These gases are formed in combustion processes both from the nitrogen present in fuels and from oxidisation of nitrogen in the atmosphere.	• Emitted from bacterial action in soils and from the reaction of nitrogen with atomic oxygen and ozone in the upper atmosphere. It is often a by product of nitrogen fertilisers used in farming. • Emission from power stations. • Vehicular traffic movement and coal trucks. • Industrial processes may contribute.	• Nitrogen dioxide is a respiratory irritant which may contribute to bronchitis in infants, children & susceptible adults when levels are excessive. • Precursors for photochemical smog. • In combination with other pollutants in high concentrations, damage can occur to vegetation.	• There is no evidence that photochemical smog and winter haze events are a problem in the Newcastle/Hunter region. • Levels of nitrogen oxides near power stations in the Hunter Valley are well below established long-term objectives.
Fluoride - a compound of fluorine which is a corrosive, poisonous chemical element.	• Emissions from the Liddell and Bayswater power stations in the form of gaseous hydrogen fluoride with particulates collected at source. • Emissions from aluminium smelting at Kurri Kurri. • Compounds of fluorine are present in low concentrations in soils, groundwaters and rivers.	• Gaseous hydrogen fluorides in sufficiently high quantities can affect vegetation including native and cultivated, in particular viticulture. • Livestock and wildlife may also be affected, such as fluorosis in cattle, if exposed to excessive quantities.	• Monitored ambient fluoride levels in the Upper Hunter Valley are well below recommended levels for very sensitive vegetation. • Concentrations of fluoride in grape vines and *Eucalyptus crebra* foliage are well below the levels at which damage has been observed to occur.
Greenhouse Gases - Carbon Dioxide and Methane	• Use of coal for electricity generation. • The motor vehicle is the major human source of carbon monoxide. • Sources of methane include animal and domestic waste. • Clearing of land for agriculture, mining and forestry remove the ability for vegetation to act as a sink by converting carbon dioxide to oxygen.	• Increased emissions of greenhouse emissions have a general potential for climate change.	• These indicators are of global significance and their application to the Upper Hunter Study is remote. However, it is not possible to address these in a regional setting without the prior international and national consideration of the most efficient and equitable means to address global warming.
Other Vehicle Emissions - Lead, Carbon Monoxide and Volatile Organic Compounds (VOCs)	• Lead emissions from motor vehicles, particularly heavy vehicles using leaded petrol. • Point sources are mainly smelters. • Motor vehicles is the major human source of carbon monoxide and VOCs. Traffic generating land uses and those using mobile plant indirectly & directly contribute to these emissions.	• Carbon monoxide has a potential for adverse health effects at low concentrations & remains in the atmosphere before being reacted upon to produce carbon dioxide. • Three critical types of lead toxicity: gastrointestinal, nervous system effects and anaemia.	• With the continuing introduction of unleaded petrol, the atmospheric levels of lead in the Upper Hunter is not considered to be significant. • CRES has found that nitrogen oxides and carbon monoxide are most likely to be of future concern due to increasing traffic volume, but the latter are likely to remain below ambient air quality standards in major towns subjected to traffic from heavy transport.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Odour - Human responses to odours depend on their intensity, detectability, character & hedonic tone (unpleasantness).	• Intensive animal industries such as piggeries, cattle feed lots & poultry farms from the management, reuse & disposal of effluent. • Use of organic fertilisers, composted material & pesticide sprays. • Residential sewage treatment plants & other waste disposal facilities. • Exhausts of vehicular traffic may accumulate & increase in urban areas, but usually only temporary. • Industrial sources including from mine blasts.	• Lower standards of living conditions for residential and rural dwellings with health effects in extreme circumstances. • Diminish the attractiveness of areas used for recreation & tourist related development.	• Odour sources tend to be in well spaced locations. Impacts will arise from the proximity of dwellings and other receptors to the odour source and the influence of topography, prevailing wind conditions and katabatic (downward) wind movements.

APPENDIX B-2. WATER QUALITY INDICATORS

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Water Supply - An adequate and reliable supply of water is vital for communities and for the continuing operation and development of agricultural activities, coal mining, power generation and associated industries. It is also important to maintain the environmental health of waterways.	• Major water consumers comprise power generation, irrigation and town water supply. • Groundwater resources are extensively used for irrigation, town water supply, commercial stock and domestic purposes. • The Liddell and Bayswater power stations draw water from both the Hunter River and outside the catchment through the Barnard River Diversion. • Forestry plantations consume large amounts of water when growing to maturity. They may cause a reduction in runoff in the longer term but short term increases in flow after harvesting may occur.	• An adequate water supply is needed for domestic consumption, agricultural activities, coal mining primarily to wash coal and power generation for cooling and recreation and tourism activities. • Alluvial aquifers associated with waterways are significant sources of groundwater and are used for urban water supply, irrigation, stock, and other purposes. • The conservation of valued ecosystems may require an adequate supply regime to ensure the survival of some species. • Water resource management is affected by variations in water supply demands and the need for additional reservoir capacity. • Stream flows will influence other indicators such as turbidity and nutrients.	• Water is obtained from streams in the catchment from the north-eastern sector where rainfall is high & evaporation is low. Significant variability in stream flow. • About one third of groundwater in storage in the Hunter Valley is good quality. Good quality water occurs in rock aquifers in the Jurassic sandstones and shales north of the Goulburn River. Water is also available in the fractured rock aquifers in most of the area north & east of the railway from Maitland to Murrurundi. Tertiary basalt outcrops are another water supply source . • The degree of river regulation and water extraction has increased over recent years, the impact of dams on the flow regime being most evident in mid-catchment where stream flow variations have been substantially reduced. Releases for power generation and summer irrigation demand and the curtailment of winter discharge from the upper catchment to fill storages strongly influence flow regimes. • Adequate water supplies from regulated sections of the Hunter River System will meet existing water use demands and there is sufficient uncommitted resource to meet a significant amount of future demand. • Water shortages are likely in unregulated sections in the future.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Bacteriological - Bacteria live by attacking and breaking down organic matter. *Escherichia coli* is the selected indicator for the bacteriological acceptability of water supplies. The coliform test is also used to assess the safety of water-contact recreational activities.	• Sewer overflows and septic tank discharge. • Effluent from abattoirs, piggeries and dairies as well as industrial effluent. • Inputs from domestic stock and wildlife living near waterways are diffuse sources of faecal coliform which can be transported into waterways after heavy rainfalls. • Animal access to watercourses provide more direct impacts. • Birds are large transporters of microbial input to waterways.	• Poor bacteriological water quality may present a health risk for people using untreated water for domestic supply or in primary contact recreation. • Agricultural uses with livestock are also at risk from contamination. • Most urban water supply systems in the Upper Hunter are capable of treating water before being used.	• Studies have found the best conditions for water quality immediately downstream of Glenbawn Dam and at Aberdeen. • The 94/95 study by DLWC found sites at Aberdeen, Muswellbrook, and Singleton failed to meet primary recreational guidelines for water quality. The Maitland site was close to failing the standard. • All sites except Murrurundi and Singleton met the guidelines for secondary contact recreation, stock watering and irrigation usage.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Water Salinity - measured by electrical conductivity (Ec). ANZECC Water Quality Guidelines specify concentrations for drinking water and freshwater aquatic systems; for irrigation depending on crop sensitivity and animal specific criteria for livestock watering.	• Weathering of sedimentary rocks of marine origin and from rainfall; tectonism and rainfall distribution influencing the composition of the salt load. • Drainage of the catchment contributes a naturally high base load of salt to the River. • Human activities associated with agriculture, coal mining, power generation, industry and urbanisation result in an increase to the naturally occurring salt levels in the waterways. • Any irrigation with groundwater increases the output of saline water onto the surface water system and therefore the salt load carried by the Hunter River. Instances are occurring where specific salts, particularly nitrates, are accumulating in more intensive irrigation areas. Because of their large water requirements, intensive livestock/feed lot facilities are potential salt generators in this regard. Sites of dryland salinity may generate saline runoff. • Coal mining activities require disposal of excess minewaters which can be highly saline and often result from the inflow of saline groundwater. Excess saline waters are disposed by irrigation or controlled discharge to streams which flow into the Hunter River. Discharges are now licensed to occur at times of high water flow, mitigating its impact. • Salinity effects from coal mining that is more difficult to control may result from the disruption of aquifers. This has the potential for increasing the salinity of receiving waters through increasing sub surface rates of flow. • Power generation at the Liddell/Bayswater complex requires significant quantities of water drawn for cooling and other purposes from which salt has to be removed and stored on site.	• Largest threat to surface and groundwater resources across NSW with the added consequence of severely impacting soils, reducing their fertility, destroying their structure and assisting in their erosion. May damage crops and metal reticulation systems. Elevated salinity levels in the Hunter River between Muswellbrook and Maitland have the potential to restrict water use particularly for irrigation of vegetable and fodder crops. • Land uses are dependent on the availability of adequate supplies of good quality water. Coal mining may be impacted by continuing high levels by reducing the capacity and opportunity to discharge saline waters. The Liddell and Bayswater power generation plants require large volumes of low salinity water for cooling. • Provided Hunter River salinity levels are maintained and managed, they will not pose a threat to those existing crops grown; and provided high natural pulses of saline water experienced on the rising stage of flood flows are taken into account, crop damage should not occur. • Improvements to existing salinity levels should encourage the return of less salt tolerant crops, eg, vegetables. Conversely, any increase in salinity levels may make some existing agricultural activities unviable.	• Significant area of saline seepage from Cessnock to Muswellbrook. • Salinity is generally low in the alluvial formations along the Hunter River and its tributaries and in the basalt areas in the north-west of the catchment, but fairly high in the carboniferous aquifers to the north of the Hunter River. Lower electrical conductivity has recently been reported at Muswellbrook but otherwise, moderate to high salinity levels were recorded in the Hunter River Basin during 1992/94. Problem sites of dryland salinity in the Hunter Valley occur from Cessnock to Muswellbrook. • Introduction of new licensing arrangements and the Hunter Salinity Trading Scheme on 1 January 1995 to reduce salinity levels in the Hunter River and improve the quality of irrigation water. Licences of coal mine operators prohibit all discharges during periods of low flow (which occurs 90% of the time). During high flow conditions, the daily total of salt which may be discharged is capped to sustain a level suitable for all agricultural uses and human consumption. Potential dischargers hold percentage shares of this allowable discharge. These shares may be traded, encouraging cooperation, while new dischargers may obtain shares from existing holders. • There is no limit on the volume or of salt concentration of discharges in flood flow conditions as the volume of saline discharges is insignificant compared with the volume of flow.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Nutrients - Phosphorus and Nitrogen - Phosphorus and nitrogen are the main nutrients which can impact on water quality.	• Discharge of urban sewage, storm waters, uncontrolled urban waste water, intensive agriculture and food processing works. • Poor land management practices involving fertiliser application, high stocking rates, vegetation clearing and soil and riverbank erosion. • Natural weathering of basaltic rock. • Modification of the benthic zone of waterways from in-stream extraction & flood mitigation works can reduce their capacity to assimilate nutrients. • Possible contamination of groundwaters with nitrates mainly from intensive animal production activities. • Water discharges from lower levels of storages in summer can be high in nutrients while the flow regime will naturally influence its concentration. • Combustion of coal may be a factor. • The composition of salt loads carried by rain shows effects of pollution from power generation with increases in oxides of sulphur and nitrogen in the form of sulphates and nitrates	• Excess nutrients, particularly phosphorus, promote the growth of algae and other aquatic plants. Water storage impoundments in particular are subject to eutrophication and receipt of nutrient loads promoting outbreaks of toxic and non-toxic algal blooms. • Blue-green algae can affect water supplies, human health, livestock, natural fauna, recreation and tourism. It increases the costs of water treatment and can lead to odour and taste problems. In extreme cases, contact may lead to skin irritations and if consumed illness. The toxins have caused the death of livestock while associated reduced oxygen levels has lead to fish kills. • The possible contamination of groundwaters with nitrates could be detrimental to human health and decrease cattle fertility and productivity if such waters are consumed.	• Phosphorus concentrations in the upper Hunter River, above Muswellbrook, are generally high, resulting it is thought from grazing activities and basaltic rock weathering. • All DLWC storages in the Hunter Valley have experienced blue-green algal blooms, the problem being pronounced in the Glenbawn Reservoir where nutrient release has occurred from inundated land following its enlargement. • High nitrate concentrations in groundwater of the Hunter River alluvium.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Water Acidity - pH - Water acidity is expressed as pH which is a measure of the hydrogen ion concentràtion in water, indicating if the water is acidic or alkaline (0 to 14 respectively). pH is partly influenced by the mineral content of water and hence by the geology and soil processes of a catchment. ANZECC Water Quality Guidelines specify individual pH ranges for drinking water, primary contact recreation, agricultural water supplies and aquatic ecosystems.	• Increased acidity of water may arise from the instream production of organic acids from decaying vegetation, runoff from acidic soils, the use of fertilisers or effluent from sewerage treatment works. Acid leachate may also be formed by water percolation through coal mine waste emplacements. • Agriculture contributes large amounts of acid to intensively used land. On fertile agricultural soils, land use generates more acid than is deposited from the atmosphere while on infertile non-agricultural soils, acid deposition may exceed acid generation from land use. Atmospheric contributions of acid to the soils are potentially limited to adding to the stresses caused by the acid accumulated from agricultural and other land uses.	• The effects of extremes in pH depends on the buffering capacity of organisms or aquatic environments. • The acceptable pH range for drinking water is primarily based on minimising corrosion and encrustation, with consideration of the effectiveness of chlorine disinfection which is impaired above pH 8. • Ideally, pH for swimming purposes should approximate the lacrimal fluid of the eye (about 7.4), however these have a high buffering capacity when contacted with solutions of different pH. • Very acidic water causes solubilisation of aluminium, manganese or heavy metals in concentrations large enough to be toxic to plants. Very alkaline water may contain high concentrations of certain ions which may affect growth and soil conditions. Water pH may affect the vigour of freshwater aquatic biota. Also pH changes can affect the toxicity of several pollutants such as ammonia and cyanide.	• Agricultural acidification is greatest on prime agricultural land and lowest in grazing areas with low soil fertility. Deposition rates are generally low but some soils are prone to rapid acidification. Under present conditions, the likely amount of acid accumulated from land use and deposited from the atmosphere is least in undisturbed natural systems and most in intensive agricultural systems. • The Hunter River and its major tributaries are alkaline in nature, having a large buffering capacity to absorb changes in pH, and therefore generally insensitive to acid inputs.
Toxicity - may be defined as the ability of a chemical to cause poisoning to a living organism when administered in an appropriate form and in adequate quantities. ANZECC Water Quality Guidelines specify levels for health-related toxicants in raw water for drinking under categories of biological parameters and toxic chemicals. It also specifies levels for the protection of aquatic ecosystems, recreational water, agricultural water use and the food and beverage industry.	• Chemical contamination of waterways include the use of chemicals for various agricultural practices, which can enter waterways through over spraying, aerial application, ground spraying and surface run-off. Their use and application indicate a potential for cumulative impact through interactive and compounding pathways. • The disposal of industrial waste waters and leachate from waste disposal sites associated with industry, coal mining and power generation in the Region.	• Environmental effects from agricultural chemicals in particular relate to their persistence in soils, potential for food chain bioaccumulation, groundwater contamination, and eutrophication of waterways, including toxic algal blooms. The main concern relates to the accumulation of toxic chemicals in the food chain and the effects of low levels of toxicity on human health, plant and animal species. Land uses sensitive to any increase in levels of toxicity in water are water users. • Valued ecosystems are also sensitive to change in toxicity.	• Little information on the extent and distribution of chemical contamination of the Upper Hunter waterways has been found although it is known to be an issue. Adoption of best management practices for agricultural activities and industrial waste disposal, and the strict regulation of contaminated sites will minimise the potential for environmental changes to toxicity levels.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Turbidity - is a measure of water clarity and an indicator of sedimentation and erosion. It is related to the amount of fine particulates suspended in the water column. ANZECC's Water Quality Guidelines for drinking water specify a limit of 5 nephelometric turbidity units (NTU) based on aesthetic considerations and less than 1 NTU at time of disinfection. Other values are provided for primary contact recreation and aquatic ecosystems.	• Sensitive to changes in sediment inputs. Cumulative effects in suspension are short term being associated with high rainfall and floods, but sedimentation effects downstream are generally of longer term duration. • Can originate naturally from flood plain soils and sediments along lowland watercourses. • Land clearing, forestry, open-cut coal mining earth movements, extraction cropping and grazing which involve changes in soil regimes may be accompanied by soil erosion leading to increased turbidity.	• Turbidity can result in a reduction of light availability, inhibit plant growth, cover benthic organisms and aquatic habitats and affect fish habitats. • Declining water quality for primary contact and stock consumption. • May also affect the condition of mechanical and industrial processes.	• Generally, turbidity levels in the Hunter River are low, with no significant change in the last five years although there are periodic peaks associated with high flows. • Conversely, in the recent drought, low river gradients in the Aberdeen area resulted in high turbidity in the Hunter River as a result of dispersible soils being washed into the river from minor rainfall events without adequate flushing capabilities. • Implementation of adequate soil erosion and sedimentation controls will minimise the potential for impacts from turbidity.
Water Table Movement - refer to the level of groundwater, that is, the upper surface of a zone of saturation. The surface is uneven and highly variable according to the weather. The lowest level to which it naturally falls is called the permanent water table.	• Movements are associated with rainfall, irrigation, vegetation and plant growth, and land clearing including forestry and open-cut coal mining. • Evaporation is a minor influence. • Plants continuously remove water from the soil by transpiration so that when trees and vegetation are removed, the water table often rises. • Poor irrigation practices where more water is applied than can be used by a crop. Here, excess water percolates to the water table, causing ground water levels to rise. Domestic, industrial and mining ground and surface water consumption may counter rising levels if sufficient volumes are removed.	• When permanent water table rises, salts occurring naturally in soil and rock are dissolved and brought towards the surface soil layer. Evaporation of saline groundwater in the surface layer cause the formation of salt crystals leading to dryland salinity. Where salts make contact with the vegetation root zone plant growth is endangered or retarded thereby encouraging erosion. • As the water table reaches the ground surface, waterlogging may become permanent and saline seepage can occur. Groundwater resources can be contaminated from nutrients, toxic material and the like and may have the potential to affect the suitability of groundwater for domestic & agricultural users.	• Saline seepage has been evident between Muswellbrook and Cessnock for some time. The Hunter Valley Salinity Strategy Task Group estimates that at least 1,000 ha of land are grossly affected by dryland salinity and more than 10,000 ha are at risk. • The level of dryland salinity reflects the gradual rising of the water table in the Upper Hunter.

APPENDIX B - 3. CATCHMENT CONDITIONS INDICATORS

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Land Stability - refers to the protection against mass movement which is the downward movement of rock and soil under the influence of gravity.	• Dependent on susceptibility to natural degradation processes such as soil erosion, geomorphological and geological activity, and water drainage. These can result in mass movements involving earth flows, landslips, subsidence etc. Mass movements can be continual and/or episodic and can occur on steeply sloping ground or on low angled slopes. They are associated with increasing soil water levels and a reduction in soil strength. • Mass movements exacerbated or created by human activities include indirect causes such as deforestation, land clearing and site development or more direct activities such as extraction and mining. The potential for subsidence as a result of underground coal mining is the most managed land stability issue.	• The effects of mass movements can be substantial and expensive (sometimes not possible) to repair so that the best policy is to prevent or limit development on land that is potentially unstable. This occurs with residential development in areas of mine subsidence as they are susceptible to surface disturbances if mining and extraction management practices are faulty. • Land uses relying on the productivity of soils, such as agriculture and forestry, or access to resources, such as sand extraction, are also affected by mass movements through the loss of productive capacity. Together with coal mining, these land uses can also be affected by restrictions to operations to maintain land stability in risk prone areas.	• Land stability problems and mass movement potential in the Upper Hunter are considered most significant in the Liverpool and Mount Royal Ranges, and in areas subject to subsidence from underground coal mines and in parts of the Hunter River flood plain subject to extraction operations. Its potential for cumulative impact are not considered significant except possibly in the higher areas above the Valley floor and in parts of the Hunter River flood plain. • Ground surface subsidence from underground coal mining is subject to strict regulatory controls.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Soil Contamination - indicates the presence of hazardous substances in the soil.	• Gasworks, chemical works, power plants, service stations, timber treatment plants and stock tick dips. • Toxicity of chemicals used for agricultural practices to replace nutrients and control pests and diseases. Certain pesticides have been withdrawn from use in agricultural production except endosulfan which does not have the same residual properties. • Salt and mineral toxicities may occur due to natural processes, eg manganese toxicity in soils developed on certain Permian age marine beds in the Hunter Valley. Agricultural land use practices can contribute to the accumulation of elements which are toxic to plant growth. • Disposal of industrial wastes, particularly leaching from industrial waste disposal sites associated with coal mining, industrial and electricity generation activities. • Other sources include airports, engine works, explosives industry, extractive industries, oil storage, railway yards, scrap yards, tanning & associated trades.	• Environmental concerns about agricultural chemicals relate to their persistence in soils, potential for food chain bioaccumulation, groundwater contamination and eutrophication of waterways. • Toxicants in the food chain can affect plant, animal and human health while leaching from contaminated soils may increase water toxicity. Accordingly, agricultural activities can be affected directly through loss of productivity or indirectly if toxicants are found in produce. • Poor management of chemical use can put people, stock and conservation of valued ecosystems at risk.	• Little data is available at State level on the use of pesticides, herbicides, insecticides and fertilisers and their impact on the environment. Monitoring mainly consists of the National Residue Survey for meat and cereal products and NSW surveys monitoring pesticide residues in fruit and vegetables. The EPA is continuing to collect data on potential contaminated sites in the Hunter Region for incorporation into a Contaminated Sites Register. • Decreased use of fertilisers, pesticides and herbicides can occur through improved sustainable agricultural management practices for which initiatives are being developed at State and local government levels. Adoption of best management practices for agricultural activities and industrial waste disposal, and the regulation of contaminated sites will reduce the potential for environmental damage arising from soil contamination.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Soil Salinisation - refers to an increase in the concentrations of soluble salts in soils and a distinction is usually made between dryland and irrigation salinity.	• Dryland salinity is the build up of salt in surface soil on nonirrigated land from rising watertables & subsequent groundwater seepage called a saline seep. • Rising watertables cause naturally occurring salts (mainly sodium chloride) in the soil and rock to dissolve and brought towards the surface. Salt content becomes concentrated by evaporation. The occurrence of dryland salinity is determined by geology, climate, soil type, farming practices and vegetation cover. Farming practices at fault are those which waste soil water through clearance of native vegetation, growing annual crops and pastures, overgrazing, sowing late and long fallow. • Clearing of native vegetation and potentially hard rock extraction, forestry, coal mining, urban and infrastructure development. Land uses which involve rehabilitation or regrowth can result in positive effects depending on use of deep rooted native vegetation. • Irrigation salinity arises from similar causes but also include seepage from drains and channels as well as poor irrigation practices such as over-watering and irrigating unsuitable soils.	• An increase in salt near the surface of soils damages vegetation and promotes the growth of more salt resistant vegetation. This can result in decreased agricultural productivity and soil erosion. Increased salinity levels in dams and streams is common and irrigation tailwaters and surface runoff also add to elevated water salinity levels.	• The Hunter Valley Salinity Strategy Task Group estimates at least 1000 ha of land in the Valley are grossly affected by dryland salinity and more than 10 000 ha are at risk. Areas affected by dryland salinity are increasing. DLWC is currently conducting a salinity mapping program and carrying out a groundwater reconnaissance program to determine the likelihood and extent of dryland salinity.
Soil Structure Decline - Soil structure is important for optimal water infiltration and aeration, and to allow good seedling emergence and maximum root growth. It declines chiefly through compaction and/or shearing.	• Cropping practices involving tillage machinery pulverises soil aggregates and compacts the soils. With poor practices, a dense layer known as the plough pan forms at the base of the cultivation layer. Tillage may also reduce the level of organic matter which is essential for good soil structure and fertility. • Trampling by stock. • The intensive use of heavy machinery which may occur in operations such as intensive agriculture, movement of stock, coal mining rehabilitation, forestry operations and land clearing	• Structural decline can reduce agricultural productivity as well as increase susceptibility to erosion. It may lead to reduced aeration, increased mechanical resistance to root growth, reduced infiltration, increased likelihood of root disease and possibly accelerated loss of organic matter. All these naturally effect the productivity of non-intensive agricultural activities.	• The extent and cost impacts of this form of land degradation has been ranked as the nation's most serious land degradation problem. • Programs and activities are being undertaken on land management practices to maintain and improve soil structure. These include encouraging pasture rotations and alternative farming techniques which minimises tillage and other mechanical disturbance of the soil through the use of herbicides to control weeds.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Soil Acidification Soils can be naturally acidic. Soil acidity is also a natural consequence of plant growth and cropping processes.	• Agriculture contributes large amounts of acid to intensively used land by the excessive use of nitrogen fertilisers for crop production, the use of legume dominant pastures, the nitrification of soil organic compounds and the removal of alkaline and waste products. • Soils containing pyrite are reactive and their exposure to air leads to increased acidity release. May occur during extraction, mining, infrastructure, flood mitigation and urban development earth works. Acids may also leach from coal mining & power generation wastes but have only localised effects on soil acidification. • Atmospheric contributions of acid to soils are potentially limited to adding to the stresses caused by the acid accumulated from agricultural uses.	• Reduced pasture and crop growth resulting in decreased ground cover and an increased susceptibility to soil erosion. Recommended treatments include liming, use of acid-tolerant plant species and changes in farm management practices. Effects on plants and microflora/fauna through soil acidification are more likely to be indirect than direct.	• Basalt-derived soils of the Upper Hunter River and the basalt alluvia along some major creeks and the river are highly resistant to acidification. The soils most susceptible are those with light textured surface layers, especially those derived from sandstones. • Agricultural acidification is greatest on prime agricultural land, which is chiefly used for irrigated pastures, viticulture and lucerne production, and is lowest in extensive grazing areas with low fertility. Implementation of best management practices for agricultural activities will minimise the potential for environmental change from acidity. • Generally, soil acidification is not considered a problem in the Upper Hunter.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Erosion - refers to the process by which rock particles and soil are detached and transported from their original site. Water is the instigator of sheet, rill, tunnel and stream bank erosion while another form is wind erosion.	• Australian soils are generally shallow. The removal of soil may result from raindrop splash &/or water runoff (sheet erosion). The action of run-off gathered into small streams may lead to rill erosion and when small rill streams unite to create stronger flows, gully erosion often results. Bare or sandy soils are also vulnerable to erosion by wind, its degree is determined by wind patterns, dominant soil texture, ground cover density & surface soil moisture. • Natural erosion operates at an extremely slow rate which is greatly accelerated by human activities, especially poor agricultural and land management practices. Once vegetation ground cover has been removed or degraded, the capacity of the ground surface to resist erosion by water or wind is reduced. Stream banks may become degraded from stream bank vegetation clearing and stock access to waterways, resulting in interference with riverbank filtration functions, stability and habitat retention.	• A decline in productivity as nutrients and organic matter become depleted. Removal of fertile topsoil layers, sedimentation of watercourses and supplies, and formation of a pathway for the removal of sediments from adjacent areas. • The loss of fine soil from wind erosion leaves only larger particles. This reduces soil nutrient levels and moisture retention for plant growth. When wind and water erosion removes surface soils, bare unproductive areas can form from the exposed subsoil which is relatively impermeable. These are difficult to regenerate with vegetation and reduce the value of grazing lands. • Agriculture is most sensitive to increased erosion from the loss of productivity. Most sensitive are the fertile alluvial flats and riparian zone along the Hunter River and its tributaries, and areas on higher and more steeply sloping ground where erosion and soil loss may affect the viability of certain agricultural operations. Land uses may also be affected by the destructive nature of gully erosion. These may include infrastructure and earth works associated with extraction, mining and urban development. • Soils moving down into the flood plains and major waterways of the valleys, the latter filling up with sediments, result in siltation causing changes to the waterway systems.	• The most common soil profiles in the Valley are highly erodible when disturbed. The EPA and Singleton Council has identified continuing land degradation problems despite advances in conservation farming techniques, mine rehabilitation and sustainable land use practices. • Extensive sheet, rill and gully erosion is evident on undulating land and widespread in agricultural land and urban areas. Stream bank erosion along the Hunter River and its tributaries is still present. Other susceptible areas to soil erosion are the Merriwa Plateau and the cleared higher slopes of the Hunter Valley. However, there is no evidence of widespread scalds. The adoption of improved soil and crop management practices is being promoted. These practices include appropriate agricultural practices suited to soil erodibility, land clearing techniques, ground cover management, and runoff and soil erosion controls. • Widespread clearing of native vegetation from stream banks and flood plains in the Hunter Valley has resulted in riverbank erosion and changes in river channel morphology.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Biodiversity - refers to the variety of all life forms in the terrestrial, aquatic and marine environments. There are three levels of biodiversity: genetic diversity (total genetic information from species), species diversity (the variety of living organisms) and ecosystem diversity (variety of habitats, biotic communities and ecological processes in the biosphere).	• Habitat loss, modification and fragmentation are considered to pose the greatest threats to biodiversity. Habitat alienation and fragmentation occurring as a result of clearing of native vegetation or from changed hydrologic regimes and the application of the use of herbicides and insecticides. • Habitat modification occurring as a result of grazing, introduced species, diseases, declining water quality, and changes to hydrological and fire regimes, as well as human induced activities such as land clearing, mining, extraction and road construction. • Permanent impacts on freshwater habitats can occur as a result of river management works, dam construction etc as well as cumulative impacts from water pollution, erosion and sedimentation from land use activities. • Land degradation processes, dieback, water regulation and future climate change effects. • Unconstrained access to conservation areas and forestry plantations could permit weed infestation. • Forestry operations unless properly controlled, especially with regard to old growth and wilderness values.	• Habitat modifications or disturbances affect the ability of species to recover and persist. • Gradual loss of species or genes and/or through a domino type effect upsetting the food chain with repercussions on the whole ecosystem. • Loss of useful genes and/or compounding cumulative effects on the food chain. • The amplification of regional and global anthropogenic impacts such as enhanced greenhouse effect and reductions in the ozone layer leading to damaging effects on the range of crop species and other biota on which humans depend.	• The threat of alienation and fragmentation of habitats may be limited to the Upper Hunter sensitive riverine environments and in more remote uncleared higher areas to the west and north above the Valley floor. Singleton Council has identified a lack of data on significant areas of habitat and wildlife corridors outside National Parks and State Forests. • Areas of biological conservation capability and suitability coincide with the western and southern parts of the Upper Hunter region but reflect disturbance effects. • Extensive clearing and/or thinning for and an influx of exotic weed species have disturbed the study area to an extent where most of the vegetation outside the existing reserve system is of little value for conservation. • Forested areas support diverse wildlife populations, but the floodplain and surrounds have little wildlife. The National Parks and Wildlife Service administers a Wildlife Atlas which contains an inventory of flora and vertebrate fauna species in NSW.

APPENDIX B-4. SOCIAL CONDITION INDICATORS

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Noise and Vibration Noise is any kind of perceived sound. The factors affecting the way sound is perceived include sound level and frequency, the period of exposure and changes in fluctuations. This makes measuring noise complex. When a noise is unwelcome it becomes noise pollution of which the community consider is a major factor in reducing quality of life. Vibrations refer to ground movements and overblast pressure immediately following explosions.	• Natural resource extraction operations, particularly 24 hour open cut coal mining - potential for cumulative impact. • Road and rail transport. • Intensive agricultural activities may generate noise from livestock and machinery. • Impacts from vibrations are experienced at receptors from blasting operations associated with quarrying and open cut coal mining.	• Residential areas and rural residences are sensitive to noise from 24 hour open cut mining operations in their vicinity. • EPA's Environmental Noise Control Manual provides planning objectives for residential areas adjacent to industrial areas which may be subject to creeping background levels as the level of industrial activity increases and to acceptable background levels in such situations. For the latter, the Manual recommends the maximum noise level for a specific premises should be at least 10dB below the acceptable level relevant to the site to hold the background level and to prevent creeping. • The productive capacity of certain livestock operations may also be affected which may include the production of eggs from battery hens and milk from dairy cows. • Recreation and tourism are also sensitive to noise in maintaining its attractiveness and suitability for leisure.	• Noise mitigation safeguards depend on a correct interpretation of acceptable background and creeping noise levels in receptor areas. Effective noise control measures must take into account variations in response between individuals to noise, the noise characteristics of the noise source (frequency/loudness/tone), circumstances of noise generation, economic/technical feasibility of noise control and the importance of the activity causing noise. • Increasing ambient noise levels can be anticipated as a result of new extensions of existing major open-cut coal mining activities in Singleton and Muswellbrook. • Existing traffic noise levels on the New England Highway may continue or even increase over a 24 hour day as a result of traffic movements along that road.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Employment and Worth Employment and income is essentially geared to the direct, indirect and induced effects of continuing enhanced regional agricultural, commercial and industrial development, and further advancement of the tourist industry.	• Coal mining for export is considered to be the main potential sources of enhanced future employment and income. Intensive livestock production may also be a new source of growth. Agricultural crop production and dairying will continue to make an important contribution to the Regional economy, but only limited economic growth is anticipated and its employment source may be strained. Regional power generation capacity would appear to be adequate for the foreseeable future and may be expected to continue to provide the present volume of employment opportunities. • The tourist industry has potential to expand however its employment base is small, and its main impact may come from increased public expenditure within the Region. • Increased inter-State through transport may generate increased expenditure in the Region's service industries.Increased inter-State through transport may generate increased expenditure in the Region's service industries.	• Increased employment and worth of Upper Hunter economic activity will create demand for additional commercial, industrial and infrastructure services. Expansion or improvements to infrastructure including road, rail, power, airports and the like may be a consequence of this increased demand if capacity does not exist. Agricultural produce and activities such as recreation and tourism are affected by the local condition of essential requirements and disposable income.	• Coal mining is considered to be the main source of increased employment in the Region, raw coal projections indicate a steady increase to about 2012 before declining after another 25 years. Industry associated with coal mining activities continues to develop in the Singleton and Muswellbrook areas. • Beef cattle grazing and cereal crops have declined in recent years. • Dairy production and vineyard planting have increased. • The Liddell and Bayswater power stations remains important for employment. • Recreation/tourism offers reasonable potential for a limited employment base.
Visual Amenity Scenic quality is an important component of regional environmental management.	• Open cut operations and the establishment of new mines will cause unavoidable visual impact on the surrounding environment. Despite progressive rehabilitation, their exposure as working operations can last many years. Company safeguards and consent conditions aim to mitigate such effects and proposals for rehabilitation in the longer term provide for progressive revegetation as operations proceed. • The size of the Liddell and Bayswater power stations is considerable but it's visual impact is constrained locally except for its stacks and cooling towers. • Extraction, land clearing and degradation, the location and design of rural and urban residential, industrial and infrastructure development in the Region.	• Decreases in visual amenity can affect the liveability of urban and rural environments. It has a direct effect on the attractiveness of areas used for most recreation and tourism purposes. More indirect effects are perceived on the image of industries such as viticulture and horse studs where "pristine" rural environments are part of industry promotion.	• From a broad perspective, the current scenic quality of the Upper Hunter Region is good, its developed areas along the course of the Hunter River and New England Hwy benefiting from views of the high ground framing the sides of the Valley to the north, west and south. The scenery of the Hunter wine growing regions is unique in NSW. • Some local visual amenity is impeded by individual coal mining activities and power stations.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Transport and Traffic Generation - Transport provides efficient means of personal movement and linking goods and services with markets. This efficiency, however, depends on the adequacy of road and rail infrastructure.	• The main potential for increased transport is road traffic along the New England Highway and its connecting arteries. The New England Highway is the national highway link between Sydney and Brisbane with an undoubted potential for increased through traffic. • Most of the transport requirements for the export of coal products are met by the rail network for which spur lines and rail heads have been installed. Coal for the Liddell/Bayswater complex is supplied by a network of conveyors. The probable continuation and expansion of the export coal industry should promote increased industrial activity and employment, and which together with increased through traffic requirements, will have a cumulative impact on the Region's transport infrastructure.	• Increased traffic suggests a need for improvements to the Highway and local roads to accommodate the increase in the number and intensity of vehicle movements. Residential areas and other sensitive land uses, such as schools and hospitals, are directly affected by such traffic and sometimes require acoustical and visual screening. Recreation and tourist operations may also be affected in a similar away or more indirectly through a decrease in accessibility from road congestion.	• A steady gradual increase in 24 hour through traffic along the New England Highway and its associated arteries as well as Regional coal industry generated traffic is anticipated. This suggests needs for road improvements and appropriate safeguards to preserve the amenity of residential development. • Appropriate traffic controls including by-pass facilities. The 1993 Muswellbrook State of the Environment Report refers to the creation of an environmental protection urban buffer zone, one of the objectives of which is to enable the future construction of a railway and highway deviation and to ensure that development does not foreclose such options. • The RTA is planning a number of road improvements to the New England Highway.
Housing and Services Demands - Demands for housing and services is a direct response to increasing population, falling occupancy rates, increasing incomes and employment as well as economic activity.	• Demand for housing is chiefly governed by immigration into the area of new workforce employees, particularly associated with the coal mining industry, and changing demographics. Experience has indicated that demand is softened by employees tending to travel to work from their existing locations inside or outside the Region. Demand for new services and utilities will depend on the adequacy of existing facilities and requirements for replacements and/or new ones. • Demand for new services and utilities also relate to new commercial and industrial development and residential development for the associated workforce. These include anticipated moderate growth in the viticulture and intensive livestock sectors.	• Land uses likely to experience growth include mining, recreation, tourism and urban residential. Meeting growth in demand will require either the upgrading or extension of existing facilities or the installation of new ones depending on location.	• The 1989 Hunter Regional Environmental Plan (REP) states that the population growth of the Region was 1% annually during the 1981-1986 period, compared with the State's annual rate of 1.1%; immigration determining the changes in population in the Muswellbrook and Singleton areas. The coal resource areas in the Upper Hunter had provided 20% of the Region's population increase. From a population of 46200 in 1986, the REP's projections for the Upper Hunter ranged from 51300/55000 in 2001 to 52700/59600 in 2011.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Resource Availability For national and regional economies that depend significantly on the exploitation of natural resources for its wealth, it is important that resource availability is maximised. For the Upper Hunter, the potential sterilisation of resources is therefore a significant issue.	• The potential for future economic exploitation of the Region's natural resources is essentially dependent on their extent, accessibility and location as well as their quality and suitability for future market requirements. Limitations to economic availability may apply to certain deeper coal reserves in the long-term, while suitable sites for surface water resources may be limited. • Agricultural, forestry and extractive resources may be sterilised by poor agricultural practices leading to soil degradation, the conservation of valued ecosystems such as national parks and unsustainable forestry practices. • Resources may also be sterilised by conflicts with incompatible land uses such as residential, recreation and tourism. Dwellings in particular can impede the availability of resources by incremental incursions into noise, odour and other buffers.	• Land uses sensitive to an increase in restrictions to resource availability include agriculture, extraction, coal mining and forestry. Agriculture may be affected through the loss of soil quality while rural and urban dwellings can affect intensive agriculture and extraction by incursions into buffer areas or sterilising effects.	• Major natural resources comprise coal, forestry and water supply. Prime agricultural soils associated with the alluvial flood plains of the Region's waterways are also a major asset to the local economy. Fragmentation of land holdings is a common means of diminishing agricultural activity while the coal industry has highlighted that National Parks have locked up significant reserves.

Indicator	Potential Causes	Potential Effects	Environmental Conditions
Waste Management and Disposal Increased production of waste products, especially for municipal solid waste is a feature of developed regions such as the Upper Hunter. With the increase in intensive animal industries, the requirement for increased effluent disposal has also increased. Wastes are high in BOD, nitrogen, phosphorus, salt content and micro-organisms.	• Waste disposal needs vary according to the land use or activity involved. Intensive animal industries generate significant quantities of effluent waste which in most cases can be used to fertilise paddocks or composted. • Forest harvesting (selective logging) and land clearing vegetation waste may be left on-site (silviculture requirements/decaying biomass/post-logging burning) or be the subject of off-site by-product production (pulpwood/fencing timber/firewood/wood chips). • Power generation wastes comprise furnace and fly ash residue which are pumped in the form of slurries to ash disposal areas in a closed system. Salt residues and chemical wastes are also produced. • Coal mining wastes are associated with coal washery refuse and overburden for disposal on-site through incorporation into rehabilitated land. Disposal of coal washery rejects has been the subject of considerable research resulting in proposals for using fluidised bed combustion of coal rejects for power generation which may be anticipated in the Upper Hunter. This process uses both rejects and tailings, it results in at least a 30% reduction of waste and produces a dry ash which is more readily disposable than the original rejects as well as harnessing the energy potential in the waste. • Domestic solid waste is usually the subject of landfill disposal with appropriate attention for waste minimisation and recycling, and possibly composting. • Sewage treatment generates sludge for land disposal and soil enhancement. • Industry generated hazardous, special and scheduled wastes require special storage, transport, handling and disposal.	• Even with waste minimisation/recycling policies, domestic waste generation can be expected to increase from increasing residential development in rural areas for which existing waste collection/disposal facilities will need upgrading. • In urban areas, existing waste disposal facilities will need to cope with continuing demands from existing housing and additional demands reflecting a gradual increase in population. • Existing industrial waste disposal facilities may need amplification. Safeguards to control water percolation through waste emplacements and the generation and seepage of leachate will need continuing strict control to minimise soil and groundwater contamination. • The ability to undertake waste utilisation for intensive livestock developments will require attention. Their impact may be local and even regional depending on the size, type and management control involved, and method of effluent management adopted.	• Each council in the Hunter Region operates at least one solid waste disposal site. There are over 25 such sites in the Region accepting about 500 000 tonnes of waste annually; most councils aim to reduce waste to landfill by 50% by 2000, and larger councils are currently preparing strategies to achieve that objective. • Varying degrees of recycling are conducted throughout the Region. • Liquid hazardous wastes are collected and treated by a number of approved methods; the disposal of hazardous wastes at municipal waste disposal sites is strongly discouraged. • Urban centres operate secondary/tertiary sewage treatment plants where sewage sludge is used for landscaping and site rehabilitation or disposed of on site. • Singleton Council operates a landfill facility providing separate schemes for urban and rural residents with a 40% recycling rate. Large nearby landfill areas for ash and wastes are provided for power generation facilities, with dry ash disposal proposed at closed open-cut mines. Coarse rejects and tailings from coal mines are disposed of on site to a pre-determined plan. • Muswellbrook Council has adopted a trade waste policy which includes sewage treatment; it has recently built a new waste depot in a mine site void which is expected to meet its needs for the next 30–40 years and which has resulted in the closure of inefficient older sites.

APPENDIX C. CUMULATIVE IMPACT ASSESSMENT GUIDELINES

Summary Tables

The following guidelines are an extract from the *Upper Hunter Cumulative Impact Study Identification Report* Department of Urban Affairs and Planning April 1996.

They are intended to provide a guide for using Cumulative Impact Assessment techniques in planning, policy development and environmental assessment.

The guidelines will require refinement as greater experience with the application of these techniques develops.

The three tables on the following pages summarise the relationships and significance between activities and environmental indicators. They are compiled from the information under potential causes and potential effects for each indicator as well as the discussions on interactions between indicators.

Table C1 summarises the *Changes to the Environment Potentially Caused by Land Uses and Other Influences.* For every activity, environmental indicators which might be effected are shown by a symbol representing the significance of this relationship. The table may also be viewed to determine all the activities which could potentially effect any of the selected indicators, ***and thus alert to possible sources of an environmental deterioration.***

Table C2 summarises the *Sensitivity of Land Uses and Other Receptors to Changes in the Environment.* Activities which might be sensitive to any change in an indicator are shown by a symbol representing the significance of this relationship. The table may also be viewed to determine all the indicators of which an activity might be sensitive to their change, ***and thus alert to possible consequences of environmental changes.***

Table C3 summarises the *Interactions Between Environmental Indicators.* Environmental indicators which might interact with or compound the effect of another are shown by a single symbol in the table. Tracing an indicator from either axis will show the same relationships, *and thus alert to possible* ***synergistic or compounding effects*** *on these environmental qualities.*

These tables represent a very concise overview of the potential relationships between activities and the environment from which cumulative impacts might arise. Their use as an initial guide to assessments necessary to undertake cumulative impact assessments is outlined in the following section.

GUIDE FOR CUMULATIVE IMPACT ASSESSMENT

As a first stage in undertaking an environmental impact assessment (EIA), it is important that all potential impacts and sensitivities in the environment are identified. This is often referred to as 'scoping' and provides the basis to target investigations to ensure that potential impacts are addressed.

It is equally important when performing these investigations to take into account other human or natural activities that could add to or alter the effect of potential impacts. This allows the cumulative potential of a proposal to be properly assessed. A preliminary examination of these factors is often recommended when selecting a site to help avoid unnecessary conflicts.

These tasks are generally made difficult because of the complexity of cumulative impacts and a lack of readily available information about the regional setting of the proposal. It is possible to harness the information in the Identification Report within a process that can initially guide assessments to address cumulative impacts.

This process is shown and explained step by step in Figure 1.

Step 1: Using Summary Table 1, list the range of environmental indicators which have the potential to be changed by the proposal.

Step 2: Using Summary Table 3, note other environmental indicators or factors that may interact with or compound the effect of those identified above.

Step 3: Again from Summary Table 1, list other activities which could also effect the environmental indicators identified in Steps 1 and 2.

Step 4: It is now appropriate to refine the list to those matters relevant to the actual proposal. This requires reference to spatial information regarding environmental conditions and land use patterns.

Examples of what could be removed might include things like water acidity if the receiving waters have a high tolerance (buffer) to acidic inputs or the physical absence of other potentially contributing activities now or in the likely future.

Step 5: Using Summary Table 2, identify activities that would be sensitive to any change in the environmental indicators remaining on the list.

Step 6: With reference to land use patterns, determine which sensitive activities are relevant to the proposal. This may also further refine the list of environmental factors where for example the absence of any sensitive receptor makes the potential impact benign (such as noise or odour in remote locations).

Step 7: In compiling the above lists it is necessary to record various relationships and pathways between the relevant activities and potential cumulative impacts by reference to the report text. This provides a framework or guide to commence assessment as shown in Figure 2.

This process provides a preliminary sketch from which to build a well targeted and focused

FIGURE C1. INITIAL GUIDE TO ASSESS CUMULATIVE IMPACT

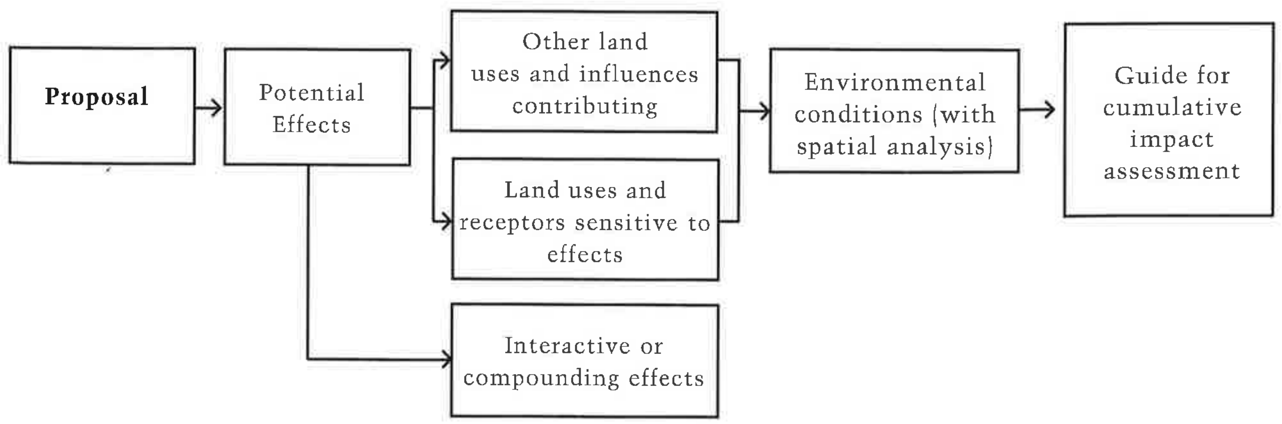


TABLE C1. POTENTIAL CHANGES TO THE ENVIRONMENT

CHANGES TO THE ENVIRONMENT POTENTIALLY CAUSED BY LAND USES AND OTHER INFLUENCES

■ = major I = moderate i = minor

INDICATOR → / LAND USES & OTHER INFLUENCES		Air							Water								Terrestrial							Socio-Economic						
		Particulates	Sulphur Dioxide	Nitrogen Oxides	Fluoride	Greenhouse Gases	Other Vehicle Emissions	Odours	Water Supply	Bacteriological	Nutrients	Water Salinity	Water Acidity	Toxicity	Turbidity	Water Table Movement	Land Stability	Erosion	Soil Structure Decline	Soil Salinisation	Soil Acidification	Soil Contamination	Biodiversity	Noise & Vibration	Visual Amenity	Traffic/Transport Generation	Housing and Services	Waste management	Employment and worth	Resource availability
Agriculture	Crops	I		i			i		I		■	■	I	I	I	I		I	■	■	■	I	I			i			I	
	Horticulture	I		i			i	i	I		■	■	I	I	i	■		i	■	■	■	I				i			I	
	Viticulture	i		i			i	i	I		■	■	I	I	i	■		i	■	■	■	I				i	i		I	
	Grazing	i		i		I	i		I	I	■	■		I	I			I	I	■	■	I	I			i		i	I	
	Horse Studs	i		i		I	i	i	I	I	■	■		I								I				i		i	I	
	Intensive Livestock	i		i		I	i	■	I	■	■	■		I								I		I		I	I	■	I	
Conservation	Valued Ecosystems																													■
Extraction	Sand	i					i				I				I	i	I	I						i	I	i			I	
	Hard Rock	I					i								I	i	I	I		i				I	I	i			I	
Flood Mitigation Works									i		I						I	I			i		I							
Forestry	Native					i	i		i						i	i	i	i	I	I	I		■		I	i		I	I	
	Plantations					i	i		i						I	I	i	i	I	I	I				I	i		I	I	
Geology - Natural Processes						I					I	■	I		I		I	i												
Infrastructure	Roads	i		i		I	I	I												I	i		I	■	I				i	I
	Rail	I																		I	i		I	I	I				i	I
	Airfields																			I	i		I	i	I	i			i	I
	Power Transmission																			I	i		I		I				i	I
	Utilities																			I	i		I		I				i	i
Land Clearing						■					I	■	i		■	■	I	■	I	■			■		I			I		
Meteorological		I	I	i					■			I			I	■	i	I		i	I		■							
Mining	Open Cut Coal	■		i		i	i	i	I			■	i	i	I	I	i	I	I	i	i	i	I	■	■	■	I	■	■	
	Underground Coal	I				i	i		I			■		i		i	■						I			■	I	■	■	
Natural Hazards	Bush Fires	I				i		i									i						I							
	Flooding								■						■	■	i	■		I										
	Drought	■							■							■	i	■					I							
Power Generation		I	■	I	I	■			I			I	I	i							i	i		I	i	i	I	■	■	
Recreation - Tourism							i		i	I																I	i	i	I	I
Rural Residential						i	i		i	■					i	i		i							I	i	i	i		■
Urban	Res. / Com.					i	i	I	I	■		i		i	I	i		I		I	i	I	i		I	I	i	■	I	■
	Industrial	i	i	i	i	i	i	I	I	i		i				i		I		I	i	I	i		I	I	i	■	i	■
Water Resource Management									■		■					I							i						■	i

TABLE C2. SENSITIVITY OF LAND USES TO ENVIRONMENTAL CHANGE

SENSITIVITY OF LAND USES AND OTHER RECEPTORS TO CHANGES IN THE ENVIRONMENT

■ = major I = moderate i = minor

INDICATOR ↓ / LAND USES & OTHER RECEPTORS		Air							Water								Terrestrial							Socio-Economic						
		Particulates	Sulphur Dioxide	Nitrogen Oxides	Fluoride	Greenhouse Gases	Other Vehicle Emissions	Odours	Water Supply	Bacteriological	Nutrients	Water Salinity	Water Acidity	Toxicity	Turbidity	Water Table Movement	Land Stability	Erosion	Soil Structure Decline	Soil Salinisation	Soil Acidification	Soil Contamination	Biodiversity	Noise & Vibration	Visual Amenity	Traffic/Transport Generation	Housing and Services	Waste management	Employment and worth	Resource availability
Agriculture	Crops	i	I	i	I	I	i		■		I	■	I	I	I	■	i	■	■	■	I	I	I					i	i	I
	Horticulture	i	I	i	I	I	i		■		I	■	I	I	I	■	i	■	■	■	I	I	I					i	i	I
	Viticulture	i	I	i	I	I	i	I	■		I	■	I	I	I	■	i	■	■	■	I	I	I		I			i	i	I
	Grazing	i	I	i	I	I	i		■	■	■	■	i	I	I	■	i	■	■	■	I	I	I					i	i	
	Horse Studs	i	I	i	I	I	i		■	■	■	■		I							I	I		■	I			i	i	
	Intensive Livestock		I	i	I	I	i		■	■	■	■		I										■					i	■
Conservation	Valued Ecosystems	i	I	i	I	I			■	■	■	I	I	■		■	I					■	■					I		
Extraction	Sand															I	I	I											I	I
	Hard Rock															I		I											I	I
Flood Mitigation Works									■						i		■	I												
Forestry	Native		i		i	i										I	i					i	■					i	i	I
	Plantations		i		i	i										I	i					i						i	i	I
Geology - Natural Processes											I	■																		
Infrastructure	Roads					i											■	I								■	I		I	
	Rail					i											■	I								■	i		I	
	Airfields					i											■	I											I	
	Power Transmission					i											■	I									I		I	
	Utilities					i											■	I									I		I	
Land Clearing																				■			■							
Meteorological						■																								
Mining	Open Cut Coal					i			I			I				I	I	I												■
	Underground Coal					i			I			I					I													■
Natural Hazards	Bush Fires																													
	Flooding																													
	Drought																													
Power Generation						I			■			I																		
Recreation - Tourism		I	I	i		i	i	I	I	■	■			I	I									I	■	I	I	I	■	
Rural Residential		■	■	■			i	■	■	■	■	I		I	I	I	■					■		■		■	I	I		
Urban	Res. / Com.	■	■	■			I	■	■		■	I		I			■	I				■		■	■	■	I	I	■	
	Industrial								■		I	I			I		■										I	I	■	
Water Resource Management				i		■			■		■	■	I	I	I	■		■												■

TABLE C3. INTERACTIONS WITHIN THE ENVIRONMENT

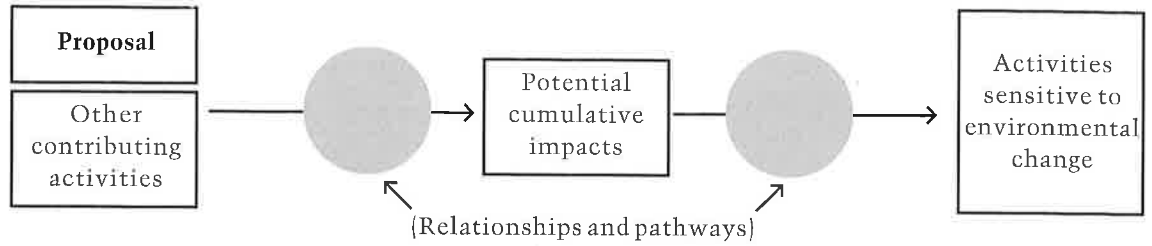
INTERACTIONS BETWEEN ENVIRONMENTAL INDICATORS
—
INTERACTIVE (SYNERGISTIC) & COMPOUNDING EFFECTS

◆ = Potential interaction

INDICATOR ↑ → INDICATOR

		Socio-Economic							Terrestrial							Water								Air						
		Resource availability	Employment and worth	Waste management	Housing and Services	Traffic/Transport Generation	Visual Amenity	Noise & Vibration	Biodiversity	Soil Contamination	Soil Acidification	Soil Salinisation	Soil Structure Decline	Erosion	Land Stability	Water Table Movement	Turbidity	Toxicity	Water Acidity	Water Salinity	Nutrients	Bacteriological	Water Supply	Odours	Other Vehicle Emissions	Greenhouse Gases	Fluoride	Nitrogen Oxides	Sulphur Dioxide	Particulates
Air	Particulates						◆																				◆	◆	◆	
Air	Sulphur Dioxide								◆																		◆	◆		
Air	Nitrogen Oxides																										◆			
Air	Fluoride								◆																					
Air	Greehouse Gases					◆			◆																					
Air	Other Vehicle Emissions					◆																								
Air	Odours			◆																										
Water	Water Supply								◆					◆	◆		◆	◆	◆	◆	◆	◆								
Water	Bacteriological			◆					◆																					
Water	Nutrients			◆										◆																
Water	Water Salinity																													
Water	Water Acidity																	◆												
Water	Toxicity			◆					◆																					
Water	Turbidity													◆																
Water	Water Table Movement											◆		◆	◆															
Terrestrial	Land Stability										◆	◆	◆	◆																
Terrestrial	Erosion								◆	◆	◆	◆	◆																	
Terrestrial	Soil Structure Decline								◆																					
Terrestrial	Soil Salinisation								◆																					
Terrestrial	Soil Acidification								◆																					
Terrestrial	Soil Contamination			◆					◆																					
Terrestrial	Biodiversity																													
Socio-Economic	Noise & Vibration					◆																								
Socio-Economic	Visual Amenity					◆																								
Socio-Economic	Traffic/Transport Generation																													
Socio-Economic	Housing and Services		◆																											
Socio-Economic	Waste management																													
Socio-Economic	Employment and worth	◆																												
Socio-Economic	Resource availability																													

FIGURE C2. GUIDE TO ASSESS CUMULATIVE IMPACT



cumulative impact assessment. It would naturally require greater elaboration for significant proposals or more complex environments. It may also require the assistance of computer applications to manage the amount of information.

EXAMPLE APPLICATION

To demonstrate the application of this process, a proposed new open cut coal mine is examined to establish the framework for assessing its cumulative impacts. This example is limited by necessity because of the generic nature of the proposal and to enable the process to be demonstrated.

Example: Open Cut Coal Mine in the Upper Hunter

As a first step, identify potential impacts which may lead to cumulative effects.

Step 1	Indicators which have the potential to be changed	Significance	Notes on Relevancy
	Particulates	major	Mainly coarse particulates only ($>PM_{10}$) .... etc
	Nitrogen Oxides	minor	
	Greenhouse Gases	minor	
	Other Vehicle Emissions:	minor	
	Odour	minor	
	Water supply	moderate	Potential disruption to surface and sub surface water supply and flow ....
	Water Salinity	major	
	Water Acidity	minor	
	Toxicity	minor	
	Turbidity	moderate	
	Water Table Movement	moderate	
	Land Stability	minor	
	Erosion	moderate	Nature and content of soils highly significant....
	Soil Structure Decline	moderate	
	Soil Salinisation	minor	
	Soil Acidification	minor	
	Soil Contamination	minor	
	Biodiversity	moderate	
	Noise and Vibration	major	
	Visual Amenity		
	Transport and Traffic	major	
	Housing and Services	major	
	Waste Disposal	moderate	
	Employment and Worth	major	
	Others ?	major	

Using only four of the above indicators for convenience (shown in bold) cumulative relationships can then be expanded:

Indicator	Step 2 Relevant Interactions	Step 3 Other Contributors	Step 5 Relevant sensitivities
Particulates	Visual Amenity (SO_x, NO_x, F not relevant)	Agriculture, Extraction, Roads/Rail, Other mines, Land clearing, Bushfires, Drought (Power & industry not relevant — mainly fine particulates)	Recreation/Tourism, Residential (Agriculture only at extremely high levels)
Water Supply	Bacteriological, Nutrients, Water Salinity & Acidity, Toxicity, Turbidity, Land stability, Erosion, Biodiversity	Agriculture, Flood works, Forestry, Flooding/Drought, Power, Meteorological conditions, Recreation, Residential, Industry, Resource Management	Agriculture, Flood works, Other mines, Power, Recreation/Tourism, Residential, Industry, Water Resources
Erosion	Water supply, Nutrients, Turbidity, Water Table Movement, Land Stability, Soil structure decline & salinisation, biodiversity	Agriculture (crops-grazing), Extraction, Flood works Forestry, geological processes, Land clearing, Flood/Drought	Agriculture (crops-grazing), Flood Works, Infrastructure, Urban, Water resources
Visual Amenity	Particulates, Traffic/ Transport	Extraction, Forestry, Infrastructure, Power, Rural and Urban development	Viticulture, Horse studs, Recreation/Tourism, Rural and Urban residential.

Examining only the interactions within the environment relating to water supply listed above, it is now possible to commence building the cumulative impact picture. For example, while any alteration to water supply has direct impacts on other users of surface or sub-surface water, it may have a much wider array of indirect effects:

- Some of these will relate to raising the concentration of stream elements such as conductivity (salinity), bacteriological and phosphorous content by way of having less in-stream water for dilution.
- Conversely, the rapid stream flows at discharge points may mobilise elements built up in the river bed over many years.
- Similarly, erosion may compound some of these effects where, for example, basalt derived soils become mobilised and raise the nutrient loads in the catchment.
- Discharge storage or the fracturing of sub-surface rock may increase the rate of leaching of high saline water to aquifers and surface streams with lower salinity levels.
- Many land uses, such as irrigation, dams and power generation, may act in unison within sub-catchments to alter the flow of stream water. This in turn could push in-stream levels of phosphorous, salinity and the like past thresholds, especially should peaks in water demand correspond with periods of dry conditions.

To begin eliminating, or designing investigations for, aspects such as these, an understanding of the environmental conditions related to the proposal and its location must now be obtained.

It is important not to limit this process to the information contained in this report as many more minor aspects of the proposal may be of significance for the location. However, the

strength of using a process such as the one presented above is the systematic checking of possibilities as well as simply 'thinking cumulatively' when preparing the groundwork to undertake project assessments.

While this example has been cursory, some of the key cumulative impact criteria for coal related developments in the Upper Hunter will usually consists of:

- the interaction of the coal mining proposal with other dust generating activities (including other coal mines, coal loading facilities, extractive industry, agriculture and the like) so as to predict the cumulative effect on air quality in terms of health and amenity;
- the ability of the proposal to discharge saline mine waste waters to the Hunter River system having regard to the River's carrying capacity, restrictions to high flows and the relevance of the Hunter Salinity Trading Scheme;
- the relationship of the proposal with the water catchment processes having regard to interaction of erosion and the interruption of stream flows with the nutrient load and turbidity of river systems;
- the relationship of the proposal with sub surface water movement, in particular ground water aquifers. In particular, the influence of the operation on the rate of leaching of high saline water to aquifers and surface streams with lower salinity levels by way of discharge storage or the fragmentation of sub surface rock;
- the contribution of the proposal to the Upper Hunter road and rail transport network demands;
- the opportunity presented through rehabilitation to contribute to reducing cumulative environmental degradation especially in terms of restoring threatened or endangered species and revegetation to stabilise or lower the water table.

Localised cumulative effects may be expected from noise, vibrations, odours, visual amenity, waste management, biodiversity and traffic generation impacts.

APPENDIX D. SUMMARY OF REPORT PREPARED BY NIGEL HOLMES & ASSOCIATES, *CUMULATIVE IMPACTS DUE TO ATMOSPHERIC EMISSIONS IN THE UPPER HUNTER VALLEY, NSW 1996*

Purpose

This report was prepared by Nigel Holmes & Associates for the Department of Urban Affairs and Planning. Its purpose was to review existing information about air quality in the Hunter Valley to determine the extent that the cumulative effects of emissions from industry (in particular mining) and agriculture are affecting air quality and the extent that cumulative effects will in the near future affect air quality. The pollutants covered include sulphur dioxide (SO_2), nitrogen dioxide (NO_2), fluorides and particulate matter. The main focus was on particulate matter and on emissions from open cut mines, although emission from agriculture and natural sources were not ignored.

Study Area

The study area runs from Cessnock in the south to Scone in the north and from Lochinvar in the east to Denman in the west. The area includes all existing open cut coal mines in the Hunter Valley and those planned for development in the near future. It also includes the Bayswater and Liddell Power Stations and the proposed Redbank Power Plant near Warkworth and the important agricultural areas on the river flats.

Issues

The study follows a recommendation by Commissioner Kevin Cleland after the Bengalla Inquiry that a cumulative impact study be undertaken in the Upper Hunter. The primary focus has for this reason been on dust from open cut mines, but the scope has been extended to include other pollutants that have the potential to contribute to cumulative air quality effects.

Pollutant Sources — Present and Future

At present raw coal production from Hunter Valley open cut coal mines has increased from 23.2 Mtpa in 1985 to 50.0 Mtpa in 1993. Raw coal from underground mines has decreased form 5.5 Mtpa to 3.6 Mtpa over the same period.

Power generating capacity has remained steady in recent years at approximately 4.5 Mwe and annual average aluminium production is currently at approximately 150,000 tpa.

The busiest road in the study area is the New England Highway through Muswellbrook, which in 1994 had an annual average daily traffic flow (AADT) of 16,330 comprised of 2,450 heavy vehicles and 13,880 light duty vehicles.

By the year 2000 raw coal production is expected to increase significantly in the future with open cut production reaching a maximum of 85 Mtpa in 2010 and underground production reaching 26 Mtpa in the same year. Underground production is expected to increase progressively from a 1996 production rate of 6.35 Mtpa to 40 Mtpa by 2020.

Power generating capacity is expected to increase by the introduction of a 100 Mwe power plant near Warkworth.

Traffic flows at Muswellbrook are expected to increase so that by 2016 the AADT on the New England Highway at Muswellbrook will be 20,230, comprised of 4,100 heavy vehicles and 12,230 light vehicles.

Regulation Of Air Pollution And Quality Goals

The relevant goals are those for sulphur dioxide, nitrogen dioxide, fluorides and particulate matter. The report also provides background material as to how air quality goals are determined.

Air quality goals are set to protect various elements of the environment identified as being valuable to the community. Human health is one of the more important considerations, but it is not the only one. Even when protecting human health, regulators make judgements as to what constitutes a significant health effect. Thus a measurable physiological response may not necessarily be considered a significant health impact provided the effect is reversible and vanishes when the cause disappears. In this sense exposure to a change in the environment caused by the presence of a pollutant can be considered the same as the change in air temperature, which might on a hot day cause humans to perspire, or blood flow to change. Thus air quality goals can be expected to change with time and to reflect changing community expectations as well as a result of improved scientific understanding of the effects of pollution.

For sulphur dioxide the World Health Organisation (WHO, 1987 and WHO, 1994) sets a goal of 500 µg/m3 as a 10-minute guideline concentration. This goal is based on the observation that exercising asthmatics show evidence of clinically significant effects beginning at a sulphur dioxide concentration of 1000 µg/m3. There is no certainty that the WHO data includes the most sensitive asthmatics and the uncertainty is dealt with by adopting an uncertainty factor of two and setting the guideline at 500 µg/m3 (10 minute average). Based on a review of similar data, but making different judgements concerning the significance of effects, the Australian National Health and Medical Research Council (NH&MRC) adopts a 10-minute goal of 1400 µg/m3. These goals are effectively under continuous review.

Similar information for nitrogen dioxide notes that the WHO guideline values have been set at 400 and 150 µg/m3 for 1 hour and 24 hour averaging periods respectively.

With fluorides, the primary concern is with the protection of vegetation and grazing animals consuming forage which has accumulated fluorides. The relevant goals are 2.9 µg/m3 for 24-hours, 1.7µg/m3 for 7-days and 0.5 µg/m3 for 90 days.

In regard to particulate matter, in recent years there has been a significant rethinking by the scientific community as to the health significance of particulate matter. Using sophisticated statistical techniques and community health data from very large populations it has been possible to identify increases in mortality associated with the concentration of fine particulate matter in the size range 10 um and 2.5 um. The conclusions of recent studies is that there appears to be no "safe-level" below which no effects are observed. The approach that is now required in assessing the effects of particulate matter is more logically based on an assessment of risk rather than the comparison with a single goal. From the perspective of air quality in the Hunter Valley, where much of the particulate matter is from mining or agriculture, the fine particle concentrations are at the low end of the range. Further WHO 1994) notes that "Limited evidence from studies on dust storms indicates such PM10 particles are much less toxic than those associated with combustion sources". Thus, although the new information has led to the introduction of new air quality goals (the PM10 goals as opposed to the TSP goals) and the goals may be subject to further revision in the future, it is likely that the prime focus on mining dust will be in its capacity to cause nuisance effects rather than health effects. However, this new information on health effects does call for revisions in the way that air quality is monitored in the Hunter Valley. This matter is discussed later.

In relation to the potential for dust to affect plant growth and to affect visibility, it is concluded that the dust levels found in the Hunter Valley due to mining would not be expected to affect vegetation nor to contribute significantly to regional-scale visibility degradation. However, visible plumes of dust from blasting and dust hazes associated with individual mines under certain, commonly occurring conditions are an aesthetic issue in the community.

Review Of Existing Data

Analysis of dust deposition and dust concentration data reveals a clear upward trend in both deposition and concentration. The trend is attributed to the increase in mining and to the fact that the data for the final years of the data set corresponded to an extended period of much lower than average rainfall in the Hunter Valley and over most of eastern Australia.

This review of the data does identify a need to significantly modify the air quality monitoring programs being undertaken in the Hunter Valley to ensure that the data are able to be easily used to identify trends in air quality.

The report then proceeds to give a brief review of the climate and meteorology of the study area.

Emissions Inventories

This report provides estimates of existing and future dust emissions from mining and agriculture and emissions of sulphur dioxide, nitrogen oxides and particulate matter from power stations.

Dust emissions from mining are estimated to increase from 52,000 tonnes in 1996 to a peak of

90,000 tonnes in 2010. Although total coal production is expected to increase marginally in some years after 2010, the increased contribution from less dusty underground mines increases with time and results in a reduction in estimated dust emissions. The estimates do not take into account improved dust control practices that might be developed by open cut mines in the future.

Models
The computer-based dispersion models used to assess the potential for cumulative air quality impacts to arise from dust emissions from coal mines and from power station emissions, are described.

The modelling analysis shows the contribution that existing coal mines make to dust fallout and concentration levels in the study area and the expected levels in the near future (approximately the year 2000). The tables below summarises the results.

TABLE D1. AREA PREDICTED TO BE AFFECTED BY DIFFERENT LEVELS OF DEPOSITION

Year	Area with deposition greater than 10 g/m²/month (annual average)	Area with deposition greater than 4 g/m²/month (annual average)	Total coal production
1996	28.7 km²	68.7 km²	56.6Mt/y
2000	36.0 km²	89.1 km²	81.7Mt/y

TABLE D2. AREA PREDICTED TO BE AFFECTED BY CONCENTRATIONS ABOVE 90 µG/M³

Year	Area with concentration greater than 90 µg/m³ (annual average)	Total coal production
1996	60.8 km²	56.6 Mt/y
2000	82.4 km²	81.7 Mt/y

The tables show that the increase in coal production is approximately 44 percent over this time and the associated increase in the land affected by dust deposition greater than 4 g/m²/month is 30 per cent. Similarly the area estimated to experience dust concentrations, due to mining, of above 90 µg/m³ increases by 36 per cent.

Conclusions
Sulphur Dioxide. Power Station emissions under rare meteorological conditions result in concentrations above the NH&MRC and WHO air quality goals. The areas affected and the very low frequency of these events means that they are of little environmental significance. All long-term SO_2 concentrations are below the relevant goals. The possible addition of the 100 Mwe Redbank Power Plant with 90 percent sulphur removal will not significantly change the position with respect to sulphur dioxide in the Upper Hunter Valley.

Nitrogen dioxide concentrations are within the EPA's goals at all monitoring sites.

Fluoride concentrations in the Upper Hunter are also within the relevant goals for sensitive vegetation. Some areas near Cessnock do experience fluoride concentrations above the goals for sensitive vegetation due to emissions from the aluminium smelter at Kurri Kurri. No additional growth in fluoride emissions is expected in the foreseeable future.

Particulate matter emissions from present mining operations are estimated to be of the order of 52,000 tpa and are estimated to rise to 72,000 tpa by the year 2000. Agricultural activities are estimated to contribute approximately 23,000 tpa. This figure is not expected to change in the near future.

The expansion of coal mining in areas to the west and to the north of Muswellbrook will lead to increased dust levels in the area. Model predictions indicate that air quality at Muswellbrook due to emissions from mining will be similar to those in Singleton by the year 2000.

Recommendations
Australia is a major coal exporter and the Hunter Valley is one of the significant coal producing areas in the country. There is a significant capacity within the industry collectively to undertake world-leading applied research into the management of air quality and other environmental matters. Some of this work is

already in progress, but progress could be accelerated by a more coordinated approach to both routine monitoring and research.

The major recommendations are:

1. Establish, either as part of the EPA, or as a separate organisation with supervisory responsibilities, a body to be responsible for the design and operation of a coordinated Upper Hunter air quality and meteorological monitoring network.

2. Redesign the existing dust monitoring network, placing less emphasis on dust deposition gauges and more emphasis on the monitoring of TSP, PM10 and PM2.5. It is suggested that monitors be placed at least at Ravensworth, Warkworth and Singleton as well as at Muswellbrook. Probably an additional ten to twenty sites will be required to comprehensively monitor the entire Upper Hunter region.

3. Operate concentration measuring monitors on a continuous basis, or at the very least on a coordinated basis so that data can be used in a diagnostic fashion to identify if high readings are due to local sources of are regional in extent. At least some of these sites should provide data on a continuous basis.

4. Initiate research programs to develop interim exposed area stabilisation methods to minimise wind erosion from exposed areas during dry wind conditions.

5. Initiate research programs to minimise the risk of dust from blasting passing over settled areas or residences.

6. Research the use of continuous mine boundary dust surveillance systems to provide mine managers with realtime information as to dust emissions leaving mine areas.

7. Initiate research studies to develop short-term air quality criteria which can be used to "objectively" assess the significance of short-term impacts.

8. Review mine performance with respect to unrehabilitated lands to ensure that unrehabilitated areas are in fact minimised.

9. Review the buffer zones required for mining taking place close to major public roads.

Additional Comments
The consultant provides some additional comments on current EIS processes and highlights some difficulties that are currently being experienced. Discussions with community groups in the course of undertaking the study has identified dissatisfaction with some of the outcomes of the scientific assessment approach used in EISs. This dissatisfaction is summarised by the statement "that EISs lack credibility". The basis of the scientific assessments used in this study and in EISs for individual mines is simple. The approach relies primarily on comparing dust deposition and or concentration levels with air quality goals designed to protect against effects on human health and nuisance. This is a common approach used in environmental assessment. When it comes to dust emissions from open cut mines, there is always a point close to the dust generating activities, where the goals are exceeded. The approach normally followed is to determine, taking account the operational details of the mine and the local dispersion conditions, the boundary between where the goals are exceeded and where they are met.

The area enclosed by the boundary is defined as the area affected by mining dust and private land owners within this zone are usually compensated or have their properties purchased. If improved dust controls allow the boundary to be contracted the EIS identifies a smaller area affected by dust emissions. This leads to the community perception that EISs design up to the environmental limits. This is a logical approach and it is difficult to see an alternative. However, a clearer explanation as to the logic of the process may be helpful. It should also be explained that the approach is not incompatible with the application of best management practice for the control of dust.

Another factor that is possibly leading to dissatisfaction is that while air quality goals may protect against health effects and work to protect almost everybody in the community, the goals set for protecting against subjective effects, such as nuisance effects, are often set at a level where 90 per cent of the population will consider air quality to be acceptable. This still leaves 10 per cent who consider that air quality is unacceptable. It is interesting to compare the EPAs 4 g/m²/month (annual average) goal with public survey data in US cities (US EPA, 1969 — Chapter 7). At an annual average dust deposition level of 10 tons/square mile (3.8 g/m²/month)"... at least 10 per cent of the affected population expressed concern about a nuisance situation". Thus compliance with the goal does not guarantee that every individual will be satisfied. Fortunately most communities exposed to dust around coal mines experience levels significantly below the goal and consequently the numbers are smaller than this.

Another factor that is likely to be important in the formulation of the community view is that the air quality goals are assessed at residences. There are many publicly accessible places where the goals are not met. Examples of such areas are along major roads where dust producing mining activities take place at times within a few hundred metres of the road. These areas are not defined as requiring protection and air quality goals are clearly not met in these areas. This possibly leads to a mismatch between the conclusions of a scientifically conducted assessment and the communities perception that dust is at unacceptable levels.

Another factor of some significance is the fact that for some members of the community a visible cloud of dust as would be seen following a blast is an unacceptable impact. This is true even if the cloud does not cause any measurable change in dust concentration at the observer's location. If the dust cloud passes over the observer then the impacts are considered quite serious and may lead to complaints even though the measured change in air quality might be quite small and no violations of air quality goals will actually occur.

The above factors may go some way to explaining some of the community's concern about air quality even though a project may meet all air quality goals.

There are some strategies that can be followed that could help improve the communities perceptions. These are listed below.

- Require that areas on, or close to public roads meet air quality goals with respect to dust deposition and concentration.
- Initiate research programs to develop blasting guidelines that will assist mining companies to reduce the probability that blasting dust passes directly over a residence and incorporate these blasting procedures into conditions of consent.
- Initiate research programs that will develop short-term air quality goals that can be used in the assessment of short-term impacts due to episodic impacts.
- Initiate research into objective methods of providing mine managers with real-time objective measures of dust crossing outside the identified "zones of affectation" so that mine shut-down procedures can be initiated before community complaints occur.
- Intensify research into the control of spontaneous combustion.
- Develop best practice standards as to the maximum exposed areas permitted before rehabilitation must occur and undertake research on the possibility of interim spoil pile stabilisation methods to provide temporary stabilisation of exposed surfaces in critical areas if these must be left unrehabilitated.

APPENDIX E. EXECUTIVE SUMMARY: UPPER HUNTER CUMULATIVE IMPACT STUDY—WATER CATCHMENT ANALYSIS, UMWELT (AUSTRALIA) PTY LTD, AUGUST 1996

EXECUTIVE SUMMARY

As part of the Upper Hunter Cumulative Impact Study prepared by the Department of Urban Affairs and Planning, an analysis of catchment attributes, land use and water quality has been undertaken. This information has been used as a basis for reviewing water quality cumulative impacts that exist or potentially may exist within the area.

This study, which is titled Water Catchment Analysis, principally considers that area of the Upper Hunter catchment that is within the boundaries of the Singleton, Scone, Muswellbrook, Merriwa and Murrurundi Local Government Areas (LGAs).

Objectives for the Water Catchment Analysis component of the Upper Hunter Cumulative Impact Study were to:

- Provide an indication of existing surface and groundwater quality and terrestrial catchment conditions,
- Establish any trends in those conditions,
- Assess the acceptability of current catchment conditions in terms of ANZECC Guidelines and relevant groundwater criteria,
- Assess the risks to and sensitivity of sub-catchments from further land use impacts,
- Provide a context and geographical basis to more accurately trigger and guide the assessment of potential impacts from development proposals,
- Examine the potential, feasibility and means by which catchment management tools may be used to improve land use decisions,
- Examine the suitability of current monitoring processes,
- Identify any significant additional restrictions on further development or management practices that may be required to sustain the maintenance of water quality goals.

To achieve these objectives and attempt to understand the interactions between land use and water quality in the Upper Hunter, available water quality, land use information and an overview of the physical attributes and characteristics of the Upper Hunter was compiled.

Physical attributes of the catchment described include:

- Topography
- Geology
- Soils
- Erosion
- Vegetation Cover
- Climate.

In many instances, only limited historical information is available in regard to these physical attributes with information frequently only being available from one-off surveys. Climatic fluctuations (i.e. wet years and dry years and prolonged wet and dry periods) were seen as one of the key components that had the potential to affect water quality. As such, it was considered necessary to take climatic influences into consideration in assessing cumulative impacts.

Land use and changes in land use also have the potential to significantly affect water quality. To this end, a profile of land use change in the Upper Hunter has been compiled in order to correlate previous land use and water quality trends and to highlight potential land use changes which may have important water quality considerations. Comparison with previous land use mapping is constrained by variation in mapping units, boundaries and categories used.

Historical land use data has been collected mainly on a Local Government Area or regional basis with little, if any, consideration of catchment boundaries. Analysis of this general data highlights land use trends for broad areas and provides a basis from which to begin focusing upon land use changes within particular subcatchments.

The most recent comprehensive land use mapping for the Upper Hunter was undertaken by the Department of Land and Water Conservation in 1995 for the Department of Urban Affairs and

Planning. Land use categories described in this study include the following:

- Urban
- Agriculture
- Vineyards
- Horticulture
- Coal Mining
- Quarrying
- Industrial
- Forestry
- Recreation and Conservation
- Public Utilities
- Power Generation
- Water Supply
- Sewage Treatment Plants and Waste Disposal Areas
- Other Land Uses.

Urban and rural residential areas are estimated to occupy 0.2% of the Upper Hunter catchment, with the majority of urban areas occurring in close proximity to major watercourses. Population trends are outlined in this study. Highest populations occur within the Singleton and Muswellbrook areas and these areas have experienced the most consistent and rapid population growth in the period from 1947 to 1991. Sustained population growth is projected for these areas.

General agricultural trends were obtained from ABS data for the period from 1968 to 1993. There has been a gradual decline in the total area of agricultural establishments in the Upper Hunter during the record period. Murrurundi, Merriwa and Scone Local Government Areas have the highest proportion of agricultural land. Trends in particular agricultural enterprises are described, including cropping; sheep, beef cattle, dairy cattle, and horse grazing; intensive animal husbandry, and fertiliser usage.

The history of the wine industry in the Hunter Region is described and trends in the area of vineyards are outlined. The location of major vineyards is described and the relatively high proportion of vineyards in Muswellbrook and Singleton Local Government Areas is noted.

Coal mining is estimated to occupy 0.8% of the Upper Hunter. Historical coal production figures are analysed and the location of coal mines is analysed. Increasing coal production higher in the catchment is noted and the likely future reliance on underground mining is highlighted.

Quarrying occupies less than 0.1% of the Upper Hunter and there are limited details compiled regarding the location and nature of these operations. Industrial areas also occupy less than 0.1% of the Upper Hunter and the largest areas are mainly associated with mining service industries in Singleton and Muswellbrook.

Public utilities include power stations, waste disposal depots, sewerage treatment works and water storage areas, and these occupy less than 0.1% of the Upper Hunter. Available details regarding these land use categories are described.

To enable water quality information to be reviewed in the context of climatic variations (i.e. drought periods or prolonged wet periods) it was considered that it would be necessary to review water quality information that spanned a ten to twenty year period. On review it was found that water quality information was available from a range of government and community bodies, however only the information held by the Department of Land and Water Conservation and the Environment Protection Authority was of sufficient duration and spatial coverage to allow potential cumulative impacts to be explored. To complement the water quality information, catchment characteristics were compiled from a wide range of previous studies. Trends in land use were compiled using a wide range of data sources including Australian Bureau of Statistics, Agricultural Statistics, Council reports and Hunter Valley Research Foundation reports.

In looking at water quality, information from a range of sources (i.e. Department of Land and Water Conservation, Environment Protection Authority and Councils) was reviewed with up to 18 water quality indicators being analysed for approximately 40 surface water sites and 43 groundwater sites throughout the Upper Hunter. Data analysed extended back to the early 1970s and covered a range of areas with differing catchment attributes and land use characteristics.

The principal surface water quality information used for this study was drawn from the Department of Land and Water Conservations

HYDSYS database which stores water quality data from the 1970s to the early 1990s for a wide range of locations within the Upper Hunter. Analysis of the available HYDSYS water information indicates that over the twenty year period for which data is available significant variations have occurred in water quality and that these variations appear to be principally driven by fluctuations in climatic conditions. Over this same period significant increases in power generation, population, intensive animal husbandry (i.e. pigs), areas of mining and (since 1989) area of vineyards have occurred while decreases have occurred in numbers of dairy cattle, numbers of sheep, area and number of agricultural establishments. These trends in land use are not apparent in the HYDSYS water quality data with the only observable relationships being between climatic conditions (i.e. streamflow) and water quality parameters. Limited groundwater quality information is also available from the Department of Land and Water Conservation with the majority of the data being derived from short term studies of specific areas within the Upper Hunter.

Despite the above observed changes in land use, after climatic fluctuations are taken into consideration there are no apparent long term trends in surface or ground water quality in the Upper Hunter. This could be partly due to the relatively small areas subject to land use changes (i.e. mining and urban populations occupy only approximately 0.8% and 0.2% of the Upper Hunter respectively). The absence of detectable changes in water quality could also be a result of the relative scarcity of the detailed water quality data that is required to allow minor long term changes in water quality to be detected in an environment that exhibits extreme variability in response to natural climatic fluctuations.

By way of example, concentrations of nearly all water quality parameters recorded may vary by several orders of magnitude in response to natural climatic fluctuations. However, in assessing cumulative impacts, a long term increase of only a few percent (i.e. considerably less than an order of magnitude) may be significant. As an example, in some sections of the Upper Hunter concentrations of salt in the water course may fluctuate between say 400–600 microsiemens per centimetre in prolonged wet periods to 4000–10000 microsiemens per centimetre in prolonged dry periods. In the longer term however, an overall increase of say 100 microsiemens per centimetre may have significant implications in terms of water quality and our ability to effectively dispose of saline waters from mines and power stations, or irrigate pastures and vineyards etc.

Water quality and interrelated climatic information that has been collected to date is not adequate to allow a thorough assessment of cumulative impacts to be completed. Consequently, it was found that following a detailed review of all available information, it was not currently possible to fulfill all of the specified objectives for the study.

In terms of assessing cumulative impacts in regard to water quality in the Upper Hunter, the existing water quality information held by the Department of Land and Water Conservation and Environment Protection Authority (EPA) has many shortfalls including:

- The length of record and frequency of sampling for monitoring sites throughout the Upper Hunter varies considerably with many parameters only being sampled a few times during the 20 year analysis period in some instances, whereas in other cases monthly and even weekly sampling has been undertaken. Apart from streamflow information, water quality data has rarely been collected on a regular basis. As such it is difficult to develop an understanding of the parameters that drive water quality or of the interactions that may exist between land use and water quality.

- The accuracy of some of the available information is doubtful which makes it extremely difficult to determine the significance of high or uncharacteristic values that appear in the data set.

- The EPA data has no climatic context (ie. daily streamflow) or land use context (i.e. mine development, effluent discharge levels etc.) within which to assess the available water quality data. This is a result of the fact that the data has been collected to verify compliance with EPA licence conditions and is not suitable for assessing if long term changes in water quality are occurring. In the majority of instances, although available water quality data for a development may span 10 years or more, sampling has not been undertaken for any length of time at a particular monitoring site. As a result, generally only short term water quality information is available.

- Groundwater information is limited to either water samples collected at the time the respective groundwater bores were constructed or information collected from site-specific short term sampling programs. As a result only very short term groundwater information is available for any specific site. In addition, information is available only for a small proportion of the Upper Hunter's groundwater resource.

- To adequately assess available water quality information in the context of streamflow conditions it is necessary to have an understanding of the context of the flow event within which the data was collected. In the HYDSYS data base analysed, only average daily flow information was available to provide climatic context for the water quality information and no indication was given as to when, in relation to a flood or streamflow event, that data was collected.

- In terms of long term trends in water quality, analysis of annual averages of recorded water quality information as undertaken for this study is not suitable to determine whether short term fluctuations in water quality are becoming more extreme or not. It is considered that the current database of water quality information is not adequate to determine if changes are occurring beyond those that would be experienced as a result of natural climatic fluctuations.

Much of the data reviewed for this study was collected prior to 1992 and it is understood, following discussions with Department of Land and Water Conservation representatives and the Environment Protection Authority, that current monitoring programs are addressing many of these inadequacies.

For a better understanding of cumulative impacts to be acquired, land use composition and changes, climatic conditions, river channel conditions, river flow and water quality parameters need to be recorded in a compatible manner that allows the data recorded to be considered in the context of prevailing climatic conditions, land use and activities. Significant changes in water quality for periods of several years have been recorded during periods of extreme climatic conditions however when consider in the context of longer term records it appears that the observed changes can be attributed to natural fluctuations with no net long term change in water quality.

To address these issues associated with the inadequacy of available data, there is a real need for a coordinated and consistent approach to all aspects of monitoring associated with water quality. There is an even greater need to ensure that the data collected is accurate and is recorded accurately. Considerable financial and human resources have been and are being expended on collecting water quality information through:

- Department of Land and Water Conservation monitoring programs (i.e. Key Sites monitoring, ongoing monitoring at gauging station sites and special program monitoring such as the Bacterial Water Quality Program, Blue Green Algae Monitoring Programs etc).

- Compliance monitoring for Environment Protection Authority Pollution Control Licences (i.e. from coal mines, power stations, wastewater treatment plants, intensive animal husbandry (piggeries), etc).

- Community based monitoring programs such as Streamwatch, monitoring undertaken by Total Catchment Management groups etc.

- Council, NSW Agriculture and Hunter Catchment Management Trust monitoring programs.

Coordination of monitoring would require the development of a monitoring protocol for the Upper Hunter that ensured that a consistent set of parameters was monitored and that data was being recorded in consistent measurement units on a regular and consistent basis. This may require the establishment of long term monitoring sites as part of major developments (i.e. coal mines, power stations, urban areas, areas of intensive animal husbandry etc) to complement the Department of Land and Water Conservation's Key Sites monitoring program. For the data to be properly

assessed in the prevailing climatic context it may also be necessary to establish streamflow monitoring stations at each of these long term monitoring sites. The lack of streamflow information (or some correlation with prevailing climatic conditions) to complement data collected by mines etc. in accordance with Pollution Control Licence requirements makes it extremely difficult to determine if long term changes in water quality are occurring. This coupled with considerable inconsistencies in the methods of recording and reporting data and the lack of sites for which continuous monitoring data is available for more than one or two years, makes the wealth of information that has been historically collected by the Environment Protection Authority of little value in assessing cumulative impacts.

Another significant issue that needs to be addressed in terms of future monitoring requirements is the extreme variability in water quality that occurs during the passage of a flood event and the impact that this has on the 'representative' value for the water quality parameter that is recorded. For example, generally there is an inverse relationship between conductivity (ie. salt concentrations) and streamflow as streamflow increases conductivity decreases. However, after dry periods, the first runoff reaching the river system has high salt loads and so for the initial stages of a flood event conductivity increases as streamflow increases. As a result, if water samples were consistently collected during the 'rising' stages of a flood event, analysis would show that there is a direct relationship between streamflow and conductivity which is not the case when the full flood event is considered. This also poses problems in comparing water quality at different sites when the hydrologic context within which the samples were collected is not known. Similar fluctuations exist in other water quality parameters.

The other outstanding issue in assessing cumulative impact is determining what water quality would have been under prevailing climatic conditions in the absence of human induced modifications (i.e. agriculture, urban and residential development, mining) and establishing what are acceptable limits or the long term sustainable 'carrying capacity' of the river system. It is apparent from the available water quality data and the recorded fluctuations in climatic conditions that the sustainable 'carrying capacity' of the river system varies widely.

The approach adopted for this study was to establish a framework that allowed the concept of a sustainable 'carrying capacity' to be explored. Considerable effort has been expended in investigating the links and interactions between water quality and processes that drive water quality (ie. climate, geology, land use etc.). However, the completeness, accuracy, consistency and length of record of available water quality information have not been adequate to develop this concept to any great extent.

Current monitoring programs such as the Key Sites Program and monitoring undertaken for the Hunter Salinity Trading Scheme are collecting significantly better quality data than was collected over the past two decades. These data sets are however, not of sufficient duration to allow natural climatic fluctuations to be taken into consideration. Due to the considerable variability in water quality that is observed in response to climatic fluctuation, it is considered that at least another 10 years of data would be required before these data sets would be of sufficient duration to allow long term trends and cumulative impacts to be assessed. In the shorter term, it may be possible to further our understanding of water quality in the Upper Hunter through reviewing the more recent data from the Key Sites Program and the Hunter Salinity Trading Scheme in the context of water quality fluctuations observed in the Department of Land and Water Conservation's HYDSYS data base.

As this would require detailed analysis of the HYDSYS and current data sets, it would be possible at the same time to further explore water quality of individual sub-catchments within the Upper Hunter to provide a more thorough understanding of water quality and land use interactions. This work would require a considerable amount of data checking (to explore if recorded data is accurate) and data synthesis (to bridge shortfalls in water quality data and climatic context information). Once developed, this information could form the basis of a water quality/land use interaction model for the Upper Hunter and is considered a necessary precursor to the development of any predictive water quality model (i.e. Catchment Management Support System or Integrated Quantity–Quality Model) for the area.

In the interim, from the analysis undertaken to date it is apparent that bacterial contamination of the main reach of the Hunter system exists, resulting in water from the Hunter not being suitable for domestic consumption and not being suitable for primary recreation for most of the time. In addition, elevated nitrate levels exist in groundwater particularly in the floodplain around Singleton, Denman and Muswellbrook. Other water quality characteristics may also exceed acceptable levels, however, it has not been possible to define the extent or nature of these using existing water quality data.

A detailed analysis based on the HYDSYS data base, of the level of compliance of water quality parameters in the Upper Hunter with accepted assessment criteria, would be misleading for the following reasons:

a) The water quality analysis undertaken as part of this study concentrated on determining whether any long term trends were evident in the various water quality parameters analysed, and if trends were evident, whether these could be explained by cumulative impacts of changing land use and water management practices. As such, long term data sets were analysed to enable changes in land use and climatic fluctuations to be taken into consideration. Analysis was undertaken using average annual concentrations in an attempt to determine whether there were observable increases in the 'Total Load' of each water quality parameter analysed that was being transported by the system. Extreme fluctuations in water quality parameter concentrations or the percentage of time that water quality parameters exceeded a predetermined acceptable level were not specifically analysed as part of this study.

b) The data set used for this study exhibited extreme variability in frequency of record, length of record and quality of data and as such, any conclusions in regard to levels of acceptability of water quality for various sections of the system are likely to be misleading.

c) Sufficient data is not available to truly quantify in absolute terms the level of compliance of water within the Upper Hunter system with acceptable levels.

d) Considerable variability occurs even within sampling periods due to marked temporal differences between pollutant concentrations and flow hydrographs (i.e. some pollutants are delivered to the Upper Hunter system in concentrated load at the commencement of surface runoff, others are released more slowly over time and others (e.g. salinity) have the potential to decrease as river discharge increases).

e) Sampling requirements for some water quality criteria (ie. suitability for swimming) require samples to be taken every six days or at other set time frames to allow comparisons with ANZECC guidelines to be made.

While a better understanding of water quality in the Upper Hunter is being attained it will be necessary to employ a range of Best Management Practices to ensure that water quality does not deteriorate as a result of land use activities in the area.

In terms of salinity levels, adoption and refinement of the current salinity management strategy for mines, coupled with increased knowledge of the extent of existing and potential dryland salinity areas and rehabilitation of these areas, will make a significant contribution to minimising salt loads on the Hunter system and minimising the impact of high salt loads. Further identification of salt prone areas and increased awareness of land clearing and mining activities will be needed to support the advances made in salt management.

Bacterial pollution is an apparent problem that could be worsened with increased human populations (both rural and urban) and with an increasing trend in intensive animal husbandry. To achieve long term acceptability of water, particularly for recreational use, it will be necessary to ensure that effluent disposal systems, utilised as part of all land use activities, are set up and maintained to ensure that direct and indirect discharge of effluent to the Hunter

system is avoided or minimised. This could be achieved through the adoption of best management practices such as:

- Properly designed land disposal systems for effluent from on-site treatment works, sewage treatment works and sites of intensive animal husbandry such as dairies, piggeries and feedlots.
- Promoting controlled stock access to streams and drainage lines and developing off stream shade and watering points to minimise the potential for effluent to be deposited into the drainage system.
- Establishing surface runoff controls on farms to minimise the potential for manure from grazing areas to be transported to the drainage system.

In terms of minimising nutrients reaching the water system, a range of management practices could be adopted to minimise nutrient generation potential. These could include:

- Establishment of riparian buffer zones
- Adoption of Best Management Practices in terms of fertiliser usage and application
- Control and minimisation of streambank erosion.

In regard to nitrate levels in groundwater, Earnshaw (1995) considered that effluent from dairy farms, vineyards and market gardens has the highest influence on nitrate levels in groundwater. On this basis, some locations, particularly on the alluvial flood plain where groundwater vulnerability is high, may not be suitable for aspects of these land use types, particularly the disposal of effluent. To reduce nitrate levels in groundwater in the future, it may be necessary for site attributes such as groundwater vulnerability and existing nitrate concentrations to be taken into consideration in determining suitable sites, disposal options and land management practices, for land uses with high potential to influence groundwater nitrate levels.

Water availability in both regulated and unregulated streams will also need to be considered to ensure that an adequate supply is available to meet environmental flow needs and to convey pollutants such as nutrients through the drainage system. As such, in the future it may become increasingly necessary to site land use activities that require a reliable water supply on regulated sections of the river system where there is currently an excess in water availability.

In summary, the following points are made:

- Analysis of available data indicates that when climatic fluctuations are taken into consideration there are no discernible long term trends in water quality, with water quality tending to be worse in dry conditions except for turbidity and faecal coliform levels, which can be unsatisfactory in both wet and dry conditions.
- Generally, water quality is within acceptable levels with the exception of:
  - Bacterial contamination which frequently exceeds acceptable levels for secondary recreation and is consistently above acceptable levels for raw drinking water for much of the system;
  - Nitrate levels in groundwater which have been regularly recorded above acceptable levels of 10 mg/L for a significant number of sites within the catchment.
- The study found that existing water quality data is poor and draws attention to the need for a focussed and integrated water monitoring system, if long term cumulative impacts are to be monitored.
- Due to the paucity of water quality data, it is at present difficult to define well established links between land use and water quality or to determine whether long term trends or cumulative impacts are occurring.

General requirements regarding future management of water quality and future needs have been identified to assist in future planning for the Upper Hunter.

APPENDIX F. ABBREVIATIONS

CRES	The Centre for Resource and Environmental Studies
DLWC	Department of Land and Water Conservation
DUAP	Department of Urban Affairs and Planning
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
EP&A ACT	*Environmental Planning and Assessment Act 1979*
HCMT	Hunter Catchment Management Trust
IQQM	Integrated Quantity and Quality Model
LEP	Local Environmental Plan
LGA	Local Government Area
NH&MRC	National Health and Medical Research Council of Australia
NOx	Nitrogen Oxides
NO_2	Nitrogen Dioxide
REP	Regional Environmental Plan
SEPP	State Environmental Planning Policy
SO_2	Sulphur Dioxide
TCM	Total Catchment Management
TSP	Total Suspended Particulates
VOCs	Volatile Organic Compounds
WHO	World Health Organisation

APPENDIX G. EXECUTIVE SUMMARY: ECONOMIC ASSESSMENT REPORT PREPARED BY THE HUNTER VALLEY RESEARCH FOUNDATION

SOCIAL PROFILE

Population

- According to the last census in 1991 the population of the Upper Hunter was 47,816 persons, representing 9% of the Hunter Region's population.

- Of the 5 Local Government Areas, the population of Singleton and Muswellbrook contained more than 70% of the Upper Hunter population in 1991.

- The 1994 Estimated Resident Population figures suggest that the Upper Hunter has grown at a rate of 2.2% p.a. since the 1991 Census. This compares with a figure of 2.4% p.a. for the Hunter and 1.8% p.a. for the State.

- In comparison with the State, there was a higher proportion of people under the age of 20 in the Upper Hunter at the time of the 1991 Census and a lower proportion of people above the age of 50.

Income

The 1991 Census indicated that income levels in the Upper Hunter tended to be above Hunter and State averages. The proportion of people with incomes over $30,000 was higher in the Upper Hunter: 19.6% of Upper Hunter residents recorded incomes of $30,000 or above compared with 14.5% and 16.4% respectively in the Hunter and NSW populations.

Education

The proportion of persons with degrees in the Upper Hunter (4.0%) was almost half that recorded in the State (7.9%) while the percentage of the population above 15 with trade qualifications (skilled vocational) was slightly higher (12.2% in the Upper Hunter compared with 10.6% in NSW).

Home Ownership

The 1991 Census indicated that home ownership in the Upper Hunter was proportionally lower than in the total Hunter Region and in NSW.

THE LABOUR FORCE

Employment

- Total employment in the Upper Hunter grew by 5.7% from 20,174 in 1986 to 21,329 in 1991. This rate of growth was below the levels recorded in NSW and the Hunter where employment grew by 8.4% and 10.4% respectively.

- The labour force consists of all employed persons plus those who are unemployed and seeking work. While employment in the Upper Hunter grew by 5.7%, the labour force grew by 6.5% indicating an increase in the number of people out of work.

Unemployment

The Upper Hunter had the lowest unemployment rate for every age group in 1991 in comparison with both the State and the Hunter. This may be as a result of people leaving the Upper Hunter when they are unable to obtain work.

Employment by Industry Sector

The largest employment sectors in the Upper Hunter are: Mining, Agriculture, forestry and fishing and Wholesale and retail trade. The Upper Hunter employed proportionally more people in the Mining; Agriculture, forestry and fishing; Public administration and defence; and Electricity, gas and water sectors compared with NSW in 1991.

Employment by Occupation

The major occupation groups in the Upper Hunter are: Labour and related workers; Tradepersons; Plant and machine operators and drivers; and Managers and administrators. There is a higher proportion of people employed in all of these occupations in the Upper Hunter when compared to the State.

State Analysis

- If employment generation were the sole objective of regional development policies, shift share analysis implies that resources should be allocated to the following sectors.

  Finance, property, and business services
  Wholesale and retail trade
  Community services
  Recreation.

- The location quotient analysis indicates that the Upper Hunter exports goods and services from: Agriculture, forestry and fishing; Mining, Utilities; and Public administration and defence. The Upper Hunter is a net importer of goods and services from all other sectors examined, in particular: Communication; Finance, property and business services; and Manufacturing.

- The highest population employment ratios for the Upper Hunter were associated with Communication; Transport and storage; Construction; Recreation, personal and other services; and Finance, property and business services. The population–employment ratios support the results from the location quotient analysis in highlighting sectors that could be potential business opportunities for the Upper Hunter.

PRIMARY INDUSTRY

Coal Mining

- The coal industry is the most significant contributor to the Upper Hunter economy in terms of employment and income generation and, consequently, flow-on economic effects.

- At the June quarter 1995 current investment (i.e. projects that are under way) totalled $4.3 billion for the Hunter Region: over one fifth of this total was invested in the mining sector. Most investment in the coal mining sector is generated within the Upper Hunter.

- During 1993–94, the Singleton–North West District exported more than 32 million tonnes of coal to overseas markets. The estimated value of these exports during that year was approximately $1.7 billion, representing 56% of total NSW coal export earnings.

- Employment in the coal mining industry accounted for the largest percentage (15%) of the Upper Hunter workforce in 1991. For NSW the proportion of people employed in mining was only 1% while for the Hunter Region as a whole the corresponding level was 5%.

Agriculture

- Employment in the agricultural sector of the Upper Hunter declined by almost 4.5% between the census periods of 1986 and 1991 from 3,122 to 2,985 persons.

- The major agricultural commodities produced by the Upper Hunter were beef cattle, milk and wool. Other products that contributed significantly included pigs; lucerne and pasture grown for hay; wheat; sorghum; and grapes.

- The recently announced funding of $3.185 million for the Upper Hunter Valley Equine Centre at Scone will establish the area as a world leader in horse research, breeding, training, racing and education.

SECONDARY INDUSTRY

Manufacturing

- The HVRF database lists 61 manufacturers that are located in the Upper Hunter.

- Of all manufacturers surveyed, the highest number of enterprises (11) indicated that their main product was industrial machinery. Typically, this industrial machinery was related to coal mining or power generation.

- Most products produced in the Upper Hunter are sold within the Hunter Region. Most of the input materials also come from the Hunter Region. This suggests scope for expansion of the Upper Hunter manufacturing industry, particularly the potential for finished products to be exported outside the Hunter Region.

TERTIARY INDUSTRY

Building

With respect to the value of building approvals, the residential sector has been a stronger performer than the non residential/commercial sector in both the Upper Hunter and the Hunter Region as well as in NSW during the period under study.

Retail

- At that time, there were 428 retail shopfronts in the Upper Hunter employing a total of 2,607 persons (on a full-time and part-time basis) which represented approximately 12% of the Upper Hunter workforce.

- Over 40% of retail shopfronts in the Upper Hunter were classified as Personal and Household Good outlets in the 1991–1992 Retail Census: this category includes department stores; furniture; housweware and appliance retailing; and recreational good retailing. A further 28.5% of shopfronts were classified as Food stores, i.e. supermarket and grocery stores or specialised food retailing outlets.

Tourism

- In 1993–94, Tourism NSW estimated that the Upper Hunter attracted approximately 315,000 visitors who spent around $56 million in the area. The represents a decline on the levels recorded for the 1992–93 period: the number of visits decreased by 3.7% whilst tourist expenditure fell by 8.2%. During the same period tourism in the Hunter Region as a whole also declined, albeit to a lesser extent, whilst the number of visitors and the level of tourist expenditure in the State rose slightly.

- The major tourism attractions in the Upper Hunter revolve around the natural features of the area and the industrial base including mining power generation farming and the vineyards. The horse industry and its associated events are also major draw cards for tourists.

- The Upper Hunter Tourism Strategy has identified a major opportunity as the new tourism market interested in history, the environment, adventure and education.

Power Generation

The Upper Hunter power stations generate approximately 40% of the State's total power. The contribution of the Upper Hunter to the total Hunter in terms of power generation has grown from 47% in 1990 to 54% in 1994.

Defence

The Singleton Military Area contains the HQ infantry Centre, School of Infantry, BASC Hunter Valley, 23 Military Police Platoon, Singleton Dental Unit, Land Welfare Centre (NSW Detatchment), Army Community Service Organisation, and Singleton Detachment 134 Signals Squadron.

APPENDIX H. ANALYSIS OF ISSUES RAISED IN PUBLIC SUBMISSIONS

BACKGROUND

The Department of Urban Affairs and Planning has endeavoured to involve all stakeholders as much as possible in preparing this study and strategy. Opportunities for community input have been provided throughout the process of preparing the study, and views expressed by the community have formed an important consideration in framing the strategy.

The *Upper Hunter Cumulative Impact Study — Overview Report, 1996* was released for public discussion and input from 12 September to 2 December, 1996. Advertisements were placed in local and regional papers offering copies of the study and encouraging people to comment and respond to the discussion paper. The release of the overview report was also the feature article of the October issue of the Departments' newsletter. Twenty two submissions were received.

Submissions came from a range of individuals, community groups, organisations such as business, industry and environment, and, all levels of government.

Views expressed in the submissions varied widely. Opposing views on some issues were evident. Many issues and problems raised were general environmental concerns, or of a localised nature and not necessarily regional cumulative impact issues.

The study aims to assist the overall understanding of cumulative environmental impacts associated with major land uses within the Upper Hunter. It is striving to assess current cumulative impacts in the Upper Hunter and the need for continual inclusion of cumulative impact consideration as part of the environmental assessment and planning process. It is not attempting to cover all environmental impacts and issues in the region, only cumulative impacts.

Cumulative impact assessment is defined as 'The assessment of the impact on the environment which results from the incremental impact of an action when added to another past, present or reasonably foreseeable actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.' (US NEPA Regulations). The definition of cumulative impact adopted for this study is: 'All the individual disturbances in the environment created by natural and human activities which have the potential to act in unison to create cumulative impacts, which in some cases may be greater than the sum of their individual impacts. These individual impacts can be additive in space or time, or they may interact together.'

It is not proposed to list all the submissions here, but to address the main concerns raised. This section summarises key themes arising from the submissions. The next section provides a summary list of the issues raised in submissions and a response to those issues.

SUPPORT FOR THE STUDY

A number of key aspects of the study attracted widespread support. Many respondents expressed support for undertaking such a study and ensuring cumulative impacts are being assessed and managed better.

Participants welcomed the opportunity to be involved in developing the study. Some thought the report would enable an improved system of environmental monitoring, of both existing and future levels as a result of further development in the Upper Hunter.

- "The importance of the study cannot be underestimated, it has a wider application to the management of such matters elsewhere in NSW." (Community Consultative Committee Member).
- "This study has the potential to lead to more informed decision making and better strategic planning." (Community Consultative member)
- "Council has appreciated the initiatives.....and hopes the end result will be to provide a useful tool in the development assessment process." (Local Government Consultative Committee member)
- "Good to see the government and community working in partnership as this is fundamental to integrated resource management and land use planning." (Community Consultative Committee Member)

- "Adoption of the recommendations should assist in better awareness and long term planning to ensure potential problems with uncontrolled development and their cumulative impacts on our valley do not occur." (Community member)

Others indicated that the study is a good tool to form consistent planning and development guidelines and processes in the Upper Hunter. Overall, most submissions were supportive of the initiative, recommendations and findings.

WHAT MAKES THE REGION IMPORTANT?

A number of submissions indicated that there are many perceived virtues that make various areas of the region special places to live and work. Of course, the Upper Hunter region is vitally important to the state and national economies in terms of coal and electricity production, however, other employment generating industries such as the variety of food, cattle, dairy and wine produced are greatly valued too. The equine industry and tourism potential of the region also contribute to the regions importance in state and local terms.

The Upper Hunter reflects a very strong sense of regional identity within the community. The unique scenery of the wine growing regions, and the common view of the Upper Hunter as developed areas along the course of the Hunter River with attractive rural views framing the valley are characteristic of the region. Many people emphasised the value of natural features of the region, as well as the prime agricultural land, particularly the alluvial flats. Residents highlight the region as a pleasant rural valley to live in.

The importance of natural resources, including large coal reserves and prime agricultural land with good soil quality, diversity of crop potential, favourable slope, drainage, available irrigation and developed viticulture and horticultural areas were also thought significant.

CONCERNS AND SUGGESTIONS

There was a widespread view that the study should not be based on the premise that development growth is either inevitable or desirable. Many respondents felt that ecologically sustainable development (ESD) should govern the rate of change and growth. In addition some felt that limits to growth for the Upper Hunter should be defined.

MONITORING

The issue of the need for a *regional monitoring* system was commonly raised in submissions. People felt that monitoring should not be confined to emitters, but should be extended to the whole region. Action 10 nominates the EPA and DLWC to ensure a coordinated and consistent approach to routine monitoring and research associated with noise, air and water quality. The development of this approach should result in a comprehensive regional monitoring system. In addition, Action 15 advocates the reviewing of the dust monitoring network by the EPA, indicating that the location of monitoring sites in the Upper Hunter region should be examined.

It will be important to clearly *establish objectives* before changing monitoring practices. Uniform procedures for dust fallout monitoring have now been adopted for all mines, meaning that data is comparable, also an integrated monitoring system of river flow and salinity have been established.

The monitoring of *odour and airborne viruses* is another issue that was raised in submissions. This is the responsibility of the Hunter Area Public Health Unit and the issue should be raised with them, as odour is not a regional issue except where it relates to spontaneous combustion.

Asthma and its relation to pollution was raised. Australia, in common with those countries with higher living standards, may well have the highest incidence of asthma in the world, however, the causes of asthma do not appear to be related to mining activity, or indeed to industrial pollution, except in some extreme cases.

It has been suggested that if current monitoring is inadequate how can it be concluded that a variety of land uses have co-existed without any depictable cumulative environmental impacts of significance. The response to this is that the assessment of cumulative impacts is limited by the existing monitoring network which is generally targeted towards monitoring the impact of individual sites on specific parameters rather than assessing cumulative impact. However, available data does suggest that at this stage there are no cumulative impacts which warrant additional regulatory intervention.

Monitoring can be undertaken in a more coordinated and more efficient way, to ensure that cumulative impacts could be more accurately assessed and this is a key recommendation of the study.

AMENITY

Many community submissions highlighted impacts on amenity caused by episodic dust events and noise. Spontaneous combustion and the associated impact of odour was raised as an issue of concern by residents.

Episodic dust events can arise because of the operation of short term and abnormal climatic and other conditions. They are usually unexpected and not easily predicted. Sources include open cut coal mines and agricultural land. Action 17 requires DMR, with local councils, the mining industry and DUAP, to develop blasting guidelines to assist mining companies to reduce the probability of blasting dust passing directly over residences. These guidelines will be incorporated into conditions of development consent for future mines. Due to the importance of this issue to the community it has high priority, i.e. it is an immediate action. In addition to the above, Action 25 will cause best practice guidelines for stabilisation and rehabilitation of areas exposed by mining to be developed, as an ongoing process. Action 12, through the EPA and local councils, will identify ways of resolving community concerns about nuisance dust. Action 13 will develop criteria for changing mining operations during conditions such as high winds to minimise local dust impacts.

The issue of what level of exposure from *episodic dust impacts* constitutes a nuisance needs to be investigated and is the subject of a current research program undertaken under the support of Australian Coal Association Research Program.

Noise is any kind of perceived sound and is difficult to quantify. The submissions indicate that night noise is of most concern, although traffic noise was also mentioned. Noise will be addressed through a focused examination of the cumulative environmental impacts of new coal mining proposals in the Muswellbrook/Scone area. (Action 2). This is currently under way. Noise will be monitored and researched in a coordinated consistent approach as a result of Action 10. This will be undertaken by EPA and DLWC.

Spontaneous combustion was repeatedly raised as a community concern. This will receive a higher priority and research will be accelerated in response to submissions. The study now includes more information on the topic, and, in response to submissions, the preparation of a code for eliminating spontaneous combustion (by DMR in consultation with the mining industry, local councils and the Department) has been targeted as an immediate action, as this is an issue of concern to the community. (Action 18 in Strategic Action Plan). The mining industry and DMR have worked out guidelines to prevent spontaneous combustion. They have been working with the CSIRO on this. DMR advise that extensive research has been carried out in recent years on open cut spontaneous combustion. This has involved research on the 4 or 5 open cuts in the valley with the greatest problem. Results have been published.

AIR QUALITY

Issues raised include episodic dust events, calls for a plain English air quality report to be produced and the Greenhouse effect.

Episodic dust events have been dealt with under the *amenity* section and *plain English* is discussed below.

Other people raised the *Greenhouse effect*. Greenhouse issues are not considered in the context of the regional cumulative impact study because greenhouse emissions are a global issue which will need to be dealt with on a global scale. A significant level of greenhouse gases is emitted in the Upper Hunter from power generation but its contribution to global warming cannot be considered without reference to a complex global equation. The effect of greenhouse gases from the power stations is not directly related to potential global warming effects in the region. This has been clarified in the report, see section 5.1.8 Air Quality.

WATER QUALITY AND QUANTITY

Some submissions raised the issues of salinity; leaching of nitrates into groundwater; concerns about over allocation and security of water supply; confusion about the Hunter River Salinity Trading Scheme; lack of up to date data on water quality; the impacts of mining on alluvial water tables and suggestions on how to best collate and evaluate water quality data.

The water quality study undertaken as part of this study confirmed that *salinity* is a significant issue within the Upper Hunter. The principle causes of salinity are the high natural salt content of the geology, soil and groundwater in the region and, increasingly, dryland salinity impacts associated with past clearing in the catchment.

Action 14 will research salinity in relation to diffuse sources; dryland salinity; groundwater; the riverine environment and land use practices. This is a short term action.

The Hunter Salinity Trading Scheme (HRSTS) has substantially reduced the salinity impacts of mining, and other activities, on the Hunter River. The aim of the scheme is to reduce salinity levels in the Hunter and improve the quality of irrigation water particularly during periods of low flow. Licences of coal mine operations in the Hunter Valley prohibit all discharges during periods of low flow (which occurs 90% of the time). During high flow conditions, the daily total of salt which may be discharged is capped to sustain a level suitable for all agricultural uses. The HRSTS will continue to manage point sources of salinity as indicated by Action 23.

Activities which could cause the *leaching of nitrates* into groundwater will be subject to site selection criteria as part of Action 20.

Water quality aspects of *new mines* will be thoroughly examined through Action 2, i.e. the Muswellbrook Cumulative Impact Study. In addition cumulative impacts will be considered in water allocation plans (Actions 7, 21 and 26) and the groundwater vulnerability maps prepared by DLWC will be used in planning and development control, (Action 8).

Water quality *monitoring* will be reviewed in developing a coordinated, consistent approach to environmental monitoring for the Upper Hunter, which will identify long term trends. (Action 10). The Window on Water map, produced by DLWC (in Appendix I and Section 5.2 — Water Quality) provides a concise, up to date evaluation of water quality within the Hunter Region.

LAND USE

Concerns were expressed regarding mining in sensitive areas such as the alluvial flats of the Hunter River. People felt that increasing land use conflict is evident, particularly concerning open cut coal mining and rural residential development. Rehabilitation of coal mines and the implications for native vegetation, particularly native grasslands were also raised.

Land use conflict is almost inevitable as people have different reactions to different types of change. The Regional Planning Strategy outlined in Action 1 will, among other things, facilitate an effective link between total catchment management and the environmental planning system. The strategy will also incorporate the remnant vegetation work being conducted by the Hunter Catchment Management Trust.

Coal mining has generally avoided the *alluvial flats* of the Hunter River, however, in 1993 consent was grated for a small open cut extension of Hunter Valley No. 1 mine to take coal from the floodplain. This was a special case and involved poor gravelly soils, very detailed hydrologic studies and rehabilitation plans. It was assessed on its merits and does not constitute a precedent for mining of alluvial soils. Muswellbrook Council has sought to prohibit mining in the 7L(1) Alluvial Areas zone. However the zone boundary does not correspond with the alluvial area. Council has agreed to revise its zone boundary and the Department of Mineral Resources has agreed to determine the coal resource, if any, in this revised area.

Prohibition of mining is not generally supported as it would be a departure from the practice of merits based assessment of major resource proposals which have the ability to significantly benefit the wider community.

PLAIN ENGLISH

Some submissions raised the need for the reports to be written in plain English. Although satisfying plain English requirements would involve a significant re-write, the Department acknowledges the need and will ensure that

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future reporting will be in less technical language. This has already been taken into account and some improvements should be found in the final reports.

DIRECTOR-GENERAL'S EIS REQUIREMENTS
Some of the Agency and Independent submissions raised questions about how the environmental triggers would be incorporated into EIS requirements as indicated by Action 3, and suggested that this could be onerous on developers.

The Upper Hunter is an area of national economic significance undergoing considerable change and with a large number of significant new resource development projects anticipated over the next 20 years. The sustainable co-existence of various activities and land uses is increasingly being questioned by the community. These legitimate concerns need to be addressed by the Government in a credible and transparent manner. A sound approach by the Government will improve decision making and give greater certainty for economic development outcomes in the interest of the broader community. The need to ensure that cumulative impact considerations are, where relevant, addressed in environmental assessment and decision making for individual projects is supported by the Government.

There is no intention to impose unusual, onerous or regionally unique requirements on proponents preparing environmental impact statements for proposed development in the Upper Hunter. The cumulative impact triggers may be seen as an aid in decision making by consent and public authorities, not as a new set of requirements or duties for proponents.

Action 3 should enable better decisions to be made regarding development proposals subject to environmental impact statement (EIS) requirements. This can be achieved by a more effective scoping of matters to be addressed, so that the EIS is more focused on relevant considerations.

RESPONDING TO SUBMISSIONS
The strategy has been prepared in the light of community views as expressed through all stages of the process, including those summarised above. Wherever possible, this document either responds to key issues or provides a framework within which major issues can be dealt with on an ongoing basis. Community input will continue throughout the implementation stage through the maintenance of the Community Consultative Committee. Many concerns raised related to detailed issues that cannot be resolved by a policy document such as this. Nor is it possible to resolve all conflicts between opposing viewpoints, or to respond fully to every issue raised Many issues concern localised environmental impacts and other issues of a non cumulative nature. Although many of the points raised have validity, it is beyond the scope of this study to deal with them all. The Upper Hunter Cumulative Impact Study is concerned with current and future potential cumulative impacts, i.e. those impacts which can combine in space and time or those which, when added together, cause an impact greater than the sum of the individual impacts.

The following table summarises all the submissions made to the overview report and in some cases provides a response to the issue raised. The submissions are grouped into community, independent organisations and local and state government categories.

TABLE H1. SUMMARY OF SUBMISSIONS TO THE UHCIS OVERVIEW REPORT

COMMUNITY MEMBERS	
Combined issues raised in five submissions received from residents	**Response**
Natural vegetation should be preserved and reinstated, esp. native grasslands. It is important to save Australia's biodiversity. A lack of data on biodiversity should not be a reason to ignore all areas, other than national parks and state forests, as significant areas of habitat and wildlife.	The Remnant Vegetation Survey will address biodiversity, see section 2.1.5
Tourism needs to be linked with the carrying capacity of the Upper Hunter.	Outside the scope of cumulative impact
Coal mining should not dominate and external costs of mining should be acknowledged, (including industry subsidies).	
Monitoring of odour levels and air borne viruses in and around intensive animal industries should be established. These industries should also be monitored for nitrates leaching into groundwater.	
Immediate moratorium and blanket ban on mining in sensitive areas—alluvial river flats; on the banks and tributaries of the Hunter river; in proximity of high quality water bearing strata.	See above section on alluvial mining.
Other forms of sewage treatment should be investigated e.g. dry conservancy systems, also solid waste is a problem, esp. Scone tip	See section 2.3.7
Land use conflicts—existing and historic usage should be a prime consideration, agriculture should be highest priority, opportunities for hemp and corn production should be investigated to provide stability and diversity. Bioregionalism should also be explored.	See Appendix H on land use. Agenda 21 is a Local Government responsibility
The equine industry should be monitored.	
Power generation could be decentralised. An Agenda 21 plan should be produced for the Upper Hunter to determine population carrying capacity levels.	
Any water management plan needs to be updated in line with 'best practice', more emphasis should be placed on surface water supplies and fertiliser, pesticide and herbicide application in relation to leaching.	See Action 26
The study assumes that economic growth is of paramount importance, it should consider 'steady state' economics also.	
Drought should be defined to mean 'natural dry period'.	The concise Macquarie Dictionary defines drought as period of dry weather.
Water should above all else be conserved and preserved.	
Employment figures should be updated.	1996 census data currently unavailable.

DUAP should put resources into researching alternative energy sources	
HRSTS, suggest discharges during flood flows be monitored.	See section 3.5
DUAP should be investigating ways of reducing spontaneous combustion and recommend that CSIRO be involved.	See action 18 and Appendix H.
What are the Hunters 'limits to growth'?	
Writer believes the community's rights to clean air, water etc. is being eroded by approval authorities who give licences to pollute. Industry should not be permitted to monitor their own pollution, The EPA should be provided with more power, technology and resources.	See Appendix H on Amenity and also Actions 19, 21, 22 and 23.
Spontaneous combustion and reactions of gaseous pollutants produced during spontaneous combustion producing a blue/white haze are not covered in report. Spontaneous combustion odours impair sense of well being and quality of life.	See action 18.
Coal fired power stations utilise steam age technology, renewable sources of energy including solar energy should be discussed, as should the greenhouse effect. "Every shire is 'bursting with energy' not just Muswellbrook Shire."	See Appendix D.
Data collection must be consistent.	See Actions 9, 10, 15 and 16.
Information should be provided on long term effects of SO_2, NO_x and fluorides on humans. Concentrations should be well below EPA limits.	
The report should place more emphasis on controlling dust as it has a major impact on community amenity.	See Appendix D
A potential interaction between air quality indicators that is not mentioned is the particulates produced following spontaneous combustion.	
Suggest a moratorium on further underground water bore licences and rural land subdivisions—future development should be connected to town water or be self sufficient.	See action 21.
Any further coal transport should be by rail, not road.	This is Government policy, evidenced by the Warkworth–Mt Thorley rail link.
Air quality monitoring should extend to the northern and western boundaries of the Upper Hunter.	This is subject of Action 10 and 14.
Preference for underground mines, especially those close to rural settlements to reduce impacts of dust, noise and visually.	Coal is mined underground when the resource is quite deep, open cut methods are used when the resource is close to the surface.

Need updated information in economic assessment.	1996 census currently unavailable
Focused assessment of the cumulative environmental impacts of New power generation proposals in the Upper Hunter should also be a key element of the strategy.	See Appendix D.
An education and community monitoring program should be set up to involve school children and interested members of the community. E.g. Airwatch.	Outside the scope of this this regional study
No mining development should occur on class 1 or 2 agricultural land, or alluvial flats. Soil capability mapping is required, this should be included in the final report or mentioned as further action. Insufficient attention has been given to the impacts of mining on alluvial water tables.	See Appendix H and section 2.1.2.
Water quality—existing and extensions of data collection need to be coordinated. Water availability needs further work in terms of over allocation and security of supply.	See actions 7, 10 , 21 and 26.
Monitoring results should be published/announced daily. A community air monitoring program should be incorporated as a demonstration program.	
Potential causes of particulates and SO_2 include spontaneous combustion, occurring at Old Ravensworth, Drayton and Old Bayswater mines, this has not been covered in the report.	
Upper Hunter contributes 40% of the States energy resources, this has significant implications for greenhouse. The prospect of global warming affects virtually every other environmental issue.	See Section 5.1.8 greenhouse
The UHCIS has concentrated on economic benefits of coal and power, not on environmental impacts of these industries.	
Renewable power should be further investigated.	
SO_2 should be included as a cause of odour.	
Haze is an indicator that has not been listed and should be investigated.	
Night noise should be investigated in Muswellbrook.	See Action 2 and Section 5.4
Will the community have an opportunity to comment on all future annual reports?	See Action 31.
Spontaneous combustion, odour and the Greenhouse Effect are not covered adequately.	See Section 5.1 and Appendix H.
Report needs to be plain English	See Appendix H and Actions 35 and 38.

INDEPENDENT ORGANISATIONS/ASSOCIATIONS	
Singleton and Upper Hunter Business Enterprise Centre	**Response**
Ongoing polluted water above Scone has not been addressed.	This is a local issue.
Some suggestions as to suitable land uses for the available land the Upper Hunter should be provided.	This is not within the scope of the study.
Need an evaluation phase. (Perhaps the UHCIS model could be used elsewhere.)	See Action 29.
Scone/Parkville Environment Watch 14.11.96	**Response**
Recommendation 6.3 (a) Improved coordination and monitoring. EPA and DLWC should investigate and monitor suspected impact areas well away from large development sites. Acid rain, for example, could be from power stations. SPEW is of the opinion that monitoring should be extended to the northern and western extremities of the Hunter Valley. This should be immediately implemented to establish benchmarks for future development. Monitoring sites and results should be published in all reports.	See Action 10 and Section 5.1.3 on acid rain.
There should be an immediate moratorium and blanket ban on mining in sensitive areas including, all alluvial flats, the banks of the Hunter River and its tributaries or within proximity of recognised high quality water bearing strata. Priority should be given to underground methods of mining.	See previous comments on mining in alluvial areas.
Intensive industries should monitor odour levels and investigate possible air borne viruses.	See Appendix H on Monitoring.
Air pollution monitoring should be in liaison with health authorities to establish any correlation to patterns of high asthma levels and pollution.	See Appendix H on Monitoring.
Hunter Valley Vineyard Association	**Response**
Would emphasise the importance of the alluvial flats in the Hunter River catchment to the future of the wine industry.	
Request zoning as for the Hunter vineyards (rural tourist 1g, currently under review), this zoning would prohibit various land uses such as industrial development, housing and open cut coal mining.	This is not a cumulative impact issue.
Still concerned in regard to salinity.	See Appendix H on Water Quality.
Total Environment Centre	**Response**
Salinity is one of the most serious issues in the catchment and is related to open cut coal mining.	See Appendix H on Water Quality.
Passive, non point sources of salinity are not covered by report	
TEC would like information on any study which has estimated the future saline load on the Hunter River attributable to the passive discharges leached from the overburden heaps.	Unaware of any such study.
Concerned that the study did not identify who will be responsible for ensuring saline waters are properly discharged when mines close.	Strict conditions are placed on coal mines to ensure that site rehabilitation occurs and that land is returned to productive use. Revegetation will ensure that mine runoff does not become an ongoing source of salt to the river system.
The study has failed to address the long term impacts, (esp. on agriculture) of increasing levels of salinity	
EPA address acute salinity only, a need for emphasis on chronic salinity conditions.	
Macquarie Generation	**Response**
The study concurs with MG's understanding that SO_2, NO_2 and fluorides are well below acceptable levels and support the finding that the existing regulatory regime is controlling these emissions "with a significant margin of safety"	
NSW Mineral Council	**Response**
The Mineral Council strongly supports the study, but identifies the following weakness: the implicit assumption that issues and impacts for which no data exists are not significant or not of concern. Greater encouragement needs to be given to the development of other industries in addition to mining, including tourism and viticulture.	See revised statement under findings in the Executive Summary
Recommendation 6.1(f) recommend that it be reworded to promote and recommend the use of 'trigger' matrices by proponents and government agencies, in determining the significant issues to be covered in EISs, rather than simply incorporating the triggers or matrices into Director's requirements. Director requirements have legal force and any failure to address those requirements could be subject to legal challenge. Many of the potential cumulative effects set out in the 'trigger' matrix are of a subjective nature and cannot be addressed scientifically, either through lack of regional data, or lack of technology for measurement.	See above section on Director-General's Requirements for EISs
Recommendation 6.3(c) Very fine particles in the PM_{10} and $PM_{2.5}$ size ranges are highly dispersive and are generated from many sources. Monitoring and analysis would be very expensive. Suggest a joint industry-government study, if fine particles are still seen as a concern.	See revised Action 15—reviewing the current dust monitoring network

UPPER HUNTER CUMULATIVE
IMPACT STUDY AND ACTION STRATEGY

Recommendation 6.5(c) The mining industry is undertaking a trial of 'real time' dust monitoring equipment, employing laser technology and are developing computer applications which will allow decisions to be made on short notice on the operation of various activities or items of equipment, based upon ambient weather conditions. Research has also commenced on defining acceptable levels of 'visible' and 'episodic' emissions. The Minerals Council is aware of short term episodic emissions and would welcome government involvement in research.	Noted
Recommendation 6.7(a) support recommendation and would be happy to assist	See revised Action 38, NSW Minerals Council as associated stakeholder.
Recommendation 6.7(d) The reference to HITS is inappropriate in this context as it is a radio data transfer system, which transfers data from monitoring stations to a central computer at Muswellbrook. The output from the computer system is readily available to the community via DLWC waterline service.	
Recommendation 6.8(a) Consider a better method to extend community consultation/monitoring committees established for many newer mines to include a review of rehabilitation performance.	Can be considered through Action 36 as mining industry is nominated as a stakeholder.
Recommendation 6.8(c) Discussions between Singleton Council and NSW Mineral Council resulted in a set of principles relating to landscape, to conform to an overall plan of the Shire. This will be reflected in conditions attached to Open Cut approvals by DMR.	Noted, see Action 6.
Recommendation 6.9(a) Minerals Council believes spontaneous combustion is confined to older mines, especially those without coal preparation plants. The problem is further confined to those mines extracting coal which was susceptible to spontaneous combustion. Due to changes in recent years, spontaneous combustion of discarded, unsaleable coal is an issue which will not recur.	See Appendix H on Amenity and spontaneous combustion.
Uniform procedures for dust fallout monitoring have been adopted for all mines, ensuring data is comparable. An integrated monitoring monitoring system of river flow and salinity is established. Therefore air and water quality monitoring of site specific emissions have now been placed on a basis that will permit comparisons of data.	See Appendix H on Monitoring.
Regional data collection is missing as monitoring is confined to 'emitters'. Regional monitoring should be carried out by the relevant government agencies. The government should also collate and analyse data collected by mines in accordance with licence conditions.	See Appendix H on Monitoring and Action 10 (routine environmental monitoring program).
Monitoring should be tailored to providing information on issues of concern, i.e. clearly establish objective before changing monitoring practices.	See Action 10 and Appendix H on Monitoring.

Consider resource implications of initiatives (in actions) to be carried out by respective agencies. in the Action Strategy.	Agencies have agreed to their roles identified
The consideration of cumulative impacts and the use of 'trigger' matrices in environmental impact assessment needs to be carefully and closely integrated with the overall approvals process, to avoid adding undue complexity and further extending the time frame for the process. It could be unfair to ask developers to address cumulative impact if the data is not available within government agencies.	See Appendix H on Director-General's EIS requirements.
LOCAL AND STATE GOVERNMENT AGENCIES	
Hunter Catchment Management Trust	**Response**
The Trust commends DUAP for this ambitious study which has gone far towards filling a gap between site oriented environmental impact studies and regional planning instruments.	
The Trust recommends that a new unit be established, with earmarked funding, to evaluate water quality by: • examining all existing water quality data and select from that data which will help indicate long term trends. • Assess existing monitoring and identify gaps. • Develop a centralised monitoring system which would coordinate and facilitate existing programs and develop new ones where necessary. • Develop the program for the whole Hunter Valley, not only Upper Hunter. Assist in the regular publishing of water quality information with annual reporting of long term trends. • Recognise that existing personnel and equipment resources cannot carry out such a program and that new and long term funding is required. • The unit should provide baseline user-friendly information. • Water quality is a major concern in the Upper Hunter and a specific and long term effort is required to determine problems, long term trends and priorities for action.	The Trust is welcome to be involved in the reviewing of the current monitoring system, particularly regarding water quality. The Action Plan has been amended to cater for this. cater for this, see Action 10.
Singleton Council	**Response**
Received a copy of Singleton Council's planning report to council which provides an overview of the UHCIS with a recommendation that council support the findings and recommendations contained in the study.	
Singleton Council formally accepted the UHCIS on 9.12.96.	
Muswellbrook Council	**Response**
Would welcome any planning/zoning control to prohibit any inappropriate development within the alluvial areas of the Hunter River. (7L(1) Alluvial Zones.	See Appendix H on Land use
Episodic dust events should be incorporated into air quality results.	See Section 5.1—Air Quality

Conditions of consent should be consistent e.g. blasting over pressures	See Action 17.
The nine recommendations from the air quality report should be incorporated into the main report.	
Earlier liaison should take place between DMR and local council regarding visual impact and landscape plans as conditions of consent.	See Action 6.
Noise, including traffic noise should be assessed.	See Action 2 and Section 5.4.3 Noise and Vibration.
Water quality study is inadequate.	See Appendix I.
Agencies should collect all mine data and collate it.	
A committee to oversee the implementation of the project should be established.	See Action 29.
Dust episodes should be further examined	See Actions 12 and 15.
The study of dust trends should be included in final recommendations as recommended by air report.	
Spontaneous combustion (and associated sulphur smell) and the continual movement of dust should be addressed.	See Section 5.1 Air Quality.
Water quality report is out of date and should be updated using DLWC or EPA data.	See Appendix I.
Areas under irrigation, fertiliser type and use and intensive cultivation should be included in the agriculture section.	
Water quality, rehabilitation, steepness of final land form etc. should be discussed in relation to coal mining.	
Concerned about implications of "No major cumulative impacts" statement on p.6 of executive summary.	Note changes to this statement in Executive Summary.
Concerned that mines can now discharge saline water to river under HRSTS and the EPA are encouraging this.	See Appendix H on Water Quality.
Water consultants should examine dairy waste water management options.	
Land use (p. 22) should be divided into local government areas to enable comparison.	Local detail.
Sewerage (p. 26) should mention Muswellbrooks agreement to recycle sewerage waste water with nil discharge of treated effluent to the river system.	See Section 2.3.7
Changes in land use trends could be a product of the general decline of rural areas and could have cumulative effects, including pressure for rural residential subdivision.	Rural residential pressure be addressed through Actions 1 and 5.

Cumulative impacts associated with increases in dust production should be identified in the report.	See Section 5.1 Air Quality.
Report should identify the cumulative impacts of the increasing number of mines in Muswellbrook.	See Action 2 and Figure 10.
Social impacts have not been assessed.	See Section 5.4 Social Conditions and Action 2.
Scone Council	**Response**
A number of maps (fig 9&10) have Aberdeen located in Muswellbrook Shire, figure 6, page 23 shows the correct location.	The maps will be corrected before final printing.
Figure 7 could be updated to include the Kayuga proposal.	As above.
Table 3 Agricultural Area Within Each Local Government Area, the 1994/95 Agricultural statistics show: Merriwa 69.2% Murrurundi 79.4% Scone 81.9% Muswellbrook 36% Singleton 36.5% Average Upper Hunter 60.6%	Revised tables 3a, 3b and 3c provided by NSW Agriculture.
No real details on the Equine Industry and it's importance to the Upper Hunter. (Some information on investment, income and expenditure provided by Scone)	Information has been incorporated, see Section 2.2.2
Current monitoring stations are inadequate especially on the fringe areas in regard to air quality.	See Action 10.
Concerned that background levels cannot be accurately established.	See Actions 9 and 10.
Considers that a monitoring station should be set up in the Wybong catchment.	Could be considered in Action 10.
Monitoring costs should be met by the mining companies through the Minerals Council, or State/Federal governments.	
Concerned that council does not have the resources to monitor compliance with SEPP 34 approvals. Suggest that resources be provided, or an individual could be employed, on a regional basis to ensure compliance with consent conditions.	A series of detailed audits will ensure SEPP 34 (major industrial projects) are complying with their conditions of consent. The audits will be publicly available through DUAP. See also Action11.
Council would endorse and support DUAP preparing a REP for the Upper Hunter.	See Action 1.
Council generally supports the thrust of the study.	
Department of Mineral Resources	**Response**
The Department believes the report achieved its objectives within the constraints of the data available.	
(f) How will the triggers be used to set the DG's requirements? Request DUAP to give presentation to Agencies on what the triggers	See Appendix H on

will be, and request consultation with DMR and industry to ensure practicability.	Director General's requirements for EISs.
6.3 (c) Discussion with the industry via the Minerals Council regarding any possible trade offs in the regionalisation of existing dust monitoring stations. How will this fit with consent conditions and who will pay for relocation?	Could be addressed through Action 10.
6.5 (a) EPA should consult with industry to define 'nuisance dust'. The EPA Community Consultative Forum could have a role in this.	See Action 12.
6.5 (b) EPA should 'rethink' noise manual and consider that some Hunter Valley areas are industrial, not rural, and adjust noise levels accordingly.	See Section 5.4 Social Conditions—Noise and Vibration.
6.6 (a) DMR suggests rehabilitation in NSW is the best in Australia.	
6.8 (a) A study of rehabilitated mining land has been carried out under an NERDDEC grant, it could be the basis for a study on the range of pursuits on agricultural land.	
(b) A field day open to miners and farmers has been held to study rehabilitated land.	For consideration in the implementation of Actions 36 and 37.
(c) DMR and Singleton Council are working on landscape and suggest leaving other council areas till Singleton is finished.	
6.9 (a) Best Practice guidelines for blasting would be site specific not general.	See Action 17.
DMR, CSIRO and industry have prepared guidelines. Extensive research has been carried out on 4/5 open cuts with greatest problems under a NERDDEC grant, results have been published, and long term effort is required.	See Appendix H on Amenity—spontaneous combustion.
NSW Agriculture	**Response**
The Department considers the agricultural lands of the Upper Hunter to be of State significance.	
The Department believes that the critical mass conditions essential for sustainable agriculture are under threat due to cumulative negative impact of non agricultural developments in this area.	Could be addressed through the sub-regional planning strategy—Action 1.
Non agricultural developments are and will continue to destabilise the opportunities for sustainable agriculture in the sub region. In particular, the level of conflict between adjacent but incompatible land uses appears to be escalating.	As above.
NSW Agriculture believes that increasing land use conflict is especially indicative of inadequate assessment of individual developments.	

Continued effective implementation of the HREP is essential, as is the preparation of Best Practice Guidelines for Cumulative Impact Assessment for use regionally and across NSW.	See 7.3 Strengthening Environmental Management Practices
Suggest the development of an agreed government and community vision for both the strategic planning and environmental management for the Upper Hunter.	
Important to maintain a communications strategy which delivers user friendly information whilst continuing to engage the community in the study's outcomes.	See Actions 35 and 38.
Murrurundi Shire Council	**Response**
Council supports the general thrust of the study and its recommendations, particularly concerning an improved monitoring system.	See Action 10
Council would support a Upper Hunter REP.	See Action 1.
Environment Protection Authority	**Response**
Objective 1: Establish Cumulative Impacts No attempt has been made to assess synergistic effects. The draft water quality analysis concluded that it is not possible to determine whether cumulative impacts are occurring The limitations of available data should be clearly acknowledged.	DUAP acknowledges the limitations of the study due to the current state of cumulative impact assessment methodology and availability of meaningful data.
Objective 2: Establish a framework for impact assessment The identification of environmental indicators (appendix B) and potential interactions of environmental stresses (appendix C) are useful. These allow the identification of geographical areas where cumulative impacts are likely and types of activity and land use that contribute to them. These appendices should be central to the report. The development of a SEA or AEAM would provide a stronger framework for cumulative impact assessment. This should be explicitly recommended in the report.	Information from these Appendices has been incorporated into various sections of the report.
Objective 3: Provide a basis for environmental monitoring Decisions about additional monitoring should be made in the context of developing a cumulative impact approach such as AEAM or SEA.	AEAM and SEA will be subject to further discussions between DUAP and EPA.
Objective 4: Facilitate future planning The report makes very relevant conclusions about how cumulative impact considerations should be incorporated into strategic and regional and local planning processes. There is an opportunity to incorporate planning recommendations into an AEAM or SEA framework which would provide a structure for future land use and environmental assessment. The EPA makes specific recommendations for changes to the executive summary (p 6 and 8), sections 5.3, 6.1 (a), 6.2 (a), 6.3 (a), 6.3 (b), 6.3 (c), 6.5 (a), 6.5 (c), 6.5 (d) and 6.5 (g), which encapsulate the above comments and recommendations.	As above. See Actions 1, 9, 10, 12, 13, 15, 19 and 34.

State and Regional Development	Response
Based on findings, it seems overly cautious and an inefficient use of resources to impose environmental assessment, based on 'triggers' described in the study, on developers. Suggests alternative to incorporating environmental triggers into the EIS process. Triggers would only identify a potential reaction or relationship, not a clear measurement. Cumulative impacts caused by existing developments is not a consideration under s. 90 of the EP&A Act 1979. Incorporating triggers in EIS requirements would serve as a disincentive to development in the Upper Hunter. Incorporation of triggers in EIS requirements is contrary to DUAP's streamlining of development approvals process as approvals will become more complex if the definition of 'triggers' is left open to interpretation. It could lead to more court challenges. Triggers are difficult to quantify and will increase costs. They will add uncertainty to the development approval process as monitoring could identify cumulative impacts at levels detrimental to the community. Monitoring of environmental triggers needs to be ongoing so developers are not disadvantaged. A case needs to be made that the Upper Hunter needs extra requirements in the EIS process to ensure that there will not be a disincentive to development in this region compared to other locations in NSW, which have not had cumulative impact studies done.	See above section on Director-General's requirements for EISs.
An up-to-date REP for the Upper Hunter would create greater certainty in the planning approvals system than incorporating cumulative impact triggers into existing EIS requirements. Recommend that cumulative impacts continue to be monitored until the cause can be conclusively demonstrated. Recommend further research by agencies so that developers responsibility is defined so that results are predictable. Recommend a new REP to establish greater certainty for developers.	See Action 1.
Department of Land and Water Conservation	**Response**
Department supports the study and believes concerns have been taken on board. The Draft Hunter Valley Strategic Water Management Plan was released in December 1996 and reinforces UHCIS recommendations.	

The GIS developed for this study should reside in the region to allow for greater community access.	See Action 16.
The State of the Rivers and Estuary Report for the Hunter will assist with recommendation 6.3 and 6.7. The Department can implement 6.7a and 6.7d and 6.7b will be implemented by the end of 1997.	Noted.
The HITS system will be ready by June 1997 and could concentrate on diffuse and dryland salinity.	Noted.
NSW National Parks and Wildlife Service	**Response**
The Service is keen to work with DUAP on further development of the study and methodology particularly in areas of Aboriginal heritage and biodiversity, and would like to discuss how natural and cultural heritage values can be incorporated into subsequent stages of the study.	The Service has been contacted regarding these issues.

APPENDIX I. WINDOW ON WATER — DEPARTMENT OF LAND AND WATER CONSERVATION, MAY 1996

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WINDOW on WATER

Regional Water Quality Maps

1. River Sites

Chemical Indicators

Three chemical indicators measured in the department's Key Sites Program form the basis of water quality reporting for river sites:

- Total Phosphorus: an indicator of nutrient enrichment and the potential for algal growth
- Electrical Conductivity: a measure of salinity
- Turbidity: a measure of water clarity and an indicator of sedimentation and erosion.

Information on river dwelling blue-green algae, macroinvertebrate communities and faecal coliform bacteria is also included in the regional water quality maps, where possible.

Blue-Green Algae

While algae are a natural part of any river environment, their presence at bloom levels is a cause of great concern to the community. Apart from being unsightly and foul smelling when in large numbers, some blue-green algae can be toxic to animals and humans under certain conditions. In addition, when algae die off and decompose, oxygen in the water is depleted and may seriously affect fish and other aquatic life.

Macroinvertebrates

Macroinvertebrates (including insect larvae, yabbies and worms) are present in a whole range of aquatic systems, allowing the health of communities to be used to indicate the condition of the systems themselves. A macroinvertebrate community that includes a wide range of different animals and many individuals indicates a healthy river system. In contrast, if few macroinvertebrates are living in a river, or if the community is dominated by a few tolerant species, this indicates that the river is in poor condition.

Macroinvertebrates can be affected by a range of impacts that include organic pollution, nutrients, pesticides and heavy metals. They can also be affected by a lack of suitable habitat and by altered flow regimes. One of the main benefits of using macroinvertebrates as indicators of river health is that they respond to events of short duration, as well as integrating longer-term impacts and combinations of different impacts.

Faecal Coliform Bacteria

For many years, the measurement of faecal coliform bacteria concentrations in natural waters has been used to indicate faecal contamination of those waters and, therefore, the likely presence of pathogenic (disease causing) microorganisms.

Faecal coliforms are found in the faeces of humans and other warm blooded animals. Although their presence is not in itself a problem, they do indicate the likelihood of other faecal pathogens being present. The main source of pathogens in fresh, estuarine and marine waters is domestic wastewater effluent, but other sources include land runoff and effluents from abattoirs, dairies, poultry processing operations and hospitals.

Presentation of Water Quality Information – Rivers

On each regional map, water quality at river sites is indicated by a column of up to six colour-coded boxes, one each for:

- **blue-green algae**
- P **total phosphorus concentration**
- C **electrical conductivity**
- T **turbidity**
- **macroinvertebrate communities**
- **faecal coliforms**

For each indicator where data was available, river water quality was rated as good (green), fair (yellow) or poor (red), based on the following criteria:

Blue-green algae

At sites where regular algal information was available, river water quality was categorised based on the severity, frequency and extent of blue-green algal blooms. The following groupings were used:

Good:	**blue-green algae generally not a problem (counts usually < 2000 cells/mL)**
Fair:	**blue-green algae an intermittent problem (counts usually 2,000-15,000 cells/mL, with occasional higher levels)**
Poor:	**blue-green algae a severe problem; frequent and/or persistent high densities (extended periods (10-25 weeks) of > 15,000 cells/mL)**

Total Phosphorus Concentration

The median (middle value) total phosphorus concentration was used to establish a water quality rating for river sites, based on guidelines for the prevention of excessive algal growth set out by Bek & Robinson (1991) and Grau & Robinson (1994):

Good:	**< 20 µg/L**
Fair:	**20-50 µg/L**
Poor:	**> 50 µg/L**

Electrical Conductivity

In the electrical conductivity boxes on each regional map, river sites were assessed as being in one of three categories – good, fair or poor – based on how their median values compared with guidelines for irrigation waters, outlined by ANZECC (1992):

Good:	**< 280 µS/cm**
Fair:	**280-800 µS/cm**
Poor:	**> 800 µS/cm**

Turbidity

Sites were rated as having good, fair or poor turbidity, based on a comparison of the median value with turbidity guidelines for drinking water (< 5 NTU) and the protection of aquatic animals and plants (< 50 NTU) (Bek & Robinson 1991):

Good:	**< 5 NTU**
Fair:	**5-50 NTU**
Poor:	**> 50 NTU**

Median values for total phosphorus, electrical conductivity and turbidity are shown next to the relevant colour coded box at each site, so it can be seen where the data lies within the category range.

WINDOW on WATER

Macroinvertebrate Communities

At sites where macroinvertebrate community data was available, river health was categorised based on the number of individuals and the range of species (types) present, as well as the presence or absence of pollution-sensitive species:

Good:	**large numbers, wide range of species; sensitive species present**
Fair:	**medium numbers of individuals of a range of different types**
Poor:	**few individuals or tolerant species predominate**

Faecal Coliforms

At sites where faecal coliform data was available, river water quality was categorised based on comparison of median values with bacterial guidelines for primary recreation such as swimming and water skiing (fair), and secondary recreation (wading, boating, fishing), irrigation and livestock watering (poor):

Fair:	**meets primary recreation guidelines (< 150 cfu/100mL & 80% of samples < 600 cfu/100mL)**
Poor:	**meets secondary recreation, irrigation and livestock water guidelines (< 1000 cfu/100mL & 80% of samples < 4000 cfu/100mL)**

Note: no "good" category has been assigned for faecal coliforms, since it is considered unrealistic to expect any natural rivers to meet drinking water guidelines (0 cfu/100mL), the only generally accepted guidelines that are more stringent than primary contact levels.

Units: µg/l — micrograms per litre or 10^{-6}g/L
µS/cm — microsiemens per centimetre
NTU — nephelometric turbidity units
cfu/100mL — colony forming units per 100 millilitre

2. Storages

Indicators

DLWC's storages provide water for irrigation, stock and domestic purposes, as well as water supply for many country towns. They are also used for recreational purposes and many have a role in flood mitigation. While these functions are the more obvious ones, the department's storages also play a key role, alongside water sharing, in management of the State's water resources. The challenge for the department is to ensure that the needs of all water users, including the environment, are considered.

The Storages Monitoring Program is designed to provide water quality information which can be used for best possible management, bearing in mind the variety of uses these storages must serve. More detailed information on the results of the1994/95 program is provided in Al-Talib *et al.* (1996).

Water quality information for each waterbody is presented on the regional maps as a colour coded "storage," providing information on thermal stratification, total phosphorus concentrations (top and bottom waters), blue-green algae and bottom water dissolved oxygen concentrations. For each storage, water quality at the site nearest the dam wall was chosen to represent the whole waterbody.

For each indicator where data was available, storage water quality was rated as good (green), fair (yellow) or poor (red).

Thermal Stratification

Storages become thermally stratified during summer when the surface layer of water is heated by the sun. As the surface waters warm and become less dense, the bottom waters remain cold and dense. If the difference in temperature and density increases, the surface and bottom layers become isolated and circulate within themselves so there is little exchange of oxygen and chemical components between top and bottom waters.

Such conditions only persist over the hotter months of the year. During autumn, when the surface layer of water starts to cool down, circulation increases and the storage becomes mixed from top to bottom. This is known as "turning over."

Some storages may not stratify strongly because they are shallow, exposed to mixing by wind or continuous flushing (inflow and outflow). Other storages may become very stable with temperature differences of up to 15°C between the surface and bottom waters.

Storage stratification has been represented here as:

no stratification **intermittent stratification** **stable stratification**

Bottom Water Dissolved Oxygen Levels

Decomposition of organic matter such as leaves, twigs, dead animals and algae in the bottom of a storage uses up available dissolved oxygen. During summer, when a storage is stratified, the bottom layer of water circulates separately from the surface layer, so does not get replenished with oxygen. This process may continue until the bottom layer has no dissolved oxygen (is anoxic). This is when chemical reactions take place that release ions such as phosphorus, iron and manganese from the sediments.

Storages were rated as having a good, fair or poor bottom water dissolved oxygen level as shown below:

Good:	**did not turn anoxic**
Fair:	**low in oxygen but not anoxic**
Poor:	**anoxic**

Total Phosphorus Concentration

The same groupings that were used to categorise river sites form the basis of top and bottom water storage quality ratings for total phosphorus, namely:

Good:	**< 20 µg/L**
Fair:	**20-50 µg/L**
Poor:	**> 50 µg/L**

Blue-green algae

Regular algal monitoring in storages is important because of the potential impact of blue-green algae on stock and domestic water supply. Other significant impacts include those on recreation and tourism.

Storage water quality was categorised based on the severity, frequency and extent of blue-green algal blooms using the following groupings:

Good:	**blue-green algae generally not a problem**
Fair:	**blue-green algae an intermittent problem**
Poor:	**blue-green algae a severe problem**

HUNTER REGION

The Sites

Rivers

The Manning, Wyong, Karuah and Hunter River Basins are included in DLWC's Hunter Region. These catchments are represented by the following Key Sites:

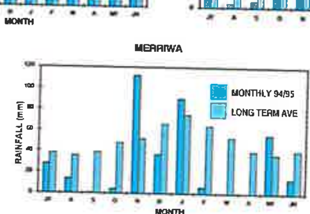
River Basin	Site No.	Station Name
Manning River	208004	Manning River: Killawarra
	208011	Barnard River: Mackay
Karuah River	209003	Karuah River: Booral
Hunter River	210002	Hunter River: Muswellbrook Bridge
	210004	Wollombi Brook: Warkworth
	210005	Hunter River: Moonan Flat
	210064	Hunter River: Greta
	210031	Goulburn River: Sandy Hollow
	21010017	Goulburn River: Gleniston
Macquarie-Tuggerah Lakes	211009	Wyong River: Gracemere

Storages

Three storages are operated by DLWC in the Hunter Region – Glenbawn Dam, on the Hunter River near Scone; Glennies Creek Dam, about 30 km north east of Singleton; and Lostock Reservoir on the Paterson River, about 60 km north of Maitland. Each storage provides water for a variety of uses including irrigation, stock and domestic purposes. Glenbawn Dam is also used for flood control management.

Rainfall and Flow

Rainfall plots for three stations in the Hunter Region showed that rainfall was below average for the first half of the 1994/95 year, but then fluctuated about the mean. In general, it tended to be wetter than the previous year, particularly on the coast. Over the whole basin, stream flow and river water quality were fairly typical of recent years, with only one large "storm flow" (associated with heavy rain in March 1995) being evident.



Water Quality

Rivers

Water quality in the rivers of the Hunter Region was very similar to 1993/94, with only minor changes to water quality rankings. For more than half of the sites sampled, median (or middle value) total phosphorus concentrations were in the medium range (20-50 µg/L). Of the remainder, two sites (Wollombi Brook at Warkworth and the Goulburn River at Gleniston) had low values, while two on the Hunter River (Muswellbrook Bridge and Greta) recorded high median concentrations.

Salinities were once again low in the Manning, Barnard, Karuah and Wyong Rivers, with median electrical conductivities of less than 280 µS/cm. In the Hunter River Basin, three out of six sites had high salinities, the only low rating being for Moonan Flat, the most upstream site on the Hunter River. Levels in the Goulburn River were among the highest in the State, with median values of over 1000 µS/cm at both sites.

Turbidities were low at all sites except the Wyong River at Gracemere, which had a median value just above the 5 NTU cut off point between low and medium categories.

Storages

Glenbawn

Glenbawn Dam thermally stratifies each summer, with serious depletion of dissolved oxygen in its bottom waters. During 1994/95, the storage had moderate to high concentrations of nutrients, particularly phosphorus, in the water column. Concentrations were especially elevated in bottom waters over the summer period, when stratification led to the release of phosphorus from the sediments under low oxygen conditions. Over the warmer months, considerable algal growth occurred in the dam, with blue-green algal blooms causing major water quality problems in the late summer and early autumn of 1995.

Glennies Creek

Generally, water quality in Glennies Creek Dam was high throughout the year. Waters were mostly clear, and salinities and nutrient concentrations were also low. Some algae were recorded throughout the year, but no major blue-green algal blooms occurred. The storage was thermally stratified for most of summer and autumn. Dissolved oxygen concentrations in the bottom water layer decreased to low levels at this time, but the waters did not become completely anoxic. Stratification was sufficient, however, to cause increased nutrient concentrations in bottom waters.

Lostock

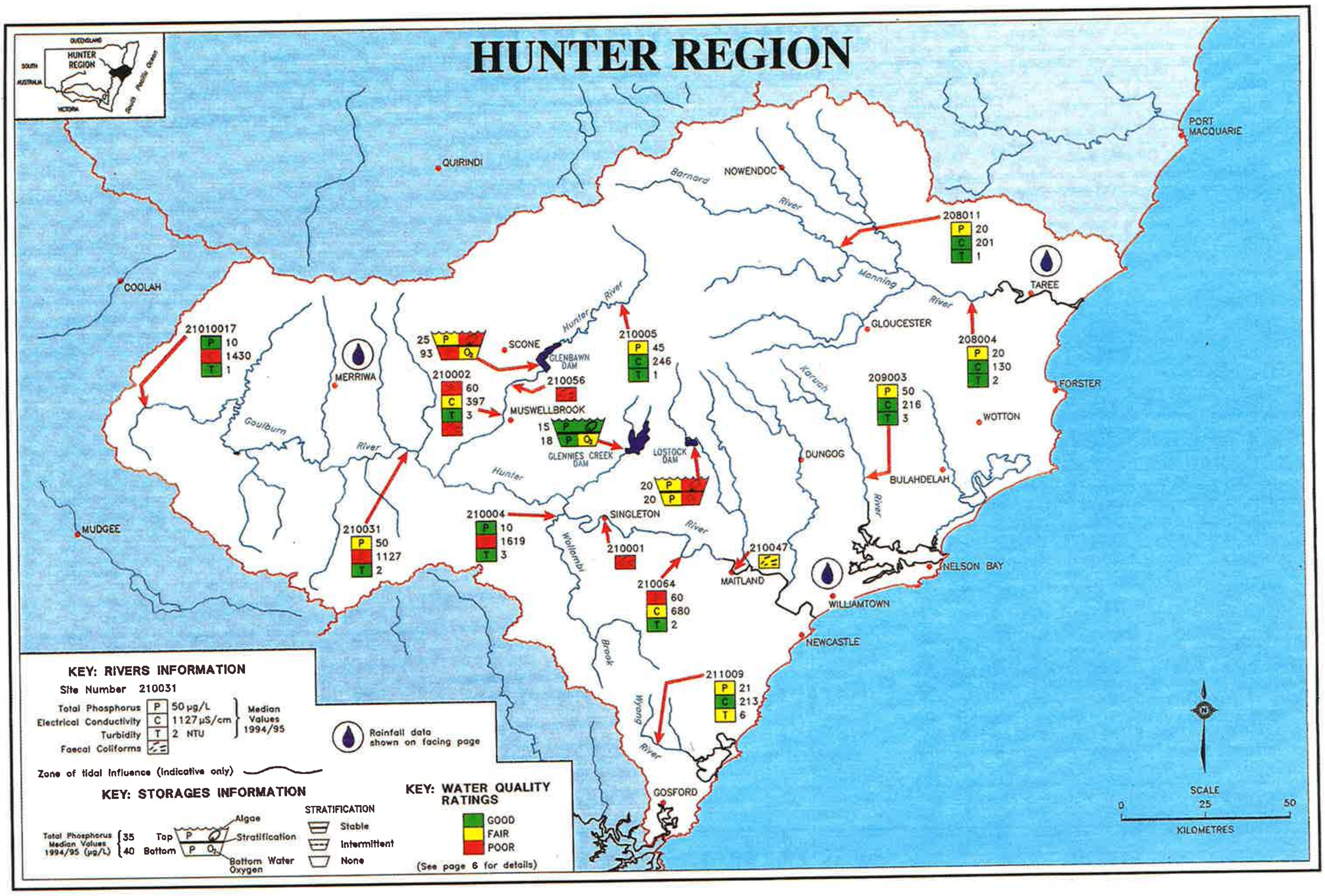
Despite having only mid-range nutrient concentrations, Lostock Storage experienced problem blue-green algal blooms throughout most of the warmer months of 1994/95. The storage had good water quality in terms of the other major parameters, with very low turbidities and the lowest electrical conductivities of any of DLWC's Hunter Valley storages. Lostock thermally stratified between spring and autumn, with bottom water dissolved oxygen concentrations declining to almost zero during that time.

Faecal Coliforms

Information on faecal coliform bacteria levels at four sites on the Hunter River was assessed, based on data from DLWC's microbiological water quality monitoring program. The sites reported here are:

River Basin	Site No.	Station Name
Hunter River	210001	Hunter River: Singleton
	d/s 210002	Hunter River: Muswellbrook (shown with site 210002 on map)
	210047	Hunter River: Maitland
	210056	Hunter River: Aberdeen

In terms of microbiological water quality, the sites on the Hunter River rated poorly. With the exception of the Hunter River at Maitland, faecal coliform levels at all sites exceeded the water quality guidelines for primary recreation activities, such as swimming, diving and water skiing. All sites were considered acceptable for secondary recreational activities (such as boating and fishing), irrigation and stock watering.



HUNTER REGION
QUEENSLAND
SOUTH AUSTRALIA
HUNTER REGION
VICTORIA
South Pacific Ocean
QUIRINDI
NOWENDOC
PORT MACQUARIE
Barnard
River
Manning
River
TAREE
COOLAH
208011
P 20
C 201
T 1
21010017
P 10
1430
T 1
MERRIWA
25
93
P
O2
SCONE
Hunter
River
GLENBAWN DAM
210005
P 45
C 246
T 1
GLOUCESTER
208004
P 20
C 130
T 2
FORSTER
210002
60
C 397
T 3
210056
MUSWELLBROOK
Karuah
209003
P 50
C 216
T 3
WOTTON
Goulburn
River
15
18
P
P O2
GLENNIES CREEK DAM
LOSTOCK DAM
DUNGOG
Hunter
20
20
P
P
BULAHDELAH
River
MUDGEE
210031
P 50
1127
T 2
210004
P 10
1619
T 3
SINGLETON
River
Wollombi
210001
210047
MAITLAND
NELSON BAY
210064
60
C 680
T 2
WILLIAMTOWN
NEWCASTLE
Brook
211009
P 21
C 213
T 6
Wyong
River
GOSFORD
KEY: RIVERS INFORMATION
Site Number 210031
Total Phosphorus P 50 µg/L
Electrical Conductivity C 1127 µS/cm
Turbidity T 2 NTU
Median Values 1994/95
Faecal Coliforms
Rainfall data shown on facing page
Zone of tidal influence (indicative only)
KEY: STORAGES INFORMATION
Total Phosphorus Median Values 1994/95 (µg/L)
35 Top
40 Bottom
Algae
Stratification
Bottom Water Oxygen
STRATIFICATION
Stable
Intermittent
None
KEY: WATER QUALITY RATINGS
GOOD
FAIR
POOR
(See page 6 for details)
SCALE
0
25
50
KILOMETRES

HTBA
HUNTER THOROUGHBRED BREEDERS ASSOCIATION

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3 July 2018

URGENT

We refer to our letter of 2 July seeking the Department's confirmation that it will make a full copy of the Deed of Agreement between MACH Energy and BMC available to the IPC and to those persons wishing to make submissions on this application to the Commission in Muswellbrook tomorrow.

We note we have had no acknowledgment of, or reply to, our letter.

Cumulative Impacts

We now make a further important request.

The 1999 planning consent for Mt Pleasant, for which MACH seeks modification approval, expressly incorporates by reference the 1997 EIS for the original project.

That EIS in turn refers (at page S.7) to the 1997 DUAP Report, "Upper Hunter Cumulative Impact Study", (**the 1997 Report**) the findings of which *"have been considered in the assessment of the Mount Pleasant project."*

The 1997 Report (apparently) deals with cumulative impacts on:

- vegetation clearance
- habitat loss
- depressurisation of hardrock coal measures
- socio-economic factors
- air quality and dust levels
- residents living near coal mines
- landscapes; and
- traffic

The 1997 Report is not available on the Department's online archives. The Department does not appear to refer to it in its 8 June 2018 Environmental Assessment Report (EAR) although, in response to criticisms about reliance on outdated impact studies by MACH (EAR, p12) the Department says that it "***is satisfied that the remaining studies from 1997 still remain relevant*.**"

We hereby seek a copy of the 1997 Report and we further request that a copy be made available to the IPC, assuming it has not already been provided with it.

As the public hearing in this matter commences in Muswellbrook tomorrow morning we would be grateful to have your response to this request by 2PM today.

Yours sincerely

Dr Cameron Collins
President