

EIS 1497

AA068116

Environmental impact statement for proposed extension of sand
and gravel quarrying in the Hunter River at Oakhampton near
Maitland : for Boral Country Concrete and Quarries.

NSW DEPT PRIMARY INDUSTRIES



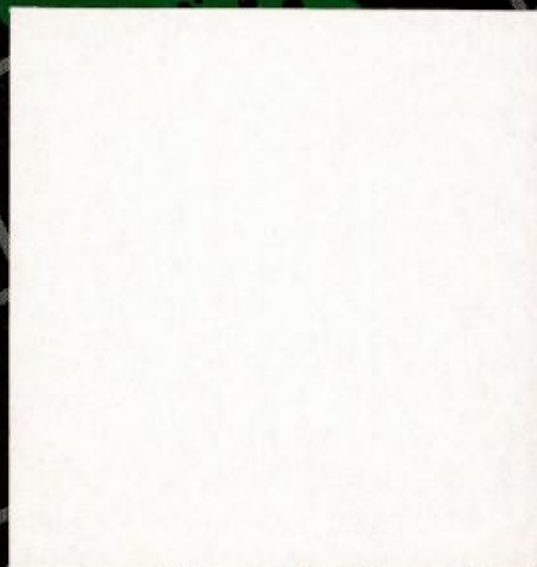
AA068116

PLANNING

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ENVIRONMENTAL
IMPACT STATEMENT
FOR PROPOSED
EXTENSION OF
SAND AND GRAVEL
QUARRYING IN THE
HUNTER RIVER
AT OAKHAMPTON
NEAR MAITLAND

For:

Boral Country Concrete and Quarries

June 1995

94649RP1

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SUMMARY

SUMMARY

Background

Boral Resources (Country) Pty Limited, trading as Boral Country Concrete and Quarries, (Boral), currently extracts sand and gravel from the channel of the Hunter River at Oakhampton by means of a floating dredge. The extracted material is screened and washed through a plant located on the southern bank of the river to produce various fractions and blends of sand and gravel. The Oakhampton quarry has been operating continuously on the site since the mid 1960's.

The objective of the proposal addressed in this document is to extend extraction upstream to allow continued production of sand and gravel.

To continue operations at the existing screening plant, Boral proposes to continue dredging upstream to supply an average of 150,000 tonnes per annum of raw feed to the plant. Approximately half of the extension area has been previously extracted and has refilled with bedload sediments.

The proposed operation would see a continuance of the existing operations and involves the following components:

- a floating dredge is used to win material which is then pumped via a pipe to a primary separator on the southern bank; and
- the raw material is deposited onto a conveyor for transport to the screening plant for washing and separating.

The main differences in the current and proposed operations are as follows:

- the dredge will operate further upstream from the plant site and consequently a longer conveyor will be required to transport raw material to the screening plant; and
- the existing process water settling ponds will be relocated away from their current location on the river bank.

Environmental Assessment and Impacts

Several key issues were identified early in the investigation process and during consultation with government authorities. These key issues are:

- noise emission impacts;
- visual impacts;
- river hydrology;
- potential impacts on river biota;
- river sediment transport capacity; and
- impacts on Aberglasslyn House.

Initial investigations concluded that noise emissions and visual impact associated with the original proposed extent of extraction would potentially impact on the amenity of Aberglasslyn House. As a result the proposed area of extraction was substantially reduced to prevent these impacts. Although this has resulted in a reduction in the available resource, it has ensured that the existing amenity of Aberglasslyn House will not be degraded.

Several landowners in the proposed extension site own freehold title to the centre thread of the Hunter River. Boral proposes to pay these landholders royalty for the resource extracted.

Oakhampton marks the upstream limit of tidal effects in the Hunter River. At this point, the river has extensive floodplains and is laterally limited by bedrock at several points. Assessment of the river at Oakhampton shows that the proposed extension of extraction is not expected to significantly affect river hydrology.

An assessment of the sediment transport capacity of the Hunter River at Oakhampton estimates that mass at 470,000 tonnes per annum. DWR general requirements are that total cumulative yearly extraction at any point on a river should not exceed the sediment transport capacity at that point. The estimated current annual production of all quarry's upstream of Oakhampton (including Boral) which extract from mobile sediment reserves is approximately 340,000 tonnes. Thus the total estimated extraction above Oakhampton is lower than the estimated sediment transport capacity at that point and consequently channel degradation is not expected to occur.

A detailed assessment of aquatic and terrestrial flora and fauna was undertaken and revealed a relatively rich aquatic biota comprising elements of both freshwater and marine environments. Conversely, past clearing for agriculture has resulted in relatively low terrestrial and riparian biotic diversity. Studies show that there is no evidence that past extraction operations within the Hunter River channel and bank deposits have had any significant impact on flora and fauna.

Currently extraction operations have a limited effect on filter feeding organisms close the dredge pond due to localised siltation, although the pond itself is host to a varied range of fish species which appear to prefer the deeper water. It is not expected that any significant or long term impacts on local terrestrial or aquatic biota will result due to the extension of quarrying in the river channel at Oakhampton.

Chapter 1

INTRODUCTION

Chapter 1

INTRODUCTION

1.1 BACKGROUND

Boral Country Concrete and Quarries (Boral) has been extracting sand and gravel from the bed and banks of the Hunter River at Oakhampton since 1965 when the company was known as Blue Metal and Gravel (Country) Pty Limited. Oakhampton is located approximately five kilometres north of Maitland (see *Figure 1.1*)

Current operations are registered with Maitland City Council (Council) pursuant to the State Environmental Planning Policy No. 37 – Continued Mines and Extractive Industries (SEPP 37) and are being conducted within the moratorium period allowed by that legislation. At the end of the moratorium period (18 September 1995) the operation will be required to cease unless a development application is received by Council on or before 18 June 1995.

The purpose of this Environmental Impact Statement (EIS) is to assess the environmental implications of the proposed extension to Boral's Oakhampton operations.

1.2 COMPANY PROFILE

Boral Country Concrete and Quarries is a division of Boral Resources (Country) Pty Limited. Boral Limited is a large diversified Australian owned company involved in the supply and placement of construction and building materials, manufacturing and a variety of other industries.

Boral Country Concrete and Quarries operates numerous quarries and concrete batching plants in country areas of New South Wales.

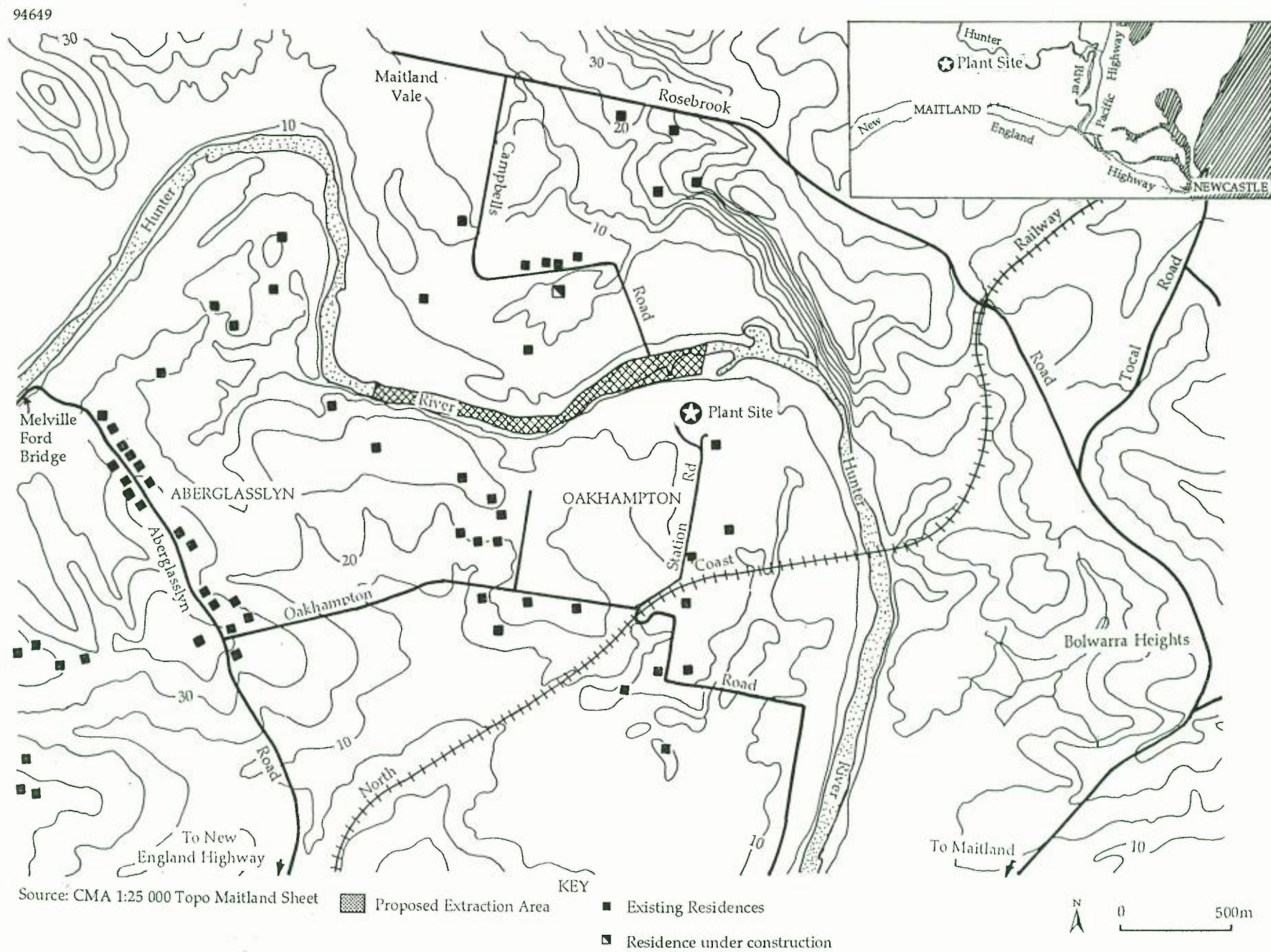


Figure 1.1 LOCALITY PLAN

1.3 THE STATUTORY PROCESS

1.3.1 *Relevant Legislation and Policy*

i. *Environmental Planning and Assessment Act, 1979*

The Environmental Planning and Assessment Act, 1979 (the Act) contains the requirements for the environmental assessment of developments and the procedures for seeking development consent. This EIS has been prepared under Part IV of the Act.

The adequacy of the contents of the EIS has been extensively discussed. An extract of comments in the *Prineas* case reproduced in the Law Book Company Planning and Development service provides useful guidance and is presented below:

An obvious purpose of the EIS is to bring matters to the attention of members of the public, the Department of Environment and Planning and to the determining authority in order that the environmental consequences of a proposed activity can be properly understood.

Specifically these comments referred to an activity under Part V of the Act but refer equally to a development under Part IV.

The required content of an EIS is specifically detailed in the Environmental Planning and Assessment Regulation 1994 (the Regulation). Schedule 2 of the Regulations specify that the EIS must contain and address various matters including:

- a summary;
- a statement of the objectives of the development;
- an analysis of feasible alternatives;
- a full analysis of the development including the nature and extent and the environmental affects of the development;
- a justification for carrying out the development having regard to biophysical, economic, and social considerations and the principles of ecologically sustainable development; and

- a list of any approvals that must be obtained under any other Act or law before the development may lawfully be carried out.

Schedule 3 of the Regulation defines the proposed quarry extension as a designated development which accordingly requires an EIS to support a development application.

A requirement of the Act is that the Director of the Department of Planning be consulted to supply requirements for matters to be addressed in the EIS.

ii. *State Environmental Planning Policy No. 37*

Section 109(2) of the Environmental Planning and Assessment Act 1979, which came into effect on 3 February 1986, prevents those mines or extractive industries (which lawfully commenced without development consent before planning controls came into force), from expanding in area or production above 3 February 1986 levels, without first obtaining a development consent.

State Environmental Planning Policy No. 37 – Continued Mines and Extractive Industries, (SEPP 37), provides for such mines and extractive industries to continue without development consent for a two (2) year moratorium period, within which time a development consent application must be lodged with Council. A prime objective of SEPP 37 is *to promote and safeguard the orderly and economic use of land for the purpose of mines and extractive industries in recognition of the importance of mining and extractive industries to the economic and social well being of the people of New South Wales.*

The Boral Oakhampton quarry has been registered under the provisions of SEPP 37 and will continue operations under this policy until development consent is determined.

Attachment 2 of the SEPP 37 guidelines details the following specific matters to be addressed in an EIS for a continuing extraction operation in addition to those required by the Environmental Planning and Assessment Regulation 1994:

- quantity and quality of the resource;
- total and annual proposed extraction;
- details of operations, machinery and production;
- material stockpiling and handling;

- ☐ hours and life of development;
- ☐ staff numbers;
- ☐ energy requirements;
- ☐ waste disposal, water management, erosion and sediment control;
- ☐ rehabilitation and landscaping proposals;
- ☐ on and off site haulage;
- ☐ proposed environmental monitoring;
- ☐ consideration of feasible alternatives;
- ☐ potential environmental impacts and mitigation measures; and
- ☐ results of consultation and any matters required by the Director of Planning.

iii. *Maitland Local Environmental Plan*

Development within the Maitland local government area is primarily controlled by the Maitland Local Environmental Plan, 1993 (LEP). The proposed development is an extractive industry and is permissible in the site's 1(a) zoning with the consent of Council.

iv. *NSW State Rivers and Estuaries Policy*

Of relevance to the proposal is the NSW Sand and Gravel Extraction Policy for Non Tidal Rivers which is a component of the NSW State Rivers and Estuaries Policy. The Sand and Gravel Extraction Policy (the Policy) has the three following major objectives:

- ☐ to ensure that the extraction of sand and gravel is undertaken on a sustainable use basis;
- ☐ to manage extraction to minimise detrimental impacts on the riverine environment; and
- ☐ to ensure that extraction policy is consistent with the aims of other Government policies and initiatives.

v. Maitland City Council Development Control Plan No. 18

Development Control Plan No. 18 (DCP No. 18) covers an area to the south of the Oakhampton quarry known as Oakhampton Heights. DCP No. 18 does not extend into the area of the quarry or associated screening plant.

1.3.2 Consent Authority

The consent authority for this proposed development is Maitland City Council. If in the unlikely event that the Department of Urban Affairs and Planning call a Commission of Inquiry, the Minister would then be the consent authority.

1.3.3 Approval and Licence Requirements

The Boral Oakhampton operation currently holds licences from the Department of Water Resources for water pumping and from the Environment Protection Authority (EPA) for discharge of process water into the Hunter River. These licences are subject to annual renewal.

Both licences will be required for the extended extraction as the new process water treatment ponds will required both the pumping of fresh water for processing and the discharge of settled water to complete the cycle. The volume of water used in the process is too large to contain within the circuit. It is expected that EPA approvals will be required for air, noise and water pollution control works.

A DWR 3A Permit is required under the Rivers and Foreshores Improvement Act as the proposed development is within a watercourse on private lands.

The banks of the Hunter River are classified under the prescribed streams provisions of the Soil Conservation Act and any damage to trees and shrubs would require a permit from the DWR. No damage to or removal of trees or river bank vegetation within the 20 metre prescribed zone is proposed and therefore a permit will not be required.

1.4 OBJECTIVES OF THE PROPOSAL

The objective of the proposal is to allow Boral to continue extraction and processing operations at the Oakhampton quarry and so continue to supply sand and gravel to it's own concrete batching plants and numerous companies and individuals involved in the building and construction industries.

1.5 CONSULTATION AND KEY ISSUES

Prior to and during preparation of the EIS relevant government authorities, statutory bodies and private individuals were consulted as to their requirements and concerns. The Director of Planning's requirements are presented in *Appendix A* and copies of consultation letters are presented in *Appendix B*.

The key issues highlighted by the consultation process were:

- potential noise and visual impact on Aberglasslyn House and other residences;
- effect of the extraction operation on aquatic flora and fauna;
- impact of extraction on sediment transport, water quality and flooding in the Hunter River; and
- effects of road haulage on residential amenity.

1.6 EIS STRUCTURE

This EIS is divided into the following chapters:

- *Chapter 1* describes the background and reason for the proposal along with the consultative process and key issues;
- *Chapter 2* examines the need for the development and alternative products and operational methods;
- *Chapter 3* describes the operation in detail including the site layout extraction and processing operations, rehabilitation, environmental management, and infrastructure requirements; and
- *Chapter 4* assesses the existing natural and human environments and how they will interact and be impacted on by the proposed development.

The appendices contain the Director's requirements, relevant consultation letters, the project team, resource analysis results, operating licences detailed subconsultants reports, a reference list and a Form 2 (Submission of environmental impact statement) as required by the Environmental Planning and Assessment Act and Regulations.

Chapter 2

NEED AND ALTERNATIVES

Chapter 2

NEED AND ALTERNATIVES

2.1 NEED FOR THE DEVELOPMENT

2.1.1 *The Need for Sand and Gravel*

The Oakhampton quarry produces the following sand and gravel fractions listed in descending order of sales volume:

- ☐ concrete sand;
- ☐ fill sand;
- ☐ Roads and Traffic Authority (RTA) sand blend;
- ☐ 20 millimetre round river gravel for use in concrete manufacture;
- ☐ seven millimetre round river gravel mainly used for use as exposed aggregates;
- ☐ ten millimetre round river gravel, used exclusively for exposed aggregates;
- ☐ 14 millimetre round river gravel for use in concrete manufacture and as exposed aggregates.
- ☐ face gravel (mix of all sizes of round river gravel and sand); and
- ☐ oversize gravel, (plus 20 millimetre), for use as a transpiration medium and for internal road works.

Sand and gravel are the major components of concrete used throughout the construction industry for homes, commercial and industrial developments, roads, bridges, kerbing and guttering and so on.

Sand, (fine aggregate), suitable for concrete use must comply with Australian Standard 2758-1-1985 *Aggregates and Rock for Engineering Purposes Part 1 - Concrete Aggregates*. Factors such as grain shape, composition and grading of the sand must be considered. The sand must be clean, fine to medium grained, and free of deleterious materials including friable particles, material finer than 2 micrometres, organic impurities, structurally weak substances, and alkali reactive materials. The sand from Oakhampton meets these requirements and the main use proposed for the sand is concrete production within Boral's own concrete plants in the region.

Oakhampton sand also possess the necessary physical properties to meet the stringent Roads and Traffic Authority (RTA) specifications for sand in highway pavements. Oakhampton sand, (RTA blend), has been used extensively in major highway projects, including:

- ☐ F3 Freeway, (Sydney - Newcastle)
- ☐ West Wallsend Interchange
- ☐ SH23 Shortland

Boral produces around 150,000 cubic metres of concrete per annum in the lower Hunter region. Total concrete produced by the other major concrete suppliers in the region is estimated to be approximately 280,000 cubic metres per annum.

Major concrete using projects in the region include:

- ☐ Tarro Interchange;
- ☐ Kooragang Island Terminal Receival Facility;
- ☐ Kooragang Island Coal Loader;
- ☐ Dartbrook Mines - varying contracts;
- ☐ Newcastle Grammar School;
- ☐ Kingston Apartments;
- ☐ Glendale Shopping Centre;
- ☐ Grain Handling Facility - Kooragang Island;
- ☐ extension to the Greenhills Shopping Centre, Maitland;

- Fingal Bay Retirement Villas; and
- Charlestown Shopping Centre.

High demand centres for concrete are:

- Salamander Bay;
- Gateshead;
- Mayfield;
- Maitland;
- Boolaroo;
- Heatherbrae; and
- Muswellbrook.

Currently 45 per cent of Boral's total concrete sales are in the domestic housing and multiple dwellings market of the lower Hunter region. The future demand for construction sand will correlate with anticipated growth in residential development, commercial development and major construction projects in the lower Hunter-Newcastle region during the next 10 to 15 years. Department of Planning (1994) indicate that the Hunter has the third highest share of the State's projected growth from 1991 to 2016 behind Sydney and the North Coast region. There will not be straight line growth, but over the next 10 to 15 year period, sales growth is expected to be equivalent to about five per cent per annum.

Current demand for Oakhampton sand and aggregate in Boral's Hunter Valley-Newcastle concrete plants is between 140,000 and 160,000 tonnes per annum. This demand is expected to increase over the next 10 to 15 years in conjunction with residential, industrial and commercial development.

Seven to 10 millimetre rounded river aggregates are commonly used on decorative surfaces on concrete driveways, paths and swimming pool surrounds. Oakhampton aggregates have the market desired properties of even size, durability, rounded smooth finish and a red and blue colour mix.

Due to the buoyant housing construction industry it is expected that demand for exposed aggregates will continue although competition from newer driveway treatments such as concrete stencilling and stamping have the potential to affect demand. If exposed aggregates are produced in excess of paving demand, the aggregates can readily be used in concrete mixes.

Fill sand is used in numerous construction applications, including use as a support filler under house slabs, as a filter material for pipe bedding and as a drainage layer under roads. Sand used for this purpose does not have to conform to the rigid specifications outlined for specialised sands. The sand, however, needs to be reasonably 'clean' (some impurities such as charcoal, shell material and ironstaining can be tolerated) and not too fine grained.

2.2 ALTERNATIVES

2.2.1 *Other Sand and Gravel Sources*

A wide range of factors affect the selection of the optimum site for extraction of construction sand. These include the availability of sand of suitable quality and quantity to support the operation, proximity to market, suitable access to main roads, planning and environmental constraints.

Sand suitable for use in concrete has to meet Australian Standard specifications and the requirements of customers. Natural sources of sand suitable for this purpose are derived from dunes, river and lake systems, or as a by-product of other extractive processes, e.g., crushing of sandstone/conglomerate.

In the lower Hunter region, there is considerable potential for construction sand sources. The Hunter River and its banks downstream of Maitland comprise mainly thick over bank deposits of silt and clay with no sand potential. Upstream of Maitland, medium - coarse grained sands are found within the river and its embankments and selected deposits have the potential to produce medium - coarse construction sands.

The other major sources of sand in the lower Hunter region are the inner and outer sand barriers of the Port Stephens peninsula. Constraints to sand extraction on the Port Stephens peninsula are the large tracts of Crown land, (a significant proportion of which is subject to Aboriginal Lands Claims), land which is under the control of the Commonwealth for defence purposes, land contained in the Tomaree National Park, land reserved for silica sand extraction and heavy minerals such as rutile and zircon, and land under the control of the Hunter Water Corporation for water catchment and supply purposes. Coupled with the Williamstown Airport, Nature Reserves, and residential development, sand extraction is confined principally to privately owned land.

The dunes in the Belmont-Jewells Crossing area are less extensive but also suitable for use as fine aggregate in concrete. Sand extraction from the dune system in the Belmont-Jewells Crossing area has been severely restricted in the past few years. Formerly the main source of fine to medium grained sand in the lower Hunter region, the owner of the land, BHP, is phasing out these operations to enable recreational/residential development to take place. There is no opportunity to establish new sand extraction operations in this area.

Sand deposits adjacent to the entrance to Lake Macquarie such as in the channel itself and the beds of Swan and Village Bays near its entrance are suitable for this purpose but contain high levels of shell and salt. The presence of shell and salt in lake sand means these materials have to be processed by washing and/or flotation, adding significantly to the cost of the final product and hence limited use is made of this material in concrete.

Sand is also produced as a by-product of the crushing of conglomerate and sandstone units of the Newcastle Coal Measures west of Lake Macquarie and at Black Hill.

Sand from the Hunter River is generally medium to coarse grained and generally meets the upper grading requirements of concrete sand. The dune sands are fine to medium grained and generally meet the lower grading requirements of concrete sand. Boral wins fine grained dune sand from its own freehold property at Fern Bay for use as the fine sand component in concrete in the lower Hunter region. Boral depends on the medium-coarse grained river sand from Oakhampton to provide the coarser sand component of this concrete.

2.2.2 Alternative Materials

There are few alternative materials that can replace sand in concrete. Sand produced from the crushing of slag at the Newcastle Steelworks has been used as a replacement for sand in certain uses but is not considered the optimum for use in concrete.

Quarry fines, (generated by the crushing and screening hard rock to produce aggregates), are gaining acceptance as a 'sand' in the manufacture of concrete although stocks cannot always be guaranteed as quarry fines find markets elsewhere such as in asphalt as a filler, as a fertiliser, as a soil conditioner to break up clay soils and as a bulk fill material.

2.2.3 Consequences of Not Proceeding

There are several economic, social and environmental consequences of not proceeding with the extension of sand and gravel extraction at Oakhampton.

Failure to secure approval to extend extraction operations upstream of the current site will necessitate the immediate closure of the Oakhampton plant which has operated continuously since 1965. Four full-time staff will either need to be relocated or retrenched. Most of the staff live locally (some adjacent to the site) and would be severely disadvantaged by a loss of employment or relocation to more distant Boral sites.

In addition to direct employment losses, purchasers of Oakhampton's products and their haulage contractors will be economically disadvantaged. Positive economic flow-on effects of the operation, such as local purchase of plant, equipment, parts, fuels and consumables would also cease.

The major potential effect of not proceeding with the extension would be the loss of Boral's prime source of gravel and medium to coarse grained sand for concrete mixes. Boral produces approximately 150,000 cubic metres of concrete each year in the lower Hunter. Loss of the Oakhampton resource will force Boral and other local concrete producers to buy alternative gravel and sands sourced further from the concrete batching plants. These products will be more expensive due to longer haul routes and consequently the price of concrete to the consumer would be expected to rise.

The use of sand sourced from more distant quarries also has the potential to increase environmental and social effects due to increased haulage and subsequent noise and traffic impacts.

The beneficial effects of not proceeding with the development associated with the subsequent closure of the plant are listed below:

- reduction in existing heavy vehicle traffic and associated road pavement damage and noise levels;
- improvement of the existing visual amenity due to removal of stockpiles and plant; and
- reduction in existing noise levels due to extraction and processing.

Chapter 3

PROPOSED DEVELOPMENT

PROPOSED DEVELOPMENT

3.1 SITE LAYOUT AND OPERATIONS

The locations of the existing and proposed extraction areas and the associated plant site are shown on *Figure 3.1*.

The operation is relatively simple and involves a floating suction dredge which excavates sand, gravel and water from the river bed and transfers the material via a pipeline to shore. The material enters a primary screen as shown on *Figure 3.2* which removes the majority of fines and organic particles. The sand and gravel material is discharged onto a conveyor for transport either direct to the plant or onto a surge pile for temporary storage.

The sand and gravel is conveyed into the screening plant for separation into various size fractions ranging from cobbles to medium sand. The finished products are stockpiled around the plant site as shown in *Figure 3.2* prior to haulage in articulated tipplers.

3.2 EXTRACTION

3.2.1 *Extraction Plan*

The proposed extraction area shown in *Figure 3.1* is an upstream extension of the existing extraction area. The majority of the proposed extension area has previously been dredged and river processes have refilled the river channel with extractable reserves of sand and gravel.

It is planned to work the floating dredge gradually upstream towards the limit of proposed extraction, some 250 metres east of Aberglasslyn House. No definite stages are planned, and progress of the dredge will be determined by sand and gravel sales.



Figure 3.1 EXTRACTION AREAS AND PLANT SITE

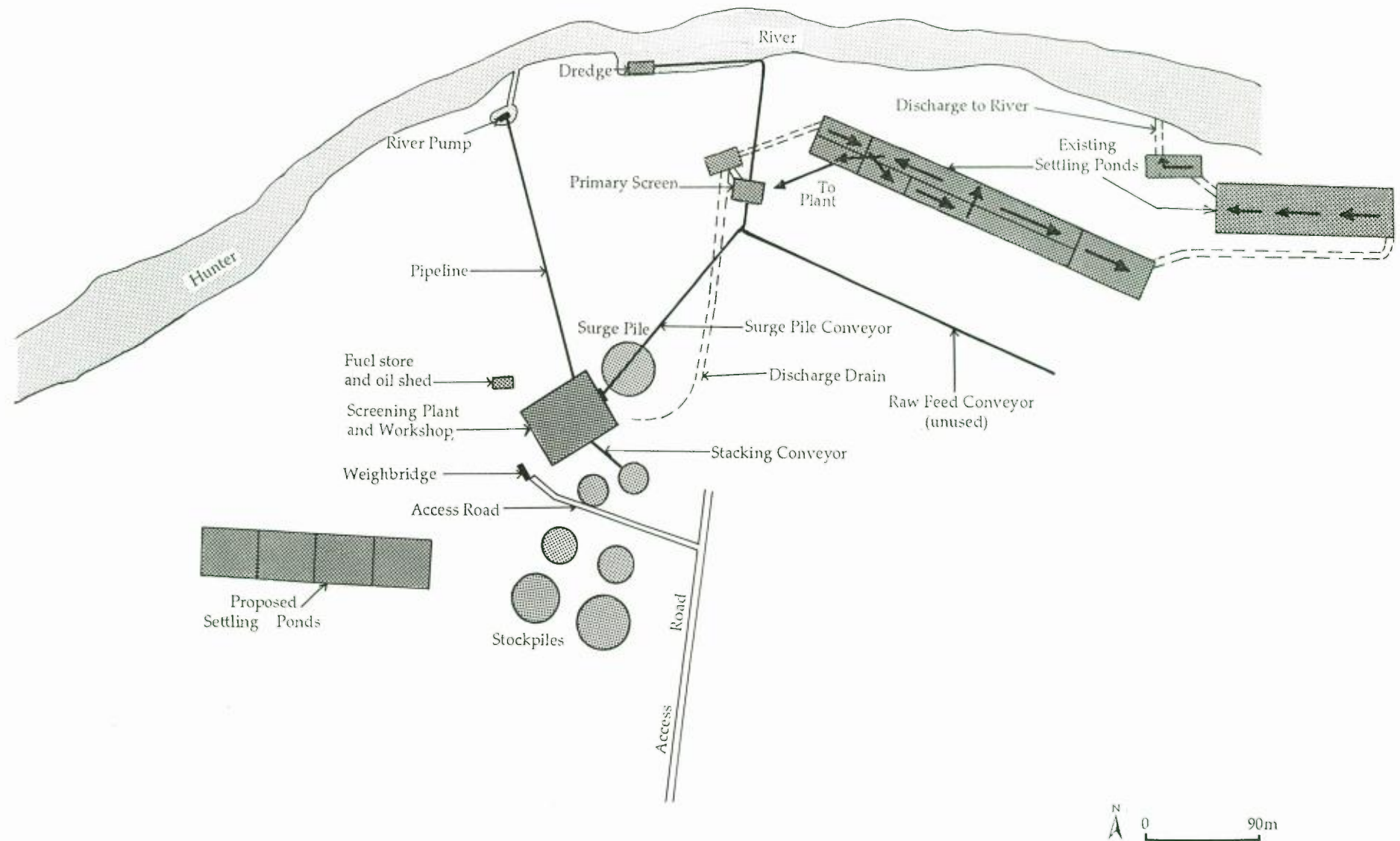


Figure 3.2 SITE LAYOUT

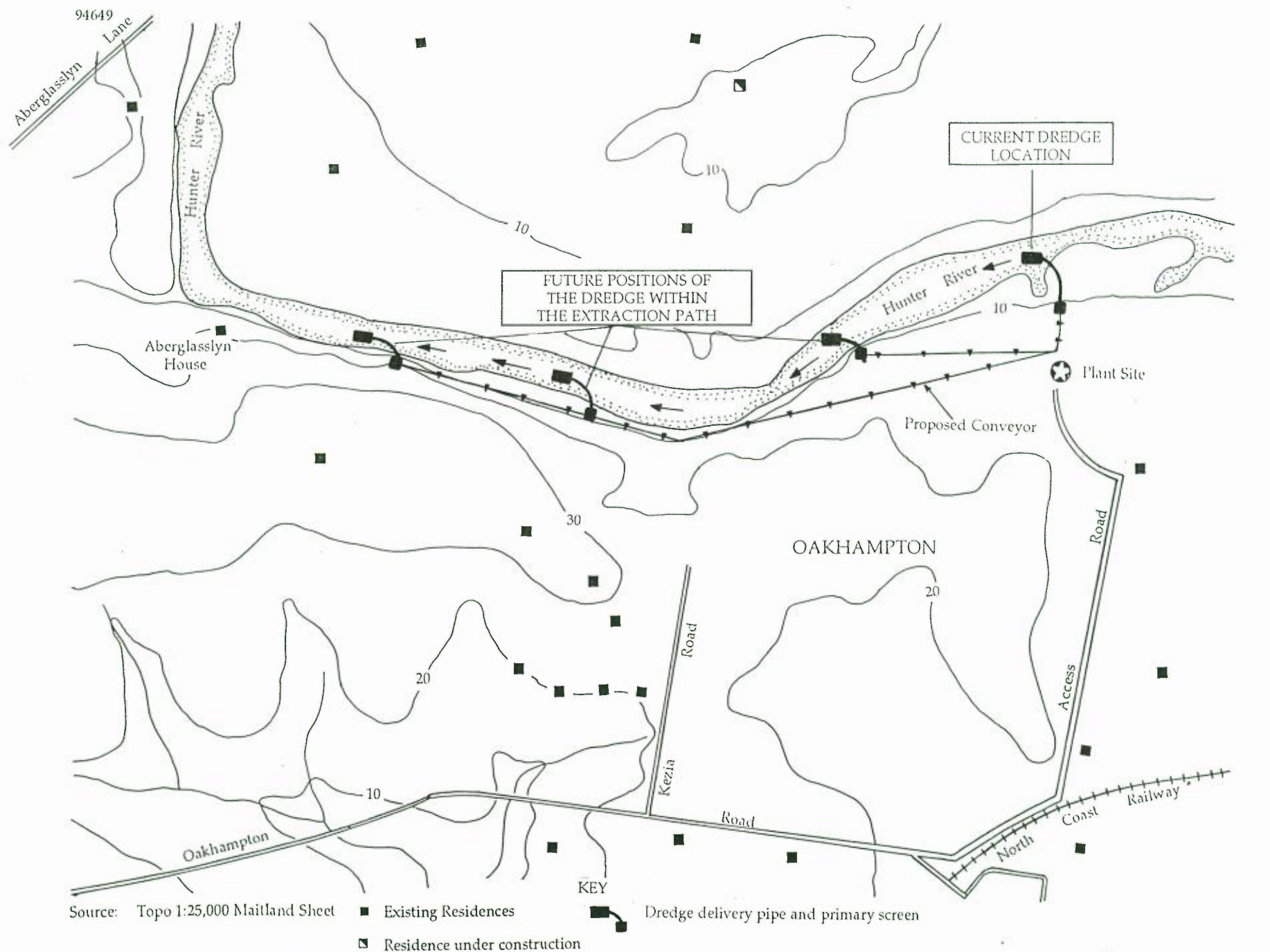


Figure 3.3 CONCEPTUAL DREDGE STAGING AND CONVEYOR LOCATIONS



Figure 3.3 shows the conceptual staging of the dredge location and the associated pipe which conveys the sand and gravel to the shore based primary screen. Also indicated on Figure 3.3 are the proposed conveyors which will transport the raw material from the primary screen to the surge pile at the screening plant. The conveyors will be built in stages corresponding with upstream progress of the dredge.

Figure 3.4 indicates a conceptual cross-section through the river showing the extractable resource and the relationship of the dredge, primary screen, and ancillary equipment.

3.2.2 Extraction Rate and Life of Operations

The annual extraction rate will be dependent on sales and is expected to vary from year to year depending on markets. The nominal annual extraction rate is currently 150,000 tonnes with an estimated annual maximum of 200,000 tonnes. No increase in production is proposed above these existing levels.

With extractable reserves of 2.5 million tonnes, the operation will continue for approximately 17 years at the average 150,000 tonnes per annum extraction rate. Given the likelihood of increased production for some of the life of the operation, it is possible that the deposit will be worked out in a shorter time.

3.3 OPERATIONS

3.3.1 Mobile Plant and Equipment

The plant and equipment currently used on site includes the following:

Mobile Equipment

- ☐ 1 x dredge;
- ☐ 2 x front end loader – Cat 966 (Boral), Cat 930 (hired);
- ☐ 1 x water cart; and
- ☐ delivery trucks as required.

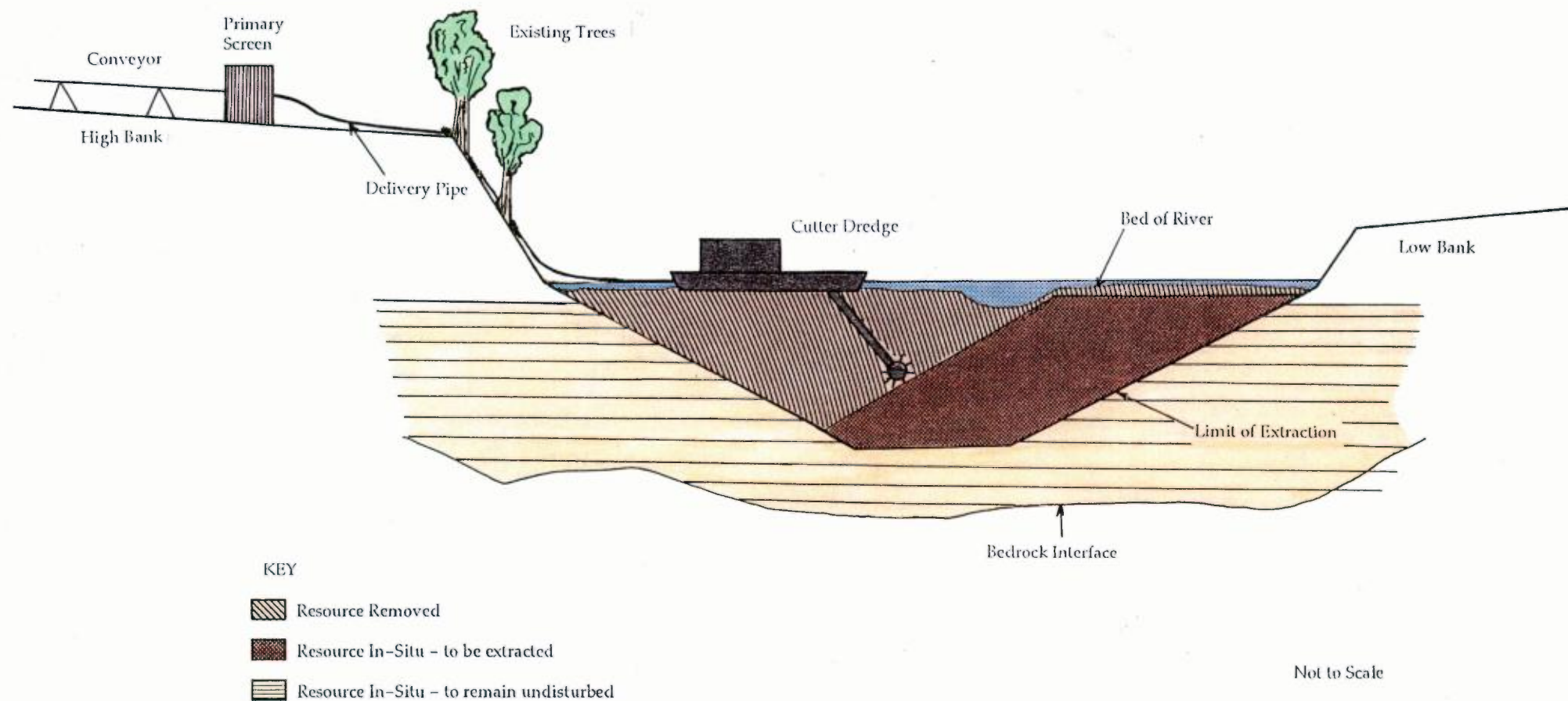


Figure 3.4 CONCEPTUAL CROSS-SECTION THROUGH OPERATIONS

Fixed Plant

- ☐ 1 x primary washing plant (including trommel, cyclone and screw);
- ☐ 1 x secondary screen;
- ☐ 1 x scrubber;
- ☐ 1 x screw;
- ☐ 1 x tertiary screen;
- ☐ 1 x classifier;
- ☐ 2 x cyclones; and
- ☐ associated bins, conveyors, classifiers and pumps.

3.3.2 Workforce and Operating Hours

Five full time staff are employed at the Oakhampton site, in addition to a maintenance contractor and a dredge operator.

The plant and dredge currently operate between 6:30am and 3:00pm Monday to Saturday.

It is proposed to change these hours to 7:00am to 5:30pm Monday to Friday and 7:00am to 3:30pm on Saturdays, for dredging, processing and sales.

3.4 WATER MANAGEMENT

Water management on the site can be divided into surface runoff and the process water circuit.

Surface runoff is a minor component as the catchment area of the plant site is small and the soils very porous. All surface runoff through the plant is contained. None is discharged to the river. Due to the relative lack of fines in the local soils, there is little potential for sediment entrainment or consequent contamination of the river.

The process water circuit is diagrammatically illustrated in *Figure 3.5*.

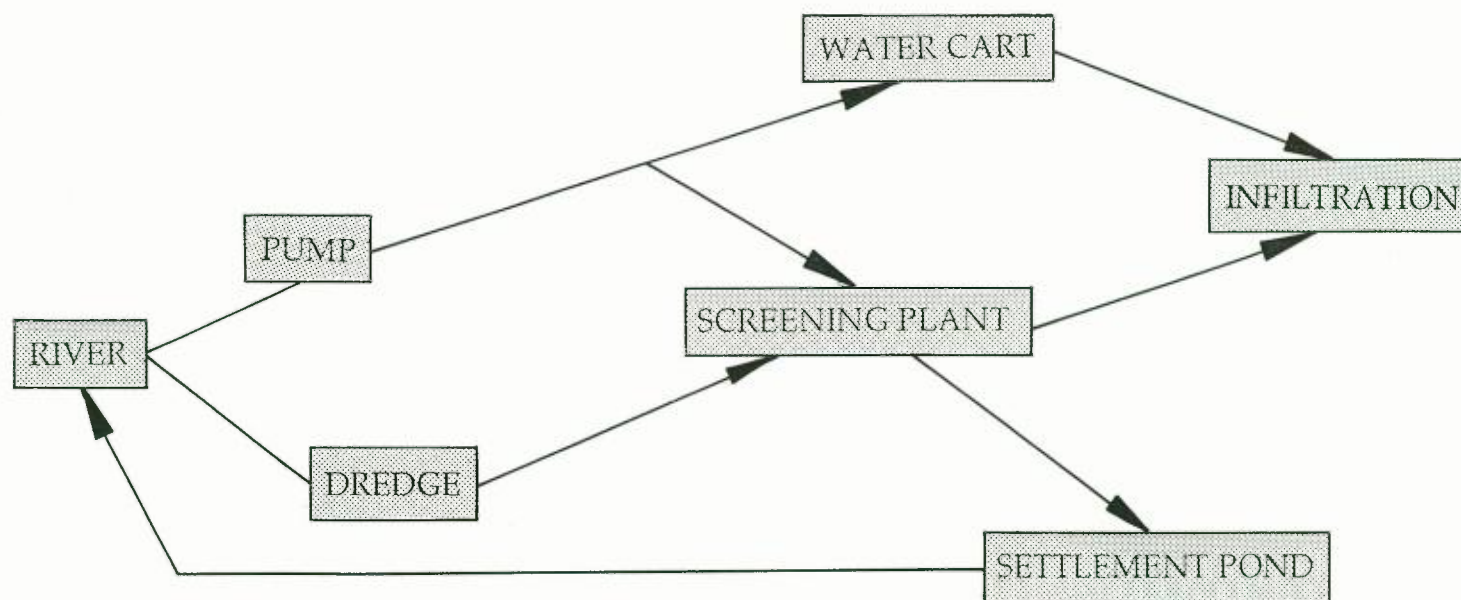


Figure 3.5 PROCESS WATER CIRCUIT

Water is pumped from the river by the floating dredge which uses water as a transport medium to convey sand and gravel to the screening plant. In addition, a large capacity licensed pump (location shown in *Figure 3.2*) extracts water for screening operations. Water is recycled to an extent within the screening plant and then drained to multiple settlement ponds currently located on the right bank of the river (as shown in *Figure 3.2*). Here the water is allowed to reside until fine materials entrained during the screening process have settled. A licensed discharge pipe drains the final pond which is required to have a non-filterable residue of no more than 30 milligrams per litre greater than the water in the Hunter River immediately upstream of the dredge at the time of discharge.

The process water circuit is proposed to remain unchanged except that the settlement ponds will be moved from the river bank to a position further from the river, west of the plant site as shown in *Figure 3.2*. Settled water will still be discharged directly to the river. The new ponds will be of sufficient capacity to hold the water until the clarification has taken place. Discharged water quality will continue to be monitored on a regular basis.

3.5 REHABILITATION

Past extraction activities removed sand and gravel from the river channel and also from banks and floodplains. As a consequence of this past activity, Boral is continuing a policy of bank restoration and revegetation. The proposed extension to extraction, however, will not disturb river banks or floodplain deposits, and consequently bank restoration and revegetation will not be required on the extension area.

Small areas associated with the proposed new settlement ponds will require rehabilitation as the ponds are established. When a series of around 12 ponds have been developed, (nine filled and three active), the first three ponds will be emptied by the excavator and the sequence of pond usage will begin again. In this way the 12 ponds will be utilised for settling throughout the life of the operation. Hence final rehabilitation of any pond will not be possible until close to the end of operations.

Once individual ponds are decommissioned, they will be capped with subsoil and topsoil sourced from the excavation of the original ponds. Following capping, the pond will be planted with native trees.

If bank slumping does occur, Boral will promptly stabilise and armour the affected section of bank.

As is common with riverside lands, noxious weeds such as Noogoora burr and castor oil plant are prevalent on the site. Boral currently employs a contractor to control these weeds with herbicide as required. This weed control will continue.

3.6 MONITORING

The current regular monitoring of the non-filterable residue component of process water discharged to the river will continue, and analysis results will be made available to Council as required. The current EPA licence restricts the non-filterable residue of discharge water to no more than 30 milligrams per litre more than the level of the Hunter River immediately upstream of the dredge at the time of discharge. This licence will be retained while ever river discharges continue and will be reapplied for on an annual basis. Any monitoring conditions required by the licence will be adhered to.

Chapter 4

ENVIRONMENTAL ASSESSMENT

Chapter 4

ENVIRONMENTAL ASSESSMENT

4.1 SITE DESCRIPTION

The site of the proposed extension of quarrying is the bed of the Hunter River five kilometres north of Maitland. The river at this point has a high bank on the southern or right bank (when viewed downstream) and an extensive floodplain on the northern or left side.

The river channel at the site is heavily infilled with sand and gravel which has been transported as a bedload during flood events.

Apart from the processing plant and extraction site, the area is mostly improved pasture used for cattle and horse grazing. The area is almost entirely cleared of native vegetation, although some spotted gum open woodland remains south-west of the site, and a small number of river oaks remain on the right bank of the river.

The Melville Ford Bridge is a low level crossing of the Hunter River which links the northern suburbs of Maitland with Maitland Vale on the northern side of the river and is located approximately 3.5 kilometres upstream of the proposed extraction site. This bridge is often overtopped in even minor river rises and an alternative river crossing is located at the Belmore Bridge in central Maitland.

The North Coast Railway crosses the Hunter River on a high level viaduct approximately 1.5 kilometres downstream of the extraction site as shown in *Figure 1.1*.

The site is accessed from Oakhampton Road which links High Street in central Maitland with Aberglasslyn Road north of Rutherford.

4.2 CLIMATE

The East Maitland-Thornton area experiences a warm temperate climate. Temperature, rainfall, humidity and wind data has been obtained from the Bureau of Meteorology's Williamstown weather station, the nearest official station to the site providing long-term, continuous meteorological records. Temperature is based on 1951 to 1991 data, and rainfall is based on 1942 to 1991 data.

i. *Temperature and Humidity*

Mean minimum and maximum monthly temperatures are shown in *Table 4.1*. Mean temperature ranges from a minimum of six degrees Celsius in July to a maximum of 27.7 degrees Celsius in January.

Mean monthly relative humidity is also provided in *Table 4.1*, and ranges from 57.5 per cent to 70 per cent.

Table 4.1 MEAN MONTHLY TEMPERATURE AND RELATIVE HUMIDITY

Mean Minimum Temperature (degrees Celsius)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
17.9	18.0	16.3	13.3	10.0	7.9	6.2	6.8	8.9	12.0	14.2	16.4
Mean Maximum Temperature (degrees Celsius)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.7	27.2	26.2	23.6	20.1	17.5	16.8	18.3	20.9	23.3	25.3	27.2
Relative Humidity (percentage)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
64.5	68.0	67.0	67.0	69.0	70.0	65.5	61.5	57.5	58.5	58.0	60.5

Source: Bureau of Meteorology

ii. *Rainfall*

Average monthly rainfall and number of raindays is shown in *Table 4.2*. Average annual rainfall is 1124 mm, with 137 mean number of raindays per year. The period of highest rainfall is from January to June.

Table 4.2 RAINFALL

Monthly Rainfall (millimetres)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
109	116	120	103	107	121	69	82	58	81	75	83
Mean Number of Raindays											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
12	12	12	11	12	13	10	11	10	12	11	11

Source: Bureau of Meteorology

iii. *Wind Speed and Direction*

Wind speed and direction data for representative seasons of the year is shown in *Figure 4.1*. The wind roses show that during summer, the predominant wind direction is from the east and south-east, with stronger winds during the afternoon. In autumn and winter months, morning breezes are predominantly from the west and north-west, with south and south-east breezes increasing in the afternoons. In winter, stronger winds generally blow from the west to north-west.

It should be noted that the above data came from a meteorological station nearer to the coast than the proposed site, and that particular coastal conditions, such as afternoon sea breezes, would be less prevalent at the proposed site, located further inland.

4.3 GEOLOGY

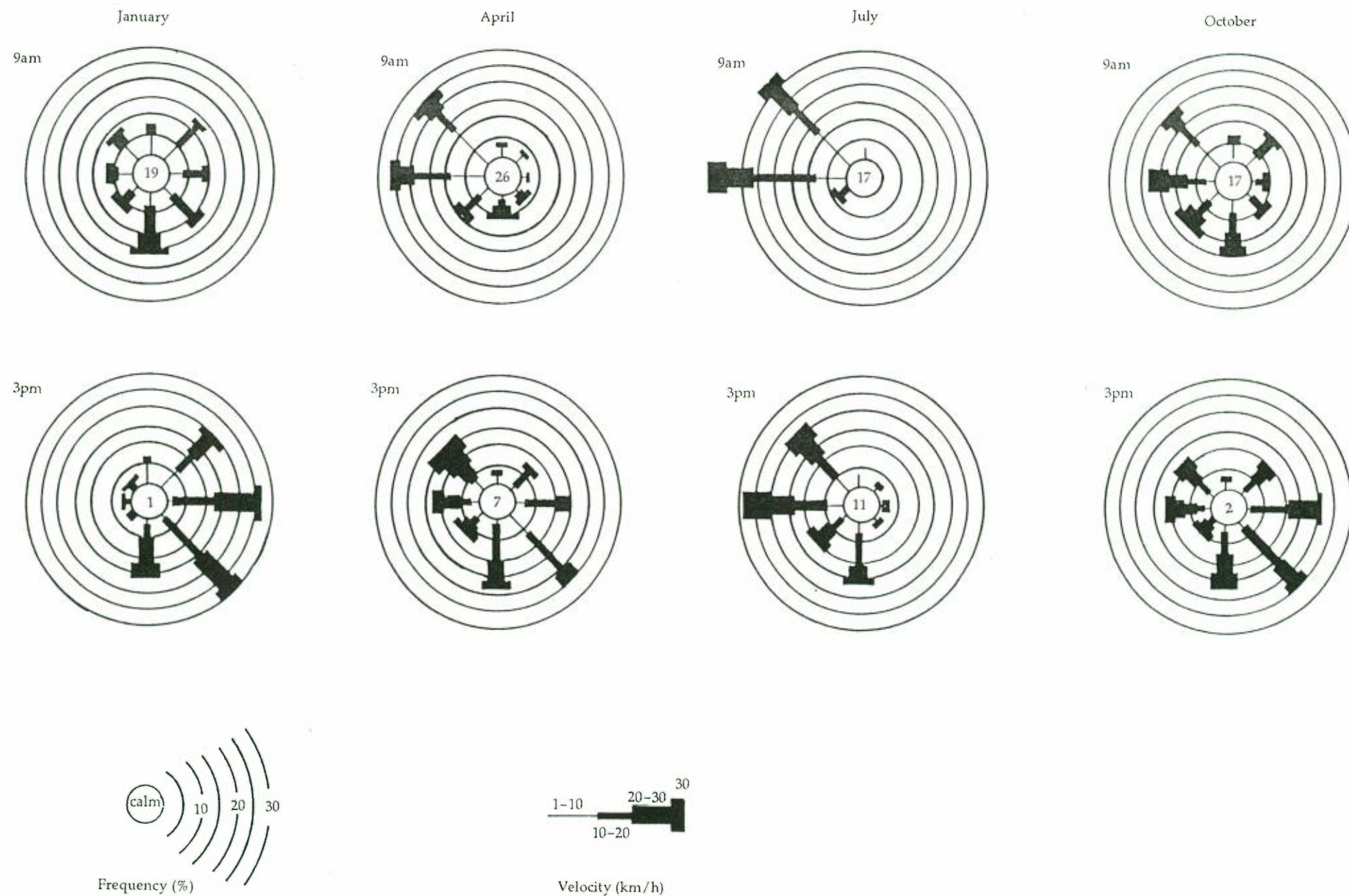
4.3.1 *Regional and Local Geology*

The Hunter River meanders in an easterly direction along a valley that follows the Hunter Valley Thrust fault. Through the Quaternary period the Hunter River has given rise to a broad floodplain composed primarily of gravel, sand and silt transported from the hinterland. Deposits of sand and gravel can be found associated with the Hunter River from Muswellbrook to the coast.

The percentage and composition of sediment types varies greatly reflecting location in the catchment and the differing geology of the regions supplying the river with sediment. The composition of the sand is principally quartz, with some small rock fragments.

The upper Hunter supplies only small amounts of bed material. Glenbawn Dam traps 100 per cent of bed material transported to the dam's site and the Pages River stores most of its bedload upstream of Aberdeen (Erskine et al, 1985). The Goulburn River supplies the bulk of the Hunter River bedload.

Extensive historical land clearing for agricultural purposes and associated grazing and cultivation has caused widespread soil erosion in the Hunter catchment. As a result, significant quantities of fine material have been deposited in the river bed.



Source: Bureau of Meteorology Williamtown Station No. 061078.
Based on 48 years of records.

Figure 4.1 WIND SPEED AND DIRECTION

In the lower Hunter, the sand bed of the river is in a state of cyclical equilibrium. That is, the river stores sediment in channel and benches during periods of lower rainfall and drought, and mobilises this sediment during higher rainfall or flood periods. The major floods of 1949 and 1955 deposited large amounts of fine to medium grained quartz sand and silt in the river channel and floodplain. Since then smaller floods have also deposited large quantities of sand and silt principally in the bed of the river. The historically recent addition of fine to medium sand has in places lead to aggradation or filling of the river channel.

Large amounts of fine sand overlies and is intermixed with older gravel and coarse sand which are remnants of a higher flow regime (Webb, 1989). The addition of fine to medium grained flood sand in recent years has contaminated many established gravel extraction sites that work the older coarse sand and gravel deposits. This has reduced the gravel bedload recovery rates to varying extents (Webb, 1989).

The Oakhampton deposit is very variable in nature and the general vertical sequence passes through fine to medium flood sand, mud lenses and horizons, Permian gravel and finally the relatively old New England gravels (Webb, 1989).

At Oakhampton large quantities of fine to medium flood sand continue to be deposited in the low flow channel and have not been flushed out by floods. As a result the older gravels and coarse sand are progressively being buried. It is expected that only an extremely large flood event would remobilise the older gravels and coarse sand of the main channel floor (Webb, 1989).

The river at Oakhampton is laterally confined in places by bedrock which appears to have controlled historical changes in the course of the river. Webb, 1989 states that the 1955 flood in the Hunter River caused the low bank to migrate 25 metres northward towards Comerfords Hill due to severe undercutting. This same flood removed all the trees on this bank. Outcrops of underlying consolidated sediments of Permo-carboniferous age occur at the base of the river bank mainly on the downstream edge of bends in the river. These outcrops are composed of massive, quartz-lithic sandstone units interbedded with softer claystones and shales (Resource Planning, 1983). No rock bars are evident at shallow levels in the river and due to the extensively silted nature of the channel, significant pools appear to be limited to the dredge pond.

4.3.2 Gravel and Sand Resource

The total gravel and sand reserves within the proposed area of extraction are estimated to be approximately 1.6 million cubic metres or approximately 2.5 million tonnes. The following assumptions were made in determining the resource volume:

- an allowance was subtracted from cross sectional areas to correspond with the low flow river channel;
- the maximum depth of proposed extraction is estimated at 16 metres;
- in accordance with the Department of Water Resources guidelines the edges of the channel will slope at a 1:2 ratio (metres vertical/metres horizontal); and
- to convert the volume of material to mass it was assumed that the extracted sediment has a bulk density of 1.60 tonnes per cubic metre.

Appendix D lists test results conducted on Oakhampton sand and gravel between 1990 to 1994. The results show that the resource consistently achieves or exceeds specifications for concrete aggregates, concrete, sand and bridge sand.

4.4 SOILS

4.4.1 Soil Description

The proposed extraction area is limited to the active channel of the Hunter River and consequently, a soil survey was conducted only of the land areas proposed for disturbance by the conveyor belt and settlement ponds.

A soil profile was described at the site of the proposed new settlement ponds adjacent to the plant site. The soil is a red brown earth (Db 3.22 in Northcote terminology) with a loamy topsoil underlain by a thick silty clay loam A₂ horizon. A deep medium clay B horizon extends at least to 40 centimetres and probably to weathered rock.

Observations on the site confirm that this soil type with minor variation occurs over the general area except in the more regularly flooded areas. Soils here consist of typical river loams and sands, the distribution of which are controlled by depositional history and flood velocity.

4.4.2 Topdressing Suitability

The described profile was assessed in accordance with Elliott and Veness (1981) to determine its suitability as topdressing medium. The results of the assessment are recorded in *Table 4.3*

Table 4.3 TOPDRESSING SUITABILITY ASSESSMENT

Characteristic	Horizon		
	A ₁	A ₂	B
Structural suitability	◆	□	◆
Ped coherence	◆	□	◆
Absence of mottling	◆	◆	◆
Ped size	◆	□	◆
Ped disruption force	◆	◆	◆
Texture	◆	◆	◆
Gravel and sand content	◆	◆	◆
pH	7.0◆	6.0◆	6.5◆

Note: Suitable ◆ Unsuitable □

The assessment recorded in *Table 4.3* suggests that both the A₁ and B horizons are suitable as a topdressing media. The thick recorded A₂ horizon (25 centimetres) lacks structural suitability and coherence as is typical for similar duplex soils.

The difficulties associated with stratified soil stripping by earthmoving machinery will necessarily result in some mixing of the A₁ and A₂ horizons. This mixing is not expected to be problematical as the A₂ horizon is neither bleached nor shows signs of high dispersibility.

Given the minimal area of proposed disturbance and subsequently low volumes of topdressing material needed, only the A₁ horizon will be selected for stripping. Sufficient topsoil exists within the proposed settlement pond site to adequately topsoil ponds as they are decommissioned.

4.4.3 Acid Sulphate Potential

Acid sulphate soils and sediments (ASS) are those which contain pyritic sulphur, which has oxidised on contact with the atmosphere to produce quantities of sulphuric acid which consequently cause a drop in the soil or sediments pH. Those materials which contain as yet unoxidised pyrites are called *potential* acid sulphate soils and sediments (PASS).

To be considered ASS or PASS the soil or sediments under question must have had a marine influence either currently or historically as it is the saline sea water which provides the sulphur that anaerobic bacteria convert to pyrite by reduction of sulphates and iron oxides.

In addition to a marine influence, the soils or sediments must currently be underwater. Any material which is dry will have oxidised previously and almost certainly the sulphuric acid formed will have been leached out.

The sediments at Oakhampton are currently underwater and have at least a minor marine influence. However, likelihood of these sediments being PASS is limited by the following factors:

- no PASS materials have been dredged from the site during past operations. Any PASS material would have oxidised in the stockpiles and the low pH affect would have been obvious by its effect on machinery, vegetation and the concrete containing the sand and gravel;
- the marine influence both currently and historically is minimal and irregular thereby limiting the sulphur supply. Lower past sea levels would have caused even less marine influence;
- the Oakhampton reach of the Hunter River cuts through bedrock, soils formed in-situ on bedrock, and freshwater sediments only. There are no marine sediments on the site;
- the bulk of the in-channel sediments have been deposited during European occupation of the country from sediment sources upstream. These sediment sources have no PASS potential due to their terrestrial origin; and
- river sediments are constantly deposited and mobilised by oxygen rich flowing water. This environment is not suited to the growth of anaerobic bacteria which produce pyrites in a reducing (that is non-oxidising) environment.

It can be concluded that the sediments proposed for extraction at Oakhampton have no acid sulphate potential, based on the following factors:

- lack of sulphur availability;
- free supply of oxygen;
- the aquatic nature of the environment; and
- site observations since the 1960's.

Similarly, the overbank deposits of sand and silt from flood events and the terrestrial soils to be disturbed for the proposed settling ponds, would also have no acid sulphate potential.

4.4.4 Existing Erosion

Apart from the bed of the Hunter River which consists of unconsolidated mobile sediments, the site and general area exhibit few signs of soil mobility. The river banks are generally well vegetated and stable except for point bars and mobile deposits. Historically, some erosion and bank slumpage has occurred on river banks adjacent to sand and gravel extraction within the river. These unstable areas were progressively rehabilitated and stabilised and are not within the proposed extraction area.

Further away from the river, the regularly inundated river flats are geomorphically areas of general deposition rather than erosion, and are currently protected from scour by a thick pasture cover.

The predominantly duplex soil slopes adjacent to the river flats are predominantly used for grazing and currently show limited signs of erosion, although minor sheet erosion could be expected to occur given appropriate climatic conditions.

4.4.5 Impacts on Soil Resources

The proposed development will have a minimal area of disturbance and will consequently have only a negligible impact on the site's soil resources.

The area of the relocated settlement ponds will be rehabilitated with topsoil sourced from the site and is expected to be able to support similar improved pasture to that which current exists.

The conveyor belt to transport raw material from the dredge to the plant will be supported at regular intervals by stands. Whilst these stands will have foundations, they will have a negligible impact on the soils.

The existing very low levels of erosion observed at the site are expected to continue and impacts on the extent or severity of erosion are not expected. Continued rehabilitation of areas alongside the river channel previously extracted will continue and will help reduce the minor erosion occurring in these areas.

4.5 HYDROLOGY AND SEDIMENT TRANSPORT

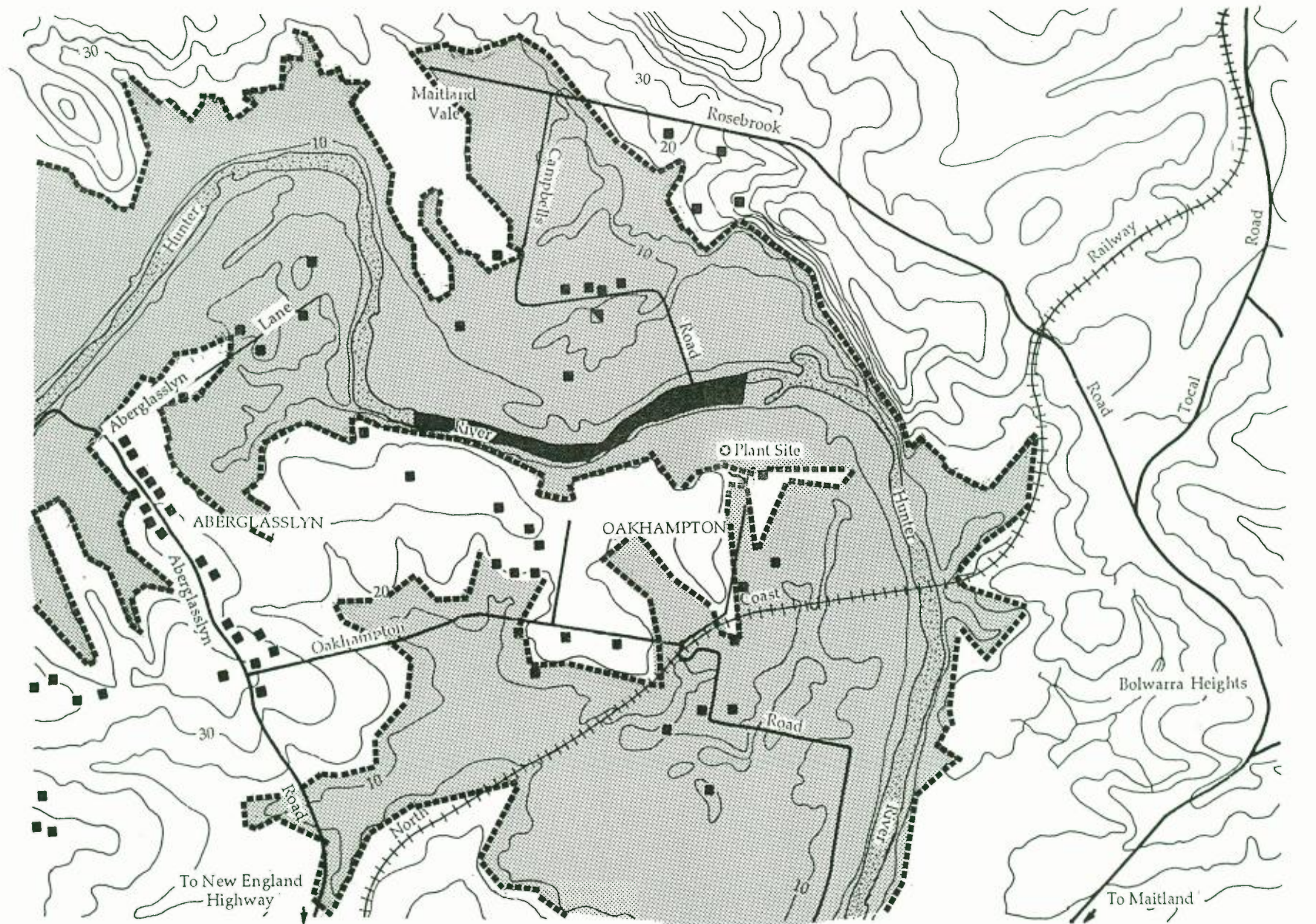
4.5.1 *River Hydrology*

i. Existing Environment

The Hunter River and its tributaries cover an area of 22,000 square kilometres, extending from Newcastle inland for approximately 400 kilometres (Mitchell and Pilgram, 1988). The catchment of the Hunter River at Oakhampton is approximately 17,500 square kilometres (Parfait, 1988). The catchment is characterised by rugged and mountainous terrain to the north and by undulating hills to the west. The southern zone of the Hunter Valley is generally flat to undulating with extensive areas of prime agricultural river flats and seasonally inundated wetlands. Approximately 35 per cent of the catchment has slopes greater than 15 degrees, with the remainder fairly evenly divided between hilly (eight to 15 degrees), undulating to hilly (three to eight degrees) and mostly flat (less than three degrees).

The boundary between the tidal and non tidal limits of the river is located at Oakhampton adjacent to the plant site. The total area of the Hunter River floodplain is estimated to be about 1,000 square kilometres or 5 per cent of the total valley area. Rainfall in the catchment varies from 1350 millimetres in the east to less than 550 millimetres in the more western areas. Annual evaporation increases from 750 millimetres in the east to 1500 millimetres in the west.

The annual discharge for the entire Hunter River basin is estimated at $1,680 \times 10^6$ cubic metres per year or about 11 per cent of average annual rainfall (Garman, 1980). The long term average annual flow at Maitland is 912,000 megalitres per year (Day, 1982).



Source: Department of Public Works, Webb, McKeown and Associates, 1994

- KEY
- Proposed Extraction Area
 - 1955 Flood Level
 - Existing Residences
 - ▣ Residence under construction

Figure 4.2 1955 FLOOD LEVEL

From year to year the Hunter River exhibits marked variations in annual flow. During periods of drought, flow can be non-existent with the record period of zero flow being 138 days in 1940 (Water Resources Commission, 1980). In contrast, the record flood of the Hunter River in 1955 had a peak freshwater discharge of 10,000 cubic metres per second at Belmore Bridge near Maitland (NSW Public Works, 1972).

The lateral extent of the 1955 flood level is shown in *Figure 4.2* and it can be seen that the Boral Oakhampton plant site is within this flood zone as are large areas of land to the north and south of the site. The edge of the low flow level is contained well within the stable river banks.

Table 4.4 shows flood heights recorded by NSW Public Works at Belmore Bridge in Central Maitland for various flood events. The results of flood frequency studies for the Hunter River at Maitland by the Department of Water Resources are summarised in *Table 4.5*

Table 4.4 HUNTER RIVER FLOOD LEVELS, BELMORE BRIDGE, CENTRAL MAITLAND

Date of Flood	Designated Return Period (Years)	Level (metres AHD)
March 1978	1 in 10	9.6
1971	1 in 20	11.0
1955	1 in 200	12.0

Source: Department of Water Resources
Webb, McKeown and Associates, 1994

Table 4.5 FLOOD DISCHARGES AT MAITLAND

Return Period (Years)	Flood Discharge (cubic metres per second)
2	740
10	2460
50	7020
100	10080

Source: Department of Water Resources, 1988

Although a recent flood study by Webb, McKeown and Associates for the Maitland City Council did not extend far enough north to cover the Oakhampton area, it does make a number of relevant findings regarding flooding in the area. The study found that the 1955 flood which was previously considered to be a 1 in 100 year event should now be considered rarer, suggesting that it was more likely to be a 1 in 200 year event.

ii. Impacts

The overall hydrological characteristics of the Hunter River will remain unaltered as a result of the dredging. That is, the extraction will have a negligible impact on flood velocities and heights, the existing course of the river will be maintained and the overall geometry of the existing channel will only be marginally altered in the short term. Past extraction has shown that dredged areas are soon infilled with river sediments and the affect of dredging on the low flow channel width and alignment will be temporary only. Formation of the dredge pond will increase the sediment trapping ability of this section of the river by a volume equal to the extraction volume.

No snags exist in this section of the channel, due to the general lack of riverside trees and continued extraction will not impact on this aspect of the channel.

No bed slope controls exist in this depositional section of the river and in any event cutter dredges are unsuited to removing rock or consolidated sediment bars.

4.5.2 Sediment Transport

i. Assessment

The capacity of the river to transport sediment is important as it helps to determine how much sand and gravel can be extracted on a yearly basis without causing channel and bank instability, however due to the complex nature of sediment transport in river beds, the transport capacity of the Hunter River is difficult to assess with confidence.

The Department of Water Resources has directed that to ensure extraction is carried out on a sustainable basis, the total bedload removed from the river must generally not exceed the amount being transported to it from upstream. The NSW Sand and Gravel Extraction Policy for Non Tidal Rivers has a similar focus.

The estimated sediment transport capacity of the Hunter River at Oakhampton is 470,000 tonnes per annum (personal communication Department of Water Resources, 1995) based on a computer model of the Ackers-White function.

The past total annual excavation rate of sand and gravel from the Hunter River above Oakhampton is 600,000 tonnes based on the average production figures compiled by the Department of Mineral Resources between 1989 and 1992. Collins Exposed Aggregates Pty Limited, a major producer of sand and gravel from the Hunter River near Denman extracted approximately 320,000 tonnes in 1992. This company now extracts within a cut-off meander away from the active channel of the Hunter River, and therefore an estimated 280,000 tonnes would be predicted to be extracted annually from the active channel based on 1989 to 1992 figures. The total estimated volume currently extracted from the active zone of the Hunter River, above Oakhampton is approximately 340,000 tonnes per annum based on 1992 to 1993 production figures.

Thus the total estimate extraction above Oakhampton is lower than the estimated sediment transport capacity at that point.

ii. Impacts

Even allowing for say a 25 per cent overestimate in the 470,000 tonnes per annum sediment transport mass, the known total extraction within the active channel of the Hunter River will be insufficient to cause channel degradation.

4.5.3 Groundwater

Groundwater resources in the area are limited to an extensive low salinity alluvial aquifer in the floodplain (Maitland Rural Lands Study, 1988). It is of variable quality and is not utilised extensively. There are no wells or bores located at the processing plant or in adjacent areas.

It is expected that some rainfall in the processing plant area would infiltrate surface soils. However, this would be minimal and would have little impact on groundwater quality or quantity.

4.5.4 Water Quality

Since 1989 Boral have been sampling and analysing water from the Hunter River upstream and downstream of the Oakhampton quarry site. More recently the company has been sampling from the river and the water discharge channel leading from the Oakhampton plant to the river.

Provided below, (in Table 4.6) is a comparison of average non-filterable residue and pH values calculated from 44 samples taken throughout 1994.

Table 4.6 AVERAGE VALUES OF NON-FILTERABLE RESIDUE AND pH IN WATER SAMPLES, 1994

1994	Non-filterable Residue (mg/L)	pH
Upstream of extraction area	25.2	7.7
Water discharged to river	23.9	7.8

Source: Boral Concrete and Quarries, river water sampling program

The average non-filterable residue level of water discharged to the river in 1994 was lower than that of the upstream average indicating an effective water clarification system. The average level is also in accordance with the Environmental Protection Authority (EPA) Pollution Control Licence which specifies that *wastes discharged shall not contain more than 30 milligrams per litre of non-filterable residue more than the waters of the Hunter River immediately upstream of the dredge*. A copy of the EPA licence is attached in Appendix E.

It is proposed to move the existing settling ponds to the opposite side of the plant but further away from the river bank. This move would act to protect the condition of the river bank.

i. *Potential Interactions*

Because of the nature of the operation the only potential interactions with water quality are:

- ☐ contamination of the river from oils and greases used around the plant site being washed from the site;
- ☐ contamination from human wastes; and
- ☐ contamination from sediment laden water.

It must be noted that this document deals with the extension of extraction operations and not the existing plant site and therefore will not deal with impacts of the plant site in great detail.

Drainage controls already exist at the plant site to ensure the preservation of water quality downstream of the site. The fuel storage facilities are bunded and operator facilities are provided with a septic system designed to the requirements of relevant authorities. The extraction and processing operations comply with the requirements of the New South Wales Clean Waters Act, 1970.

ii. Impacts

Moving the settlement ponds further away from the river bank would decrease impacts on the river bank such as erosion, river bank stability and sediments transported back during flood events.

All process water and excess rainfall from the plant site area is directed to settling ponds where the fine clay and silt carried in suspension is settled out and the clean water recycled.

During periods of flood any material washed down from the raw material pad will not have a significant impact, as the river will already be carrying very high loads of suspended matter from natural causes.

Since the processing operation does not require the use of any chemicals, and flocculants are not used in the settling ponds, the operation is not expected to have any effect on the chemical quality of the water in the river or groundwater. Similarly, the operation is expected to have no effect on the salinity of the water in the river.

If flocculants are used in the future in conjunction with the new settling ponds, only flocculants which will not impact on water quality within the river will be used. The DWR will be consulted before any decision is taken to use flocculants at Oakhampton.

Refuelling of the dredge is undertaken offshore. A distillate fuel delivery pipe from a mobile tanker is floated across to the dredge in a dinghy. The delivery hose is attached to the dredge refuelling port prior to the hose being pressurised. Any accidental spills which would potentially occur would be contained by the sealed sump below the refuelling port. Following refuelling, the delivery hose is returned to shore with the hose end secured to the dinghy. The potential for even minor fuel spills is limited and no impacts on water quality are expected.

All processes will be very similar to those carried out at present and therefore will not change the current situation which generates no measurable impacts on water quality.

4.6 FLORA AND FAUNA

A detailed survey of the proposed extraction site and adjacent terrestrial and aquatic environments was undertaken by Australian Water Technologies-Ensign (AWT-Ensign) and the results of this survey are reproduced in *Appendix F*. The following sections summarise the AWT-Ensign report.

4.6.1 Aquatic and Riparian Vegetation

The Hunter River at Oakhampton consists of a wide, shallow, sandy channel dominated by point bars, mid-channel bars and lateral bar deposits. The river meanders through farmland and the riparian zone has been highly modified.

Port Jackson Figs (*Ficus rubiginosa*), Red Kamala (*Mallotus philippensis*) and Tuckeroo (*Cupaniopsis anacardioides*) occur with River She-oaks (*Casuarina cunninghamiana*) and Ornamental Olives (*Olea europaea africana*) beneath the steep, sheltered embankments downstream of Aberglasslyn House. Wandering Jew (*Tradescantia albiflora*) is the dominant ground cover in heavily shaded areas such as this. Elsewhere, few trees remain along the river banks except for the southern slopes of Comerfords Hill which is located downstream of the current extraction area. The remaining trees are mainly River She-oaks and Weeping Willows (*Salix babylonica*). Where trees are absent, Couch Grass (*Cynodon dactylon*) and Castor Oil Plant (*Ricinus communis*) dominate the flora. Couch forms a dense sward and plays a major role in stabilising the river banks. Noogoora Burr (*Xanthium occidentale*), Buchan Weed (*Hirschfeldia incana*) and various grasses are also common in these open areas. Some 75 per cent of all species in this zone are exotic.

The sand bars are sparsely vegetated by herbs and sedges, of which approximately 60 per cent are exotic weeds. The dominant flora of this zone are Couch, Noogoora Burr, Fleabane (*Conyza* spp.) and Bushy Starwort (*Aster subulatus*).

Little aquatic vegetation is present in the channel of the Hunter River between Aberglasslyn House and Comerfords Hill (between which points lies the proposed extraction area) except for emergent macrophytes along the edge of the river. This is not surprising given the mobile nature of the bottom sediments. In addition, there are few snags and very little organic debris as there is no well-developed riparian zone. Club-rushes, *Bolboschoenus medianus*, and Water Couch, *Paspalum distichum*, are major components of the river edge along the aggrading banks; the lateral and point bar deposits of sand and gravel support few macrophytes. The Water Fern, *Azolla* sp., is found along the river wherever there is protection from the current such as in backwaters and amongst emergent macrophytes.

The only significant submergent aquatic vegetation occurs on a bend of the Hunter River opposite Comerfords Hill, where it covers approximately 30 per cent of the channel, although this is outside the proposed extraction area. The introduced Fanwort, *Cabomba caroliniana*, has not previously been recorded from the Hunter River (Royal Botanic Gardens). Its presence is cause for concern as this species has the potential to become a serious weed of waterways (Jacobs 1990).

The floristic composition of the riparian zone is typical of coastal rivers in eastern Australia. All species are widespread, and many are exotic weeds that colonise disturbed land and pastures. The occurrence of the Marsh Club-rush, *Bolboschoenus medianus*, is a new record for the north coast. It is very similar in appearance to *B. fluviatilis* which is common along coastal rivers.

4.6.2 Macroinvertebrates

The macroinvertebrate fauna comprised about 100 species (listed in *Appendix C*). They are common and widespread species that are typical of the freshwater reaches of large lowland rivers (cf. Chessman and Grouns 1994; Williams 1994). Some estuarine elements such as penaeid prawns were also present.

The number of species per site in the edge habitat was very similar at all sites surveyed, with the exception of the site on the eastern bank of the current dredging pond, which had only about half as many species as the other sites. The only common species at this site were small snails (*Austropeplea* sp.), the mayfly nymph *Tasmanocoenis* sp., and the water boatman *Micronecta batilla*. *Tasmanocoenis* is much more tolerant of siltation and sediment movement than other types of mayflies, since it has protective covers that shield the abdominal gills. It is typically one of the few common species in mobile, sandy river beds (e.g. Hogg and Norris 1991). *M. batilla* is also a tolerant species, being highly mobile within the water column and breathing at the surface. It typically dominates the edge habitat in disturbed lowland rivers (e.g. Chessman and Robinson 1987).

Species that were rare or absent in the edge habitat at the dredge pond site, but were common at most or all of the other sites, included the clam *Corbiculina australis*, the introduced snail *Physa acuta*, the shrimp *Paratya australiensis*, damselfly nymphs, the beetle larva *Lancetes* sp., the blackfly larva *Simulium nicholsoni* and leptocerid caddis fly larvae. Clams are sensitive to dredging and relatively slow to recolonise disturbed areas, and blackfly larvae filter the water using delicate fans on the head, which could be affected by mobile sediment. The other species mostly breathe using gills, and could be affected by smothering of these respiratory surfaces by fine sediment.

The wood and snag habitat was absent from the dredge pond, but supported a similar community at the other sites. More species were recorded in the current and recent dredging area than in the past and proposed extraction zones.

4.6.3 Fish

The sixteen species of fish detected in the river at Oakhampton are listed below and reports of another two species, the Eeltail Catfish (*Tandanus tandanus*) and Flathead (probably *Platycephalus fuscus*), were received from local inhabitants (Mr John Kershaw, a Boral employee, and Mr R. Jackson, owner of "Jacksonville" which adjoins the river):

- ☐ Short-finned Eel (*Anguilla australis*);
- ☐ Long-finned Eel (*A. reinhardtii*);
- ☐ Freshwater Herring (*Potamalosa richmondia*);
- ☐ Australian Smelt (*Retropinna semoni*);
- ☐ European Carp (*Cyprinus carpio*);
- ☐ Mosquitofish (*Gambusia affinis*);
- ☐ Bullrout (*Notesthes robusta*);
- ☐ Australian Bass (*Macquaria novemaculeata*);
- ☐ Sea Mullet (*Mugil cephalus*);
- ☐ Striped Gudgeon (*Gobiomorphus australis*);
- ☐ Cox's Gudgeon (*G. coxii*);
- ☐ Empire Gudgeon (*Hypseleotris compressa*);
- ☐ Flathead Gudgeon (*Philypnodon grandiceps*);
- ☐ Dwarf Flathead Gudgeon (*Philypnodon* sp.);
- ☐ Yellowfin Goby (*Acanthogobius flavimanus*); and
- ☐ Yellowfin Bream (*Acanthopagrus australis*).

Australian Museum records indicate the presence of an additional three species, the Tamar River Goby (*Favonigobius tamarensis*), Largemouth Goby (*Redigobius macrostoma*) and the Jewfish (*Argyrosomus hololepidotus*). All species are common and widespread in the coastal rivers of south-eastern Australia, although there is some concern about the status of the Freshwater Herring over parts of its range (Koehn and O'Connor 1990). Three species are exotic – the Mosquitofish, European Carp and the Japanese Yellowfin Goby. The Yellowfin Goby was accidentally introduced to Australia in the early seventies, probably via the bilge water of cargo ships (Gomon *et al.* 1994), and is now common in the estuarine reaches of a number of Australian rivers.

The Mosquitofish, Sea Mullet, Flathead Gudgeon and Long-finned Eel were the most widespread and abundant species detected by the survey. Some species, such as Australian Bass and Freshwater Herring, were apparently uncommon but this may have been because the sampling methods used were less efficient in collecting these species. Herring are mainly an open water species (Briggs 1980) and Bass prefer deep holes and areas with overhanging trees, snags or boulders (Koehn and O'Connor 1990; *pers. obs.*).

Mosquitofish, Carp, Flathead Gudgeons, Dwarf Flathead Gudgeons and Empire Gudgeons were found amongst reeds, rushes and overhanging water couch along the edges of the river and in backwaters. Bream were found in similar habitats but only in the main channel. Mosquitofish often swam near the surface close to grass cover whereas Empire Gudgeons were well concealed. Both species of Flathead Gudgeon rest on the bottom (Merrick and Schmida 1989). Striped Gudgeons were caught in the shaded thalweg of the river in moderate current, amongst boulders along the edge of the river and beneath overhanging grass. Cox's Gudgeons were generally found along the river edge amongst macrophytes or under overhanging grass. Both Long- and Short-finned Eels occurred along the river edge amongst boulders, macrophytes and overhanging grass but Short-finned Eels were confined to deeper sections in the lower reaches of the river. Bullrout were caught on the downstream end of a sand bar and in the thalweg of the river. The Bass was caught along the edge of a former dredging pool beneath the cover of a weeping willow. Mullet were observed and caught in all habitats and sections of the river.

Young Yellowfin Bream were common in the Hunter River at Oakhampton, and were caught amongst overhanging grass, macrophytes and boulders along the edge of the river. The average size of bream was 73 millimetres length to caudal fork with a range of 62 to 86 millimetres which corresponds to an age of less than 1 year (Pollock *et al.* 1983). Immature Short- and Long-finned Eels, European Carp, Sea Mullet and Bullrout were also caught.

There was no significant trend in the number of fish species with river length, which might be expected if there were differences between the tidal and non tidal reaches of the river. Also, there were no significance differences in the number of fish species occurring in reaches of the river with different histories of sand and gravel extraction (i.e. recent extraction, past extraction, no extraction).

4.6.4 Herpetofauna

One species of frog, (*Limnodynastes ornatus*) a Short-necked Tortoise, (*Emydura* sp.), and an Eastern Water Dragon (*Physignathus lesueurii*) were encountered during the survey. All three species are widespread and common. The frog was observed in grass next to the river opposite Aberglasslyn House during rain. The tortoises were observed in the river at sites close to the dredging operations. Water Dragons were observed along the river wherever trees overhung the water.

The Australian Museum has recorded another three frog species from the Maitland region including the threatened Green and Golden Bell Frog (Schedule 12, NSW National Parks and Wildlife Act). This species inhabits large, permanent swamps containing plenty of emergent macrophytes (Robinson 1994) and is unlikely to occur in the river at Oakhampton.

4.6.5 Birds

Birds observed in the Oakhampton area were typical of riparian and farmland habitats and included no rare or unusual species. A list of species is provided in Appendix F.

4.6.6 Mammals

No evidence of Platypus, *Ornithorhynchus anatinus*, was found during the survey and it is unlikely that they occur in this reach of the river. The most downstream sighting of Platypus for the Hunter River is at Singleton (Tom Grant, *pers. comm.*). The Water Rat (*Hydromys chrysogaster*) was not observed at the site and a search of the National Parks and Wildlife Service Wildlife Atlas revealed no records in the area.

An assessment of the potential of the proposed extraction area extension to affect koala habitat was conducted in accordance with the requirements of State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44). None of the species of koala feed trees listed in Schedule 2 of the policy guidelines or other trees known to be browsed by koalas are present on the site. No direct evidence was found of koalas. The site is assessed as having no potential koala habitat.

4.6.7 Impacts

The proposed extension of extraction will be limited to the channel and bed of the Hunter River and associated point bars and shoals. The banks of the river will not be disturbed by extraction or ancillary operations, and therefore potential flora and fauna impacts will be limited to the aquatic environment.

River bed siltation due to increases in suspended sediment concentrations in the water can severely reduce the density and diversity of macroinvertebrate communities (Gammon 1970; McLelland and Brusven 1980; Lenat *et al.* 1981). Fine sediment clogs invertebrate gills and creates an unfavourable habitat for non-burrowing species by smothering clean substratum surfaces and filling the interstitial spaces between sand and gravel. Such effects have been observed in streams subjected to extractive activities such as placer mining (Wagener and La Perriere 1985; Quinn *et al.* 1992), but these impacts cannot necessarily be extrapolated to the operation at Oakhampton, because of differences in mining practices and the treatment of wastes. The Oakhampton survey revealed a reduction in macroinvertebrate diversity in the immediate vicinity of the current operations, but showed no differences between recently mined sections and the areas proposed for future extraction. This is consistent with the observation of Pearson and Jones (1975) that the recovery of benthic macroinvertebrate communities after dredging operations can be rapid.

Dredging and associated sedimentation can also destroy spawning grounds for fish, especially those species that lay demersal eggs (Koehn and O'Connor 1990; NSW Department of Water Resources 1992). Increased turbidity may also interfere with the predatory behaviour of some fish and make conditions unsuitable for aquatic plants. The river at Oakhampton is used by at least some of the fish species for breeding and as a nursery area for juvenile fish. Young bream and sea mullet, for example, fit into the latter category (Thompson 1955; Pollock 1984). The Australian bass is catadromous (ie. it moves downstream to the estuary to breed) and young fish and males are very likely to be found in the lower non-tidal reaches of the river (Harris 1988). The spawning behaviour of the bullrout is unknown (Merrick and Schmida 1988) but Richardson (1984) found juveniles close to the estuary.

The severity of these types of impact depend largely on the proportion of fine particles mixed with the sand and gravel deposits (Erskine 1990), and on the method of extraction and processing (SPCC 1984). In the upper Hawkesbury River, dragline operations were found to increase turbidity much more than cutter suction dredges. Draglines disturb the fine sediments more than cutter suction dredges which pump extracted material onshore for sorting. Nevertheless, cutter suction dredging can significantly elevate turbidity downstream of the dredge (Bryce 1977), although the effect of this turbidity at Oakhampton is only a temporary reduction in the macro-invertebrate populations in the immediate vicinity of the dredge.

Current, substratum and depth are important determinants of the complexity of aquatic environments for fish (Gorman and Karr 1978). Pools, riffles, backwaters, runs and glides can be defined in terms of these variables. Riparian and aquatic vegetation and coarse non-living particulate matter will add to the complexity of habitat structure by creating microhabitats with different characteristics of flow and substratum. Richardson (1984) found that the diversity and heterogeneity of the fish assemblage was positively correlated with depth, velocity and bank cover in the Tweed River. Sand and gravel extraction can have a major impact on instream habitats because of its potential to alter channel form and river morphology (Erskine *et al.* 1985; Erskine 1990). While some of the effects of dredging might reduce the heterogeneity of instream habitats (Pearson and Jones 1975), modifications to the river channel can stabilise the channel and improve habitat quality (Erskine 1992). An analysis of the sediment budget at Oakhampton reveals that total extraction does not exceed sediment transport ability at that point and therefore morphological changes in the river bed or banks are not expected in the long term. In the short term however, dredging is expected to increase the heterogeneity of the river bed and so increase habitat diversity.

No evidence was found at Oakhampton that past and continuing dredging have caused any significant or long term effect on aquatic flora and fauna. Consequently, it is expected that an extension of dredging will have similarly low impacts.

4.7 PROPERTY OWNERSHIP AND LAND USE

4.7.1 *Property*

Landowners and their respective properties are listed in Table 4.7. Cross reference to Figure 4.3 shows the location of these properties correlating to the identification numbers listed in Table 4.7.

Property ownership in this area of the Hunter River extends to the middle thread of the river. Therefore in this instance landowners actually own the river bank adjacent to their holdings and half of the river bed. No Crown lands occur in the vicinity.

4.7.2 Land Use

i. Existing Environment

Three land uses predominate in the Oakhampton area, namely, agriculture, extractive industry and rural residential, with dairying and beef cattle grazing being the primary agricultural activities. Minor agricultural activities, such as horse and goat breeding are also carried out in the area.

Boral and Rosebrook Gravels Pty Limited operate separate sand and gravel quarries on and adjacent to the Hunter River respectively. Rosebrook Gravels Pty limited were granted development consent in 1994 to continue extraction operations on the Hunter River floodplain on the left bank north-east of Aberglasslyn House.

A rural residential development exists to the south of the proposed extraction extension area which is accessed from Kezia and Oakhampton Roads as shown on *Figure 4.3*. Several older houses are located adjacent to the main access road to the plant site as shown in *Figure 4.3*.

Figure 4.2 shows the location of rural residences along Aberglasslyn Road to the west of the development site. A large rural residential development is currently being released and built on in stages in the Aberglasslyn Estate approximately two kilometres to the south-west of the Oakhampton property.

Table 4.7 LAND OWNERSHIP

Number	Lot	DP	Owner	Address
1 – 3	12–14	37580	Rosebrook Sand & Gravel	15 Chapel St, Lakemba
4	193	246309	P Campbell	PO Box 177 Maitland
5	196	246309	Esor Nominees P/L	93 Maize St Tenambit
6	20	37580	EJ & PA Bone	Rosebrook Rd Maitland Vale
7	Portion 34		RT Comerford & J Donnelly	c/- Rosebrook Rd Maitland Vale
8	2, 4, 6 & 7	217178	LB & DR Atkins	'Rainsford' Oakhampton
9, 10 & 14	1–3 & 5	217178	Boral Resources	PO Box 42, Wentworthville
12	Lot 1–3	798084	CH Ellicott	Oakhampton Road
15	Portion 38		NC & BA Kirkwood	RMB 128 Oakhampton Park Estate, Oakhampton
16	4	248331	P Thompson	4 Keizia Road Oakhampton
17	5	248331	G Cawthorne	75 Fairfield Ave New Lambton
18	6	248331	G & S East	6 Keizia Road Oakhampton
19	7	248331	A & J Davis	Keizia Road, Oakhampton
20	8	248331	Maitland Dredging Co P/L	PO Box 229 East Maitland
21	41	611238	R Jackson	Aberglasslyn
22	1411	717879	BA Dean	Oakhampton Rd Aberglasslyn
23	3 and 5	255369	Mr and Mrs Maule	Aberglasslyn House
24	3	562346	Neil Sutherland	Lot 3 Oakhampton Road, Aberglasslyn
25	2	562346	T & M Power	Lot 2 Oakhampton Park, Oakhampton
26	1	562346	K & A Wethered	Lot 1 Oakhampton Road, Maitland
27	324	835231	T Hancock & E Burt	Lot 324 Campbells Road, Maitland Vale

Note: Numbers can be cross referenced to *Figure 4.3* to locate properties.

Source: Maitland City Council, 1995.

ii. *Interactions and Impacts*

The proposed dredging extensions will not occupy any agricultural land and no extension of the plant site is proposed. Therefore direct impacts on land use as a result of the proposal will be negligible. Potential indirect impacts such as noise, visual and dust impacts of the proposed extension on residential land uses are discussed in *Sections 4.8, 4.9, and 4.10, respectively.*

4.8 NOISE

A noise impact statement has been prepared by Boral in accordance with Australian Standard 1055, 1989 *Description and Measurement of Environmental Noise* Parts 1, 2 and 3 and with reference to the Environment Protection Authority – Environmental Noise Control Manual and the Noise Control Act, 1975, NSW. This noise impact statement is reproduced in full in *Appendix G*, and the following sections are sourced from this document.

4.8.1 *Existing Acoustic Environment*

i. *Background Noise*

A background noise survey was conducted in February and April 1995 at residences adjacent to the Oakhampton site as shown on *Figure 4.3*. The following average daytime L_{90} noise levels were measured while quarry and processing operations were halted:

- Residence A (Atkins) – 37 dB(A);
- Residence B (King) – 36 dB(A);
- Residence C (Aberglasslyn House) – 31 dB(A);
- Residence D (Hancock) – 35 dB(A).

ii. *Traffic Noise*

Vehicles access the site from the New England Highway via Aberglasslyn Road and Oakhampton Road. Although traffic flow from the operation is relatively low it still has the potential for annoyance due to the high percentage of heavy vehicles. In these situations an L_{Aeq} value is the noise descriptor preferred by the EPA.

Chapter 157-3 of the Environmental Noise Control Manual states that an L_{Aeq} of 55dB(A) should be adopted as the goal for existing situations in rural areas.

The major noise impact from traffic entering and leaving the site is from heavy vehicles using the unsealed section of Oakhampton Road just prior to the quarry. Noise levels were measured from quarry trucks adjacent to the front of Residence E (see Figure 4.3). In order to calculate L_{Aeq} for average and maximum traffic flows the sound exposure level of several quarry trucks was measured at a distance of nine metres from the roadway. The results of the measurements are as detailed in Table 4.8.

Table 4.8 TRUCK NOISE MOVEMENTS

Location	Truck Type	Sound Exposure Level dB(A)	Comments
Residence E	rigid	77.9	unloaded
	truck & dog	83.1	unloaded
	truck & dog	82.8	loaded
	truck & dog	85.1	loaded
	truck & dog	75.2	loaded
	trailer	75.0	loaded
	truck & dog	82.6	unloaded

Source: Boral

Assuming a similar distribution of traffic noise levels for loaded and unloaded vehicles the L_{Aeq} was calculated for the average and maximum traffic flow occurring over an 8 hour period at the Oakhampton Road residence. This data is shown in Table 4.9.

Table 4.9 PREDICTED TRUCK NOISE

Description		Predicted Noise Level 134 Oakhampton Rd. $L_{Aeq}(8hrs) - dB(A)$
☐	Average traffic movements (54 per day)	54
☐	Maximum traffic movements (100 per day)	57

Source: Boral

As can be seen from the above table the noise level for average traffic movements is below the EPA limit of an L_{Aeq} of 55 dB(A) for rural residences. The noise level for maximum traffic movements exceeds the EPA limit for rural residences but is below that which would be acceptable in a residential area.

The noise from transport generated by the operation at other residences on the haulage route, between the quarry and the New England Highway, will be the same or less than at this residence.

4.8.2 Noise Impact

In order to assess the impact of the quarrying operation on the surrounding area, in different stages of development, the plant and equipment at the quarry were computer modelled using the Environmental Noise Model (ENM) which has been produced in conjunction with the Environment Protection Authority. A map giving all relevant topographic features was digitised into the computer, along with noise source, ground cover and atmospheric information. The model uses this information to predict the noise at each residence and eventually to produce the Noise Contour Maps shown in *Appendix G*. The contours shown link areas with the same noise level and are in dB(A). The noise contours depict the noise levels which would occur when all equipment is operated simultaneously and at full power. Neutral atmospheric conditions were assumed.

The assigned design goal and predicted noise levels at noise modelling locations A to D (see *Figure 4.3*) are detailed below:

- Location A (Atkins) – With regard to background noise levels recorded, the planning limit for noise at this residence should be 42 dB(A).

To reduce the noise level at this residence a bund wall will be constructed. With the bund in place it can be seen from the noise contour map in *Appendix E* that the noise level at this residence will be approximately 45 dB(A) due to the processing plant and mobile equipment. This level will decrease slightly as the dredge and primary screen move upstream.

Although the level at this residence is above the suggested planning limit it is on the acceptable limit for outdoor background noise suggested by the EPA.

No complaints about noise from the operation have been received from the long term occupant of this residence.

- Location B (King) – The planning limit based on the background levels recorded should be set to approximately 41 dB(A).

This residence would experience a noise level of 35 dB(A) for the existing operation. As the dredge and primary screen move upstream this level would increase to 38 dB(A). These levels are below the planning limits for this residence.

- Location C (Aberglasslyn House) – The planning limit based on background noise levels which ignore the existence of the Rosebrook Sand and Gravel operation would be 36 dB(A). If noise from the Rosebrook operation was included as part of the background this planning limit would rise to 43 dB(A).

The noise level at Aberglasslyn House will be below 35 dB(A) and hence below the lowest of the planning limits for all stages of the development.

- Location D (Hancock) – This residence would experience a noise level of 38 dB(A) for the existing operation. As the dredge and primary section move upstream this level would increase to a maximum of 41 dB(A). At this level the planning limit for this residence would be exceeded marginally. The noise level would still be well below the acceptable limit for outdoor background noise suggested by the EPA.
- Other Residences – The noise levels due to Borals operations will be below 40 dB(A) at all other residences and should therefore not cause disturbance.

Whilst the noise generated by the Oakhampton quarry will not change as a result of the extension of the development, the noise at residences upstream from the current operation will increase as the dredge and primary plant move upstream from their present positions. The increases in noise, however, will be kept within acceptable limits. Noise at the closest residence to the plant will be reduced by the construction of a bund wall to screen the residence.

Noise from average traffic movements generated by the operation will be kept below EPA guidelines.

4.9 VISUAL ASPECTS

i. *Existing Visual Amenity*

Pleasant rural views predominate in the Oakhampton area with key visual elements being the undulating grazing land, flood prone river flats and the steep hills north of the Hunter River. Where it is visible, the river itself is a strong visual element, although it is difficult to see from most residences and public viewpoints.

Numerous residences have views of both the Rosebrook Gravels Pty Limited operation and the Boral screening plant. No residences have a view of the extraction operation itself due to the low lying nature of the river channel and the shielding effects of the river banks.

Recent and continued tree planting by Boral on the riverbank adjoining the plant site will tend to visually screen the plant particularly from the north and north-west. Whenever possible, Boral have attempted to limit the height and extent of its product stockpiles to further reduce the visual impact of the plant.

Several views of the proposed extraction area and the surrounding areas can be seen on *Plates 1 to 4*. *Plates 1 and 2* show the existing riverscape while *Plate 3* shows the existing view from Campbells Road toward the plant site. *Plate 4* is a general view of Aberglasslyn House looking east toward the proposed extraction site.

ii. *Impacts*

The proposed development is an extension of the existing dredging and screening process. The screening plant will remain substantially unmodified and therefore no additional visual impacts are expected from this point.

The dredge itself is not expected to be visible from any residences. The shore based conveyor, however, will be visible from residences to the north and south of the river. The owners of some of these residences hold title to the middle thread of the river on their respective lots and will be paid a royalty by Boral for extraction of sand and gravel. This royalty could be considered compensation for temporary loss of visual amenity from these residences.

Several other residences further from the river to the north of Campbells Road which currently have a view of the Boral plant (see *Plate 3*), the primary screen and the disused raw material conveyor will also have views of the proposed conveyor extension. It is not considered that this impact will be a significant degradation of the visual amenity of these more distant residences.



Plate 1: An upstream view of the proposed extraction area showing the existing dredge pond in the right foreground and the target sand and gravel deposit in the fore and midground. The photograph was taken during a period of low flow and the river can be seen in the right mid ground.



Plate 2: A view of the middle section of the extraction area taken during a minor rise in water level. The sparsely vegetated river banks can be clearly seen. These banks will remain undisturbed by the proposed development.



Plate 3: A view towards the river of the Oakhampton plant site from Campbells Road. The river channel and dredge cannot be seen from this area due to their low elevation.



Plate 4: Aberglasslyn House viewed from the main driveway. This historical residence is currently being restored by its new owners. The proposed extraction area and conveyor site are not visible from this residence due to the screening effects of topography and vegetation.

Aberglasslyn House (see *Plate 4*) to the west of the proposed limit of extraction has no view of the current operation, nor will any views be possible of the extension area even from the upper floor windows. There will be no visual impact on Aberglasslyn House.

4.10 AIR QUALITY

4.10.1 Existing Environment

The river dredging and wet screening operations currently used on the Oakhampton site would be continued as part of this proposed quarry extension. These operations have limited potential to cause dust due to the following factors:

- ❑ wet dredging of raw materials;
- ❑ transfer of wet raw materials in pipes and on conveyor belts;
- ❑ wet screening of raw materials;
- ❑ stockpiled products vary in particle size from coarse gravel to medium sand and therefore have limited potential for wind entrainment;
- ❑ stockpiled products are moist;
- ❑ few fines exist in the raw material; and
- ❑ product haul roads are gravelled and regularly watered to avoid dust generation, particularly on dry and windy days.

4.10.2 Impacts

The existing operation produces negligible volumes of dust and the proposed extension of quarrying will not effect the current situation. Consequently there is expected to be no impact on existing air quality.

4.11 ZONING AND PLANNING

4.11.1 Maitland Local Environmental Plan, 1993

Development within the Maitland local government area is primarily controlled by the provisions of Maitland Local Environmental Plan 1993 (the LEP). Zoning of land effected by the proposal and in the surrounding area is shown in Figure 4.3. The area where extraction and processing is to be undertaken is zoned 1(a) – Prime Rural Land.

The objectives of the zone are as follows:

- *to identify the City's most valuable agricultural land and other land requiring development control to prevent alienation from agricultural use and land degradation;*
- *to discourage further subdivision and encourage consolidation of existing agriculture landholdings;*
- *to permit appropriate agriculture-related land uses and certain non agriculture-related land uses which will not adversely affect agricultural productivity;*
- *to control development that could:*
 - *have an adverse impact on the rural character of the land in the zone;*
 - *create unreasonable or uneconomic demands for the provision or extension of public amenities and services; or*
 - *be subjected to physical limitations such as erosion hazard, bushfire risk and flooding.*

The proposal is an extractive industry as defined in the LEP and is permissible with Council's consent.

In determining an application for development in the Prime Rural Land zone Council must have regard to the zone objectives.

The proposal will predominantly be carried out within the river channel. Shore based activities such as the pump, treatment areas, storage and loading will be undertaken on land that can be used for agricultural purposes. However, whilst the proposal is not an agricultural activity it will not in the medium to long term alienate the land from agricultural use.

The proposal does not involve subdivision and will not impact upon the agricultural productivity of adjoining land. The controls proposed for operation of the land based activities will ensure that no degradation of the land results.

Given the nature of the development proposed it will not create new or additional demands for public utilities and services nor will it be subject to bushfire risk. Whilst the development could be the subject of flooding and erosion hazard, the management procedures to be adopted will ensure that these limitations can be overcome.

Potential exists for minor adverse visual impact to arise as a result of this development due to existing stockpiles, dredge and the proposed land based activities generally. This issue is discussed in detail in *Section 4.9*.

There are no other provisions within the LEP relevant to the proposal.

4.11.2 Hunter Regional Environmental Plan, 1989

The 1989 Hunter Regional Environmental Plan (the Plan) deals with *social, economic, settlement, access, natural resources and ecological issues*, (Department of Planning, 1989), to assist government bodies, councils, developers and the community in the management and planning of development in the region.

The plan highlights the various constraints and opportunities to development such as:

- ☐ infrastructure;
- ☐ demographic issues;
- ☐ water and natural resources;
- ☐ conservation areas;
- ☐ agricultural areas; and
- ☐ minerals and extractive resources.

In terms of the plan's relevance to the proposed extension of Boral's Oakhampton quarry, the plan identified an estimated regional population growth rate of between 0.6 per cent and 1.1 per cent per annum. To accommodate this growth, approximately 4,000 to 5,000 new dwellings are constructed in the Hunter region each year (Department of Planning, 1989). This growth in population and housing stimulates a corresponding growth in sand and gravel products which are used extensively in construction of housing and associated infrastructure.

The Plan noted that:

Adequate deposits of construction materials must be delineated and protected for future use close to settlement sites and major civil engineering works, otherwise the cost of transporting large volumes of "low cost" products will become a burden to the community. Protection of present and potential exploitation sites is necessary.

The sand and gravel deposit within the Hunter River at Oakhampton is an existing resource in the lower Hunter close to a major area of consumption of construction materials. The Hunter Region Environmental Plan identifies Maitland, East Maitland, Wallsend and Edgeworth as major proposed and potential urban development centres. These areas are within the current sales area of products from the Oakhampton quarry.

4.12 SOCIO-ECONOMIC CHARACTER

4.12.1 Population

The proposed development is located at Oakhampton in the central of the three sectors of the Maitland local government area (LGA). Of the three sectors, the central sector has the smallest population making up approximately 18 per cent of the population of the whole LGA.

Maitland's population is currently estimated to be about 47,000 people, but is expected to grow to 54,000 by the year 2001. This represents an increase of 16 per cent over the 10 year period from 1991 – 2001. Over the 20 year period 1981 to 2001, population growth is expected to be about 38 per cent (Maitland City Council, 1993).

A large proportion (41 per cent) of Maitland's population is under 25 years old. This compares to 37 per cent for the Hunter Region and New South Wales as a whole.

The proportion of people over 55 years of age in the Maitland area has increased in the period from 1981 to 1991 growing from 12 per cent in 1981 to 16 per cent in 1986 and to 17 per cent in 1991. The 1991 proportions are lower than the Hunter average of 22 per cent and the New South Wales average of 21 per cent.

Compared to the rest of New South Wales, Maitland has only a small ethnic population with 91.3 per cent of the population born in Australia, compared to 74.8 per cent for New South Wales. English is spoken by 95.5 per cent of the population as a first language and the other main languages spoken include Chinese, German and Polish (Maitland City Council, 1993).

4.12.2 Employment

The largest employment area for residents of Maitland LGA is the private sector, employing 75.5 per cent of the population in 1991. State Government accounted for 12.8 per cent of employment in 1991 down from 14.5 per cent in 1986. In 1991, 69 per cent of the population worked in excess of 35 hours a week, down from 76 per cent in 1986 (Maitland City Council, 1993).

The 1991 Australian Bureau of Statistics census indicated that 10.3 per cent of Maitland's labour force were unemployed. In the March 1993 quarter this figure had increased to 13.1 per cent of the workforce.

4.12.3 Housing

Maitland City has a large range of urban areas located within and above the floodplain. Approximately 1500 dwellings lie within the 1955 flood level.

In Maitland LGA at the 1991 census, 41.7 per cent of occupants owned dwellings, 30.8 per cent of dwellings were being purchased and 23.1 per cent of dwellings were rented.

4.12.4 Impacts

Continuation of the extraction operation will not place significant additional pressure on existing social services or infrastructure. The continued employment of staff and contractors combined with the multiplier effects of wage spending in the local community will provide a much needed positive impact on the local economy.

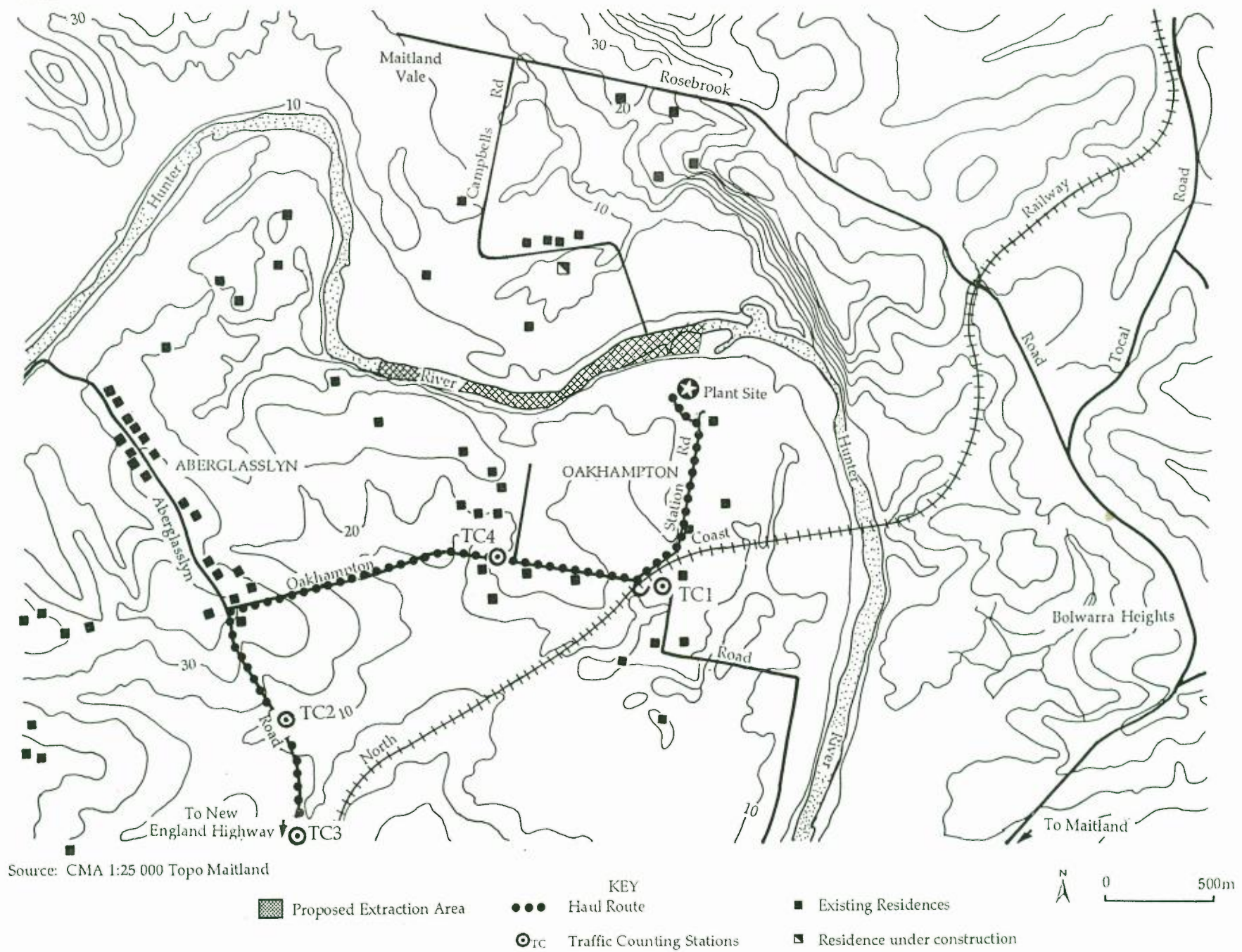


Figure 4.4 HAUL ROUTE AND TRAFFIC COUNTING STATIONS

The continued supply of construction sand from the site to markets in the lower Hunter region is important in terms of efficient resource usage and maintenance of the current cost of construction materials. Supply of this material from the site contributes to continued economic growth in the region.

Transport costs are a major component of the cost of the delivered product. The location of the Oakhampton resource in close proximity to the lower Hunter market ensures a significant contribution towards maintaining the current cost of concrete and construction materials. The quality of the resource allows a relatively simple, low cost extraction method to be employed with little or no processing. This further contributes towards maintenance of low costs to the consumer.

High quality sand and gravel is produced from Boral's Oakhampton site. Consequently, specified performance criteria are met by the extracted material and the consumer benefits in being able to depend on the stated performance of the construction materials in which the sand is used.

Continued extraction at Oakhampton will provide continued employment for the on-site full-time and relief staff, contractors, sub-contractors, tradesman and servicemen. The current operation employs four quarry staff on a full-time basis and the quarry manager operates from the site office on a daily basis. In addition there are, on average, 20 Boral Transport trucks and ten contract drivers hauling material from the site each day. Regularly employed contractors, sub-contractors, tradesmen and servicemen include a contractor for rehabilitation and landscaping, fitters and boilermakers, a dozer driver, a dozer float driver, electricians and weighbridge maintenance and servicing technicians. A dredge operator is contracted on a full-time basis. In addition, the continued availability of high quality, cost efficient sand in close proximity to markets will ensure continued employment within industries which utilise sand from the site.

4.13 ROAD AND TRAFFIC CONDITIONS

4.13.1 Road Networks

The haul route currently in use allows access to the New England Highway from the plant site on the southern side of the Hunter River. This route will not change as a result of the extension of operations. Access to the New England Highway is currently gained via Station Road, Oakhampton Road and Aberglasslyn Road as shown in *Figure 4.4*. This road network is already established and the volume of trucks using this route is not expected to increase as a result of the proposed development.

Both Oakhampton and Aberglasslyn Roads are two lane sealed roadways. Station Road and the access road to the plant site are largely unsealed two lane roadways with the exception of a small section of Station Road which is sealed adjacent to residences.

4.13.2 Traffic Volumes

Traffic volume data has been obtained from Maitland City Council for three locations which are shown in *Figure 4.4*. Data for a fourth traffic station has been interpolated from this information. Traffic flow data is given below in *Table 4.10*.

Table 4.10 TRAFFIC VOLUMES IN THE VICINITY OF OAKHAMPTON

Station Number	Road	Location	Date Counted	Vehicles/day
1	Oakhampton Road	60 metres east of rail crossing	15.3.95 7 days	189
2	Aberglasslyn Road	800 metres north of Alexandra Avenue	14.3.95 7 days	1094
3	Aberglasslyn Road	south of Denton Park Lane	28.3.91 7 days	837
4	Oakhampton Road	near Kezia Road	estimate	average 230 maximum 250

Note: Traffic flow in both directions

Source:: Maitland City Council, 1995

The Roads and Traffic Authority (RTA) do not have any permanent or temporary traffic counting stations in this area.

The existing Oakhampton quarry's production is not proposed to increase with the extension of the extraction area, therefore the data provided in *Table 4.10* is relevant to both the existing and proposed haulage routes. *Table 4.11* displays the estimated average daily and hourly haulage rates for both the expected average extraction rate of 150,000 tonnes per annum and the estimated maximum of 200,000 tonnes per annum.

Table 4.11 TRUCK MOVEMENTS – EXISTING AND PROPOSED

	Truck movements for average extraction rates	Truck movements for estimated maximum extraction rates
Daily	54	100
Hourly	7	13

Note: Truck movements equal full loads multiplied by two to account for return trips. Estimates are based on an average load of 20 tonnes.

4.13.3 Traffic Impact Assessment

Boral proposes to extract an average of 150,000 tonnes of material per annum over the life of the quarry, increasing to a maximum of 200,000 tonnes as required. The quarry transport will operate, on average, 260 days per year. All the material extracted will be transported by the haul route outlined in *Section 4.13.1*.

Based on interpolated Maitland City Council data presented in *Table 4.10*, there are currently about 230 vehicles using Oakhampton Road near Kezia Road daily. In March 1995, traffic counts on Aberglasslyn Road 800 metres north of Alexandra Avenue showed that traffic was at a volume of 1094 vehicles per day. These figures incorporate all traffic generated by the plant site at Oakhampton at the current average production rate. At the maximum production rate this represents a four percent increase (over existing average rates) in vehicle movements along Aberglasslyn Road to 1140 vehicles per day.

On Oakhampton Road, a 20 percent increase over existing average vehicle traffic could be expected during times of maximum extraction. It must be noted however, that this flow rate can and has occurred due to the continuing operations and consequently additional impacts are not expected.

Existing quarry traffic makes up 17 percent of the traffic flows on Oakhampton Road in the vicinity of Kezia Road and 3.6 percent of traffic flow on Aberglasslyn Road 800 metres north of Alexandra Avenue.

Traffic lights are situated on the New England Highway at the intersection of Aberglasslyn Road allowing safe access to the highway for trucks northbound and southbound on the New England Highway.

Vehicles turning from Station Road to Oakhampton Road have safe access as traffic travelling along Oakhampton Road slows considerably at the level crossing just east of the Station Road/Oakhampton Road intersection.

The proposed haul route is adequate to accommodate existing vehicle movements and it is not expected that increased vehicle movements beyond existing average or maximum levels will result from the proposed extension of quarrying.

The site layout has adequate provisions for loading, unloading, manoeuvring and parking of haulage vehicles and provides adequate car parking spaces for employees and service vehicles.

4.14 SERVICES AND UTILITIES

4.14.1 Electricity

i. Existing Usage

The existing Oakhampton operation purchases approximately 900,000 kWh of electricity per year from Orion Energy (formerly Shortland Electricity) to power conveyor motors, screens and pumps.

ii. Impacts

There is expected to be a minor increase in electricity consumption due to the proposed extra length of conveyor required to service the dredge when operating further from the plant. This increase is expected to be less than five per cent or 45,000 kWh. This small increase can be supplied by the existing infrastructure.

4.14.2 Water and Sewerage

Neither reticulated water nor sewerage is connected to the site. Make up process water is pumped directly from the river to balance losses in the water recycling system while potable water is collected off roofs.

Effluent is disposed of in a Council approved septic system.

4.15 ABORIGINAL AND EUROPEAN ARCHAEOLOGY

4.15.1 Aboriginal Archaeology

i. *Literature and Data Review*

Brayshaw (1984) conducted an archaeological investigation of a 120 hectare site approximately two kilometres south-east of the proposed development area in which one stone artefact scatter and a scarred tree were recorded. The stone artefact scatter (NPWS# 38-4-120) consisted of 40 artefacts made from silcrete, indurated mudstone, quartz, chert, quartzite and fine-grained basic raw materials. Artefact types included cores, multiplatformed cores, modified pieces, a scraper, unmodified flakes and flaked pieces.

The presence of cores suggested that stone tool manufacture may have been undertaken at the site, while modified tools suggest some maintenance activities (Brayshaw, 1984). No diagnostic tool types, such as backed blades, were present, nevertheless the use of quartz from which three of the cores were made, suggests Aboriginal activity in the area less than 1500 years ago (McBryde, 1980; Brayshaw, 1984).

Brayshaw (1984) noted the presence of pebbles and boulders of indurated mudstone, chert, quartz, quartzite and fine-grained basic rocks in the Hunter River. It was also noted that the quartz could have been derived from a quarry such as that at Rosebrook. The sources of silcrete had not been defined.

Due to the degree of disturbance to the area surrounding the artefact scatter such as from floodwaters, grazing, ploughing, vehicle traffic and pipe laying, the site was deemed at that time to have minimal scientific value.

The scarred tree was recorded approximately two kilometres south east from the proposed development area. The scar was found on a *Eucalyptus pauciflora* species, 57 centimetres above the ground. The scar is 10 centimetres deep, 112 centimetres long and a minimum of 33 centimetres wide. Brayshaw (1984) observed that the scar was in many ways consistent with those made by Aborigines in the manufacture of shields and containers. Its depth suggests some antiquity and the nature of the bark regrowth is suggestive of the Aboriginal method of bark removal. It was recommended that the tree be preserved.

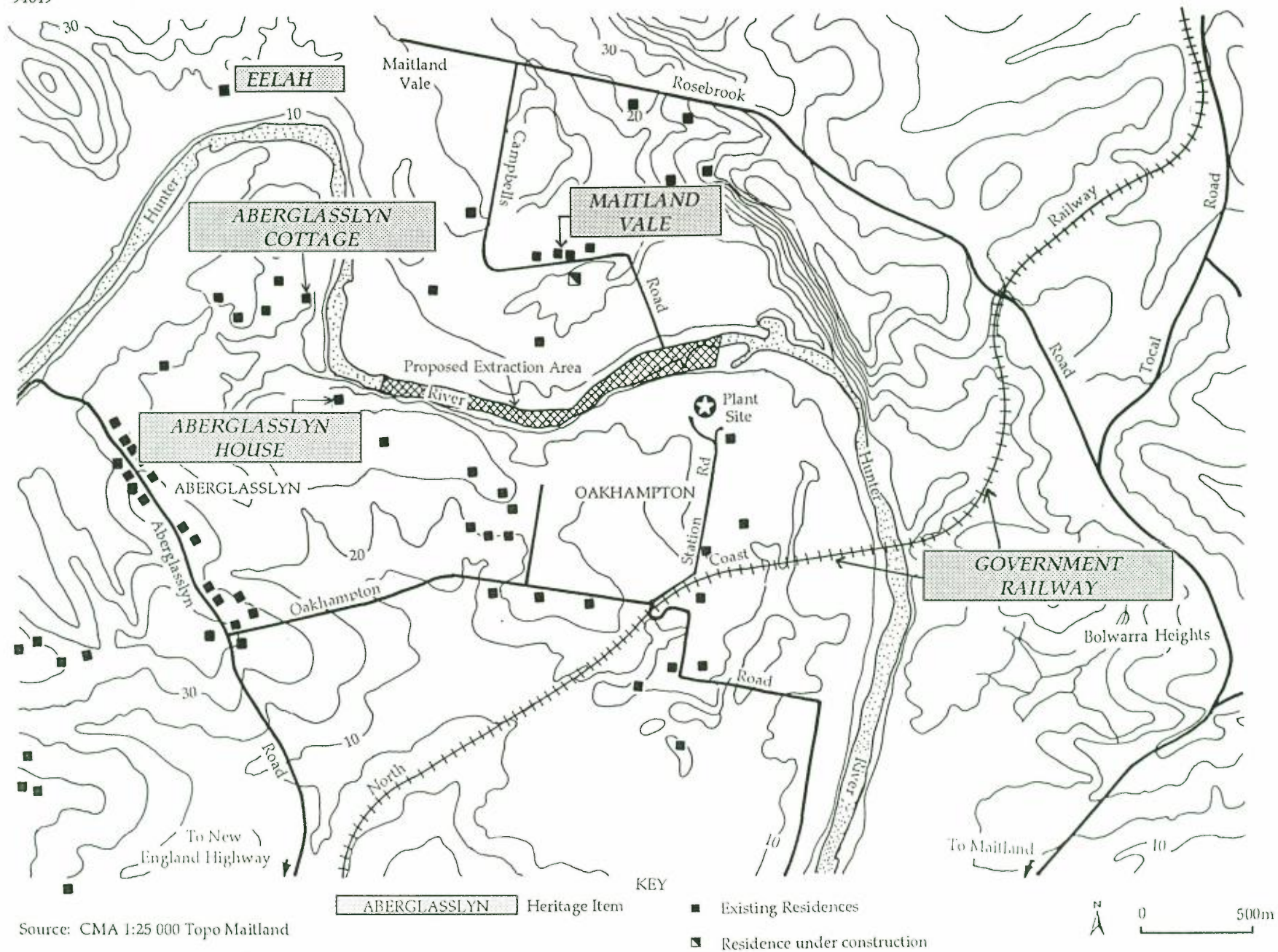


Figure 4.5 HERITAGE ITEMS

A search for known sites on the National Parks and Wildlife Service (NPWS) was conducted prior to current field investigation so that any site within the proposed development area could be inspected. The aim of the search was to determine the presence or otherwise of known sites within the boundaries of the proposed development area. The search was extended to a two kilometre radius around the study area.

As a result of the search, two open camp sites (NPWS# 38-4-58 and 38-4-120) were listed. These sites were located outside the boundaries of the proposed development area. From the description of each site from the NPWS site recording forms, it appears that the site has been given two separate site numbers. The associated report by Brayshaw (1984) indicates that only one stone artefact scatter was recorded with the same description that appears on both site cards.

ii. Survey Results

A field survey was conducted on foot along the length of the proposed development area with the assistance of the Mindaribba Local Aboriginal Land Council.

A log book was maintained in the field to record immediate observations such as topographic features, vegetation cover, surface visibility and any other observations. Prepared recording forms were available for site recording as determined by the recording requirements of the National Parks and Wildlife Service (NSW).

No Aboriginal archaeological sites were located during the field investigation. The main area of development is the Hunter River channel which is considered to have minimal archaeological potential.

Other parts of the proposed development area are situated along the tops of the steep banks of the Hunter River which were vegetated by dense grass cover at the time of the survey which reduced the area of surface visibility.

4.15.2 *European Heritage and History*

Maitland local government area has over 200 sites identified as being significant in terms of European heritage. These sites include sites of local and national significance (McDonald, 1994). Five heritage items have been identified nearby the proposed development. These sites are:

- Aberglasslyn House, Aberglasslyn Lane;
- Aberglasslyn Cottage, Aberglasslyn Lane;
- Government Railway;
- Eelah, Rosebrook Road; and
- Maitland Vale, Campbells Road.

The locations of these items are shown on *Figure 4.5*.

The most significant of these heritage items is Aberglasslyn House located on Lots 3 and 5, DP 255369, Aberglasslyn Lane, Aberglasslyn.

Aberglasslyn House stands on the edge of the Hunter River approximately 1.6 kilometres west of the existing operation at Oakhampton and approximately 250 metres west of the proposed development. The house and its curtilage (property boundary) is classified by the National Trust of Australia (NSW), is included in the Registers of the National Estate, and is the subject of a permanent conservation order under the NSW Heritage Act 1977. It is considered to have State and National significance as a heritage item. The curtilage or property boundary of Aberglasslyn House is shown on *Figure 4.3*.

Aberglasslyn House was built by pioneer grazier and squatter George Hobler, who emigrated from England to Van Diemens Land in 1825. In 1836, he and his family moved to New South Wales and purchased the Oakhampton estate of Sir John Jamieson near Maitland. By 1840 the foundation stone of Aberglasslyn was laid and Hobler had become established as a 'gentleman farmer' (Walker, 1982).

In the 1840's depression, Hobler came upon hard times and moved out of the district before Aberglasslyn was finished. In 1844 the house was leased and eventually purchased by William Nicholson and the house remained in the Nicholson family until 1962 when it was purchased by Robert Jackson.

The house remained largely derelict until acquired by Elizabeth and Phillip Jones in 1976, at which time the house was in need of extensive repairs. The Jones' immediately set about restoring the house with the aid of loans from the New South Wales Heritage Council.

The house was put up for auction in July 1982 but was passed in after failing to reach the reserve price. The house was recently purchased by Mr and Mrs Maule and is presently intermittently occupied by the owners.

Aberglasslyn House has commanding pastoral views of the Oakhampton area and shows excellent workmanship and finish throughout. It is built of local Ravensworth sandstone and has a slate roof. Other features include timber floors, unpainted cedar joinery and marble fireplaces in two reception rooms. A stone cantilevered stairway with domed roof and curved windows give Aberglasslyn House a similar style and elegance to Elizabeth Bay House designed by John Verge. Although not confirmed, John Verge is believed to have been the architect of Aberglasslyn because of these similarities.

Aberglasslyn Cottage is also located on Aberglasslyn Lane and is considered to have local heritage significance. Maitland Vale on Campbells Road also has local heritage significance.

The Government Railway and Eelah on Rosebrook Road both have regional heritage significance.

The Government Railway is a two track railway generally on embankments and elevated structures throughout Maitland LGA. The railway is considered to have historic, scientific and aesthetic values.

4.15.3 Impacts

i. Aboriginal

No artefact sites were located in the area of the proposed extension or on the proposed site of the raw feed conveyor and consequently no impacts on Aboriginal archaeology are expected.

If artefacts are discovered during extraction or associated works, the National Parks and Wildlife Service will be notified immediately.

Correspondence from Mindaribba Local Aboriginal Land Council which details their concurrence with the archaeological assessment is attached in *Appendix B*.

ii. European Heritage

The proposed extraction area was reduced from its originally proposed extent to avoid visual and noise impacts on the residence and curtilage of Aberglasslyn House. Noise emissions whilst dredging is undertaken at the western limit of extraction, will be limited to 5 dB(A) above background noise levels when measured at the eastern curtilage of Aberglasslyn House. This design goal of 35 dB(A) is identical to that imposed upon the Rosebrook Gravels Pty Limited operation across the river from Aberglasslyn House.

The proposed extension to extraction operations at Oakhampton will not impact on any of the other listed European heritage sites.

4.16 ENERGY STATEMENT

Distillate fuel is used to fuel the cutter dredge and haul trucks. The annual distillate consumption is dependent on sales and extraction rates but approximates 170,000 litres per year.

Electricity consumption is approximately 900,000 kWh per year.

Limited volumes of petrol are used in small pumps and ancillary equipment. Boral fleet cars are powered by compressed natural gas.

The proposed extension of the extraction area will not significantly increase the total fuel consumption of the operation apart from a minor expected increase in electricity consumption detailed in *Section 4.14.1*.

4.17 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

4.17.1 Definition of Ecologically Sustainable Development

The national strategy for ecologically sustainable development (ESD) details the Federal Government policy which seeks to achieve economic development in an environmentally sustainable manner. The four principles of ESD are listed in Schedule 2 of the Environmental Planning and Assessment Regulation (1994) as follows:

- *The precautionary principle – namely that if there are threats of a serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;*
- *Inter-generational equity – namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;*
- *Conservation of biological diversity and ecological integrity; and*
- *Improved valuation and pricing of environmental resources.*

4.17.2 Ecologically Sustainable Development Assessment

i. The Precautionary Principle

The potential threats to the environment posed by the continuation of dredging at Oakhampton have been assessed as minor and of a short to medium term nature. There is no scientific uncertainty regarding potential impacts due to this development and consequently the precautionary principle does not apply in this instance.

ii. Inter-Generational Equity

Sand and gravel at the Oakhampton deposit unlike most similar deposits is effectively a renewable resource. Calculations and past experience at the site show that the dredge pond formed by extractive operations will refill with bed load sediment from further upstream. Thus extraction at this site will not prevent future extraction.

The bulk of the material produced by Boral's Oakhampton quarry is used as construction material to build roads, bridges, houses and commercial buildings. The majority of these structures will still be in use for future generations. As noted by James 1995, a proportion of materials from demolition of these structures can be recycled for further use.

The overall health of the environment will not be significantly affected by the proposal due to proposed ameliorative measures and the very nature of the development.

The productivity of the site will be maintained by the proposed continuation of quarrying. Failure to continue extraction would in fact reduce the site's productivity. The limited use of dry land means that only a negligible and reversible reduction in agricultural productivity will occur.

iii. *Conservation of Biological Diversity and Ecological Integrity*

A flora and fauna impact assessment has confirmed that past, current and future dredging is not expected to reduce species diversity in the Hunter River or detrimentally impact on ecological integrity.

Similarly no impacts on biological diversity or ecological integrity are expected to occur as a result of land based operations.

iv. *Improved Valuation and Pricing of Environmental Resources*

Environmental resources can be defined to include natural resources such as flora, fauna, rivers, sand and gravel and the human built environment such as roads and railways. As stated by James (1995) the *valuation and pricing* [of extractive materials] *is related to the customer's perception of the value of the product and their willingness to pay. In general, extractive materials are considered to be low value, low cost materials so that there is little opportunity for improved valuation and pricing of the environmental resources.*

While this is a valid perception, the final cost of the extractive material increasing includes the total cost of extraction and delivery which includes costs associated with:

- ☐ environmental assessment;
- ☐ rehabilitation;
- ☐ environmental management and monitoring; and
- ☐ road use contribution.

Due to increasingly tight legislation controls by State and local governments, it is reasonable to expect that quarry products, including those from Oakhampton will increase in value, although improved productivity may balance long term value increases.

APPENDICES

Appendix A

DIRECTOR'S REQUIREMENTS



Department of Planning

The Manager
Boral Country Concrete Quarries
P.O. Box 42
WENTWORTHVILLE NSW 2145

Remington Centre
175 Liverpool Street, Sydney 2000
Box 3927 G.P.O. Sydney 2001
DX. 15 Sydney

Telephone : (02) 391 2000 Ext: 2078

Fax No. : (02) 391 2111

Contact : M. Beveridge

Our Reference : N94/00208

Your Reference :

Attention: Mr G. Pollington

Dear Mr Pollington,

PROPOSED EXTENSION TO EXISTING QUARRY **OAKHAMPTON, NEAR MAITLAND**

Thank you for your letter of 21 July 1994 indicating that you are consulting with the Director with regard to the preparation of an environmental impact statement (EIS) for the above development.

2. It is understood that the quarry is registered with Maitland Council under State Environmental Planning Policy No.37 - Continued Mines and Extractive Industries (SEPP 37). It is recommended that you seek Council's view as to whether the proposal is designated development under SEPP 37, or pursuant to Schedule 3 of the Environmental Planning and Assessment Regulation 1980.

3. As development consent is required for the proposal, and if it is a designated development, an EIS must accompany the development application to the Maitland City Council. The EIS shall be prepared in accordance with clause 34 of the Regulation and shall bear a certificate required by clause 26(1)(b) of the Regulation (See Attachment No.1).

4. In addition, pursuant to clause 35 of the Regulation, the Director requires that the following matters be specifically addressed in the EIS:

- review of the environmental performance of the existing extraction operations, and an assessment of the need for further impact mitigation measures;
- impact of proposal (including both previous and future operations) on the hydrologic and hydraulic regime within the river. This should include consideration of changes to bank profiles, and means to ensure bank stability;
- description of proposals for water management, particularly means to prevent loss of water quality within the river, and means for disposal of waste water;
- assessment of noise and dust impacts and proposed mitigation measures;

- assessment of a likelihood of acid sulphate soils being disturbed during the operations, and (if warranted) proposed mitigation measures;
- impact of proposal (both previous and intended future extraction) on the riparian environment, particularly in relation to impacts on aquatic flora and fauna (particularly on any rare or endangered species) and riparian vegetation;
- assessment of flood related issues;
- assessment of the proposal on the heritage values of the nearby Aberglasslyn House (particularly in relation to its curtilage and visual amenity) and proposed mitigation measures;
- assessment of transportation impacts;
- consideration of relevant matters in:
 - State Environmental Planning Policy No.37 - Continued Mines and Extractive Industries.
 - Hunter Regional Environmental Plan
- results of consultation with:

Environment Protection Authority
Department of Water Resources
NSW Fisheries
National Parks and Wildlife Service
Public Works Department
NSW Heritage Council
Department of Conservation and Land Management

5. Attachment No.2 is a guide to the type of information most likely to be relevant to the development you propose; not all of the matters raised therein may be appropriate for consideration in the EIS for your proposal; equally, the guide is not exhaustive.
6. In preparing your EIS you should approach the Maitland Council and take into account any comments Council considers may apply to its determination of the proposal.
7. Should you require any further information regarding this matter please do not hesitate to contact us again.

Yours faithfully

Neville Osborne

N. Osborne
Acting Manager

25/8/94

Assessments and Major Hazards Branch
As Delegate for the Director

Appendix B

CONSULTATION LETTERS



Department of Planning

27 FEB 1995

The Manager
ERM Resource Planning
PO Box 388
EAST MAITLAND 2393

Remington Centre
175 Liverpool Street, Sydney 2000
Box 3927 G.P.O. Sydney 2001
DX. 15 Sydney

Telephone : (02) 391 2000 Ext: 2047

Fax No. : (02) 391 2111
N94/00208/001

Contact: R. Maini

Our Reference :

Dear Sir/Madam,

PROPOSED EXTENSION TO SAND & GRAVEL
QUARRY AT OAKHAMPTON, MAITLAND

Please refer to your letter dated 12 December, 1994, regarding the abovementioned work. It is noted that a part of the proposed extraction area is located on the boundary of Aberglasslyn property and that it is proposed to dredge the river immediately in front of Aberglasslyn House.

Aberglasslyn House is the subject of a Permanent Conservation Order (1981) and is considered to be a building of State and National Heritage Significance. The building is classified by the National Trust and is on the Register of the National Estate.

It is a fine example of a Regency Period House which commands extensive pastoral and Hunter River views. The Heritage Council considers the cultural landscape surrounding Aberglasslyn to be an important aspect of its cultural significance. It is noted that a considerable amount of money was spent by the previous owner of Aberglasslyn House and the new owners intend to conserve the house and use the land around it to provide some public access to this historic property.

The Heritage Council has had previous involvement in commenting on proposals for sand and gravel extraction on the flood plain and in the river opposite Aberglasslyn.

Recently, it commented on the extension to Rosebrook Sand and Gravel and noted that the EIS did not adequately assess the heritage issues.

Previous applications (1977, 1982) from different extraction companies to establish a new industry on the flood plain opposite Aberglasslyn House have been refused by Maitland Council because of their detrimental effect on the rural landscape and in particular on Aberglasslyn House and its setting.

.../2

It should be noted that there was an SPCC Inquiry into an approved gravel extraction operation on the bank opposite Aberglasslyn in 1979. The Inquiry heard objections from the then owners of Aberglasslyn, the National Trust and the then Planning and Environment Commission concerning the impact of the proposal on the heritage significance of Aberglasslyn. This Inquiry resulted in the approval being overturned by the Minister for Planning and Environment and, while not precluding further extraction from the area, imposed conditions on the extent of such works.

It is therefore requested that the proposal be discussed with the officers of Heritage Branch, Department of Planning prior to finalisation of the proposal details and the EIS. Should you have any queries in this regard please contact Rajeev Maini on 391 2047.

Yours sincerely,

M. Knaggs 1/2/95

for

R. Power
Manager
Heritage Branch

c.c. Maitland Council
Mr. and Mrs. Maule

Heritage Council of New South Wales

PLAN

Under the Heritage Act, 1977

Description

~~Lots 3 & 5 D.P. 255369~~

(Aberglasslyn House)

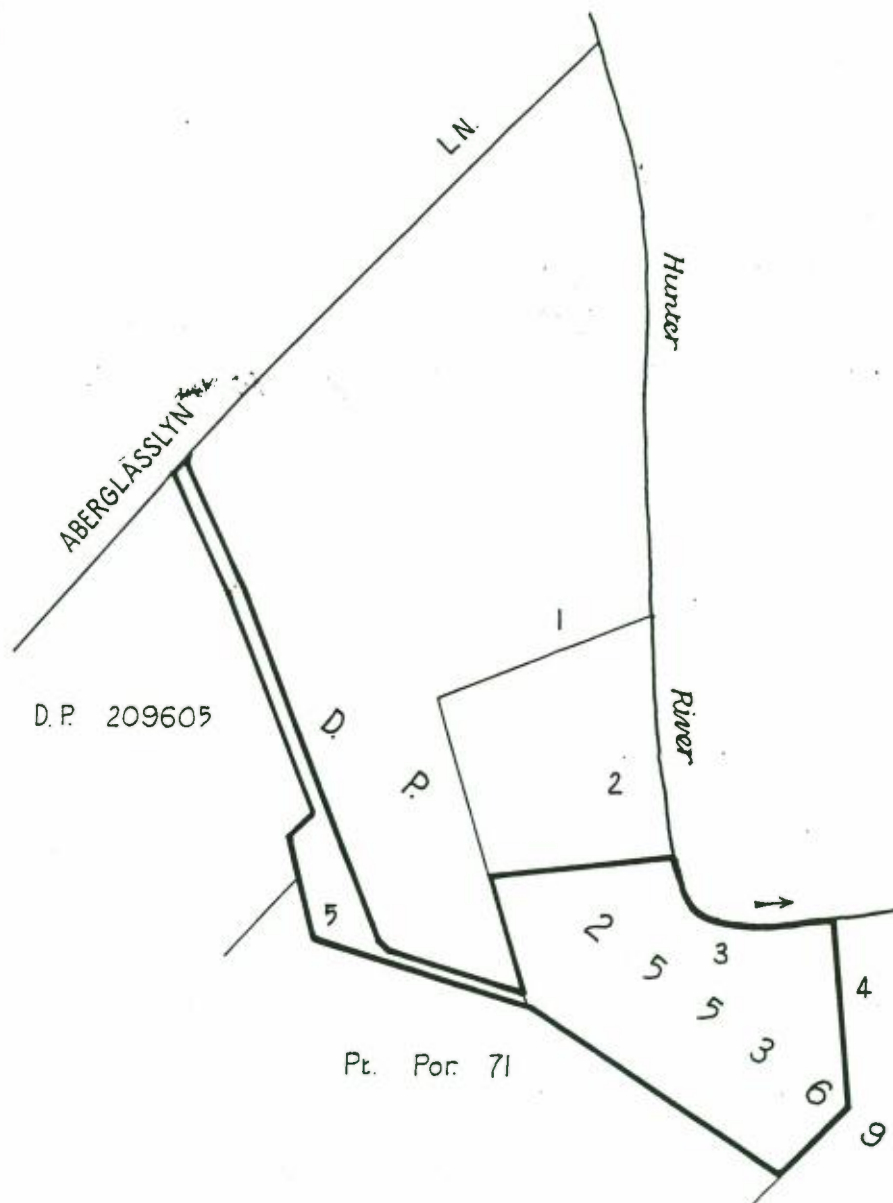
~~Municipality~~/City Maitland

Locality Aberglasslyn

Parish of Gosforth

County of Northumberland

Scale 1:5000



COMPILED FROM INFORMATION IN

D.P. 255369 &

Search S78/542

BY RST

DATE 1-9-78

FILE REFERENCE

H.C. 32082

PLAN APPROVED

Chris Walters

for SECRETARY, HERITAGE COUNCIL

PLAN NUMBER

H.C.

461

THIS IS THE PLAN REFERRED TO IN ~~INTERIM~~/PERMANENT CONSERVATION ORDER No. 195

N. S. W. GOVERNMENT GAZETTE No. 134 OF -4 SEP 1981

SUBJECT LAND EDGED THUS:





[Published in Government Gazette No. 134 of 4th
September, 1981.]

HERITAGE ACT, 1977

PERMANENT CONSERVATION ORDER No. 195.

IN pursuance of section 44 of the Heritage Act, 1977, I, the
Minister for Planning and Environment, do, by this my
order—

- (i) make a Permanent Conservation Order in respect of
the item of the environmental heritage specified or
described in Schedule "A"; and
- (ii) declare that this Permanent Conservation Order shall
apply to the curtilage or site of such item being the
land described in Schedule "B". (H.C. 32082)

ERIC BEDFORD,
Minister for Planning and Environment.
Sydney, 4th September, 1981.

SCHEDULE "A"

The building, being the house known as "Aberglasslyn"
situated on the land described in Schedule B.

SCHEDULE "B"

All those pieces or parcels of land situated at Aberglasslyn,
City of Maitland, Parish of Gosforth, County of Northumber-
land, being lots 3 and 5 in D.P. 255369, as shown edged
heavy black on plan catalogued H.C. 461 in the office of the
Heritage Council of New South Wales. (2947)

NAME OF PLACE ABERGLASSLYN HOMESTEAD

001234 1/09/062/0001/01
REGISTERED

LOCATION/BOUNDARIES:

APPROXIMATELY 8KM NORTH-WEST OF MAITLAND ON ABERGLASSLYN ROAD, 2KM
DUE NORTH OF THE NEW ENGLAND HIGHWAY.

TITLE INFORMATION:

STATEMENT OF SIGNIFICANCE:

ABERGLASSLYN IS THE MOST OUTSTANDING HOUSE REMAINING IN THE HUNTER
DISTRICT. SITED ON A RISE ABOVE BANK OF THE HUNTER RIVER, COMMANDING
EXTENSIVE PASTORAL VIEWS.

SIGNIFICANT ASSOCIATIONS:

SIGNIFICANT DATE(S):

1840-92

DESCRIPTION:

FINE REGENCY, TWO STOREY (12 ROOMS & CELLAR) HOUSE, SHOWING EXCELLENT
WORKMANSHIP & FINISH THROUGHOUT. BUILT OF STONE WITH SLATE ROOF,
TIMBER FLOORS, STONE FLAGGED VERANDAH & UNPAINTED CEDAR JOINERY.
MARBLE FIREPLACES IN TWO RECEPTION ROOMS. CELLARS VAULTED & STONE
FLAGGED. STONE CANTILEVERED STAIRWAY WITH DOMED ROOF & CURVED WINDOWS,
SIMILAR IN STYLE & ELEGANCE TO ELIZABETH BAY HOUSE. VERANDAH
WITH IRON COLUMNS ON PEDESTALS ADDED IN 1860.

CONDITION:

RESTORATION URGENTLY NEEDED & IS INTENDED IN VERY NEAR FUTURE (1977).

BIBLIOGRAPHY:

27 JUL 1994

TELEPHONE: (049) 34 9700

FACSIMILE: (049) 33 3209

DX 21613 MAITLAND



All correspondence should
be addressed to
General Manager

P.O. BOX No. 220,
MAITLAND, N.S.W. 2320

Administration Building,
MAITLAND, N.S.W.

Our Ref. MD/KM/103/59/1
Your Ref. 37151

Telephone Enquiries:

Mr. Daniels

25th July, 1994.

Boral Country
Concrete & Quarries
DX 1277
SYDNEY

ATTENTION: Mr. G. Pollington

Dear Sir,

**RE: Proposed Extensions to Sand & Gravel Extraction Operation at
Oakhampton**

Thank you for your letter dated 20th May, 1994 and I apologise for the delayed response.

Essentially Council's requirements for the proposed extension should be contained within the Environmental Impact Statement which will be prepared in consultation with the Department of Planning and the guidelines of the Director.

Further, as mentioned in your letter copies of relevant licences and approvals from Public Works Department / Water Resources and Environment Protection Authority will be necessary.

Should you have any enquiries please contact Mark Daniels of Council's Development & Environmental Services Department on (049) 349 815.

Yours faithfully,

**MARK DANIELS
TOWN PLANNER**



Boral Resources (Country) Pty Ltd
PO Box 42
WENTWORTHVILLE NSW 2145

Facsimile: (065) 43 4164
Telephone: (065) 42 1222
Ext: 221
Contact Name: A Parfait
Our Reference: E772

Attention: Mr Granville R Pollington

Dear Sir

Re: Proposed Extension to Sand and Gravel Extraction Operation at Oakhampton

I refer to your letter dated 20 May 1994 advising the Department of the preparation of an EIS for the above development. The EIS needs to include the following issues:

1. Existing Stream Channel

- high bank location, edge of low flow, long term changes, bedrock, bars, riffles, pools, benches, vegetation (including species), snags, eroding banks;
- pumps, erosion control works, structures, old excavations, property boundaries, extraction upstream and downstream;
- Details of all areas previously excavated.

2. Existing Floodplain

- extent, terraces, levees, flood runners, lagoons, scour holes, floodways, vegetation;
- breakout locations and return period for first site flooding;
- changes since last flood;
- maximum recorded flood levels, velocities and directions.

3. Operation Plan

- plans and cross sections showing where, when (stages), how, how much, how big, how deep;
- Depth of Excavation and Side Slope;
Prior to the construction of the tailings storage, the right bank of the river was unstable. It is uncertain when the extraction was undertaken - ie before, during or after the construction of the storage. This will have a significant bearing on the permissible depths and side slope. Side slope will also depend on where you have dredged the channel before and where you propose to dredge or re-dredge. It appears that a grade steeper than 1:3 but not steeper than 1:2 may be acceptable. Any concession from the standard grade of 1:3 would, however be conditional on your willingness to immediately repair, stabilise, rehabilitate and maintain any affected section.
- materials to be removed or filled;
- design and construction details for structural works, including erosion protection, compaction of fill, safety factors.

4. Rehabilitation Plan

- preservation, landscaping and rehabilitation of embankments, settling ponds and other disturbed areas.

5. Impact on Stream Channel

- Channel alignment and width, low flow alignment and width, bed slopes controls, bar location and shape, bankful velocity/water level, sediment trapping, snags;
- bank stability;
- water users (impact on both quality and quantity of water);
- instream habitat of fish and other aquatic fauna;
- ecology from the lowest order - benthic communities - to the higher order - fish and platypus;
- Cumulative effect on bed load with other operations upstream and downstream. It is essential that bedload transport study is carried by means of the more reliable methods, eg the Ackers-White function. To ensure that the extraction is carried on a sustainable use basis, the total bedload removed from the river must not exceed the amount being transported into it from upstream.

6. Impact on Floodplain

- flood levels, velocities and directions, breakouts, floodways.

7. Monitoring

The Department would require a monitoring program (similar to the requirements of PWD) consisting of the regular resurvey of a series of cross sections.

I have also attached a copy of the Department's General Requirements For Environmental Impact Statements.

If you need further information, please contact Mr Adolphe Parfait of this office.

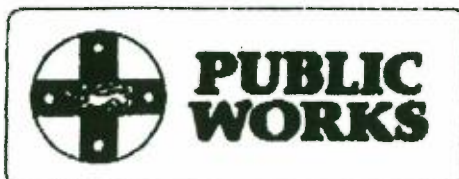
Yours faithfully



E A Harris
Manager Resource Management
Hunter Region

July 12, 1994

(musamp\www2\apboroak)



The Senior Geologist
Boral Resources (country) Pty. Ltd.
P.O. Box 42
Wentworthville NSW 2145

NSW PUBLIC WORKS Hunter-New England Region

117 Bull Street, Newcastle West, 2302
P O Box 5177, Newcastle West, 2302
Telephone: (049) 269920 Fax: (049) 269954

File No: / 587
Your Ref:

25 October, 1994

Contact: Mr. Brian Ayling
Phone: (049) 269 941

Attention: *G. R. Pollington*

Dear Sir,

Proposed Extension to Sand and Gravel Extraction Operation at Oakhampton

I refer to your letter of 20 May, 1994 concerning issues to address in preparation of an Environmental Impact Statement for a sand extraction operation above the tidal limit at Oakhampton on the Hunter River.

Under the Rivers and Foreshores Improvement Act, Public Works has statutory responsibilities to ensure the hydraulic stability of estuaries below the tidal limit. Accordingly Public Works is interested in any proposed changes that may detrimentally affect the existing state of the Hunter River Estuary.

The following issues should be addressed in the EIS:-

ESTUARY MANAGEMENT

1. A full description of the sand extraction to include extraction area, dredged profiles, settlement ponds, drainage networks and over flows.
2. assess potential adverse hydraulic affects on the tidal area of the river, including river bank stability and proposed remedial measures.
3. Measures taken to control silt and sediment from the plant and extraction site from finding its way into the tidal area.
4. The potential to alter salt water penetration above the present tidal limit, its impact and proposed safeguards.
5. Particular attention should be made to water quality issues and ways to minimise pollution and to improve water quality where feasible.
6. Streamlining of dredge profiles should be considered to minimise stratification of water layers in dredged holes and reduce silt / pollution build up.

quality service • value • innovation

7. Describe strategy to be used to preserve scenic quality of the river.
8. Restoration of the site at the completion of extraction.
9. Clearly identify any other proposed works which may adversely affect the adjacent estuary and any remedial measures proposed.

Attention is also drawn to the following Public Works documents which will be of assistance in preparing the EIS.

- Guidelines on Public Works Requirements for Sand and Gravel Extraction Proposal in or near Estuaries.
- Estuary Management Manual.

Copies can be made available upon request.

FLOODING ASPECTS

The subject proposal is primarily located upstream of the tidal limit and within Department of Water Resources Jurisdiction. Nevertheless, the proposed extension to the sand and gravel extraction could have an impact on the flood behaviour the downstream reaches of the Hunter River. Consequently, the EIS would need to determine the short and long term impacts that the proposed works would have on downstream flood behaviour, for different frequency flood events. Such an assessment should examine the hydraulic impacts as well as any changes to the integrity of the existing flood mitigation levee system, the flood hazard and property damages.

If you require any further assistance on this matter please contact Mr Brian Ayling on (049) 269 941

Yours faithfully,

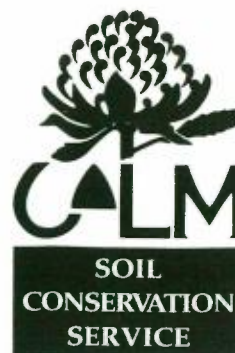


for Bob Gray,
Client Manager,
Local Government.

24 JAN 1995
20 January 1995

ERM Resource Planning
Po Box 388
EAST MAITLAND NSW 2323

Your ref: 95649L2JG:LW
Our ref:
Contact: Mr P Dwyer



464 King St
PO Box 5166
Newcastle West NSW 2302

Phone (049) 29 1537
Fax (049) 29 4387

Dear Sir/Madam,

**RE: EIS for Proposed Extension to Existing Quarry at
Oakhampton, North of Maitland**

I refer to your letter dated 12 December 1994, seeking the Service's comments on matters to be included in the EIS for the above operation.

Since the extraction area is to include the river channel and permission would be required from the Department of Water Resources, CaLM has only two matters of concern with the proposal.

The first of them is that progressive rehabilitation be carried out and sediment controls be implemented and maintained to minimise sediment entering the stream flow.

The second concerns any trees growing within the bank or within 20 metres of the banks of the Hunter River. The definition of a tree includes a sapling, shrub or scrub. The destruction of any "trees" growing within the above zone will require an authority under section 21D of the Soil Conservation Act 1938.

Yours faithfully,

P.J. Dwyer

for

**S. RUSSELL
DISTRICT MANAGER
NEWCASTLE**



The Department of Conservation and Land Management incorporates: the Soil Conservation Service, Crown Lands Service, Land Information Centre, Valuer-General's Office, Land Titles Office and Forestry Policy Unit.



NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

31 January 1995

Ms Clare Brown
Resource Planning
Post Office Box Box 388
EAST MAITLAND NSW 2323

7 FEB 1995

Our Reference: HD:A:EIS
Your Reference: BL:amb
9464912JG:LN

Dear Madam

**Re: Preparation of Environmental Impact Statement
for
Proposed Extension to an Operating Sand and Gravel Quarry at
Oakhampton, North of Maitland, NSW**

I refer to your letter dated 12 December 1994.

The National Parks & Wildlife Service (NPWS) has statutory responsibilities for the protection of aboriginal sites, wildlife and nature conservation in general.

All Aboriginal sites and relics are protected under the National Parks & Wildlife Act, 1974. National Parks & Wildlife Service therefore usually requires that an adequate archaeological survey be undertaken by a suitably qualified archaeologist as part of the preparation of an Environmental Assessment.

National Parks & Wildlife Service will need to know if the proposed development is likely to impinge, or have any effect on areas of Service estate or areas in which the Service otherwise has an interest.

The Environmental Planning and Assessment Act requires that a Fauna Impact Statement be prepared where a development or activity is likely to significantly affect the environment of endangered fauna.

To assist you in this instance you should take into consideration all the factors mentioned in Section 4A of this Act in deciding whether there is likely to be a significant effect on the environment of endangered fauna. In this regard attached is a copy of the Service's Guidelines for applicants, consent authorities and determining authorities.

Hunter District
2 Bourke Street West
Raymond Terrace
NSW 2324 Australia
PO Box 270
Raymond Terrace
NSW 2324 Australia
Tel: (049) 873 108
Fax: (049) 831 031

Head Office
43 Bridge Street
Hurstville NSW
Australia
PO Box 1967
Hurstville 2220
Tel: (02) 585 6444
Fax: (02) 585 6555

If you have any queries please contact Senior Ranger John Martindale on (049) 87 3108.

Yours faithfully,



IJ Nowacki
District Manager
Hunter District

Att.

Hunter Catchment Management Trust

30 JAN RECD



Ms Clare Brown
Manager
ERM Resource Planning
PO Box 388
EAST MAITLAND 2323

PO Box 204
Maitland NSW 2320

Telephone: (049) 335 455
Facsimile: (049) 335 164
892

Our ref: 94649L2

Your ref:

Dear Ms Brown

**Re : Proposed Extension to an Operating Sand and Gravel Quarry
at Oakhampton North of Maitland NSW**

Thank you for your letter of 12 December 1994 requesting comments from the Trust on this proposal. These are set out below:

1. Extraction operations should not adversely affect water quality in the Hunter River.
2. Aquatic flora and fauna should be assessed as part of the EIS and all efforts made to protect them from undue disturbance during operations. Removal of any streambank vegetation (other than weeds) should be compensated by vegetation re-establishment following extraction.
3. Extraction should not result in the establishment of a continuous pit adjacent to the stream which could act as a diversion channel for the river.
4. No stockpiles should be stored within a floodway.
5. The extraction site should be rehabilitated progressively to restore a landform similar to that typical of the local area.
6. The site should be re-vegetated with grasses ~~and~~ appropriate to the proposed future land use and trees native to the area (a list of appropriate tree species for the lower Hunter River is attached).
7. Dust contamination of adjacent pasture and other vegetation should be limited by adequate dust suppression measures.

I trust the above comments are of assistance.

Yours faithfully

Sharon Vernon
for Glenn Evans
Chief Executive Officer

25 January 1995



Total Catchment Management

Community And Government Working Together



HUNTER CATCHMENT MANAGEMENT TRUST

SPECIES SUITABLE FOR PLANTING ALONG THE LOWER HUNTER RIVER

Trees

<i>Alphitonia excelsa</i>	Red Ash
<i>Angophora floribunda</i>	Rough-barked Apple
<i>Casuarina cunninghamiana</i>	River Oak
<i>C. glauca</i>	Swamp Oak
<i>Cupaniopsis anarcardioides</i>	Tuckeroo
<i>Dysoxylum fraseranum</i>	Rosewood
<i>Ehretia acuminatus</i>	Koda
<i>Elaeocarpus obovatus</i>	Hard Quandong
<i>Eucalyptus camaldulensis</i>	River Red Gum
<i>E. grandis</i>	Flooded Gum
<i>Ficus macrophylla</i>	Moreton Bay Fig
<i>Livistona australis</i>	Cabbage Tree Palm
<i>Melia azedarach</i>	White Cedar
<i>Toona australis</i>	Red Cedar

Small trees/shrubs

<i>Acacia decurrens</i>	Green Wattle
<i>A. fimbriata</i>	Fringed Wattle
<i>A. longifolia</i>	Sydney Golden Wattle
<i>Acmena smithii</i>	Lilly Pilly
<i>Backhousia myrtifolia</i>	Grey Myrtle
<i>Bursaria spinosa</i>	Sweet Bursaria
<i>Callistemon citrinus</i>	Lemon Bottlebrush
<i>C. salignus</i>	Willow Bottlebrush
<i>Commersonia fraseri</i>	Brush Kurrajong
<i>Daphnandra micrantha</i>	Socketwood
<i>Ficus coronata</i>	Creek Sandpaper Fig
<i>Glochidion ferdinandi</i>	Cheese Tree
<i>Hibiscus heterophyllus</i>	Native Rosella
<i>Hymenosporum flavum</i>	Native Frangipani
<i>Leptospermum flavescens</i>	Yellow Tea-tree
<i>Mallotus philippensis</i>	Red Kamala
<i>Melaleuca linariifolia</i>	Narrow-leafed Paperbark
<i>M. styphelioides</i>	Prickly-leafed Paperbark
<i>Streblus brunonianus</i>	Whalebone Tree
<i>Syzygium australe</i>	Brush Cherry
<i>Tristaniaopsis laurina</i>	Water Gum

Ground cover/reeds

<i>Lomandra longifolia</i>	Spiny Mat Rush
<i>Phragmites australis</i>	Common Reed
<i>Schoenoplectus validus</i>	River Club-rush

18 January 1995
RLHB



New England
Hunter and
Metropolitan Region

NSW Agriculture

24 JAN 1995
ERM Resource Planning
PO Box 388
East Maitland NSW 2323

Attention: Ms Clare Brown

35-37 Abbott Street
PO Box 546
GUNNDAH NSW 2380

Telephone (067) 42 9277
Facsimile (067) 42 4018

Dear Ms Brown,

Sand/Gravel Extraction, Oakhampton
Lot 1 DP 217178, Lots 1/2/3/5 DP 248331, Lot 1 DP 717228
Parish of Maitland

I refer to your letter of 12 December 1994 seeking Departmental requirements and comments for an EIS for the above proposal to extend an existing sand and gravel operation.

The general concerns held by the Department for such operations include:

- that adverse impacts on productive agricultural land be avoided or minimised;
- that the operation should not disadvantage primary producers through increased dust, noise, vehicle movements or other adverse factors;
- that appropriate erosion control structures/practices are implemented;
- that adverse impacts on water quality are avoided;
- that appropriate weed control practices are implemented, and;
- that, after extraction, the site should be rehabilitated to achieve at least its former agricultural productive potential.

The land adjacent to the proposed extraction area is classed as a mixture of Class 2, 3 and 4 agricultural land (map attached). Class 2 and 3 lands are regarded as prime agricultural land and the Department prefers to see such land protected from disturbance where possible, particularly Class 2 land. The impact of the proposal on such land should be detailed in the EIS, including proposed rehabilitation procedures on completion of extraction activities.

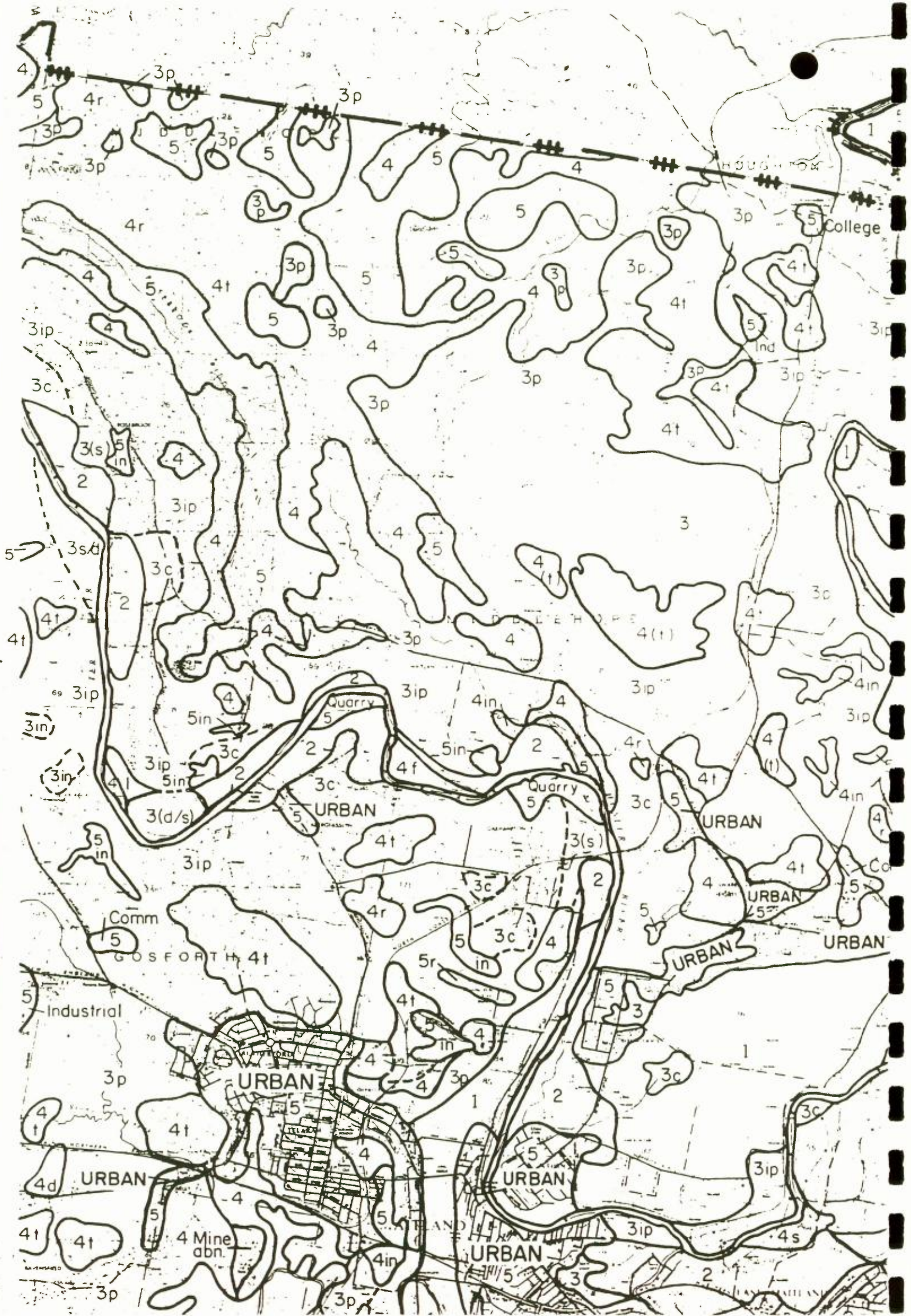
It would appear that the main extraction area is within or adjacent to the bed of the Hunter River. The Department would be pleased to see in the EIS that due consideration has been given to environmental management of the riparian zone, including fauna and flora impacts, rehabilitation of appropriate vegetation, and aesthetic issues.

The opportunity to contribute at this stage is appreciated.

Yours sincerely,

A handwritten signature in dark ink, appearing to read 'R.L.H. Browne', written in a cursive style.

R.L.H. Browne
Agricultural Environment Officer
New England & Hunter



307.5395/94;1
Mr S Kerr
Ph (049) 240 269
Fax (049) 240 348

16 JAN RECD

Roads and Traffic
Authority
Newcastle Zone



The Manager
ERM Resource Planning
PO Box 388
EAST MAITLAND NSW 2323

59 Darby Street
Locked Bag 30
Newcastle
New South Wales 2300
Telephone (049) 27 2200
Facsimile (049) 29 3818
DX 7813 Newcastle

Dear Ms Brown

I refer to your letter dated 12 December 1994 requesting the Authority's initial comments on the proposed extension to the existing sand and gravel quarry at Oakhampton (Lot 1,2,3,5 DP 217178 and Lot 1 DP 717228).

The Authority has no objections in principle to the proposal however it is requested that the Environmental Impact Statement detail the proposed access arrangements, haulage routes and volumes.

The Authority reserves the right to further comment at the development application stage.

It should be noted that quarries are designated developments under SEPP 11 and as such will need to be considered by the Regional Development Committee.

Yours sincerely

A handwritten signature in dark ink, appearing to be 'S Kerr', written over a light-colored background.

S Kerr
Regional Development Co-ordinator
Newcastle Zone Office
13 January, 1995



16 JAN REC



ERM Resource Planning
PO Box 388
EAST MAITLAND NSW 2323

NSW DEPARTMENT OF MINERAL RESOURCES
Minerals and Energy House, 29-57 Christie Street
(P.O. Box 536), St Leonards, NSW 2065, Australia
Phone (02) 901 8888 · Fax (02) 901 8777
DX 3324 St Leonards

Attention: Clare Brown

Our Ref.: L95-0003
Your Ref.: 94649L2JG:LN

Dear Ms Brown

**PROPOSED EXTENSION TO OPERATING
SAND AND GRAVEL QUARRY, OAKHAMPTON**

Thank you for your letter of 12th December, 1994, that seeks this Department's requirements for an environmental impact statement (EIS) to be prepared for the above proposal.

Sand and gravel are not prescribed minerals under the Mining Act, 1992. Therefore, the Department of Mineral Resources has no statutory authority over the extraction of these commodities, apart from its role under the Mines Inspection Act, 1901 (as amended) with respect to safe operation of mines and quarries. This Department is however the principal government authority responsible for assessing the State's resources of construction materials and for advising State and local government on their planning and management.

The operator must observe all relevant requirements of the Mines Inspection Act, 1901 (as amended). Advice on these requirements should be sought from Mr Bruce Kremmer, Senior Inspector of Mines, Mines Inspection Branch, Armidale regional office - telephone (067) 702 201.

With regard to the requirements of the Department of Mineral Resources for geological and resource information that should be incorporated in environmental impact statements, the following are considered essential:

1. The amount of sand and gravel available for extraction and the exploration methods (e.g. drilling, geological mapping, trenching) and geological assumptions (e.g. thicknesses, extent, relative densities) used to determine these amounts. Where possible, resources should be reported according to guidelines contained in the *Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves* (September 1992). Plans and cross-sections showing the extent of the resources, preferably at a scale of 1:25 000, with drillhole locations etc. and the area proposed for extraction, should be provided. Relevant supporting documentation such as drill logs should also be appended.

2. Characteristics of the sand and gravel to be produced. This should include a description of grainsize, grading, clay content and contaminants present in the sand and gravel as well as the main properties of the sand and gravel. Details of tests conducted to determine these characteristics should be appended.
3. An assessment of the quality of the materials based on the testing, and of the suitability of the material for the anticipated range of applications should be given.
4. Proposed methods of extraction, and mining and environmental constraints likely to affect the extraction operations.
5. Anticipated annual production, staging (if any), and life of the operation.
6. Alternative sources to the proposal and their availability.
7. Justification for the proposal in terms of local and, if appropriate, regional context.

If you have any queries on this matter please contact Mr John Whitehouse of the Geological Survey on (02) 901 8513.

Yours faithfully



S R Lishmund
for Director General

9th January, 1995



Environment
Protection
Authority
New South Wales

Clare Brown
ERM Resource Planning
PO Box 388
EAST MAITLAND NSW 2323

NSW Government Offices
117 Bull Street Newcastle West NSW 2302
PO Box 488G Newcastle NSW 2300
Tel .049. 26 9971 Fax .049. 29 6712

Our Reference: 270066A1 AF:NC

Your Reference: 94649L2 JG:LN

- 9 JAN 1995

Contact: Colin Halverson

Dear Ms Brown

**PROPOSED EXTENSION TO AN OPERATING SAND AND GRAVEL QUARRY AT
OAKHAMPTON, NORTH OF MAITLAND, NSW.**

Thank you for your letter dated 12 December 1994 in which you seek identification of the Environment Protection Authority's (EPA's) requirements for consideration in an Environmental Impact Statement (EIS) in support of the above proposal.

As you will be aware Boral Resources (Country) Pty Ltd currently have a licence for discharge of wastewater from the EPA. It is expected that the quarry will continue to operate within the limits of the licence. In preparing an EIS for the proposal we recommend that the following issues be addressed to enable the EPA to accurately assess the environmental implications of the proposal.

OPERATION AND SITE INFORMATION

The EIS should describe the proposed operation of the quarry, including the extraction and processing phase, a detailed site layout and a map of the general locality. The locality map should indicate adjoining residences and any land use or area of environmental significance likely to be affected.

AIR POLLUTION

The EIS must identify any activities and operations with potential to generate dust together with measures which will be implemented for their control. In addition, areas and activities such as unsealed roads, storage and manoeuvring areas subject to truck and plant movement etc, should be evaluated and, if necessary, dust controls implemented.

WATER POLLUTION

The EIS must identify what contaminated wastewater will be generated and must also describe measures to be implemented to prevent adverse impacts, by process water and contaminated stormwater, on the water quality of the Hunter River and local groundwaters. The EIS should include:-

- the type of dredge to be used and the nature (pH and fraction of settleable solids and organics) of the material to be extracted.
- likely affects on water quality
- the potential for acid-sulphate soils and siltation
- methods for treatment and disposal of process water
- volume of sediment to be removed, and the flow rates of water involved.
- details of the proposed disposal site for the dredge spoil and proposed methods of water quality and runoff control.
- Contingency plans to minimise the impacts on water quality in the event of petrol or oil spillage during operations.
- erosion effects of dredging on shoreline
- the ecological effects of the operation and the discharge pipeline.
- water quality monitoring.
- methods proposed to reduce the impacts of the disturbance of fine sediment during dredging.

NOISE POLLUTION

The operation must not cause offensive levels of noise at neighbouring residences. The proposal will be assessed in accordance with criteria described in the EPA's "Environmental Noise Control Manual".

The EIS should identify any noise sources and describe the effect of noise emitted on adjoining residents. This, in turn, will determine the need and extent to which the proponent will have to implement noise control techniques which should also be detailed in the EIS.

Proposed hours of operation must be specified. Depending on the proximity of residences to the extraction area and access roads, supporting argument may have to be made in the EIS if work is contemplated in the early morning or evening on week days or on Saturdays.

GENERAL

Your client is advised that, subject to all the necessary approvals being granted, any commitments made in the EIS, may be formalised as a condition of either our approval or licence. Accordingly, pollution control measures should not be proposed if they are not genuinely meant to be implemented or are unrealistic.

If you have any further inquiries with regard to this matter please do not hesitate to contact Colin Halverson on (049) 269 968.

Yours faithfully

C Halverson

COLIN HALVERSON
Acting Regional Manager, Hunter
for Director-General



NSW FISHERIES

Clare Brown
Manager
ERM Resource Planning
P O Box 388
East Maitland
NSW 2323

Ref: H(C): JH:3386

20 December 1994

Dear Madam,

Re: Environmental Impact Statement for Proposed Extension to Quarry at Oakhampton, North Maitland.

Thank you for consulting with NSW Fisheries concerning the preparation of an Environmental Impact Statement for the above proposal.

Matters that should be considered in the preparation of the above document are listed in the attached "Freshwater Habitat Management Guidelines".

If you wish any further discussion on this matter, please contact John Holliday, Acting Biologist (Habitat Management) on (049) 821232.

Yours faithfully

John Holliday
for
P A Crew
Director of Fisheries

CENTRAL REGION

Brackish Water Fish Culture Research Station — Taylors Beach Road — Post Office Salamander Bay NSW 2301
Telephone: (049) 82 1232 • Facsimile: (049) 82 1107



MINDARIBBA LOCAL ABORIGINAL LAND COUNCIL

SUITE 12, 420 HIGH STREET, MAITLAND, 2320
P.O. BOX 453 MAITLAND

Phone: (049) 34 3390

Fax: (049) 34 3393

To whom it may concern

I Stephen Talbott & Tod Maley did attend a Koorie (Aboriginal) sites survey, on the 7/4/95. With Archaeologist Noeleen Curran. The survey was conducted at Oakhampton for extentions to the Boral gravel & sand quarrie. No Koorie sites were found in the area which we surveyed, however this would not have been helped by the ground cover, EG: Well grassed). This doesn't mean there are no Koorie sites. We therefore recommend that should any sites be unearthed during works, that work stop immediately and the above council & National Parks + Wild Life Service be contacted.

Please Note; It is an offence under the N.P.W.S act to remove and destroy any Aboriginal sites, without the consent of the Director of N.P.W.S.

Thanking you

Stephen Talbott
Stephen Talbott

Thanking you

Tod Maley
Tod Maley

Appendix C

PROJECT TEAM

Appendix C

PROJECT TEAM

The companies and individuals involved in the preparation of the environmental impact statement were:

i. *Boral Country Concrete and Quarries*

G. Pollington	Project supervisor
J. Cotterill	Noise assessment
D. Sargent	Operations

ii. *ERM Resource Planning*

S. O'Connor	Project director and planning
M. Shelly	Project manager, operations, water management and sediment transport
K. Halliday	River hydrology, flooding and resource assessment
T. Jeyaretnam	Land use, water quality
J. Gibbs	Land ownership, traffic, european heritage and socio-economics
N. Curran	Aboriginal heritage
J. Davies	Graphics
S. Parsons	Graphics
L. Neville	Word processing

iii. *Australian Water Technologies - Ensignt*

H. Jones	Author and fieldwork
B. Chessman	Editor
D. Holleley	Fieldwork
C. Kinross	Fieldwork
L. Ledwich	Literature search

Appendix D

SAND AND GRAVEL TEST RESULTS

TABLE 4.7 - TEST RESULTS ON OAKHAMPTON SAND & GRAVEL PRODUCTS 1990-94

TEST	10mm ROUND RIVER GRAVEL (Concrete Aggregate)			CONCRETE RIVER SAND (Concrete Aggregate)			RTA RIVER SAND (Concrete for Bridges)			BRIDGE SAND		
	Spec AS2758.1	Results		Spec AS2758.1	Results		Spec RTA350	Results		Spec RTAB80	Results	
		Range	Av. (No. of samples)		Range	Av. (No. of samples)		Range	Av. (No. of samples)		Range	Av. (No. of samples)
Grading (% Pass)												
13.2 mm	100	100	100									
9.5 mm	85-100	83-92	87 (3)	100			100		100 (3)	100		100 (1)
6.7 mm	-	1-14	7 (3)	-	100	100 (4)	-	100	100 (3)	-	100	100 (1)
4.75 mm	0-20	1-2	1 (3)	90-100	99-100	99.5 (4)	90-100	99-100	99 (3)	90-100	99	99 (1)
2.36 mm	0-5	0.3-1	0.8 (3)	60-100	87-94	89.8 (4)	65-95	86-90	88 (3)	65-95	91	91 (1)
1.18 mm	-	0.2-1	0.5 (3)	30-100	69-80	73.5 (4)	40-80	60-76	68 (3)	40-80	78	78 (1)
600 micron	-	-	-	15-100	47-57	53.5 (4)	24-52	33-55	46 (3)	24-52	55	55 (1)
425 micron	-	-	-	-	38-46	42.7 (3)	-	-	-	-	39	39 (1)
300 micron	-	-	-	5-50	20-26	22.8 (4)	8-25	18-19	19 (3)	8-25	24	24 (1)
150 micron	-	-	-	0-15	1-2	1.8 (4)	1-8	1-2	2 (3)	1-8	3	3 (1)
-75 micron	0-2	0.2	0.2 (2)	0-5	0.6-1	0.8 (4)	0-3	0.6-1	0.8 (3)	0-5	0.6	0.6 (1)
-2 micron										Max.1.0	N/A	N/A (1)
Bulk Density (Dry) kg/m ³	Min.2100	2560-2580	2573 (3)	Min.2100	2540-2560	2545 (4)				Min.2100	2559	2559 (1)
Bulk Density (SSD) kg/m ³		2600-2610	2607 (3)		2577-2600	2587 (4)					2593	2593 (1)
Water Absorption (%)		1.2-1.4	1.3 (3)		1.4-1.7	1.6 (4)				Max.5.0	1.4	1.4 (1)
Apparent Density (Dry) kg/m ³											2650	2650 (1)
Unit Mass (Loose) kg/m ³		1480-1490	1487 (3)		1520-1560	1542 (4)					1564	1564 (1)
Unit Mass (Comp) kg/m ³	Min.1200	1580-1620	1597 (3)	Min.1200	1650-1690	1668 (4)				Min.1200	1690	1690 (1)
Yield (Loose) m ³ /t		0.67-0.68	67 (3)		0.64-0.66	0.65 (4)					0.64	0.64 (1)
Yield (Comp) m ³ /t		0.62-0.63	0.63 (3)		0.59-0.61	0.60 (4)					0.59	0.59 (1)
Aggregate Dry Strength (kN)	Sev.Min.100 Mod.Min.80 Prot.Min.50 Sev.Max.25 Mod.Max.35 Prot.Max.45	376-385	380.5 (2)									
Aggregate Wet Strength (kN)		334-335	334.5 (2)									
Wet/Dry Strength Var. (%)		11-13	12 (2)									
Sodium Sulphate Soundness (% Loss)				Sev.Max.12 Mod.Max.15 Prot.Max.15	0.6-1	0.85 (4)						
0.75 +2.36 mm										Max.4	0.8	0.8 (1)

TEST	10mm ROUND RIVER GRAVEL (Concrete Aggregate)			CONCRETE RIVER SAND (Concrete Aggregate)			RTA RIVER SAND (Concrete for Bridges)			BRIDGE SAND		
	Spec AS2758.1	Results		Spec AS2758.1	Results		Spec RTA350	Results		Spec RTAB80	Results	
		Range	Av. (No. of samples)		Range	Av. (No. of samples)		Range	Av. (No. of samples)		Range	Av. (No. of samples)
-2.36 +1.18 mm										Max.6	1.0	1.0 (1)
-1.18 +600 micron										Max.8	0.5	0.5 (1)
-600 +300 micron										Max.12	0.4	0.4 (1)
Weak Particles (%)										Max.1.0	Nil	Nil (1)
Light Particles (%)		0.18	0.18 (1)							Max.1.0	0.15-0.20	0.175 (2)
Silt Content (%)											1.0	1.0 (1)
Organic Impurities other than sugar										Not darker than standard	Lighter	Lighter (1)
Sugar		Not detected	Not detected (1)								Not detected	Not detected (2)
Alkali Reactivity										>0.1% @ 10 days	0.106	0.106 (1)
Sulphate Content as SO ₃ (%)		0.0386	0.0386 (1)								0.0420	0.0420 (1)
Chloride Content (%)		0.0003	0.0003 (1)								0.0007	0.0007 (1)

Appendix E

LICENCES



ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

LICENCE

ORIGINAL

Licence Number: 000562
File Number: 270066/E01
Granted On: 1 September, 1993
In Force Until: 25 August, 1994

Name and Address of Licensee:
BORAL RESOURCES (COUNTRY) PTY LTD
P O BOX 42
WENTWORTHVILLE NSW 2145

Name and Address of Premises, the subject of this Licence:
OAKHAMPTON QUARRY
OAKHAMPTON ROAD
OAKHAMPTON NSW 2320

This licence under the Pollution Control Act 1970 ("the Act") is granted to: BORAL RESOURCES (COUNTRY) PTY LTD ("the licensee") in respect of premises situated at: OAKHAMPTON ROAD, OAKHAMPTON ("the premises") subject to the conditions specified below:

Other than in accordance with section 17B of the Act this licence is not transferable.

The conditions of this licence may be varied or revoked, or new conditions attached, at any time by notice in writing given to the licensee.

DEFINITIONS

In this licence except in so far as the context or subject matter otherwise indicates or requires -

"Authority" means the Environment Protection Authority (EPA).
"Certificate" means the form entitled Certificate of Compliance with Licence Conditions. (copies of which are available from the Authority)

"head office", for the purpose of correspondence means
The Director-General,
Environment Protection Authority
PO BOX 1135 CHATSWOOD NSW 2057

"regional office" means
Environment Protection Authority
HUNTER Regional Office
NSW GOVERNMENT OFFICES, 117 BULL STREET
NEWCASTLE WEST NSW 2302
Phone (049)269971 Fax (049)296712

Postal Address
P O BOX 4886
NEWCASTLE NSW 2300

"after hours pollution line" means the phone answering service on
(049)693488

"dry weather conditions" means less than ten millimetres of rain falling within a 24 hour period.



ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

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OAKHAMPTON ROAD
OAKHAMPTON NSW 2320

C. DITIONS

For the purpose of preventing, controlling or mitigating the pollution of the environment, this licence is granted subject to the following conditions:

- L1. This licence must be made available at the premises for reference by any person concerned in the activities to which it relates and be produced on demand to a member or officer of the EPA.
- L2. Except as may be provided in any other condition of this licence, the licensee must comply with section 16 (1), (2), (3) and (4) of the Clean Waters Act 1970.
- L3. Where wastes are discharged to waters in accordance with the conditions of this licence, a record must be kept of the volume of the wastes discharged which may be either ascertained daily or determined by measurement, certified plant production or authorised discharges to a sewerage system.
- L4. Pollution control equipment, fuel burning equipment or industrial plant installed in or on the premises must be maintained in an efficient condition and operated in a proper and efficient manner.
- L5. Any activities conducted in or on the premises that, if carried out incompetently, may adversely affect the environment, in a manner that could be prevented, must be carried out in a proper manner by a competent person in accordance with the conditions of this licence.
- L6. Matter and substances on the premises must be processed, handled, moved and stored in a proper and efficient manner.
- L7. No alteration or modification to the place or method of disposal of wastes or pollutants, or to the method of operation of plant, works, fuel burning equipment or pollution control equipment, which is likely to cause or increase air or water pollution or noise being emitted from the premises shall be made without



ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

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OAKHAMPTON QUARRY
OAKHAMPTON ROAD
OAKHAMPTON NSW 2320

approval in writing from the EPA.

- L8. Any record required to be kept by a condition of this licence must be kept in a legible form at the premises and retained for a period of not less than two years following measurement or recording and produced on demand to a member or officer of the EPA.
- L9. The tests for any monitoring required by a condition of this licence must be carried out in accordance with the methods prescribed in the Clean Air Regulations 1964, Clean Waters Regulations 1972, Noise Control Regulations 1975 or as otherwise specified or approved by the EPA in writing.
- L10. The occurrence of any event which causes or is likely to cause substantial pollution of the environment must be notified to the EPA's regional office, head office or after hours Pollution Line as soon as practicable after it becomes known to the licensee or by one of its agents or servants.
- L11. Where required by the EPA, a written report must be supplied to the EPA within 21 days of any event described in condition L10. Such a report must include full details known to the licensee (or those details that may be discovered after reasonable enquiry undertaken by the licensee) of the cause, time and duration of the event, the type, the volume and concentration of any pollutants, any remedial action taken and any measures taken or to be undertaken by or on behalf of the licensee to prevent or mitigate against a recurrence of such an event.
- L12. The licensee must not discharge substances which may pollute waters, at a point not authorised by this licence.
- L13. Any licensee that has not forwarded the completed Compliance Certificate in respect of the previous licence period must do so within 30 days of the granting of this licence. The licensee must state in the Certificate



ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

LICENCE

ORIGINAL

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File Number: 270066/E01
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In Force Until: 25 August, 1994

Name and Address of Premises:

OAKHAMPTON QUARRY
OAKHAMPTON ROAD
OAKHAMPTON NSW 2320

- (a) the extent to which conditions of the preceding licence have been complied with: and
- (b) identify any conditions not complied with: and
- (c) the reasons for any non-compliance referred to in paragraph (b) for the period covered by the Certificate.

The period to which the Certificate relates must be from the date of grant of the preceding licence to the date at which the preceding licence expired.

The Certificate for this licence must be supplied to the EPA within 30 days of the date at which this licence expires or is terminated or revoked.



ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

LICENCE

ORIGINAL

Further conditions with respect to the Clean Waters Act 1970

Licence Number: 000562

File Number: 270066/B01

Granted On: 1 September, 1993

In Force Until: 25 August, 1994

Name and Address of Premises:

DAKHAMPTON QUARRY
DAKHAMPTON ROAD
DAKHAMPTON NSW 2320

A total of 1 point(s) of discharge, the locations of which are specified individually hereafter, are authorised by this licence. The licensee may discharge in accordance with the conditions of this licence the volume, concentration or type of pollutants described below.

Location of authorised discharge point:
DISCHARGE INTO HUNTER RIVER "THROUGH" THE
NORTHERN WALL OF THE DREDGING IMPOUNDMENT

Code number of authorised discharge point: 001

Discharge Classification: DRAIN, WITH LIKELY DAILY DISCHARGE OF MORE
THAN 10,000 KILOLITRES

CONDITIONS

GENERAL CONDITIONS

The volume of wastes discharged shall not exceed 19,000 kilolitres per day.

The wastes that may be discharged shall not -

W2.1 contain more than 30 milligrams per litre of non-filtrable residue more than the waters of the Hunter River immediately upstream of the dredge.

ADDITIONAL CONDITIONS

Wastes from the dredge and sand washing plant shall be directed to a sedimentation pond.

Any sedimentation pond shall be maintained at least to a minimum capacity approved by the Authority, or to a depth of at least one metre.

Runoff from any stockpile area shall be directed to a sedimentation pond



ENVIRONMENT PROTECTION AUTHORITY
NEW SOUTH WALES

Pollution Control Act, 1970.

LICENCE

ORIGINAL

Further conditions with respect to the Clean Waters Act 1970

Licence Number: 000562

File Number: 270066/B01

Granted On: 1 September, 1993

In Force Until: 25 August, 1994

Name and Address of Premises:

OAKHAMPTON QUARRY

OAKHAMPTON ROAD

OAKHAMPTON NSW 2320

- 5 Uncontaminated storm runoff shall be directed away from any sedimentation pond or stockpile area.
- 7 Matter shall not be discharged to a sedimentation pond during desilting operations.

Appendix F

FLORA AND FAUNA REPORT

**Australian Water Technologies
EnSight**

Report No. 95/51

March 1995

**OAKHAMPTON SAND AND GRAVEL
EXTRACTION PROPOSAL:
ENVIRONMENTAL ASSESSMENT
FOR FLORA AND FAUNA**

by

Hugh Jones

Prepared for ERM Resource Planning

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EXECUTIVE SUMMARY

Boral (Country) Pty Ltd operates a lease to remove sand and gravel from the lower Hunter River between the tidal limit and a point upstream of the railway bridge at Oakhampton. Reserves of sand and gravel are nearing depletion in this reach and Boral proposes to extend its quarrying operations farther upstream. This extension would affect the reach bounded by the tidal limit and a point approximately 500 m upstream from Aberglasslyn House (Fig. 1). This section of the river is not tidal and is under the jurisdiction of the Department of Water Resources.

ERM Resource Planning is preparing an environmental impact statement for the continuation of sand and gravel extraction operations. AWT EnSight was contracted to survey the river to assess the likely impacts of the proposed extension of operations on riparian and aquatic flora and fauna. Six sites were sampled in January-February 1995: two in the area of past extraction activities, two in the area of recent and current operations, and two in the area of proposed future operations.

The Hunter River at Oakhampton is a sand-bed river with large deposits of sand and gravel stored in the river bed and the flood plain. The riparian vegetation has been extensively cleared and only scattered clumps of native trees remain on steep, protected banks. Elsewhere, scattered occurrences of river she-oak (*Casuarina cunninghamiana*) and weeping willow (*Salix babylonica*) are combined with a dense sward of couch grass (*Cynodon dactylon*). The species list is dominated by exotic herbs and grasses. Riparian cover, including trees, is an important influence on aquatic habitats, contributing organic matter such as leaves and logs and providing shade. Organic matter adds to the complexity of instream habitats by increasing food resources and the diversity of microhabitats. The poor development of the riparian zone as well as the small amount of variation in depth and current in the river bed provides poor quality habitat for many invertebrates and fish.

The emergent macrophytes, *Bolboschoenus medianus* and *Schoenoplectus validus*, dominate the aquatic flora. Aquatic plants are confined to the edge of the river except on the bend at the foot of Comerfords Hill where *Potamogeton crispus*, *P. pectinatus* and *Cabomba caroliniana* cover a large area of the channel. The occurrence of *B. medianus* is a new record for the region, although this species is widespread elsewhere. The council of the City of Maitland should be notified of the presence of *C. caroliniana*. This species has the potential to become a major weed choking the river channel and should be eradicated.

About 100 species of aquatic macroinvertebrates were recorded, being common species widespread in lowland rivers. The macroinvertebrate community was similar at all sites, except in the immediate vicinity of current dredging operations, where the number of species was approximately halved, and species with sensitive structures such as exposed gills were rare or absent. This indicates that macroinvertebrate communities will be affected during extraction operations but will recover rapidly afterwards.

Sixteen species of fish were detected but 18 species are likely to occur in the area. While none of these is unexpected or rare, the size distributions indicate that the area is used by several species for breeding and as a nursery. Emergent macrophytes, overhanging grass along the river's edge and boulders are important components of habitat structure for most fish species. There were no significant differences in the number of species occurring in sections of the river that had a history of sand and gravel extraction, are presently being dredged, or have never been mined. No platypus were detected and the nearest reported sighting is from the Hunter River near Singleton. All amphibians, reptiles and waterbirds encountered during the survey are common and widespread along the southeast coastal region of Australia.

Sand and gravel mining activities can result in major adjustments to the geometry of the river channel by disrupting sediment transport and altering the energy gradient of the river. Because changes in the morphology of the channel can influence flow, depth and the composition of the substratum, sand and gravel extraction has the potential to severely dislocate the riverine ecosystem. The following recommendations are therefore made to minimise adverse environmental effects of the proposal:

- Wastewater from gravel-washing operations should be passed through a series of sedimentation ponds to remove suspended sediment.
- Emergent macrophytes should be re-established along the edge of the river. These are an important habitat for aquatic fauna. Suitable local species include *Bolboschoenus medianus*, *B. fluviatilis*, *Schoenoplectus validus*, *Typha orientalis*, *T. domingensis* and *Phragmites australis*.
- Dredging operations should be performed in a manner which does not jeopardise the stability of the river bank. If damage occurs as a result of sand and gravel extraction operations, stabilisation works should be undertaken immediately to restore the bank.
- Although the river bank was cleared of trees before the advent of sand and gravel extraction operations, consideration ought to be given to revegetating the banks with locally-occurring native species. Trees help to reduce bank erosion and enhance the aquatic habitat. Planting should extend from the water level to the top of the banks and should be mainly *Casuarina cunninghamiana* combined with couch grass, *Cynodon dactylon*, to bind the bank. Some of the other species mentioned in the discussion could be planted with *C. cunninghamiana* along sheltered reaches.
- Maintenance of the grounds surrounding the processing plant should include adequate control of weeds.

Boral (Country) Pty Ltd currently operates a lease to remove sand and gravel from the Hunter River at Oakhampton, north of Maitland, NSW. The lease extends between the tidal limit and a point upstream of the railway bridge (Lot 1, DP 717228 and Lots 1 & 3, DP 217178). Reserves of sand and gravel are nearing depletion in this reach and Boral wishes to extend its quarrying operations farther upstream. The proposed development would affect the reach bounded by the tidal limit and a point approximately 500m upstream from Aberglasslyn House (Fig. 1). This section of the river is not tidal and is under the jurisdiction of the Department of Water Resources (DWR). The tidal section of the river is administered by the Department of Public Works.

ERM Resource Planning is preparing an environmental impact statement (EIS) for the continuation of sand and gravel extraction operations by Boral. AWT EnSight has been contracted to assess the likely impacts of the proposed extension of operations on the riparian and aquatic flora and fauna. The DWR has requested that the EIS consider the impact on the stream channel and specifically '... instream habitat of fish and other aquatic fauna' and '... ecology from the lowest order, benthic communities to the highest order, fish and platypus'. The Department of Planning has also requested that the EIS address '... the impact of the proposal (both previous and intended future extraction) on the riparian environment, particularly in relation to impacts on aquatic flora and fauna (particularly on any rare and endangered species) and riparian vegetation'. Although no advice has yet been received from NSW Fisheries, it is likely that they will have similar requirements.

The scope of this investigation is to:

- survey the aquatic and river-dependent flora and fauna of the area, including platypus;
- assess the impact of current operations on the aquatic and river-dependent biota of the region;
- predict the likely impact of proposed future operations on the biota; and
- recommend management actions to minimise adverse impacts of current and proposed future operations.

2 STUDY AREA

2.1. Physiography

The Hunter River and its tributaries drain an area of 22 000 km², extending from Newcastle inland for approximately 400 km (Mitchell and Pigram 1988). The boundary between the tidal and non-tidal portions of the river occurs at Oakhampton about 500 m upstream of an unnamed creek (Fig. 1). The northern and southern boundaries of the catchment are rugged and mountainous, whereas to the west the terrain is composed of undulating hills. Glenbawn Dam impounds the upper reaches of the Hunter River above its confluence with the Pages River. Two other major tributaries, the Goulburn River and Wollombi Brook, drain the western and southern portions of the Hunter basin respectively. The Goulburn River joins the Hunter River downstream of Denman and Wollombi Brook joins the river upstream of Singleton.

The geomorphological processes affecting the Hunter River have been investigated in detail (Erskine and Bell 1982; Erskine *et al.* 1985; Erskine 1986). The lower Hunter River is a sand-bed river in a state of cyclical equilibrium (Nanson and Erskine 1988). That is, the river stores sediment in channel benches during periods of lower rainfall (drought-dominated regimes), and releases it during wetter rainfall cycles (flood-dominated regimes). Flood-dominated regimes and major land clearance along the flood plain last century have been responsible for severe bank erosion and aggradation of the channel at Maitland (Erskine 1986; Erskine and Warner 1988). The river at Oakhampton is laterally confined by bedrock and has remained laterally stable since European settlement. There has not been the case for the river between Maitland and Morpeth which has undergone a marked decrease in sinuosity due to the influence of both climatic and human-induced changes.

Only small amounts of bed material are supplied by the upper Hunter River. Glenbawn Dam traps all bed material and the Pages River stores most of its bedload upstream of Aberdeen (Erskine *et al.* 1985). Also, extensive river training works have been built along the upper Hunter River, restricting bank erosion and limiting the supply of sediment. Most of the bed-material load is supplied by the Goulburn River, Wollombi Brook and other tributaries downstream of Denman. Large amounts of sand have been stored in the lower Hunter River since the early part of the century.

2.2. Catchment Land Use

There is a broad range of land uses including viticulture, dairying, forestry and pastoral enterprises such as horse studs, poultry and beef cattle production (Resource Planning 1982; Mitchell and Pigram 1988). Significant industrial development is based at Singleton and Muswellbrook, and coal mining is carried out in the Upper Hunter and near Cessnock. In addition, coal-fired power stations are situated at Liddell and Bayswater. The upper reaches of the southern tributaries of the Hunter River are bordered by national parks and state forest reserves.

2.3. History of Sand and Gravel Extraction

Most sand and gravel mining on the Hunter River occurs downstream of Glenbawn Dam (Erskine *et al.* 1985). Sand and gravel has been removed from the river at Oakhampton since about 1960. In the past, material was quarried from both channel and floodplain deposits (Fig. 2). The Boral quarry now extracts up to 211 000 tonnes of material annually from the riverbed only, using a 10" cutter suction dredge. A 16 m depth limitation has been imposed from a one-in-three embankment batter by the Department of Public Works. The dredged material is pumped to primary and secondary washing and screening plants on the edge of the river where the sand and gravel are cleaned and sorted. Wastewater is returned to the river from a single discharge point after it has passed through a series of settling ponds to remove suspended sediment. Environment Protection Authority regulations require the discharge to be monitored daily and non-filtrable residue concentrations to be less than 30 mg/L.

2.4 Sampling Sites

Six sites on the Hunter River at Oakhampton were sampled for fish and macroinvertebrates between 30 January 1995 and 1 February 1995 (Fig. 1). The sites were chosen so that areas of past, present and proposed sand and gravel removal were replicated twice (Table 1). The dredging pond that was abandoned 12 months ago was included as a replicate of the present quarrying operations because the existing dredging pond cannot be replicated. Site OAK2 was subdivided into sites OAK2E (eastern bank) and OAK2W (western bank) when sampling for macroinvertebrates because the eastern bank was affected by sand and gravel extraction far more than the western bank.

Table 1. Details of sampling sites and summary of history of sand and gravel extraction.

Site code	Description	Map reference (Maitland 1:25 000)	History of sand & gravel extraction
OAK1	Hunter River at Comerfords Hill	655822	Ceased 12 months ago
OAK2	Dredging pond	649823	Present
OAK3	Hunter River 300m upstream of dredge pool	646822	Past: 1975-1978
OAK4	Hunter River 800m upstream of dredge pool	643820	Past: 1975-1978
OAK5	Hunter River 500m downstream of Aberglasslyn House	637821	Proposed
OAK6	Hunter River at Aberglasslyn bend	632822	Proposed

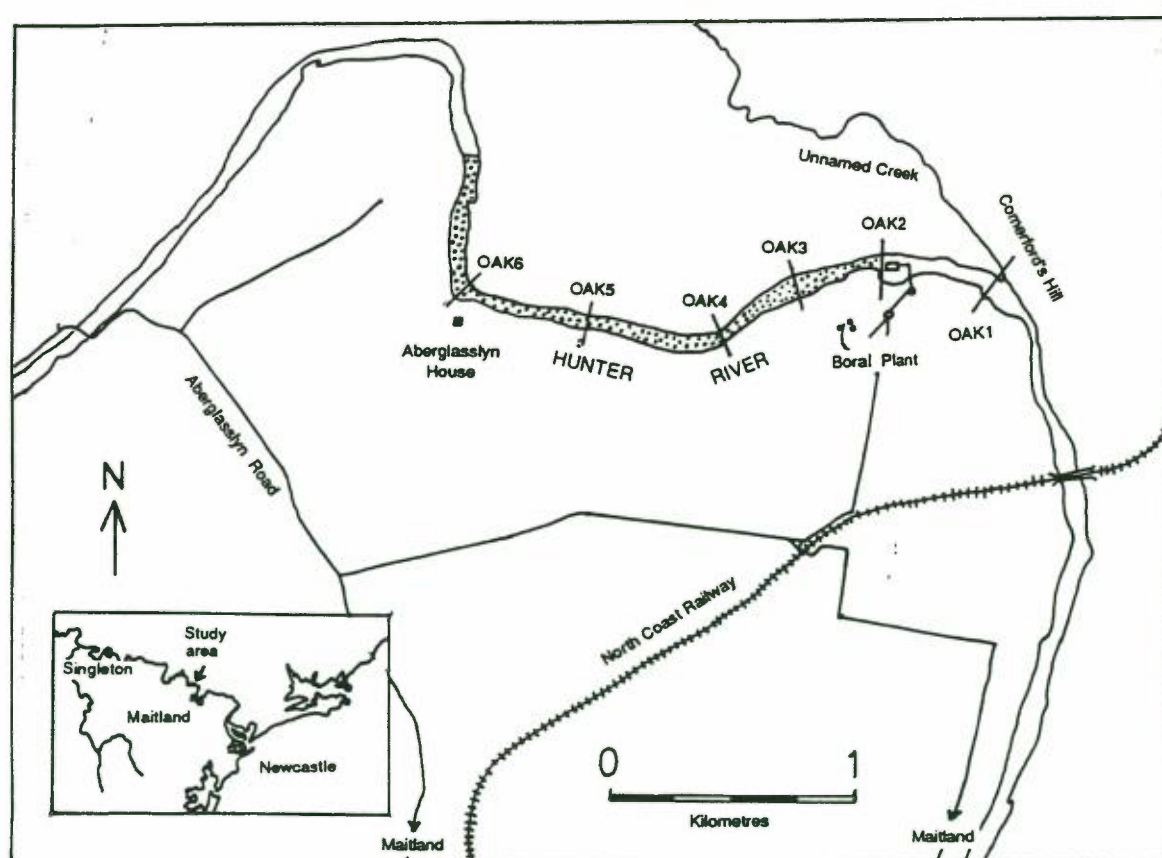


Figure 1. Positions of sites sampled on the Hunter River at Oakhampton. The stippled zone is the area proposed by Boral (Country) Pty Ltd for continuation of sand and gravel mining operations.

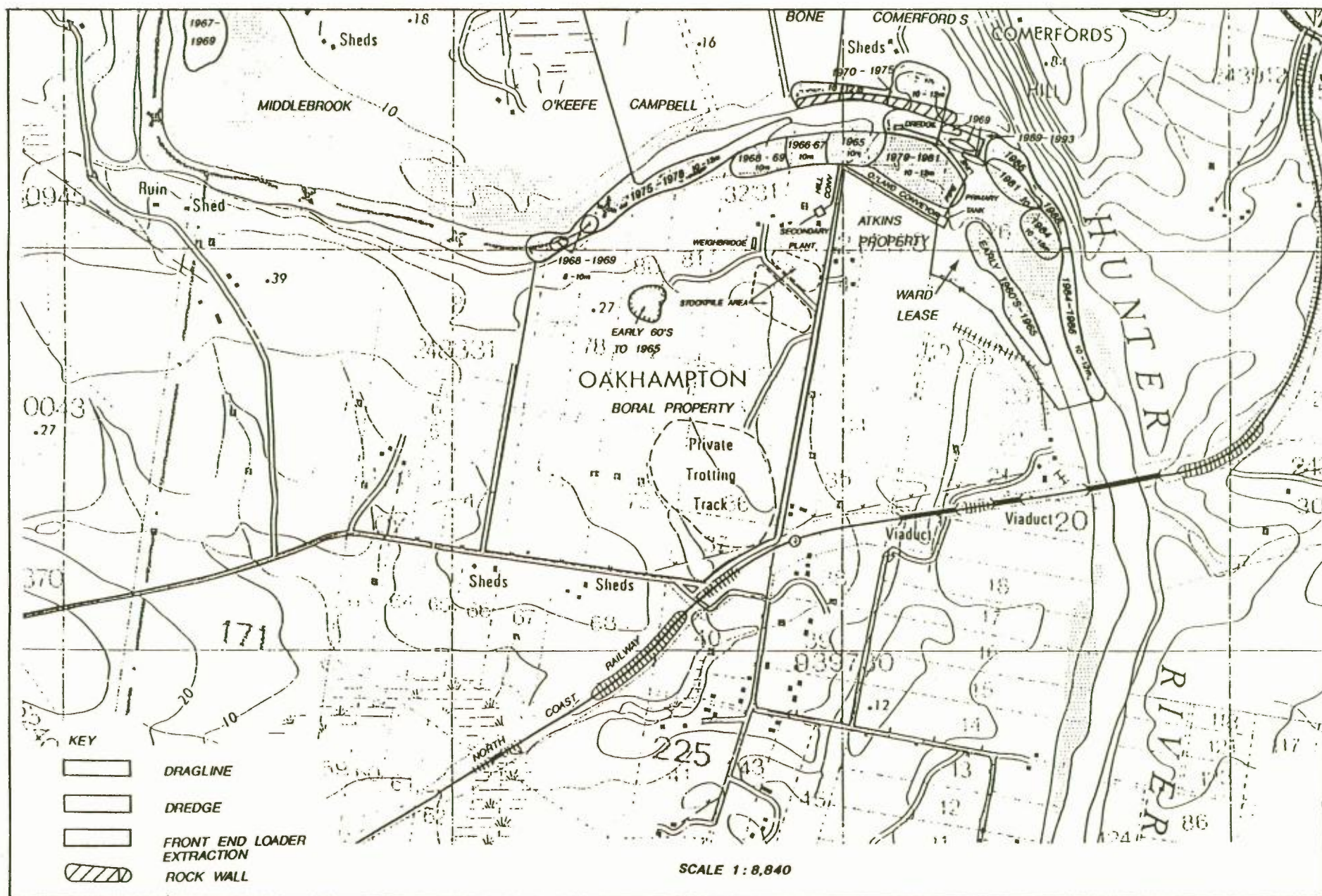


Figure 2. Locations and periods of past sand and gravel extraction operations in the Oakhampton reach of the Hunter River.

3.1 Vegetation Survey

Aquatic and riparian vegetation communities were surveyed at five sites (OAK1, OAK2, OAK3, OAK5 and OAK6). Four zones of floral assemblages could be recognised:

- Zone 1: bank: steeply sloping banks bordering the floodplain terrace;
- Zone 2: floodplain: point bars and sand and gravel deposits along the edge of the river; and
- Zone 3: river edge: aquatic and semi-aquatic macrophytes; and
- Zone 4: aquatic.

Species composition and percentage cover were assessed in each zone. Plants were often dispersed over large areas of bare sand along the river's edge and on the floodplain. Qualitative assessment of cover would have been inaccurate in these zones so cover was assessed over ten randomly chosen 1-m² quadrats. Cover was assessed by eye for the remaining zones.

Plants were identified with the aid of Lamp and Collet (1989), Harden (1990, 1991, 1992, 1993), and Sainty and Jacobs (1994). The identities of many species, including unusual records, were confirmed from pressed specimens by the Royal Botanic Gardens, Sydney.

A standardised description of adjacent land and bank and bed condition was recorded using the riparian, channel and environmental inventory (RCE) developed by Peterson (1992), as modified for Australian conditions by Chessman and Gowns (1994).

3.2 Macroinvertebrate Sampling

Sampling followed the rapid assessment procedure developed by Chessman (1995) with modifications to enable the assessment of conservation importance (species rather than family-level identification). Standardised samples were collected from two distinct habitats, the river's edge and submerged wood, within a 100-m reach of the river at each site. No distinction was made between the runs, backwaters and pool habitats.

The river's edge was sampled with a hand-held dipnet with a 320 x 250-mm opening and 0.25-mm mesh. The stream bed was disturbed to dislodge invertebrates while holding the dipnet downstream. The net was dragged through submerged vegetation and the surfaces of boulders were scrubbed by hand to dislodge animals. A time of 5 minutes was taken to collect each edge sample. The net contents were then emptied onto a large, white sorting tray in a small quantity of water and invertebrates were picked out with forceps and a pipette.

Wood was removed from the water and specimens were picked from the surface, care being taken to search under bark and in interstices. Where possible several pieces of wood were examined at each site.

Approximately 100 animals were picked over 30 minutes from each sample. As wide a range of species as possible were sampled within these constraints; where a species was present in large numbers, then no more than 10 individuals were collected. Care was taken to avoid bias such as selecting slow-moving or obvious animals, and cryptic species were readily detected by their

movements. Specimens were preserved immediately in 70% ethanol and were later identified in the laboratory using published keys (see Hawking 1994), unpublished keys supplied by colleagues or written by AWT staff, and the AWT reference collection of freshwater invertebrates.

Collecting gear was thoroughly cleaned before each sampling occasion.

3.3 Fish Sampling

Fish and decapod crustacea were sampled with a Smith-Root model 12 POW backpack electrofisher powered by a 24V DC battery. The output was set to 400 V at 40 Hz with 6 ms pulses. Each site was fished over a distance of 100 m for a total elapsed time of 30 minutes. Fish were temporarily immobilised, collected, identified on site and released back into the river. A 10 m purse seine net and two fyke nets (set overnight) were also trialled in order to capture species missed by the electrofisher. Netting was abandoned as it did not detect extra species, and was time-consuming and generally ineffective in this environment. Fish were identified using McDowell (1980), Allen (1991), and Gomon *et al.* (1994).

3.4 Herpetofauna, Birds and Mammals

All species of reptiles and birds encountered during the course of the survey were recorded. Frogs were observed by searching at night and after rain. A watch for any signs of Platypus was maintained throughout the field work.

4.1 Aquatic and Riparian Vegetation

The Hunter River at Oakhampton consists of a wide, shallow, sandy channel dominated by point bars, mid-channel bars and lateral bar deposits (Appendix: Table A1). The river meanders through farmland and the riparian zone has been highly modified.

Port Jackson Figs (*Ficus rubiginosa*), Red Kamala (*Mallotus philippensis*) and Tuckeroo (*Cupaniopsis anacardioides*) occur with River She-oaks (*Casuarina cunninghamiana*) and Ornamental Olives (*Olea europaea africana*) beneath the steep, sheltered embankments downstream of Aberglasslyn House (Appendix: Table A2). Wandering Jew (*Tradescantia albiflora*) is the dominant ground cover in heavily shaded areas such as this. Elsewhere, few trees remain along the river banks except for the southern slopes of Comerfords Hill. These are mainly River She-oaks and Weeping Willows (*Salix babylonica*). Where trees are absent, Couch Grass (*Cynodon dactylon*) and Castor Oil Plant (*Ricinus communis*) dominate the flora. Couch forms a dense sward and plays a major role in stabilising the river banks. Noogoora Burr (*Xanthium occidentale*), Buchan Weed (*Hirschfeldia incana*) and various grasses are also common in these open areas. Some 75% of all species in this zone are exotic.

The sand bars are sparsely vegetated by herbs and sedges (Appendix: Table A3), of which 59% are exotic weeds. The dominant flora of this zone are Couch, Noogoora Burr, Fleabane (*Conyza* spp.) and Bushy Starwort (*Aster subulatus*).

Little aquatic vegetation is present in the channel of the Hunter River between Aberglasslyn House and Comerfords Hill except for emergent macrophytes along the edge of the river. This is not surprising given the mobile nature of the bottom sediments. In addition, there are few snags and very little organic debris as there is no well-developed riparian zone. Club-rushes, *Bolboschoenus medianus*, and Water Couch, *Paspalum distichum*, are major components of the river edge along the aggrading banks; the lateral and point bar deposits of sand and gravel support few macrophytes (Appendix: Table A4). The Water Fern, *Azolla* sp., is found along the river wherever there is protection from the current such as in backwaters and amongst emergent macrophytes.

The only significant submergent aquatic vegetation occurs on a bend of the Hunter River opposite Comerfords Hill, where it covers approximately 30% of the channel (Table 2). The introduced Fanwort, *Cabomba caroliniana*, has not previously been recorded from the Hunter River (Royal Botanic Gardens). Its presence is cause for concern as this species has the potential to become a serious weed of waterways (Jacobs 1990).

Table 6. Percentage cover of submergent aquatic flora in the Hunter River at Comerfords Hill (site OAK1).

Family	Scientific name	Common name	Percentage cover
Potamogetonaceae	<i>Potamogeton crispus</i>	Curly Pondweed	20
	<i>P. pectinatus</i>	Sago Pondweed	10
Cabombaceae	* <i>Cabomba caroliniana</i>	Fanwort	1

The floristic composition of the riparian zone is typical of coastal rivers in eastern Australia. All species are widespread, and many are exotic weeds that colonise disturbed land and pastures. The occurrence of the Marsh Club-rush, *Bolboschoenus medianus*, is a new record for the north coast. It is very similar in appearance to *B. fluviatilis* which is common along coastal rivers.

4.2 Macroinvertebrates

The macroinvertebrate fauna comprised about 100 species (Appendix: Table A5). They are common and widespread species that are typical of the freshwater reaches of large lowland rivers (cf. Chessman and Growns 1994; Williams 1994). Some estuarine elements such as penaeid prawns were also present.

The number of species per site in the edge habitat was very similar at all sites, with the exception of site OAK2E on the eastern bank of the current dredging pond, which had only about half as many species as the other sites (Table 3). The only common species at this site were small snails (*Austropeplea* sp.), the mayfly nymph *Tasmanocoenis* sp., and the water boatman *Micronecta batilla*. *Tasmanocoenis* is much more tolerant of siltation and sediment movement than other types of mayflies, since it has protective covers that shield the abdominal gills. It is typically one of the few common species in mobile, sandy river beds (e.g. Hogg and Norris 1991). *M. batilla* is also a tolerant species, being highly mobile within the water column and breathing at the surface. It typically dominates the edge habitat in disturbed lowland rivers (e.g. Chessman and Robinson 1987).

Table 3. Numbers of macroinvertebrate species recorded from two habitats at each sites.

Site	Number of species	
	Edge	Wood
OAK1	32	23
OAK2E	16	Habitat not present
OAK2W	30	25
OAK3	30	16
OAK4	33	18
OAK5	30	15
OAK6	35	16

Species that were rare or absent in the edge habitat at site OAK2E, but were common at most or all of the other sites, included the clam *Corbiculina australis*, the introduced snail *Physa acuta*, the shrimp *Paratya australiensis*, damselfly nymphs, the beetle larva *Lancetes* sp., the blackfly larva *Simulium nicholsoni* and leptocerid caddis fly larvae. Clams are sensitive to dredging and relatively slow to recolonise disturbed areas, and blackfly larvae filter the water using delicate fans on the head, which could be affected by mobile sediment. The other species mostly breathe using gills, and could be affected by smothering of these respiratory surfaces by fine sediment.

The wood habitat was absent from site OAK2E, but supported a similar community at the other sites (Table 3 and Appendix: Table A5). More species were recorded in the current and recent dredging area than in the past and proposed extraction zones.

4.3 Fish

Sixteen species of fish were detected in the river at Oakhampton (Table 3) and reports of another two species, the Eeltail Catfish (*Tandanus tandanus*) and Flathead (probably *Platycephalus fuscus*), were received from local inhabitants (Mr John Kershaw, a Boral employee, and Mr R. Jackson, owner of "Jacksonville" which adjoins the river). The Australian Museum have recorded another three species not collected in this survey (Appendix: Table A6). All are common and widespread in the coastal rivers of south-eastern Australia, although there is some concern about the status of the Freshwater Herring over parts of its range (Koehn and O'Connor 1990). Three species are exotic - the Mosquitofish, European Carp and the Japanese Yellowfin Goby. The Yellowfin Goby was accidentally introduced to Australia in the early seventies, probably via the bilge water of cargo ships (Gomon *et al.* 1994), and is now common in the estuarine reaches of a number of Australian rivers.

Table 3. Distribution and relative abundance of fish in the Hunter River at Oakhampton. Abundance codes: +=uncommon; ++=common; +++=abundant. * denotes exotic species.

Species	OAK1	OAK2	OAK3	OAK4	OAK5	OAK6
Short-finned Eel (<i>Anguilla australis</i>)	++	++	++			
Long-finned Eel (<i>A. reinhardtii</i>)	++	++	+++	++	++	++
Freshwater Herring (<i>Potamalosa richmondia</i>)			+			
Australian Smelt (<i>Retropinna semoni</i>)		++	+			
*European Carp (<i>Cyprinus carpio</i>)				+	++	++
*Mosquitofish (<i>Gambusia affinis</i>)	+++	+++	+++	+++	+++	+++
Bullrout (<i>Notesthes robusta</i>)			++			
Australian Bass (<i>Macquaria novemaculeata</i>)	+					
Sea Mullet (<i>Mugil cephalus</i>)	+++	+++	+++	+++	++	++
Striped Gudgeon (<i>Gobiomorphus australis</i>)	++	++	++			++
Cox's Gudgeon (<i>G. coxii</i>)		++	++	+	+	++
Empire Gudgeon (<i>Hypseleotris compressa</i>)	++		++	++	++	++
Flathead Gudgeon (<i>Philypnodon grandiceps</i>)	+++	+++	+++	+++	+	++
Dwarf Flathead Gudgeon (<i>Philypnodon</i> sp.)	+	+				
*Yellowfin Goby (<i>Acanthogobius flavimanus</i>)	+					
Yellowfin Bream (<i>Acanthopagrus australis</i>)		++	++	+	++	++

The Mosquitofish, Sea Mullet, Flathead Gudgeon and Long-finned Eel were the most widespread and abundant species detected by the survey (Table 3). Some species, such as Australian Bass and Freshwater Herring, were apparently uncommon but this may have been because the sampling methods used were less efficient in collecting these species. Herring are mainly an open water species (Briggs 1980) and Bass prefer deep holes and areas with overhanging trees, snags or boulders (Koehn and O'Connor 1990; *pers. obs.*).

Mosquitofish, Carp, Flathead Gudgeons, Dwarf Flathead Gudgeons and Empire Gudgeons were found amongst reeds, rushes and overhanging water couch along the edges of the river and in backwaters. Bream were found in similar habitats but only in the main channel. Mosquitofish often swam near the surface close to grass cover whereas Empire Gudgeons were well concealed. Both species of Flathead Gudgeon rest on the bottom (Merrick and Schmida 1989). Striped Gudgeons

were caught in the shaded thalweg of the river in moderate current, amongst boulders along the edge of the river and beneath overhanging grass. Cox's Gudgeons were generally found along the river edge amongst macrophytes or under overhanging grass. Both Long- and Short-finned Eels occurred along the river edge amongst boulders, macrophytes and overhanging grass but Short-finned Eels were confined to deeper sections in the lower reaches of the river. Bullrout were caught on the downstream end of a sand bar and in the thalweg of the river. The Bass was caught along the edge of a former dredging pool beneath the cover of a weeping willow. Mullet were observed and caught in all habitats and sections of the river.

Young Yellowfin Bream were common in the Hunter River at Oakhampton, and were caught amongst overhanging grass, macrophytes and boulders along the edge of the river. The average size of bream was 73 mm LCF (range 62 - 86 mm) which corresponds to an age of less than 1 year (Pollock *et al.* 1983). Immature Short- and Long-finned Eels, European Carp, Sea Mullet and Bullrout were also caught (Appendix: Table A7) in all reaches.

There was no significant trend in the number of fish species with river length, which might be expected if there were differences between the tidal and non tidal reaches of the river. Also, there were no significance differences in the number of fish species occurring in reaches of the river with different histories of sand and gravel extraction (i.e. recent extraction, past extraction, no extraction). However, there were only two replicates of each extraction group so the power of these statistical analyses is unlikely to be very high.

4.4 Herpetofauna

One species of frog, *Limnodynastes ornatus*, a Short-necked Tortoise, *Emydura* sp., and an Eastern Water Dragon, *Physignathus lesueurii*, were encountered during the survey. All three species are widespread and common. The frog was observed in grass next to the river opposite Aberglasslyn House during rain. The tortoises were observed in the river at sites OAK1 and OAK3 close to the dredging operations. Water Dragons were observed along the river wherever trees overhung the water.

The Australian Museum has recorded another three frog species from the Maitland region (Table 10) including the threatened Green and Golden Bell Frog (Schedule 12, NSW National Parks and Wildlife Act). This species inhabits large, permanent swamps containing plenty of emergent macrophytes (Robinson 1994) and is unlikely to occur in the river at Oakhampton.

4.5 Birds

Birds observed in the Oakhampton area were typical of riparian and farmland habitats and included no rare or unusual species. The following species were recorded:

Waterfowl

- Pelican
- Black swan
- Royal Spoonbill
- Intermediate Egret

Great Egret
Little Pied Cormorant
Shag
Black Duck

Waders

Black-fronted Dotterel (sand bars)

Riparian strip & adjacent farmland

Red-browed Finch
Zebra Finch
Yellow-rumped Thornbill
Rainbow Bee-eater
Willy Wagtail
Magpie
Australian Raven
Pied Butcherbird
Rufous Songlark

Birds of prey

Wedge-tailed Eagle
Whistling Kite
Collared Sparrowhawk

4.6 Mammals

No evidence of Platypus, *Ornithorhynchus anatinus*, was found during the survey and it is unlikely that they occur in this reach of the river. The most downstream sighting of Platypus for the Hunter River is at Singleton (Tom Grant, *pers. comm.*).

5

DISCUSSION

The removal of sand and gravel from a river channel disrupts the physical conditions governing flow and sediment transport (Chang 1987). The river seeks to establish equilibrium such that there is equal sediment discharge along the channel and uniformity in the rate of energy expenditure. This process is subject to physical constraints imposed by bed armouring, bank protection and channel control structures. The excavation of a large hole in the channel sets up three discontinuities in sediment transport (Erskine 1990). Headward erosion, or upstream progressing degradation (Galay 1983), occurs at the upstream end of the hole where there is a sudden change in the energy gradient. The second discontinuity occurs in the hole where there is an increase in cross-sectional area and a decrease in hydraulic slope. This is a region of low energy and sediment is deposited into the hole. The third discontinuity occurs at the downstream end of the hole where the supply of sediment is less than the transport capacity. This shortfall is satisfied by removal of bed material resulting in downstream progressing degradation (Galay 1983). Degradation of the channel continues until equilibrium is reached in both sediment transport and in the rate of energy expenditure. This will occur when the hole is filled (Erskine 1990). Variation in the width of the channel may also occur as the river seeks to equalise the energy gradient near the hole (Chang 1987). The rate of channel adjustment is limited by the rate of sediment movement (Chang 1987). Thus, changes in sediment supply, particle size and river discharge will all influence channel's response to disequilibrium. If sediment cannot be obtained from the bed (e.g. because of armouring), then the river will erode the bank (Galay 1983).

Channel degradation and bank erosion due to sand and gravel extraction can cause extensive damage to structures and buildings on the edge of the channel (Erskine *et al.* 1985), result in diversion of the river channel (Erskine 1990; Lagasse *et al.* 1980), and initiate erosion of tributaries by lowering of the base level where the tributary meets the main stream (Galay 1983). River degradation can be avoided by ensuring that the rate of removal of sand and gravel from the bed and temporary storages such as bars and benches is less than the rate of replenishment of the same size fractions (Lagasse *et al.* 1980; Erskine *et al.* 1985). The coarser sediment tends to form a protective armour layer on the river bed and sand bars. Removal of this armour layer can result in bed degradation and alterations in channel form (Lagasse *et al.* 1980). Temporary storages of sediment in the river channel provide an important buffer in times of large floods. Depletion of these reserves could cause instability of the river system resulting in major erosion in the future.

Healthy stands of riparian vegetation improve bank stability and aesthetics. In the past, the Hunter River at Oakhampton would have been lined with stands of River She-oak (*Casuarina cunninghamiana*) from the water's edge to the top of the bank. The stable, aggrading banks would have supported a more mature vegetation community than the recently-formed point and lateral sand bar deposits. Remnants of the riverine rainforest community exist on the protected southern slopes of Comerford's Hill and along parts of the right bank downstream from Aberglasslyn House. In addition to Port Jackson Figs, Tuckeroo and Red Kamala, it is likely that this forest type would have included Weeping Lilly Pilly (*Waterhousea floribunda*), Ironwood (*Backhousia myrtifolia*), Scentless Rosewood (*Synoum glandulosum*) and species of Lilly Pilly (*Syzigium* spp.). The adjacent land at the top of the bank would have been covered by eucalypts - probably Forest Redgum (*Eucalyptus tereticornis*), Spotted Gum (*E. maculata*) and ironbarks (e.g. Grey Ironbark, *E. paniculata* and Narrow-leaved Ironbark, *E. crebra*).

The riparian zone bordering the river has been greatly modified since European settlement. Activities associated with the extraction and processing of sand and gravel from the river are unlikely to further degrade the riparian vegetation in most cases. Many of the plants growing along the river

are exotic weeds and grasses that colonise disturbed ground. These would proliferate around the processing plant, roads and settlement ponds, and it is important to control their spread. Existing native trees in the riparian zone should not be damaged, especially the remnant vegetation on the aggrading bank between sites OAK4 and OAK6. Extraction of the point bar on the bend opposite Aberglasslyn House would destroy the stand of young she-oaks that are recolonising the point bar.

The riparian zone makes an important contribution to the quality of the aquatic habitat by providing shade, cover and organic debris (Large and Petts 1994). Much of the instream habitat originates from riparian zone vegetation; the roots of overhanging trees, fallen branches and logs and accumulated leaves and bark provide shelter and food (Koehn and O'Connor 1990) and create microhabitats of varying flow and substratum type (Large and Petts 1994). Organic material from terrestrial sources can be a major source of energy in rivers and streams (Fisher and Likens 1973). The timing and seasonality of litter accession in Australian streams differs from that in Northern Hemisphere streams (Campbell *et al.* 1992). In Australian streams, litter fall occurs mainly in summer and seasonal differences are not as great. Consequently, rehabilitation of riparian margins should be with native flora.

Current, substratum and depth are important determinants of the complexity of aquatic environments for fish (Gorman and Karr 1978). Pools, riffles, backwaters, runs and glides can be defined in terms of these variables. Riparian and aquatic vegetation and coarse non-living particulate matter will add to the complexity of habitat structure by creating microhabitats with different characteristics of flow and substratum. Richardson (1984) found that the diversity and heterogeneity of the fish assemblage was positively correlated with depth, velocity and bank cover in the Tweed River. Sand and gravel extraction can have a major impact on instream habitats because of its potential to alter channel form and river morphology (Erskine *et al.* 1985; Erskine 1990). While some of the effects of dredging might reduce the heterogeneity of instream habitats (Pearson and Jones 1975), modifications to the river channel can stabilise the channel and improve habitat quality (Erskine 1992).

The diversity and quality of aquatic habitat is not high in most reaches of the Hunter River at Oakhampton, including the sections of the river that have not been mined for sand and gravel. Probably the most heterogeneous aquatic habitat occurs near the bend of the river at the base of Comerford's Hill (site OAK1). At this location, there are various flow regimes, a range of depths (pools and runs), overhanging trees and emergent macrophytes which line the river. The riparian vegetation has supplied logs and organic litter to the river bed, and an extensive stand of submergent aquatic vegetation covers the channel. These conditions are ideal for fish and aquatic invertebrates, providing protection and food resources (Rogan 1977; Koehn and O'Connor 1990). Elsewhere, the most important components of habitat structure are the emergent macrophytes and overhanging grass along the river's edge. This is similar to what has been found in other coastal rivers in south-eastern Australia (Arthrington *et al.* 1983; Richardson 1984). Young Australian Bass prefer the cover of emergent and submergent macrophytes (SPCC 1977; Harris 1986, 1988). Dredging operations should therefore be planned to avoid disrupting the stands of emergent macrophytes that grow along the edge of the aggrading bank.

River bed siltation due to increases in suspended sediment concentrations in the water can severely reduce the density and diversity of macroinvertebrate communities (Gammon 1970; McLelland and Brusven 1980; Lenat *et al.* 1981). Fine sediment clogs invertebrate gills and creates an unfavourable habitat for non-burrowing species by smothering clean substratum surfaces and filling the interstitial spaces between sand and gravel. Such effects have been observed in streams subjected to extractive activities such as placer mining (Wagener and La Perriere 1985; Quinn *et al.* 1992), but these impacts cannot necessarily be extrapolated to the operation at Oakhampton, because of differences in mining practices and the treatment of wastes. The Oakhampton survey revealed a reduction in

macroinvertebrate diversity in the immediate vicinity of the current operations, but showed no differences between recently mined sections and the areas proposed for future extraction. This is consistent with the observation of Pearson and Jones (1975) that the recovery of benthic macroinvertebrate communities after dredging operations can be rapid.

Dredging and associated sedimentation can also destroy spawning grounds for fish, especially those species that lay demersal eggs (Koehn and O'Connor 1990; NSW Department of Water Resources 1992). Increased turbidity may also interfere with the predatory behaviour of some fish and make conditions unsuitable for aquatic plants. The river at Oakhampton is used by at least some of the fish species for breeding and as a nursery area for juvenile fish. Young bream and sea mullet, for example, fit into the latter category (Thompson 1955; Pollock 1984). The Australian bass is catadromous (ie. it moves downstream to the estuary to breed) and young fish and males are very likely to be found in the lower non-tidal reaches of the river (Harris 1988). The spawning behaviour of the bullrout is unknown (Merrick and Schmida 1988) but Richardson (1984) found juveniles close to the estuary.

The severity of these types of impact depend largely on the proportion of fine particles mixed with the sand and gravel deposits (Erskine 1990), and on the method of extraction and processing (SPCC 1984). In the upper Hawkesbury River, dragline operations were found to increase turbidity much more than cutter suction dredges. Draglines disturb the fine sediments more than cutter suction dredges which pump extracted material onshore for sorting. Wastewater is returned to the river after treatment by a series of sedimentation ponds to remove fine material. Nevertheless, cutter suction dredging can significantly elevate turbidity downstream of the dredge (Bryce 1977).

6

RECOMMENDATIONS

The following recommendations are made to minimise the adverse environmental impacts of the proposal, so that such effects would be localised and transient:

- Wastewater from gravel washing operations should be passed through a series of sedimentation ponds to remove suspended sediment before return to the river, according to conditions imposed by the Environment Protection Authority.
- Emergent macrophytes along the edge of the river should not be disturbed during operations. Where this is impractical, stands should be re-established as soon as possible after mining, as these are an important habitat for aquatic fauna. Suitable local species include *Bolboschoenus medianus*, *B. fluviatilis*, *Schoenoplectus validus*, *Typha orientalis*, *T. domingensis* and *Phragmites australis*.
- Dredging operations should be performed in a manner which does not jeopardise the stability of the river bank. If damage occurs as a result of sand and gravel extraction operations, stabilisation works should be undertaken immediately to restore the bank.
- Although the river bank was cleared of trees before the advent of sand and gravel extraction operations, consideration ought to be given to revegetating the banks with locally-occurring native species. This would ensure long-term stability, as well as improving aesthetics and the ecological values of the river edge. Planting should extend from the water level to the top of the banks and should be mainly *Casuarina cunninghamiana* combined with couch grass, *Cynodon dactylon*, to bind the bank. Some of the other species mentioned above could be planted with *C. cunninghamiana* along sheltered reaches.
- Maintenance of the grounds surrounding the processing plant should include adequate control of weeds.

7

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- Allen, G.R. (1989). *Freshwater Fishes of Australia*. T.F.H. Publications, Brookvale.
- Arthington, A.H., Milton, D.A. and McKay, R.J. (1983). Effects of urban development and habitat alterations on the distribution and abundance of native and exotic freshwater fish in the Brisbane region, Queensland. *Australian Journal of Ecology*, 8, 87-101.
- Briggs, I.C. (1980). Family Clupeidae. Herrings. In: *Freshwater Fishes of South-eastern Australia* (ed. R.M. McDowell) pp. 48-50. A.H. and A.W. Reed Pty Ltd, Sydney.
- Bryce, M.N. (1977). *A Study of Sediment Movements Downstream from a Hydraulic Dredge*. Bachelor of Arts Thesis, University of New South Wales.
- Campbell, I.C., James, K.R., Hart, B.T. and Devereaux, A. (1992). Allochthonous coarse particulate organic material in forest and pasture reaches of two south-eastern Australian streams. I. Litter accession. *Freshwater Biology*, 27, 341-52.
- Chang, H.H. (1987). Modelling fluvial processes in streams with gravel mining. In: *Sediment Transport in Gravel-Bed Rivers* (eds C.R. Thorne, J.C. Bathurst & R.D. Hey) pp. 977-985. John Wiley and Sons, Chichester.
- Chessman, B.C. (1995). Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family level identification and a biotic index. *Australian Journal of Ecology*, 20, 122-129.
- Chessman, B.C. and Grouns, J.E. (1994). *Williams River Aquatic Macroinvertebrate Study*. Australian Water Technologies report No. 94/84.
- Chessman, B.C. and Robinson, D.P. (1987). Some effects of the 1982-83 drought on water quality and macroinvertebrate fauna in the La Trobe River, Victoria. *Australian Journal of Marine and Freshwater Research*, 38, 289-299.
- Erskine, W.D. (1986). *River Metamorphosis and Environmental Change in the Hunter Valley, New South Wales*. Ph.D. Thesis, University of New South Wales.
- Erskine, W.D. (1990). Environmental impacts of sand and gravel extraction on river systems. In: *The Brisbane River: A Source Book for the Future* (eds P. Davie, E. Stock and D. Low Choy) pp. 295-302. Australian Littoral Society Inc. and Queensland Museum, Brisbane.
- Erskine, W.D. (1992). Channel response to large-scale river training works: Hunter River, Australia. *Reg. Rivers*, 7, 261-278.
- Erskine, W.D. and Bell, F.C. (1982). Rainfall, floods and river channel changes in the upper Hunter. *Australian Geographical Studies*, 20, 183-196.
- Erskine, W.D. and Warner, R.F. (1988). Geomorphic effects of alternating flood- and drought-dominated regimes on NSW coastal rivers. In: *Fluvial Geomorphology of Australia* (ed R.F. Warner) pp. 223-244. Academic Press Australia, Sydney.

- Erskine, W.D., Geary, P.M. and Outhet, D.N. (1985). Potential impacts of sand and gravel extraction on the Hunter River, New South Wales. *Australian Geographical Studies*, **23**, 71-86.
- Fisher, S.G., and Likens, G.E. (1973). Energy flow in Bear Brook, New Hampshire: an integrative approach to stream ecosystem metabolism. *Ecology*, **43**, 421-39.
- Galay, V.J. (1983). Causes of river bed degradation. *Water Resources Research*, **19**, 1057-1090.
- Gammon, J.R. (1970). The effect of inorganic sediment on stream biota. USEPA Water Pollution Control Research Series 18050 DWC 12/70 141pp.
- Gomon, M.F., Glover, J.C.M. and Kuitert, R.H. (eds) (1994). *The Fishes of Australia's South Coast*. The Flora and Fauna of South Australia Handbooks Committee, Adelaide.
- Gorman, O.T. and Karr, J.R. (1978). Habitat structure and stream fish communities. *Ecology*, **59**, 507-15.
- Harden, G.J. (ed.) (1990). *Flora of New South Wales. Volume 1*. New South Wales University Press, Sydney.
- Harden, G.J. (ed.) (1991). *Flora of New South Wales. Volume 2*. New South Wales University Press, Sydney.
- Harden, G.J. (ed.) (1992). *Flora of New South Wales. Volume 3*. New South Wales University Press, Sydney.
- Harden, G.J. (ed.) (1993). *Flora of New South Wales. Volume 4*. New South Wales University Press, Sydney.
- Harris, J.H. (1986). Reproduction of the Australian Bass, *Macquaria novemaculeata* (Perciformes, Percichthyidae) in the Sydney Basin. *Australian Journal of Marine and Freshwater Research*, **37**, 209-235.
- Harris, J.H. (1988). Demography of Australian Bass, *Macquaria novemaculeata* (Perciformes, Percichthyidae) in the Sydney Basin. *Australian Journal of Marine and Freshwater Research*, **39**, 355-369.
- Hawking, J. (1993). A Preliminary Guide to Keys and Zoological Information to Identify Invertebrates from Australian Freshwaters. Cooperative Research Centre for Freshwater Ecology, Albury, Identification Guide No. 2.
- Jacobs, S.W.L. (1990). Cabombaceae. In: *Flora of New South Wales. Volume 1* (ed. G.J. Harden) pp. 148-149. New South Wales University Press, Sydney.
- Koehn, J.D. and O'Connor, W.G. (1990). *Biological Information for Management of Native Freshwater Fish in Victoria*. Department of Conservation and Environment, Arthur Rylah Institute for Environmental Research, Melbourne.
- Lamp, C. and Collet, F. (1989). *Field Guide to Weeds in Australia*. Inkata Press, Sydney.

- Lagasse, P.F., Winkley, B.R. and Simons, D.B. (1980). Impact of gravel mining on river system stability. *Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings American Society of Civil Engineers*, **106**, 389-404.
- Large, A.R.G. and Petts, G.E. (1994). Rehabilitation of river margins. In: *The Rivers Handbook. Hydrological and Ecological Principles. Volume I.* (eds P. Calow and G.E. Petts) pp. 401-419. Blackwell Scientific Publications, Melbourne.
- Lenat, D.R., Penrose, D.L. and Eagleson, K.W. (1981). Variable effects of sediment addition on stream benthos. *Hydrobiologia*, **79**, 187-194.
- McClelland, W.T. and Brusven M.A. (1980). Effects of sedimentation on the behavior and distribution of riffle insects in a laboratory stream. *Aquatic Insects*, **3**, 161-169.
- McDowell, R.M. (1980). *Freshwater Fishes of South-eastern Australia*. A.H. and A.W. Reed Pty Ltd., Sydney.
- Merrick, J.R. and Schmida, G.E. (1984). *Australian Freshwater Fishes. Biology and Management*. Griffin Press, Netley.
- Mitchell, B. and Pigram, J. (1988). *Integrated Catchment Management and the Hunter Valley, N.S.W.* Occasional Paper No. 2, University of New England, Armidale.
- Nanson, G.C. and Erskine, W.D. (1988). Episodic changes of channels and floodplains on coastal rivers in New South Wales. In: *Fluvial Geomorphology of Australia* (ed. R.F. Warner) pp. 201-221. Academic Press Australia, Sydney.
- Pearson, R.G. and Jones, N.V. (1975). The effects of dredging operations on the benthic community of a chalk stream. *Biological Conservation*, **7**, 273-285.
- Peterson, R.C. Jr (1992). The RCE: a riparian, channel and environmental inventory for small streams in the agricultural landscape. *Freshwater Biology*, **27**, 295-306.
- Pollock, B.R., Weng, H. and Morton, R.M. (1983). The seasonal occurrence of postlarval stages of yellowfin bream, *Acanthopagrus australis* (Günther), and some factors affecting their movement into an estuary. *Journal of Fish Biology*, **22**, 409-415.
- Quinn, J.M., Davies-Colley, R.J., Hickey, C.W., Vickers, M.L., and Ryan P.A. (1992). Effects of clay discharges on streams. 2. Benthic invertebrates. *Hydrobiologia*, **248**, 235-247.
- Resource Planning (1982). *Environmental Impact Statement for the Extraction and Processing of Sand and Gravel from the Hunter River, Singleton*. Prepared for Pioneer Concrete (N.S.W.) Pty Ltd.
- Richardson, B. (1984). *Instream Flow Requirements in Relation to the Biology and Ecology of Freshwater Fishes in the Tweed River, Northern New South Wales*. M. Sc. Thesis, Macquarie University.
- Robinson, M. (1994). *A Field Guide to Frogs of Australia*. Reed Books Australia, Sydney.
- Rogan, P. (1977). Maintaining wildlife values in streams. *Victoria's Resources*, **19**, 24-26.

- Sainty, G.R. and Jacobs, S.W.L. (1994). *Waterplants in Australia. A Field Guide*. 3rd edn. Sainty and Associates, Sydney.
- SPCC (1984). *Sand and Gravel Extraction in the Upper Hawkesbury River*. State Pollution Control Commission, Sydney.
- Thompson, J.M. (1955). The movements and migrations of mullet (*Mugil cephalus* L.). *Australian Journal of Marine and Freshwater Research*, **6**, 328-347.
- Wagener S.M. and La Perriere, J.D. (1985). Effects of placer mining on the invertebrate communities of interior Alaska streams. *Freshwater Invertebrate Biology*, **4**, 208-214.
- Williams, S. (1994). *Macroinvertebrate Survey of the Hawkesbury-Nepean River and Selected Tributaries*. Australian Water Technologies report No. 94/188.

Table A1. River descriptors and associated categories used in the modified riparian, channel and environmental inventory (Chessman and Grown 1994, adapted from Petersen *et al.* 1992). Separate descriptions are given for the right (R) and left (L) banks of the river, and for pools (P) and the channel (C) in some cases.

Descriptor and category		OAK1	OAK2	OAK3	OAK4	OAK5	OAK6
1.	Land-use pattern beyond the immediate riparian zone						
	Native vegetation						
	Mixed native vegetation and pasture/exotics	L					
	Mainly pasture, crops or pine plantation	R	+	+	+	+	+
	Urban						
2.	Width of riparian strip of woody vegetation						
	More than 30 m	L					
	Between 5 and 30 m				R	R	R
	Less than 5 m			+			
	No woody vegetation	R	+		L	L	L
3.	Completeness of riparian strip of woody vegetation						
	Riparian strip without breaks in vegetation						
	Breaks at intervals of more than 50 m					R	
	Breaks at intervals of 10 - 50 m					L	
	Breaks at intervals of less than 10 m	+	+	+	+		+
4.	Vegetation of riparian zone within 10 m of channel						
	Native tree and shrub species						+
	Mixed native and exotic trees and shrubs	L			R	R	
	Exotic trees and shrubs			L			R
	Exotic grasses/weeds only	R	+	R	L	L	L
5.	Stream bank structure						
	Banks fully stabilised by trees, shrubs etc.	L			R	R	
	Banks firm but held mainly by grass and herbs		L	L	L	L	+
	Banks loose, partly held by sparse grass etc.	R		R			
	Banks unstable, mainly loose sand or soil		R				

Descriptor and category		OAK1	OAK2	OAK3	OAK4	OAK5	OAK6
6.	Bank undercutting						
	None, or restricted by tree roots and boulders	+	L			+	+
	Only on curves and at constrictions			+	+		
	Frequent along all parts of stream						
	Severe; bank collapses common		R				
7.	Channel form						
	Deep: width/depth ratio less than 7:1	P					
	Medium: width/depth ratio 8:1 to 15:1						
	Shallow: width/depth ratio greater than 15:1	C	+	+	+	+	+
	Artificial: concrete or excavated channel						
8.	Riffle / pool sequence						
	Frequent alternation of riffles and pools						
	Long pools with infrequent short riffles						
	Natural channel without riffle/pool sequence	+	+	+	+	+	+
	Artificial channel; no riffle/pool sequence						
9.	Retention devices in stream						
	Many large boulders and/or debris dams						
	Rocks/logs present: limited damming effect						
	Rocks/logs present but unstable, no damming	+	+				
	Stream with few or no rocks/logs			+	+	+	+
10.	Channel sediment accumulations						
	Little or no accumulation of loose sediments						
	Some gravel bars but little sand or silt						
	Bars of sand and silt common	+	+	+	+	+	+
	Braiding by loose sediment						
11.	Stream bottom						
	Mainly clean stones with obvious interstices						
	Mainly stones with some cover of algae/ silt						
	Bottom heavily silted but stable						
	Bottom mainly loose and mobile sediment	+	+	+	+	+	+

Descriptor and category		OAK1	OAK2	OAK3	OAK4	OAK5	OAK6
12.	Stream detritus						
	Mainly unsilted wood, bark, leaves						
	Some wood, leaves etc. with much fine detritus						
	Mainly fine detritus mixed with sediment	P					
	Little or no organic detritus	C	+	+	+	+	+
13.	Aquatic vegetation						
	Little or no macrophyte or algal growth		+	R	L	R	L
	Substantial algal growth; few macrophytes						
	Substantial macrophyte growth; little algae	+		L	R	L	R
	Substantial macrophyte and algal growth						

Table A2. Percentage cover of riparian vegetation on stable river banks (zone 1) of the Hunter River at Oakhampton.

Family	Scientific name	Common name	Right bank					Left bank				
			OAK1	OAK2	OAK3	OAK5	OAK6	OAK1	OAK2	OAK3	OAK5	OAK6
Chenopodiaceae	<i>*Chenopodium album</i>	Fat Hen	+	+								
Caryophyllaceae	<i>Stellaria flaccida</i>			+								
Polygonaceae	<i>*Rumex crispus</i>	Curled Dock		+	+						+	
	<i>Persicaria prostrata</i>	Creeping Knotweed							+			
Malvaceae	<i>*Pavonia hastata</i>		+		+							
	<i>*Sida rhombifolia</i>	Paddy's Lucerne		+	+							+
Euphorbiaceae	<i>*Ricinus communis</i>	Castor Oil Plant		15	20	5		30				
Brassicaceae	<i>*Hirschfeldia incana</i>	Buchan Weed	+	+	5		+	+	+			5
Onagraceae	<i>*Oenothera longiflora</i>	Evening Primrose		2					+		+	+
Fabaceae	<i>*Trifolium repens</i>	White Clover										+
Oxalidaceae	<i>Oxalis sp.</i>				+							
Vitaceae	<i>Cissus antarctica</i>	Water Vine				+						
Apiaceae	<i>*Foeniculum vulgare</i>	Fennel			+	+		5	+		2	+
	<i>*Ammi majus</i>	Bishop's Weed							+			
Asteraceae	<i>*Ambrosia sp.</i>	Ragweed										
	<i>*Aster subulatus</i>	Bushy Starwort										
	<i>*Verbesina encelioides</i>	Crownbeard		+								
	<i>*Xanthium occidentale</i>	Noogoora Burr	30	+	1	2	1	+	2			1
	<i>*Conyza bonariensis</i>	Flaxleaf Fleabane	+	2		+	+	+	+			+
	<i>*C. parva</i>	Fleabane	+									+
	<i>*Senecio madagariensis</i>	Fireweed		+	+		+					1
	<i>*Tagetes minuta</i>	Stinking Rodger					15					1
	<i>*Onopordum acanthium</i>	Scotch Thistle			+							
	<i>*Lycium ferocissimum</i>	African Boxthorn								1	1	+
Solanaceae	<i>*Nicotiana glauca</i>	Tree Tobacco		+	+						+	
	<i>*Solanum nigrum</i>	Black Nightshade	+		+			+	+			
	<i>*Verbascum virgatum</i>	Twiggy Mullein							+		+	
Plantaginaceae	<i>*Plantago lanceolata</i>	Plantain							+			+
Verbenaceae	<i>*Lantana camara</i>	Common Lantana			+	30		30				
	<i>*Verbena bonariensis</i>	Purpletop	+	+	+	+	+	+	+			+
	<i>*V. littoralis</i>										+	
Commelinaceae	<i>Commelina cyanea</i>		1			5		2				
	<i>*Tradescantia albiflora</i>	Wandering Jew	10			25		10				
Juncaceae	<i>Juncus usitatus</i>	Common Rush							+			
Poaceae	<i>*Bromus unioloides</i>	Prairie Grass					+				+	

Family	Scientific name	Common name	Right bank					Left bank				
			OAK1	OAK2	OAK3	OAK5	OAK6	OAK1	OAK2	OAK3	OAK5	OAK6
	<i>*Chloris gayana</i>	Rhodes Grass				+	5					+
	<i>Cynodon dactylon</i>	Couch	20	95	70	15	80	40	98	95	95	80
	<i>Dichanthium sericeum</i>	Queensland Bluegrass			1		1					
	<i>Echinochloa telmatophila</i>	Swamp Barnyard Grass										
	<i>*Eleusine indica</i>	Crowsfoot Grass										1
	<i>*Paspalum dilatatum</i>	Paspalum			3							
	<i>*Rhynchelytrum repens</i>	Natal Red Grass		+								
	<i>*Setaria gracilis</i>	Slender Pigeon Grass								+	+	+
	<i>Themeda australis</i>	Kangaroo Grass					+					
Trees												
Lauraceae	<i>*Cinnamomum camphora</i>	Camphor Laurel				1						
Moraceae	<i>Ficus rubiginosa</i>	Port Jackson Fig				10						
Euphorbiaceae	<i>Mallotus philippensis</i>	Red Kamala				2						
Sapindaceae	<i>Cupaniopsis anacardioides</i>	Tuckeroo				2						
Salicaceae	<i>*Salix babylonica</i>	Weeping Willow			1	5		15	1	2	+	
	<i>*Salix alba</i>	Willow						1		1		
Casuarinaceae	<i>Casuarina cunninghamiana</i>	River She-oak		1	5	30	3	5			1	5
Anacardiaceae	<i>*Schinus ariera</i>	Pepper Tree			1							
Fabaceae	<i>*Robinia pseudoacacia</i>	Black Locust					10					
Solanaceae	<i>*Cestrum parqui</i>	Green Cestrum				2	20				+	
Oleaceae	<i>*Olea europaea africana</i>	Ornamental Olive				20						

Table A3. Percentage cover of riparian vegetation on sand and gravel floodplain and point bars (zone 2) of the Hunter River at Oakhampton.

Family	Scientific name	Common name	OAK1	OAK2	OAK3	OAK5	OAK6
Chenopodiaceae	* <i>Chenopodium ambrosioides</i>	Mexican Tea	+		+		+
Amaranthaceae	<i>Alternanthera denticulata</i>	Lesser Joyweed		+			+
	* <i>Amaranthus retroflexus</i>	Red-root Amaranth			+		
Caryophyllaceae	* <i>Polycarpon tetraphylla</i>	Four-leaved Allseed			+		
Polygonaceae	* <i>Rumex crispus</i>	Curled Dock				+	
	<i>Persicaria decipiens</i>	Redshank					
	<i>P. lapathifolium</i>	Pale Knotweed	+			+	+
Malvaceae	* <i>Modiola caroliniana</i>	Carolina Mallow	+	+			
	* <i>Sida rhombifolia</i>	Paddy's Lucerne	+	+			
Euphorbiaceae	* <i>Ricinus communis</i>	Castor Oil Plant	+				+
Cucurbitaceae	* <i>Citrullus lanatus</i>	Camel Melon		+			
Onagraceae	* <i>Oenothera longiflora</i>	Evening Primrose			+		
Asteraceae	* <i>Ambrosia</i> sp.	Ragweed			+		
	* <i>Aster subulatus</i>	Bushy Starwort	+		+	2	+
	* <i>Xanthium occidentale</i>	Noogoora Burr	2	3	3	9	4
	* <i>Conyza bonariensis</i>	Flaxleaf Fleabane	+		+	+	+
	* <i>C. parva</i>	Fleabane	+		+	+	+
	* <i>Senecio madagariensis</i>	Fireweed	+				+
	* <i>Tagetes minuta</i>	Stinking Rodger	+			+	+
	* <i>Onopordum acanthium</i>	Scotch Thistle	+				+
Solanaceae	* <i>Solanum nigrum</i>	Black Nightshade			+		
Convolvulaceae	<i>Polymeria calycina</i>		+	+			
Verbenaceae	* <i>Verbena bonariensis</i>	Purpletop			+		
Typhaceae	<i>Typha domingensis</i>	Narrow-leaved Cumbungi					
	<i>T. orientalis</i>	Broad-leaved Cumbungi					
Juncaceae	* <i>Juncus acutus</i>	Sharp Rush				+	
	<i>J. articulatus</i>	Rush	+				+
	<i>J. usitatus</i>	Common Rush	1				+
Cyperaceae	<i>Bolboschoenus medianus</i>	Marsh Clubrush					
	* <i>Cyperus eragrostis</i>	Umbrella Sedge	+				+
	<i>C. exaltatus</i>	Sedge	+				
	<i>C. polystachyos</i>	Sedge	+				+
	* <i>C. rotundus</i>	Nutgrass					+
	<i>Eleocharis</i> sp.	Spikerush			+		
	<i>Fimbristylis velata</i>	Sedge	+				
	<i>Schoenoplectus mucronatus</i>	Rush					

Family	Scientific name	Common name	OAK1	OAK2	OAK3	OAK5	OAK6
Cyperaceae	<i>S. validus</i>	River Clubrush					
Poaceae	* <i>Bromus unioloides</i>	Prairie Grass		+			
	* <i>Chloris gayana</i>	Rhodes Grass		+			
	<i>Cynodon dactylon</i>	Couch	8	18	11	19	8
	<i>Echinochloa telmatophila</i>	Swamp Barnyard Grass					
	<i>Paspalum distichum</i>	Water Couch				7	
	* <i>Rhynchelytrum repens</i>	Natal Red Grass					
	* <i>Eleusine indica</i>	Crowsfoot Grass		+			
	* <i>Digitaria ciliaris</i>	A Summer Grass		+			+
TREES							
Casuarinaceae	<i>Casuarina cunninghamiana</i>	River She-oak					5

Table A4. Percentage cover of riparian vegetation along the edge (zone 3) of the Hunter River at Oakhampton.

Family	Scientific name	Common name	Right bank					Left bank				
			OAK1	OAK2	OAK3	OAK5	OAK6	OAK1	OAK2	OAK3	OAK5	OAK6
Ranunculaceae	<i>*Ranunculus sceleratus</i>	Celery Buttercup	+									
Chenopodiaceae	<i>*Chenopodium ambrosioides</i>	Mexican Tea	+									
Polygonaceae	<i>*Rumex crispus</i>	Curled Dock	+							+		
	<i>Persicaria decipiens</i>	Redshank					+			+	+	
	<i>P. lapathifolium</i>	Pale Knotweed	+			+		1		2		
Asteraceae	<i>*Aster subulatus</i>	Bushy Starwort	+			+	10				2	
	<i>*Xanthium occidentale</i>	Noogoora Burr		+		+	+	+		+		
	<i>*Conyza bonariensis</i>	Flaxleaf Fleabane						+				
	<i>*C. parva</i>	Fleabane						+				
Verbenaceae	<i>*Verbena bonariensis</i>	Purpletop				+		+				
Typhaceae	<i>Typha domingensis</i>	Narrow-leaved Cumbungi									5	
	<i>T. orientalis</i>	Broad-leaved Cumbungi	+					1				
Juncaceae	<i>Juncus articulatus</i>	Rush	1.3			+				1		
	<i>J. usitatus</i>	Common Rush	3.9			+		+			+	
	<i>J. polyanthemus x usitatus</i>	Rush				+						
Juncaginaceae	<i>Trichoglochin procerum</i>	Water Ribbons									+	
Cyperaceae	<i>Bolboschoenus medianus</i>	Marsh Clubrush	+					8	10		65	5
	<i>*Cyperus eragrostis</i>	Umbrella Sedge	+	+		+		+	+	+		
	<i>C. exaltatus</i>	Sedge	+					+				
	<i>C. polystachyos</i>	Sedge	+					+				
	<i>Eleocharis sp.</i>	Spike-rush								+		
	<i>Fimbristylis velata</i>	Sedge	+									
	<i>Schoenoplectus mucronatus</i>	Sedge	+									
	<i>S. validus</i>	River Clubrush	+			+		5				
Poaceae	<i>Cynodon dactylon</i>	Couch	+	+		2		10	20	3	+	
	<i>*Echinochloa crus-galli</i>	Barnyard Grass						+				
	<i>E. telmatophila</i>	Swamp Barnyard Grass					+					
	<i>*Eleusine indica</i>	Crowsfoot Grass	+					+				
	<i>Paspalum distichum</i>	Water Couch				3	50	60	40	21	30	
	<i>Phragmites australis</i>	Common Reed						10				

Table A5. List of aquatic macroinvertebrate species from the Hunter River at Oakhampton. Life cycle stages are as follows: A: adult; L: larva; N: nymph.

Class Order	Family	Genus/species/stage	Edge						Wood							
			OAK 1	OAK 2E	OAK 2W	OAK 3	OAK 4	OAK 5	OAK 6	OAK 1	OAK 2W	OAK 3	OAK 4	OAK 5	OAK 6	
Turbellaria																
Seriata	Dugesiidae	SWB2				1										
		SWB3			1				1				1			
Bivalvia																
Heterodonta	Corbiculidae	<i>Corbiculina australis</i>			4	11	7	5	4		6	5	3	2	3	1
Gastropoda																
Basommatophora	Hydrobiidae	<i>Potamopyrgus antipodarum</i>				1	1		1							
		<i>Potamopyrgus</i> TC 0760					1									
		indeterminate				1		1								
	Lymnaeidae	<i>Austropeplea lessoni</i>							1							
		<i>Austropeplea</i> indeterminate		4												
		<i>Pseudosuccinea columella</i>	1		12			2	1		9	3				
	Physidae	<i>Physa acuta</i>	3		3	11	11	10	8		8	15		8		5
	Planorbidae	<i>Glyptophysa</i> SWB1		1							1					
		TC 0769						1								
	Thiaridae	<i>Thiara balonnensis</i>				2		1						1		
Oligochaeta																
Haplotaxida	Tubificidae	indeterminate												1	2	
Arachnida																
Acarina	Eylidae	<i>Eylais</i>						1								
	Glossiphoniidae	SWB1					1									1
	Sphaeromatidae	<i>Cymodetta</i> TC 0076	1													
Crustacea																
Ostracoda								1		1						
Decapoda	Atyidae	<i>Australatya striolata</i>	1			1										
		<i>Paratya australiensis</i>	10		5	5	5	2	7		1					
	Palaemonidae	<i>Macrobrachium australiense</i>				1			1							
	Penaeidae	TC 0784	3	1	1	10	2	2	3							
Insecta																
Ephemeroptera	Baetidae	<i>Baetis</i> SWB2N	1										2			
		<i>Baetis</i> SWB4N	11	1			6		9		11	11	2	2	13	3
		<i>Baetis</i> indeterminate N	1		2	1		3								
		<i>Cloeon</i> SWB1N	1	1	3				5							

Class Order	Family	Genus/species/stage	Edge							Wood					
			OAK	OAK	OAK	OAK	OAK	OAK	OAK	OAK	OAK	OAK	OAK	OAK	OAK
			1	2E	2W	3	4	5	6	1	2W	3	4	5	6
Odonata	Caenidae	<i>Tasmanocoenis</i> SWB1N	5	7	2	6	5	6	1	4	3	2	16		12
		<i>Tasmanocoenis</i> indeterminate N	2												
	Coenagrionidae	<i>Austrocnemis splendida</i> N									1				
		<i>Argioconemis rubescens</i> TC 0685 N	1												
		<i>Austroagrion watsoni</i> N	3			1									
		<i>Ischnura aurora</i> N								1					
		<i>Ischnura heterosticta</i> N	6		2	2	7	6	3						
		<i>Ischnura</i> indeterminate N			2	2		4							
		<i>Pseudagrion aureofrons</i> N			6	7	4	3	8					1	
		<i>Pseudagrion microcephalum</i> N			1										
		indeterminate N			9			1							
	Isostictidae	<i>Rhadinostictus simplex</i> N	6												
	Protoneuridae	<i>Nososticta solida</i> N				1			1						
	Gomphidae	<i>Austrogomphus cornutus</i> N					1								
Hemiptera		<i>Austrogomphus</i> indeterminate N		1											
	Libellulidae	<i>Nannophlebia risi</i> N							3		1				
		indeterminate N												1	
	Mesoveliidae	indeterminate N							1						
	Ochteridae	TC 0744 N			1			6		1			1		
	Corixidae	<i>Agraptocorixa</i> indeterminate N							1						
		<i>Agraptocorixa</i> indeterminate A						3							
		<i>Micronecta batilla</i> A		8	3	8	9	3	2		2	3			
		<i>Micronecta</i> indeterminate A	1	13	9	19	21	6	5						
		indeterminate N		1		15		1							
	Naucoridae	TC 0096 N						1							
		TC 0426 A					1								
	Notonectidae	<i>Anisops</i> indeterminate A		1											
		<i>Paranisops</i> indeterminate A			1										
Coleoptera	Dytiscidae	<i>Batrachomatus daemeli</i> A								1	5		7		1
		<i>Lancetes</i> SWB1L												2	
		<i>Lancetes</i> SWB2L	6		1	9	8	5	5						1
		<i>Necterosoma pencillata</i> A				1	1				2				
	Gyrinidae	SWB2L						1							
		<i>Aulonogyrus strigosus</i> A				7									
		<i>Macrogyrus</i> SWB1L	1												
	Hydrochidae	SWB2A			2										

Class Order	Family	Genus/species/stage	Edge						Wood						
			OAK 1	OAK 2E	OAK 2W	OAK 3	OAK 4	OAK 5	OAK 6	OAK 1	OAK 2W	OAK 3	OAK 4	OAK 5	OAK 6
Diptera	Hydrophilidae	SWB2L						1							
		<i>Helochares</i> SWB10A								1					
		SWB14A						1							
		TC 0768 A						2							
	Elmidae	<i>Coxelmis novemnotata</i> A												1	
		<i>Coxelmis v-fasciata</i> L								1			2		
		<i>Coxelmis v-fasciata</i> A								16	16	9	15	25	15
		<i>Notriolus</i> SWB2L											1		
		<i>Notriolus</i> SWB6A										1	1	1	
		<i>Simsonia</i> SWB3A													1
		<i>Simsonia</i> TC 0756 A				1		1							
	Curculionidae	TC 0762 A					1								
	Chironomidae							1							
	Tanypodinae	<i>Ablabesmyia notabilis</i> L									1				
		<i>Coelopynia pruinosa</i>													
		<i>Procladius</i> SWB1L				1	1				1				
	Orthocladiinae	<i>Cricotopus</i> SWB1L	1		1		2	1	5						1
		<i>Cricotopus</i> indeterminate L					1								1
	Chironominae	<i>Chironomus</i> SWB1L			1										
		<i>Cladotanytarsus</i> SWB1L	1				1				1	3			1
		<i>Cryptochironomus</i> SWB1L					1								
		<i>Dicrotendipes</i> TC 0792 L			3										
		<i>Kiefferulus</i> SWB1L			1										
		<i>Harnischia</i> SWB1L	1	1		1									
		<i>Parachironomus</i> SWB1L									2				
		<i>Paratanytarsus</i> SWB1L							2						
		<i>Polypedilum leei</i> L	2		5				1		1				
		<i>Rheotanytarsus</i> SWB1L				1		1				3			
		<i>Skusella</i> SWB1L		1											
		indeterminate L				2									
	Ceratopogonidae	L	1												
	Simuliidae	<i>Austrosimulium</i> indeterminate L				1									
		<i>Simulium nicholsoni</i> L	10			18	6	7	4	13	6	6	9	14	37
		<i>Simulium ornatipes</i> L	1				1			2	1	2			
		<i>Simulium</i> indeterminate L				5		1							
	Stratiomyidae	SWB1 L									1				

Class Order	Family	Genus/species/stage	Edge						Wood							
			OAK 1	OAK 2E	OAK 2W	OAK 3	OAK 4	OAK 5	OAK 6	OAK 1	OAK 2W	OAK 3	OAK 4	OAK 5	OAK 6	
Trichoptera	Hydropsychidae	SWB3 L			1											
		<i>Cheumatopsyche</i> SWB1L							2	1	2	18	4	5	7	
		<i>Cheumatopsyche</i> SWB5L	9			4	5	2	5	6	9	25	13	26	15	
		<i>Cheumatopsyche</i> indeterminate L			2											
	Ecnomidae	<i>Ecnomina</i> SWB3L								1		4				
		<i>Ecnomus</i> SWB6L									1		3			
		<i>Ecnomus</i> SWB8L					2			12	7	5	3	4	2	
	Leptoceridae	<i>Notalina spira</i> L	1		1	1										
		<i>Notalina</i> indeterminate L		1	1											
		<i>Oecetis</i> SWB2L			2						1					
		<i>Oecetis</i> SWB3L							1						1	
		<i>Oecetis</i> SWB4L			1						1		1			
		<i>Oecetis</i> SWB6L							1							
		<i>Oecetis</i> indeterminate L					1									
		<i>Oecetis</i> TC 0361L	2													
		<i>Triaenodes</i> SWB1L	2		2	2	3	1	4						1	
		<i>Triaenodes</i> indeterminate L						1								
		<i>Triplectides altenogus</i> L					1			1						
		<i>Triplectides australicus</i> L		1		7	6	7	7		3			2		
		<i>Triplectides australis</i> L			4					1		1	1			
		<i>Triplectides ciuskus</i> L	12		8		5	3	4	7	5					
		<i>Triplectides magnus</i> L			1											
		<i>Triplectides truncatus</i> L	7						3		1					
		<i>Triplectides</i> SWB1L	4			1	3		7							
		<i>Triplectides</i> indeterminate L			7	1		1								
		Lepidoptera	Pyralidae	TC 0683 L	1											
TC 0761 L							1									

Table A6. Records of fish and amphibians collected from the lower Hunter Valley held by the Australian Museum. The Green and Golden Bell Frog is listed as a threatened species in Schedule 12 of the NSW National Parks and Wildlife Act.

Family	Scientific name	Common name	Location	Collection date
Fish				
Clupeidae	<i>Potamalosa richmondia</i>	Freshwater Herring	West Maitland 32°44'S 151°30'E	21 Jul 1971
Eleotrididae	<i>Philypnodon</i>	Flathead Gudgeon sp.	Hunter River 30 km from Newcastle 32°40'S 151°30'E	21 Jul 1971
Gobiidae	<i>Favonigobius tamarensis</i>	Tamar River Goby	Hunter River 30 km from Newcastle 32°40'S 151°30'E	21 Jul 1971
	<i>Redigobius macrostoma</i>	Largemouth goby	Hunter River 30 km from Newcastle 32°40'S 151°30'E	21 Jul 1971
Poeciliidae	<i>Gambusia affinis</i>	Mosquitofish	Fishery Creek, Maitland 32°45'S 151°31'E	Registered May 1944
Sciaenidae	<i>Argyrosomus hololepidotus</i>	Jewfish	Hunter River 30 km from Newcastle 32°40'S 151°30'E	Apr 1949
Amphibians				
Hylidae	<i>Litoria aurea</i>	Green and Golden Bell Frog	Maitland 32°44'S 151°34'E	31 Jan 1976
	<i>L. peronii</i>	Peron's Tree Frog	East Maitland 32°45'S 151°35'E	Registered 1914
Myobatrachidae	<i>Limnodynastes ornatus</i>	Ornate Burrowing Frog	82 Church Street, Maitland 32°44'S 151°34'E	Nov 1984
	<i>Uperoleia</i>	Toadlet	East Maitland 32°45'S 151°35'E	Registered 1914

Table A7. Sizes (mm) of fish caught at each site. Mean lengths, number of individuals (parentheses) and the size range are given.

Species	OAK1	OAK2	OAK3	OAK4	OAK5	OAK6
<i>Anguilla australis</i>	120 (2) 115-125	88 (2) 75-100	206 (1)			
<i>A. reinhardtii</i>	320 (3) 100-600	304 (4) 107-510	389 (3) 180-750	168 (1)	503 (2) 385-620	330 (4) 108-530
<i>Potamalosa richmondia</i>			131 (1)			
<i>Retropinna semoni</i>		30 (1)	34 (2) 33-35			
<i>Cyprinus carpio</i>				25 (1)	22 (3) 19-26	330 (2) 70-590
<i>Gambusia holbrooki</i>	(53) 13-34	25 (8) 13-30	23 (38) 11-44	(150) 7-54	(18) 13-40	
<i>Notesthes robusta</i>			80 (4) 35-150			
<i>Macquaria novemaculeata</i>	173 (1)					
<i>Mugil cephalus</i>		178 (2) 95-260	129 (15) 70-394	114 (14) 62-325	214 (1)	
<i>Gobiomorphus australis</i>	92 (2) 72-112	100 (6) 75-136	90 (3) 29-150			94 (2) 92-95
<i>G. coxii</i>		101 (5) 65-152	158 (4) 133-179	120 (1)	44 (2) 37-50	102 (2) 93-110
<i>Hypseleotris compressa</i>	57 (6) 50-70		52 (2) 50-54	56 (3) 51-60	51 (2) 46-55	95 (1)
<i>Philypnodon grandiceps</i>	36 (28) 22-51	38 (23) 29-58	35 (30) 27-48	38 (10) 26-54	48 (1)	28 (2) 24-32
<i>Philypnodon</i> sp.	36 (1)	31 (2) 31-31				
<i>Acanthogobius flavimanus</i>	112 (1)					
<i>Acanthopagrus australis</i>		73 (9) 61-84	71 (2) 70-71	62 (1)	76 (2) 73-78	78 (2) 70-86

Appendix G

NOISE ASSESSMENT

Noise Impact Statement

for

Oakhampton Quarry

Prepared for : **Boral Resources (Country) Pty. Limited**
 P.O. Box 42
 Wentworthville NSW 2145

Prepared by : **J.W.Cotterill B.E. M.A.A.S.**
 Noise Control Engineer
 Boral Resources (Country) Pty. Limited

Reference No. **9502/NI**

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APPENDIX A

1.0 Introduction

Boral Resources (Country) Pty. Limited own and operate a sand and gravel quarry on the Hunter River at Oakhampton NSW. Sand and gravel extraction commenced on the site around 1960. Blue Metal and Gravel (Country) Pty. Limited (now Boral Resources (Country) Pty. Limited) acquired the quarry in 1964 and have operated it since this date. The quarry is working as a "continuing use rights" operation.

Oakhampton quarry is affected by State Environmental Planning Policy No. 37 - Continued Mines and Extractive Industries (SEPP37), gazetted on 18 th June 1993. Under this policy Boral have registered the quarry, allowing it to operate during a two year moratorium period. During this period a development application will be submitted to Maitland City Council supported by a Environmental Impact Statement (EIS). The Development Application will seek consent for the continuation of quarrying at the site with an extension to the current extraction area upstream of the tidal limit.

In recent years the quarry has produced up to 211,000 tonnes of sand and gravel per annum. The river sand produced is of high quality and is one of the few sands which meet the very stringent specifications called for in RTA expressway pavement projects.

Oakhampton quarry supplies concrete aggregates, exposed aggregates, washed river sand and fill sand to markets within the Newcastle and Hunter Valley region.

This noise impact statement will form part of the EIS and has been prepared in accordance with Australian Standard 1055, 1989 "Description and Measurement of Environmental Noise" Parts 1, 2 and 3 and with reference to the Environment Protection Authority - Environmental Noise Control Manual and the Noise Control Act, 1975, NSW

2.0 Project Description

2.1 Quarrying Method

Extraction of sand and gravel from the river bed is by 250mm cutter suction dredge. The dredge generally operates to a depth of 9 to 10 metres which is well within the extractable limits set by the Public Works Department.

The material obtained from the river bed comprises approximately 90% clean sand with small pebbles, cobbles and minor grit making up the remaining 10%. This raw feed is pumped to a primary washing plant on the southern embankment of the river, from where it is conveyed further from the river to a secondary washing and screening plant for final processing. Finished products are stockpiled on the ground prior to loading onto trucks for delivery directly to the customer.

No change in the operation is intended either in terms of tonnage extracted or plant capacity. A change in the plant configuration, involving the relocation of the primary washing plant upstream, will be required as the dredge moves upstream.

2.2 Plant and Equipment

The plant and equipment currently used on site includes the following:-

Mobile Equipment

- 1 x dredge
- 1 x front-end loader - Cat 966, sales
- 1 x front-end loader -Cat 966, sales/production
- 1 x water cart
- delivery trucks as required

Fixed Plant

- 1 x primary washing plant (including trommel, cyclone and screw)
- 1 x secondary screen
- 1 x scrubber
- 1 x screw
- 1 x tertiary screen
- 1 x classifier
- 2 x cyclones

3.0 Site Details

Oakhampton Quarry is located on the southern side of the Hunter River approximately 4 kilometres north of Maitland, NSW. The majority of the 92.7 hectares of land used for the purposes of extracting sand and gravel is owned by the Company.

The property details are as follows:-

Lots 12-14	DP 37580
Lot 193	DP 246309
Lot 196	DP 246309
Lots 1-3&5	DP 217178
Lot 8	DP 248331
Lot 41	DP 611238
Lot 324	DP 835231

Parish of Maitland
County of Northumberland
City of Maitland

The land is zoned 1a (Prime Rural Land) and 1b (Secondary Rural Land). Extractive industry is permitted under this zoning with Council consent.

There are several residences surrounding the site on both the northern and southern side of the Hunter River. These residences are shown on the location map on page 4. The most affected of these residences have been denoted A to E. Aberglasslyn House, a house of significant historical value, is located approximately 1.6 kilometres to the west of the current plant and is denoted as residence C.

4.0 Hours of Operation

The intended hours of operation of the quarry are as follows:-

Dredging, processing & sales	7.00 am to 5.30 pm	Monday to Friday
	7.00 am to 3.30 pm	Saturday

There is no quarrying on Sundays or public holidays.

5.0 Transportation

Finished product from the quarry is transported in normal highway trucks. The traffic generated by the development is as follows:-

5.1 Traffic Generation

<u>Description</u>	<u>Traffic movements per day</u> <u>(Total despatch and return)</u>	
Trucks	54	average
	100	maximum

5.2 Traffic Noise Impact

Vehicles access the site from the New England Highway via Aberglasslyn Road and Oakhampton Road. Although traffic flow from the operation is relatively low it still has the potential for annoyance due to the high percentage of heavy vehicles. In these situations an L_{Aeq} value is the noise descriptor preferred by the EPA.

Chapter 157-3 of the Environmental Noise Control Manual states that an L_{Aeq} of 55 dB(A) should be adopted as the goal for existing situations in rural areas and 60 dB(A) for existing situations in residential areas.

The major noise impact from traffic entering and leaving the site is from heavy vehicles using the unsealed section of Oakhampton Road just prior to the quarry. Noise levels were measured from quarry trucks adjacent to the front of the residence at No. 134 Oakhampton Road (residence E on Location Map). This residence and the residence directly adjacent to it are considered to be the most affected by noise from traffic from the quarry.

In order to calculate L_{Aeq} for average and maximum traffic flows the sound exposure level of several quarry trucks was measured. The results of the measurements are as follows:-

Location	Truck Type	Sound Exposure Level dB(A)	Comments
Residence E 134 Oakhampton Rd. 9 metres from roadway	rigid	77.9	unloaded
	truck & dog	83.1	unloaded
	truck & dog	82.8	loaded
	truck & dog	85.1	loaded
	truck & dog	75.2	loaded
	trailer	75.0	loaded
	truck & dog	82.6	unloaded

Assuming a similar distribution of traffic noise levels for loaded and unloaded vehicles the L_{Aeq} was calculated for the average and maximum traffic flow occurring over an 8 hour period at the Oakhampton Road residence.

Description	Predicted Noise Level 134 Oakhampton Rd. $L_{Aeq}(8hrs)$ - dB(A)
* Average traffic movements	54
* Maximum traffic movements	57

As can be seen from the above table the noise level for average traffic movements is below the EPA limit of an L_{Aeq} of 55 dB(A) for rural residences. The noise level for maximum traffic movements exceeds the EPA limit for rural residences but is below that which would be acceptable in a residential area.

The noise from transport generated by the operation at other residences on the haulage route, between the quarry and the New England Highway, will be less than at this residence.

6.0 Noise Control Measures

All equipment used on site are fitted with appropriate silencers which are thoroughly maintained. Trucks entering and leaving the site will be normal highway vehicles and therefore, will comply with the usual noise requirements for registration.

A bund wall along with tree planting has been constructed along the eastern boundary of the property to screen the quarry operations from residence A. The bund shall be increased in height to approximately 5 metres.

8.0 Discussion of Noise Survey Results

The instrumentation used, procedures followed and noise levels recorded are contained within Appendix A "Noise Monitoring Survey for Oakhampton Quarry, NSW".

8.1 Background Noise Levels

Background noise levels were measured on the 22 nd to 24 th February 1995 and the 18 th to 20 th April 1995 at residences A, B, C, and D. A summary of the results is as follows:-

Residence A - Background noise level (L₉₀) - Atkin's Residence

Day-time Boral quarry operating	- 44 to 49 dB(A) Average 46 dB(A)
Day-time no quarry operating	- 31 to 46 dB(A) Average 37 dB(A)
Night-time no quarry operating	- 30 to 36 dB(A) Average 31 dB(A)

Noise at this residence included the Boral processing plant, birds, some domestic animals and some noise from crickets .

Residence B - Background noise level (L₉₀) - King's Residence

Day-time Boral quarry operating	- 33 to 44 dB(A) Average 39 dB(A)
Day-time no quarry operating	- 32 to 42 dB(A) Average 36 dB(A)
Night-time no quarry operating	- 32 to 39 dB(A) Average 34 dB(A)

Noise at this residence included, birds and some minor traffic noise. The Boral operation was barely audible at this residence.

Residence C - Background noise level (L₉₀) - Aberglasslyn House

Day-time Rosebrook quarry operating	- 33 to 43 dB(A) Average 38 dB(A)
Day-time no quarry operating	- 28 to 39 dB(A) Average 31 dB(A)
Night-time no quarry operating	- 28 to 33 dB(A) Average 30 dB(A)

Noise at this residence included noise from Rosebrook Sand and Gravel, birds and some domestic noise. Apparently some grass slashing was undertaken around the time of survey in the area near the monitor. No evidence, both in terms of levels recorded on the logger or audible records on an audio tape (which operates in conjunction with the logger), was detectable to suggest that slashing occurred during the monitoring period. The Boral quarry was not audible at this location.

Residence D - Background noise level (L₉₀) - Hancock's Residence

Day-time Boral quarry operating	- 35 to 44 dB(A) Average 40 dB(A)
Day-time no quarry operating	- 29 to 45 dB(A) Average 35 dB(A)
Night-time no quarry operating	- 27 to 35 dB(A) Average 29 dB(A)

Noise at this location included noise from the Boral quarry, some domestic noise and some noise from livestock.

8.2 Equipment Noise Levels

The sound power levels, measured for the equipment used on-site, are given below :-

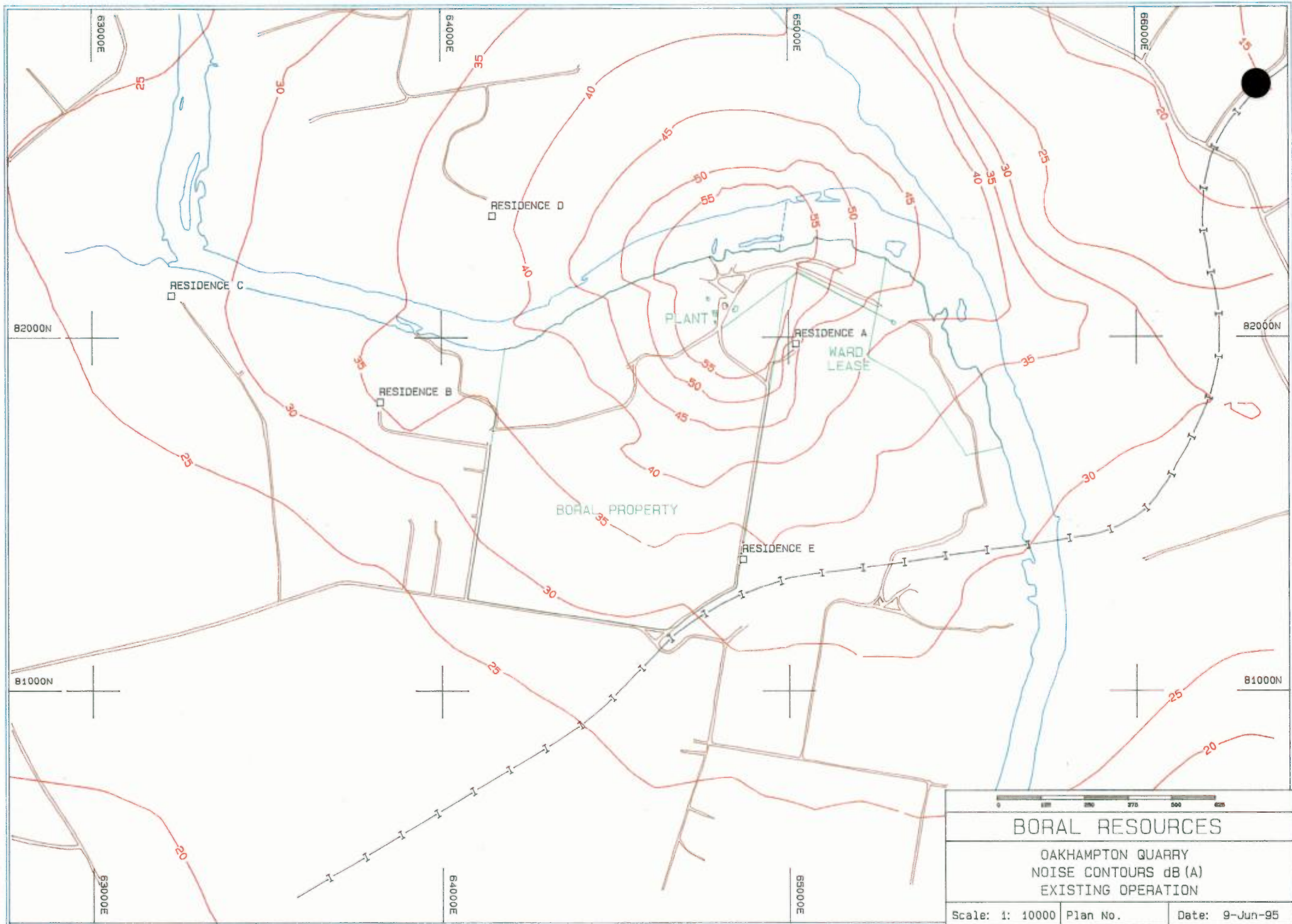
Description	Sound Power Level dB(A)
Mobile Equipment	
1 x dredge	108
1 x front-end loader - Cat 966, sales	108
1 x front-end loader - Cat 966	111
1 x water cart	103
1 x delivery truck	106
Fixed Plant	
1 x primary washing plant (including trommel, cyclone and screw)	103
1 x scrubber & secondary screen	107
1 x tertiary screen	105
1 x cyclones pumps & sand cone	106

9.0 Assessment of Noise Impact

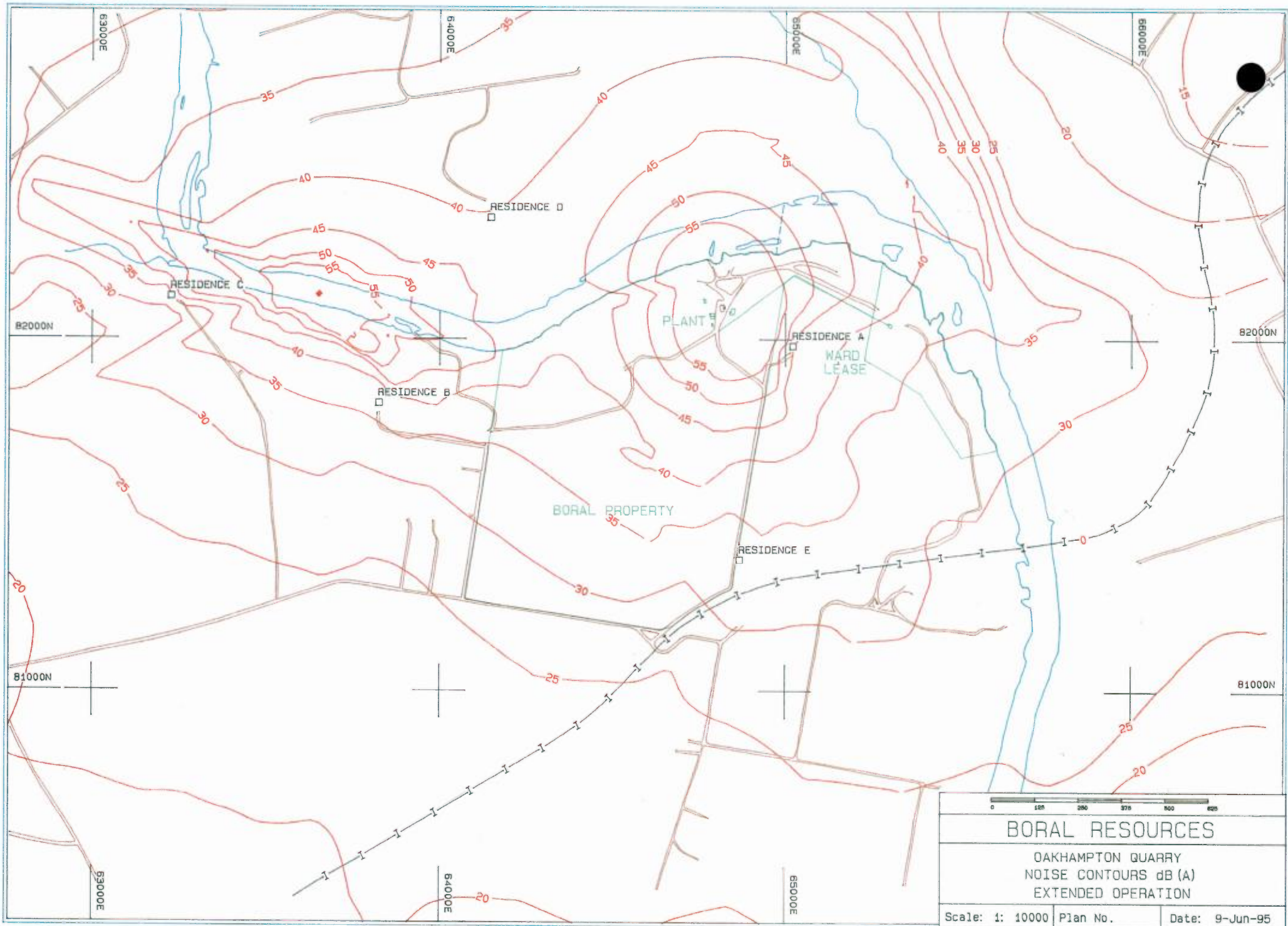
In order to assess the impact of the quarrying operation, on the surrounding area, in different stages of development the plant and equipment at the quarry were computer modelled .

9.1 Noise Modelling

The Environmental Noise Model (ENM) used has been produced in conjunction with the Environment Protection Authority. A map giving all relevant topographic features was digitised into the computer, along with noise source, ground cover and atmospheric information. The model uses this information to predict the noise at each residence and eventually to produce the Noise Contour Maps shown on pages 10 and 11 . The contours shown link areas with the same noise level and are in dB(A). The noise contours depict the noise levels which would occur when all equipment is operated simultaneously and at full power. Neutral atmospheric conditions were assumed.



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9.2 Noise Impact

The Environment Protection Authority suggests Recommended Outdoor Background Noise Levels in their Environmental Noise Control Manual. An excerpt from the table is given below:-

Table 20-1
RECOMMENDED PLANNING LEVELS

Existing background noise level at the most sensitive point in an affected residential area	Recommended maximum noise level, for planning approval purposes, at that point as a result of a proposed new noise source
A. Background is above relevant acceptable level (from chapter 21)	* preferably, set maximum planning level 10 dB(A) or more below acceptable level * at least, set maximum planning level 10 dB(A) below existing background level
B. Background is at acceptable level	* set maximum planning level 10 dB(A) below acceptable level
C. Background is below acceptable level by - 1 dB(A) 2 dB(A) 3 dB(A) 4 dB(A) 5 dB(A) 6 dB(A)	* set maximum planning level 9 dB(A) below acceptable level 5 dB(A) below acceptable level 3 dB(A) below acceptable level 2 dB(A) below acceptable level 2 dB(A) below acceptable level 5 dB(A) above background level

<u>Recommended Outdoor Background Noise Levels</u> (For use with chapters 19 and 20)					
R O W	Zoning of noise receiver area	Predominant land-use of receiver area	Time Period	L ₉₀ Background Noise Level - dB(A)	
				Acceptable Limit	Extreme Limit
a)	Rural (approx R1 AS1055)	Residential, church, hospital, school	Day Night	45 35	50 40
b)	Residential area	Residential, church, hospital, school	Day Night	45 35	50 40
e)	Residential on a busy road or near an industrial area	Residential, church, hospital, school	Day Night	50 40	55 45

Residence A - With regard to the preceding tables and based on the background noise levels recorded, the planning limit for noise at this residence should be 42 dB(A).

To reduce the noise level at this residence a bund wall will be constructed as discussed in section 6.0 Noise Control Measures. With the bund in place it can be seen from the noise contour map that the noise level at this residence is approximately 45 dB(A) from the processing plant and mobile equipment. This level will decrease slightly as the dredge and primary section move upstream.

Although the level at this residence is above the suggested planning limit it is on the acceptable limit for outdoor background noise suggested by the EPA in the preceding table.

No complaints about noise from the operation have been received from the long term occupant of this residence.

Residence B - The planning limit based on the background levels recorded should be set to approximately 41 dB(A).

This residence would experience a noise level of 35 dB(A) for the existing operation. As the dredge and primary section move upstream this level would increase to 38 dB(A). These levels are below the planning limits for this residence.

Residence C - The planning limit based on background noise levels which ignore the existence of the Rosebrook Sand and Gravel operation would be 36 dB(A). If noise from the Rosebrook operation was included as part of the background this planning limit would rise to 43 dB(A). The lower planning limit will be adopted at this residence as the basis for noise impact.

The noise level at Aberglasslyn House will be below 35 dB(A) and hence below the planning limit for all stages of the development.

Residence D - This residence would experience a noise level of 38 dB(A) for the existing operation. As the dredge and primary section move upstream this level would increase to a maximum of 41 dB(A). At this level the planning limit for this residence would be exceeded marginally. The noise level would still be well below the acceptable limit for outdoor background noise suggested by the EPA.

Other Residences

The noise levels at all other residences will be below the 40 dB(A) contour and the proposed operation should therefore not cause disturbance.

10.0 Conclusion

Whilst the noise generated by Oakhampton Quarry will not change as a result of the extension of the development, the noise at residences upstream from the current operation will increase as the dredge and primary plant move upstream from their present positions. The increases in noise, however, will be kept within acceptable limits. Noise at the closest residence to the plant will be reduced by the construction of a bund wall to screen the residence.

Noise from traffic generated by the operation will be kept below EPA guidelines for average traffic movements.



J. Cotterill
Noise Control Engineer

Appendix A

Project: **Noise Survey for Oakhampton Quarry, N.S.W.**

Client: **Boral Resources (Country) Pty Limited**

Project No: 9502/NI

1. Instrumentation

<u>Instrument</u>	<u>Model</u>	<u>Serial No.</u>
CEL Sound Level Analyser	593:C1	094291
CEL Microphone	CEL192-2F	16209
CEL calibrator	284/2	02411129
Acoustic Research Laboratories Environmental noise logger	EL 215	193408
Brueel & Kjaer Barometer		
Zeal Sling Psychrometer		

2. Procedures

The noise surveys in this report were conducted in accordance with Australian Standard 1055-1989 "Description and Measurement of Environmental Noise" Parts 1, 2 and 3 and with reference to the Environment Protection Authority - Environmental Noise Control Manual and the Noise Control Act, 1975.

3. Background Noise Measurements

Background noise levels were measured at residence A and B from the 22nd to the 24th February 1995 and at residence C and D from the 18th to the 20th March 1995. The environmental noise logger was used to monitor noise at these residences over a 24 hour period. The microphone of the instrument was set to a height of 1.5 metres above the ground.

The results of the background noise surveys are as follows:-

Background Noise Levels - Atkins Residence

Date	Time	Lmax	L1	L5	L10	L50	L90	L95	L99	Lmin	Leq
22/2/94	15:30	72	63	62	61	51.5	45.5	44.5	43.5	42.5	56.5
22/2/94	15:45	64.5	62.5	61.5	60.5	50.5	44.5	44	42.5	41	55.5
22/2/94	16:00	79.5	70.5	65	64.5	61	43	42	41	40	61.5
22/2/94	16:15	71.5	66.5	65.5	65.5	49.5	40.5	39.5	38	36.5	61
22/2/94	16:30	67	64.5	64	63.5	61.5	42	40	37.5	35	60.5
22/2/94	16:45	91.5	63.5	62.5	61.5	45.5	38	37.5	36.5	35	59
22/2/94	17:00	69.5	66	65	64.5	59.5	45	42	39	36.5	60.5
22/2/94	17:15	67.5	65	64	63	52	40	38.5	37	35.5	57.5
22/2/94	17:30	71	65	64	63.5	52.5	39	37	34	32	58
22/2/94	17:45	65	61	60.5	59.5	40.5	33	32	31.5	30	52
22/2/94	18:00	71.5	62.5	61.5	61	57.5	35	33.5	31.5	30	57.5
22/2/94	18:15	77	68.5	62	61.5	50	33.5	32.5	31.5	30.5	58
22/2/94	18:30	67.5	61.5	56.5	52	39	31.5	31	30	29.5	49
22/2/94	18:45	75	63	57	52.5	37	31.5	31	30.5	29.5	50.5
22/2/94	19:00	79.5	63.5	55	49.5	37	31.5	31.5	30.5	30	51.5
22/2/94	19:15	65.5	58.5	52	49	42	34	33	31.5	30	46.5
22/2/94	19:30	69	55	50.5	46	37	32	31.5	30.5	29.5	44
22/2/94	19:45	78	50.5	41.5	40.5	35	32.5	32	31	30	44
22/2/94	20:00	84.5	67.5	67	66.5	48	39	36	33.5	32.5	61.5
22/2/94	20:15	69	67.5	67	66.5	63.5	46	45.5	44.5	43	63.5
22/2/94	20:30	83.5	48.5	46	45.5	43.5	40.5	39.5	38.5	37	47
22/2/94	20:45	58.5	43.5	41	40.5	37.5	34	33.5	33	32.5	38
22/2/94	21:00	65	48.5	41.5	38	34	33	32.5	32.5	31.5	37.5
22/2/94	21:15	57	41	36.5	35.5	33.5	32	31.5	31	30	34.5
22/2/94	21:30	62	58.5	52.5	46	33.5	30.5	30.5	30	29.5	45
22/2/94	21:45	42.5	36.5	35	34.5	32.5	31	30.5	30.5	29.5	32.5
22/2/94	22:00	65	39.5	35.5	35	32.5	31	31	30.5	30	36.5
22/2/94	22:15	56	50	45.5	41.5	33	31	31	30.5	30	38.5
22/2/94	22:30	52.5	40.5	37	35	32.5	31	30.5	30	29.5	33.5
22/2/94	22:45	61.5	58.5	53.5	48	34	31	30.5	30	29	45.5
22/2/94	23:00	56	46	35.5	34.5	31.5	30	30	29.5	29	34.5
22/2/94	23:15	62	59.5	56	52	35	32.5	32	31	29.5	47.5
22/2/94	23:30	43.5	37	35.5	35	33	31	31	30.5	29.5	33
22/2/94	23:45	60	58	48	42.5	33.5	31.5	31	30.5	29.5	43.5
23/2/94	0:00	59	56	41	36.5	33.5	31	30.5	29.5	29	40.5
23/2/94	0:15	48	44.5	39.5	37	33.5	31	30.5	30	29	35
23/2/94	0:30	63	54.5	47.5	39.5	33.5	31	30.5	30	29.5	41
23/2/94	0:45	46	39.5	37	36	33.5	31.5	31	31	30	34
23/2/94	1:00	46	41	37	35.5	33.5	31.5	31	30	29.5	34
23/2/94	1:15	51.5	36	34.5	34	32	30.5	30	29.5	29	32.5
23/2/94	1:30	69.5	59.5	53.5	44.5	33	30.5	30.5	29.5	29	46
23/2/94	1:45	55.5	46.5	37.5	35	32.5	30	29.5	29	28.5	35
23/2/94	2:00	49	38	34	33.5	32	30	29.5	29	28.5	32
23/2/94	2:15	45	37	34.5	33.5	32	30.5	30	29.5	29	32
23/2/94	2:30	47	37	34.5	34	32.5	30.5	30	29.5	29	32.5
23/2/94	2:45	49.5	36.5	33.5	33	31	30	29.5	29.5	29	31
23/2/94	3:00	54.5	36	35	34.5	32	30	29.5	29	28.5	32
23/2/94	3:15	70	59.5	56	51.5	34.5	33	32.5	31.5	30.5	47.5
23/2/94	3:30	71	63.5	58.5	56	43.5	36	35	33.5	32.5	52
23/2/94	3:45	70.5	64	58	55	40	36	35.5	34	33	51.5
23/2/94	4:00	65	52.5	45.5	39	33	31.5	31.5	31	30.5	40
23/2/94	4:15	67.5	58	43	37	33.5	31.5	31.5	31	30.5	43.5
23/2/94	4:30	63.5	48	35	33.5	31.5	31	30.5	30.5	30	37.5
23/2/94	4:45	67.5	59	41	36	32.5	31.5	31.5	31	30.5	45
23/2/94	5:00	70.5	61.5	56.5	45	34.5	32.5	32.5	32	31	48
23/2/94	5:15	67.5	60.5	50	40.5	33.5	31.5	31	30.5	29.5	46
23/2/94	5:30	66	59	35	34	31	30	30	29.5	29	44
23/2/94	5:45	65.5	59.5	46.5	38.5	31	30	29.5	29.5	28.5	44.5
23/2/94	6:00	68	62	58	47	33	31.5	31	30.5	30	49
23/2/94	6:15	68.5	64	59.5	56	38.5	32	31.5	31	30	51.5
23/2/94	6:30	71	63.5	59	56.5	46.5	39.5	38	36.5	35	52.5
23/2/94	6:45	71.5	63.5	58.5	54	48.5	45.5	45	44.5	43.5	52.5
23/2/94	7:00	68.5	59	55	52.5	48	46.5	46.5	46	45	50
23/2/94	7:15	72.5	64.5	60.5	58.5	50.5	47.5	47	46.5	45.5	54.5
23/2/94	7:30	67	59.5	53.5	52	50	48.5	48	47.5	46.5	50.5
23/2/94	7:45	72.5	64.5	57.5	54.5	50	48.5	48.5	48	47	53.5
23/2/94	8:00	70	61.5	56	53	50	48.5	48	47.5	46.5	51.5
23/2/94	8:15	75.5	67	59.5	57	48.5	47	47	46.5	45.5	54.5
23/2/94	8:30	65.5	59	53.5	51.5	48	46.5	46	45.5	44	49.5
23/2/94	8:45	66.5	57	52.5	50.5	47	46	45.5	45	44	48.5
23/2/94	9:00	69.5	63.5	58	53	47	45.5	45	45	44	51.5
23/2/94	9:15	72	62.5	57	54	46	43.5	43	42	41	51
23/2/94	9:30	77.5	66	60.5	56.5	47.5	44.5	44	43	42	54.5
23/2/94	9:45	93.5	72.5	62	57	47.5	44.5	44	43.5	42	64
23/2/94	10:00	81.5	69.5	62	58.5	48	45.5	44.5	43.5	42	56
23/2/94	10:15	73	72	68	60.5	52.5	45.5	44.5	43.5	42	59.5
23/2/94	10:30	77.5	67	62	60	49.5	46	45.5	45	44	56

B Ground Noise Levels - King Residence

Date	Time	Lmax	L1	L5	L10	L50	L90	L95	L99	Lmin	Leq
23/2/94	11:30	71	64	58.5	55.5	48	40	39	38	37	52
23/2/94	11:45	72	65	59	55.5	43.5	39	38	37	36	52.5
23/2/94	12:00	71.5	62	56.5	53	44	39.5	38.5	37.5	36.5	50.5
23/2/94	12:15	72	64.5	60	57	45.5	39.5	38.5	36.5	35	53
23/2/94	12:30	72	65	59.5	56.5	44.5	38.5	37.6	36	34.5	53
23/2/94	12:45	71.5	64.5	59.5	56.5	45.5	39.5	38.5	37	35.5	53
23/2/94	13:00	72	67	62	59	47.5	40	38	36	34.5	55
23/2/94	13:15	73.5	67	63	60	49.5	42.5	41.5	40	38	56
23/2/94	13:30	76	68	62.5	59.5	49.5	42.5	41.5	40	37.5	56
23/2/94	13:45	72.5	64	59.5	56	46.5	40.5	39.5	38	36.5	52.5
23/2/94	14:00	72.5	67	62.5	60	50	41	39.5	38	36	56
23/2/94	14:15	72	66.5	62	59.5	50.5	43.5	42	40	38	55.5
23/2/94	14:30	70	64	59.5	57	46.5	39.5	38.5	37	36	53
23/2/94	14:45	71	63	57.5	54.5	44.5	39	38.5	37	36	51.5
23/2/94	15:00	71.5	66	61.5	59	50	42.5	41	39	37.5	55
23/2/94	15:15	72.5	66.5	61.5	59	49	41.5	40.5	39	36	55
23/2/94	15:30	91.5	65.5	61	58.5	47.5	38.5	37	34.5	33	56.5
23/2/94	15:45	72.5	66	60.5	57.5	45.5	37.5	36.5	35.5	34	54
23/2/94	16:00	72.5	64.5	59	55.5	44	37.5	36.5	35.5	35	52
23/2/94	16:15	71.5	65.5	60.5	57.5	45.5	37	36	35	34	53.5
23/2/94	16:30	77	65	59	56	45	37.5	36.5	34.5	34	53
23/2/94	16:45	71.5	65.5	61	58.5	48.5	39	36.5	34.5	32.5	54.5
23/2/94	17:00	72.5	64.5	59.5	57	46.5	36.5	35.5	34.5	33.5	53.5
23/2/94	17:15	71	63	58	54.5	43	35.5	34.5	33	32	51
23/2/94	17:30	70.5	63.5	58.5	55	43.5	35.5	34.5	33.5	31.5	51.5
23/2/94	17:45	69.5	61.5	56	53	42	35.5	34	33	32	49.5
23/2/94	18:00	71.5	64	58.5	55.5	44.5	38	37	35.5	34.5	52
23/2/94	18:15	72	62	57	54	43.5	36	35.5	34	33	50.5
23/2/94	18:30	71.5	63.5	58.5	55.5	44.5	36.5	35	33	32	52
23/2/94	18:45	71	62.5	56.5	53	40	34.5	33.5	32	31	50
23/2/94	19:00	67.5	57.5	50.5	47	37	33	32.5	31.5	31	45
23/2/94	19:15	69	57	51	47	35	32	31.5	31	30	45
23/2/94	19:30	51	43	39.5	38.5	34.5	32	32	31	30.5	36
23/2/94	19:45	55.5	46.5	41.5	39	34.5	32	32	31	30.5	36.5
23/2/94	20:00	64	51.5	44.5	42.5	40	35.5	34	33	31.5	42
23/2/94	20:15	68	60	53	48.5	41	39	39	38	37	47.5
23/2/94	20:30	70.5	57.5	49	44.5	38	36.5	36.5	36	34.5	44.5
23/2/94	20:45	71	46.5	40	39	37	36	35.5	35	34	39.5
23/2/94	21:00	46	40	38	37.5	36	35	35	34.5	33.5	36
23/2/94	21:15	53	41.5	39.5	38.5	36	35	34.5	34.5	33.5	36.5
23/2/94	21:30	63	53.5	47.5	45	37	34.5	34	33.5	32.5	42
23/2/94	21:45	63	54.5	48	40.5	36	34.5	34	33.5	32.5	41.5
23/2/94	22:00	55.5	49.5	46.5	41.5	36.5	34.5	34	33.5	32.5	39.5
23/2/94	22:15	53.5	51	51	51	51	34.5	34	33	32	46
23/2/94	22:30	69.5	54.5	51.5	51	44.5	34.5	34	33.5	32.5	48
23/2/94	22:45	65.5	53	51.5	51	37.5	34.5	34	33	31.5	46
23/2/94	23:00	60.5	51.5	49	47.5	37	34.5	34	33.5	31	42.5
23/2/94	23:15	68.5	50	48.5	43	36	33.5	33	32	30.5	41.5
23/2/94	23:30	71.5	51	50.5	50.5	39.5	34.5	34	33.5	32	46.5
23/2/94	23:45	72	54	49.5	44.5	37	35	34.5	33.5	32.5	45
24/2/94	0:00	72.5	51	51	50.5	38.5	36	35.5	34.5	33	47
24/2/94	0:15	67	51.5	51	51	47	38	37	36	33.5	47.5
24/2/94	0:30	55.5	52.5	52	52	49.5	39	38	37	34.5	48.5
24/2/94	0:45	52.5	52.5	52	52	51	37.5	36.5	35	34	50
24/2/94	1:00	53.5	52	52	51.5	48	37	36.5	35.5	34	48
24/2/94	1:15	52	51.5	51.5	51	41	34.5	34	33	32	46.5
24/2/94	1:30	46	43	41.5	41	38.5	36	35.5	34.5	33	38.5
24/2/94	1:45	45	43	41.5	40.5	38	36	35.5	34.5	32.5	38.5
24/2/94	2:00	51	50.5	49.5	42	36.5	34.5	34	33.5	32.5	40.5
24/2/94	2:15	51	44.5	42	40.5	38	35.5	35	34	32.5	38.5
24/2/94	2:30	60.5	48	45	43.5	39	36	35.5	34.5	32.5	41
24/2/94	2:45	47	43	41.5	40	36	33.5	33	32.5	31	37
24/2/94	3:00	43.5	42	41	39	34.5	32	31.5	31	30	35.5
24/2/94	3:15	44	42.5	41.5	39.5	35	32.5	32	31.5	30.5	36.5
24/2/94	3:30	43.5	42.5	41	40	35.5	33	32	31.5	30	36.5
24/2/94	3:45	44.5	42.5	41	40	35	32.5	32	31	30	36.5
24/2/94	4:00	48	42	41	40	35.5	32.5	32.5	31.5	30.5	36.5
24/2/94	4:15	44	42	41	40	36	33	32.5	32	31	36.5
24/2/94	4:30	43.5	42.5	41.5	40	36	33.5	32.5	32	31	37
24/2/94	4:45	45.5	42	41	40	35.5	33	32.5	32	31	36.5
24/2/94	5:00	47	41.5	40.5	39.5	34.5	32.5	32	31.5	30.5	36
24/2/94	5:15	44	41.5	40	39	34	31.5	31.5	31	30	35
24/2/94	5:30	47.5	42	40.5	39	34.5	32.5	32	31	30.5	36
24/2/94	5:45	83	46	42.5	41	35.5	32.5	32.5	31.5	31	43
24/2/94	6:00	67	51	46.5	43.5	37	33.5	33	32	31	40.5
24/2/94	6:15	64.5	58	47.5	44.5	38	34.5	34	33	31.5	44
24/2/94	6:30	60	50.5	45.5	43.5	39	35	34.5	33	32	41
24/2/94	6:45	68	58	55	52.5	42.5	37.5	36.5	34.5	33	48
24/2/94	7:00	60.5	51	47.5	46	41.5	38.5	38	37	35.5	43
24/2/94	7:15	72.5	59	56.5	53.5	44.5	40	39	37	36	50.5
24/2/94	7:30	61	53	49	47.5	44.5	42.5	42	41	40	45.5
24/2/94	7:45	70	63.5	56.5	51.5	46	43	42	41.5	40.5	50.5
24/2/94	8:00	61	53.5	47	45	40	37.5	37	36.5	35.5	42.5
24/2/94	8:15	72	56	47.5	43	37	34.5	34.5	33.5	33	43.5
24/2/94	8:30	59	45.5	39.5	38	35	33.5	33.5	33	32.5	37
24/2/94	8:45	56	48.5	42	39.5	35.5	34	33.5	33	32	38
24/2/94	9:00	69.5	49.5	41	39.5	35.5	33.5	33	32.5	31.5	41
24/2/94	9:15	72	50.5	45	41	35.5	33	32.5	32	31.5	43
24/2/94	9:30	57.5	49.5	46	43.5	38	34.5	34	33	32	40.5
24/2/94	9:45	57.5	48.5	43.5	42	38.5	36	35.5	34.5	33.5	40
24/2/94	10:00	60.5	53.5	49	47	40	36	35	34	33	43.5
24/2/94	10:15	60.5	54	50	47.5	41	38.5	37.5	36	34.5	44.5

Boral Quarry Operating

Background Noise levels - Aberglassyn House

Date	Time	Lmax	L1	L5	L10	L50	L90	L95	L99	Lmin	Leq
18/4/95	13:00	68	55.5	48	46	41	37	36	34.5	33.5	44.5
18/4/95	13:20	63.5	52	46.5	44.5	40.5	36.5	36	35	33	42.5
18/4/95	13:40	66.5	56	48	45.5	40.5	37.5	36.5	35.5	34.5	44.5
18/4/95	14:00	69	58.5	50.5	46.5	41	37.5	36.5	35	33	46
18/4/95	14:20	66.5	56.5	47.5	45	40.5	38	37	36	34.5	44.5
18/4/95	14:40	65.5	55	45.5	43	38.5	35.5	34.5	33	31	42.5
18/4/95	15:00	65.5	45	40	38.5	35	32.5	32	31.5	30.5	37.5
18/4/95	15:20	64	48	42.5	39	32.5	30	29.5	29	28.5	38
18/4/95	15:40	64.5	51	44	40.5	33	30.5	30	29	28.5	39.5
18/4/95	16:00	68	50.5	44	41	34.5	31	30	29.5	29	40
18/4/95	16:20	71	45	40.5	38	32	30	29.5	29.5	28.5	36
18/4/95	16:40	67	44.5	41	39	33.5	30.5	30	29.5	29	36.5
18/4/95	17:00	59.5	44.5	41	39	34	31	30.5	29.5	29	36
18/4/95	17:20	58.5	49	43	40.5	35.5	32	31	30	29	38.5
18/4/95	17:40	73	64.5	48	42	33	30	29.5	29	28.5	51
18/4/95	18:00	60.5	52	44.5	40	35	31	30.5	30	29	39.5
18/4/95	18:20	59	44.5	41.5	41	39.5	38.5	38	37.5	36.5	40
18/4/95	18:40	57.5	48	40.5	39.5	38	36.5	36	35	34	39
18/4/95	19:00	53	44	39	37	34.5	33	33	32	31.5	36
18/4/95	19:20	48.5	37.5	35	34	32	30.5	30	29.5	29	32.5
18/4/95	19:40	50.5	42.5	39.5	36.5	32	30.5	30	29.5	29	34
18/4/95	20:00	52	42.5	37.5	36	33.5	32	31.5	31.5	30.5	34.5
18/4/95	20:20	47.5	37	35	34.5	32.5	31	30.5	30.5	29.5	32.5
18/4/95	20:40	50	42	37	35	32	30.5	30.5	30	29	33.5
18/4/95	21:00	59.5	39	37	35.5	32	30.5	30	29.5	29	33.5
18/4/95	21:20	44	35.5	33	32	30.5	29.5	29.5	29	29	31
18/4/95	21:40	51	38	35.5	34.5	31.5	30	30	29.5	29	32.5
18/4/95	22:00	47	38.5	35	33.5	30.5	29.5	29.5	29	28.5	31.5
18/4/95	22:20	50	41.5	39	34	30.5	29.5	29.5	29	28.5	32.5
18/4/95	22:40	48	38	34.5	32.5	30.5	29.5	29	29	28.5	31
18/4/95	23:00	50	43	38	36	31	29.5	29	28.5	28	33.5
18/4/95	23:20	45.5	37	33.5	32.5	31	30	30	29.5	29.5	31.5
18/4/95	23:40	56	49.5	37	34	32	30.5	30	29.5	29	36
19/4/95	0:00	49	35	33	32.5	31.5	30	30	29.5	29	31.5
19/4/95	0:20	49	36.5	34.5	33	31.5	29.5	29	29	28.5	31.5
19/4/95	0:40	43	37	34	32.5	30.5	29	29	28.5	28	31
19/4/95	1:00	40	36.5	34.5	33.5	31	29.5	29.5	29	28.5	31.5
19/4/95	1:20	43.5	36	34.5	34	32.5	31	30.5	30.5	30	32.5
19/4/95	1:40	41.5	37.5	35.5	34.5	33	31	31	30.5	30	33
19/4/95	2:00	44.5	39	37	36	32.5	30.5	30	29.5	29	33.5
19/4/95	2:20	41.5	36	34	33	30.5	29	29	28.5	28.5	31
19/4/95	2:40	42.5	39.5	37	35.5	32.5	30.5	30.5	30	29.5	33
19/4/95	3:00	42.5	38.5	36.5	35.5	32	31	31	30.5	30	32.5
19/4/95	3:20	42.5	35.5	34	33	30	29	29	28.5	28	31
19/4/95	3:40	36	33.5	32.5	32	30.5	29.5	29	29	28.5	30.5
19/4/95	4:00	67.5	42	35	33	30	29	28.5	28	27.5	32.5
19/4/95	4:20	42	36.5	33.5	33	30	28.5	28.5	28	27.5	30.5
19/4/95	4:40	45.5	33.5	31.5	31	29.5	28.5	28	28	27.5	29.5
19/4/95	5:00	41.5	35	33.5	32.5	29.5	28.5	28.5	28	27.5	30
19/4/95	5:20	45.5	33.5	30.5	30	28.5	28	27.5	27.5	27	28.5
19/4/95	5:40	45.5	35	32.5	31.5	30	28.5	28	27.5	27	30
19/4/95	6:00	65.5	45.5	38.5	35	31	29.5	29.5	29	28	35.5
19/4/95	6:20	63.5	53.5	45	41	34	31.5	31	30.5	29.5	40.5
19/4/95	6:40	61	49.5	44	41.5	36	33	32.5	31.5	30	39.5
19/4/95	7:00	66.5	54.5	47	43.5	36.5	33	32.5	31.5	30	42.5
19/4/95	7:20	62.5	52.5	46	43	36	33	32.5	31.5	30.5	41
19/4/95	7:40	68	55.5	47	43.5	36.5	34	33.5	32.5	31.5	43
19/4/95	8:00	61.5	52.5	48	45	36.5	33	32.5	32	30.5	41.5
19/4/95	8:20	62.5	50	44	40.5	34.5	32	31.5	31	30	39
19/4/95	8:40	58.5	48	40	38	34	32	31.5	31	30	37
19/4/95	9:00	58.5	45.5	41.5	39.5	35.5	33	32.5	31.5	31	37
19/4/95	9:20	60.5	50	45	42.5	37	34	33.5	32.5	31.5	40
19/4/95	9:40	63	48	44	42	37.5	35	34.5	33.5	32	39.5
19/4/95	10:00	64.5	46.5	44	42	37.5	34.5	34.5	33.5	32.5	39
19/4/95	10:20	68.5	56	48	45.5	41.5	39	37.5	35.5	33.5	45
19/4/95	10:40	70.5	56.5	48.5	45.5	42.5	40.5	40	39	37.5	45.5
19/4/95	11:00	69	57.5	49	45.5	41	38	37.5	36.5	35.5	45.5
19/4/95	11:20	68	57.5	49	44.5	39.5	36.5	36	35	33.5	44.5
19/4/95	11:40	68.5	59	52.5	50	41	37	36.5	35.5	34.5	47
19/4/95	12:00	70.5	55.5	47.5	46	41.5	37.5	37	35.5	35	45
19/4/95	12:20	69	57.5	49.5	45.5	40	37	36.5	35	34	45
19/4/95	12:40	73	61.5	53.5	48.5	41.5	36.5	35	33	31.5	49.5
19/4/95	13:00	68	55	48	45	40	35	34	32.5	31.5	44
19/4/95	13:20	69.5	56	48	43.5	38	35	34.5	33.5	31.5	44
19/4/95	13:40	67	51	44.5	43	38	35	34.5	33.5	32	42
19/4/95	14:00	63	47.5	44.5	42.5	38.5	34.5	34	33	32	40
19/4/95	14:20	68.5	53	44.5	42	37.5	34.5	33.5	33	32	41.5
19/4/95	14:40	67	52.5	45.5	43.5	39	34.5	33.5	32.5	31.5	42
19/4/95	15:00	101.5	65	44.5	42.5	38	34.5	33.5	32	30.5	63.5
19/4/95	15:20	64.5	50	43	40.5	33.5	30	29.5	29	28.5	39
19/4/95	15:40	69	49	39.5	36	30	28.5	28.5	28	27.5	38.5
19/4/95	16:00	69	41	33	31.5	29	28	28	28	27	33.5
19/4/95	16:20	71	47	43	40	32	29.5	29	28.5	28	37.5

Background Noise Levels - Hancock Residence

Date	Time	Lmax	L1	L5	L10	L50	L90	L95	L99	Lmin	Leq
19/4/95	17:00	75.5	68	62.5	59.5	50.5	44.5	43	41.5	37.5	56.5
19/4/95	17:20	70	59	53.5	50.5	43.5	40	39	37	34.5	48
19/4/95	17:40	70.5	62.5	55.5	52	44	38.5	37.5	36	34.5	50
19/4/95	18:00	66	58	52.5	48.5	40	36.5	36	35	33.5	46
19/4/95	18:20	65.5	51.5	47	45	42	38.5	37.5	36.5	35.5	43.5
19/4/95	18:40	59	46	43.5	42.5	39	37	36.5	35.5	34	40
19/4/95	19:00	70.5	57	51	44	38.5	37	36.5	35.5	34	45
19/4/95	19:20	56.5	40	39	38.5	37	35.5	35	33.5	32	37
19/4/95	19:40	70.5	49	44.5	40.5	36.5	34.5	33.5	32.5	31.5	41
19/4/95	20:00	50	43	38.5	37.5	35.5	33	32.5	31.5	30.5	36
19/4/95	20:20	65.5	51	41.5	40.5	38	33.5	32.5	31	30	40.5
19/4/95	20:40	71	44.5	41	40.5	38.5	34.5	33.5	31.5	30	39.5
19/4/95	21:00	53.5	40.5	39	39	36.5	31.5	31	30	28.5	36.5
19/4/95	21:20	71.5	52.5	46.5	41	36	31	30	29.5	28.5	40.5
19/4/95	21:40	86.5	37	36	35	31	29	29	28.5	28	44
19/4/95	22:00	45.5	39.5	38	37	33	30	29.5	29	28.5	33.5
19/4/95	22:20	65	55.5	47	42	37	31	30	29	28	42
19/4/95	22:40	45	40	39	38	34.5	29.5	29	28.5	28	35
19/4/95	23:00	55.5	48.5	39.5	37.5	32.5	29.5	29	28.5	28	36.5
19/4/95	23:20	41	38	37	36.5	32	29	28.5	28	27.5	33.5
19/4/95	23:40	48	38.5	37	36	30	28.5	28.5	28	27.5	32
20/4/95	0:00	51	41.5	39	38.5	35	29	28.5	28	27	35.5
20/4/95	0:20	44.5	39	38.5	38	31	28.5	28.5	28	27.5	34
20/4/95	0:40	43.5	38	37	35.5	29	28	28	27.5	27	31
20/4/95	1:00	66.5	58.5	52	44.5	31	27.5	27.5	27	27	44.5
20/4/95	1:20	46.5	36	32.5	31.5	28.5	27.5	27.5	27	26.5	29.5
20/4/95	1:40	45	37	35.5	33.5	29.5	27.5	27.5	27	27	30.5
20/4/95	2:00	41	38.5	35.5	33	28.5	27.5	27.5	27.5	27	30.5
20/4/95	2:20	38	35	33.5	31.5	28.5	27.5	27.5	27	26.5	29.5
20/4/95	2:40	44.5	39.5	35.5	34	28	27	27	27	26.5	30.5
20/4/95	3:00	67.5	57	49.5	42.5	30.5	28	27.5	27.5	27	43
20/4/95	3:20	64.5	52.5	38	36.5	30	28.5	28	27.5	27	39.5
20/4/95	3:40	62.5	40.5	37	36.5	30	27.5	27.5	27	27	36
20/4/95	4:00	65.5	55	53	46.5	36	30.5	29	28	27	43.5
20/4/95	4:20	61.5	50.5	37.5	37	36	29	28	27.5	27	38.5
20/4/95	4:40	64.5	59.5	52.5	46.5	32.5	29	28.5	27.5	27	45.5
20/4/95	5:00	54.5	52	45	36.5	29.5	28	28	27.5	27	38.5
20/4/95	5:20	66.5	59.5	39.5	37.5	31.5	28	28	27.5	27.5	44
20/4/95	5:40	69	61	47.5	39.5	35.5	29	28.5	28.5	27.5	46
20/4/95	6:00	64.5	53	43	40.5	33.5	30.5	30	29.5	29	40.5
20/4/95	6:20	69	59	48	44	38.5	34.5	33.5	32.5	30.5	45.5
20/4/95	6:40	70	61	55	52	40.5	36.5	36	34	33	48.5
20/4/95	7:00	70	54	51	50	46.5	43.5	43	42	40.5	47.5
20/4/95	7:20	70.5	58.5	51.5	48.5	43.5	39.5	39	38	37.5	47.5
20/4/95	7:40	72	52.5	49.5	48	44.5	43	42.5	42	41	46.5
20/4/95	8:00	67	56.5	47.5	46.5	44	41	40.5	39	37	45.5
20/4/95	8:20	102.5	66	51.5	47.5	44.5	41.5	41	39.5	38.5	68
20/4/95	8:40	60.5	54	50	48	45	43	42.5	41	38.5	46
20/4/95	9:00	68.5	57	49.5	48	45	42	41	39.5	37.5	47.5
20/4/95	9:20	72	56	49.5	48	44.5	42	41.5	40.5	39	47
20/4/95	9:40	80.5	51.5	49.5	48.5	45.5	43.5	43	42	39.5	47
20/4/95	10:00	59.5	52	49.5	48.5	45.5	43.5	43	42	40	46.5
20/4/95	10:20	68	54	50.5	49.5	46	43	42	40.5	39	47
20/4/95	10:40	69	52	49.5	48.5	45.5	43.5	42.5	40.5	39.5	46
20/4/95	11:00	68	53.5	49	47.5	43	39	38	36.5	35	45.5
20/4/95	11:20	70.5	52	47	45	40.5	37.5	37	36	34.5	44
20/4/95	11:40	70	49	45.5	43.5	39	36.5	36	35.5	34.5	43
20/4/95	12:00	71.5	47	43.5	42.5	38.5	35.5	35.5	34.5	33.5	42
20/4/95	12:20	59	48.5	45.5	44	39	35.5	35	34	32.5	41
20/4/95	12:40	64	52	46	44	39	35.5	35	34	32.5	42
20/4/95	13:00	65.5	45.5	42.5	41.5	37.5	35	34	33	32	40
20/4/95	13:20	64.5	52.5	48.5	46.5	42	38.5	37.5	35.5	34.5	44
20/4/95	13:40	62	51	47.5	46.5	43	40	39	37.5	36	44
20/4/95	14:00	58.5	51	48.5	47.5	44	40.5	39.5	38	36	45
20/4/95	14:20	67	53.5	48.5	47.5	44	41	40	38	36.5	45.5
20/4/95	14:40	57	51.5	49.5	48.5	45	42	41.5	40.5	39	46
20/4/95	15:00	52	48.5	47	46	43.5	41.5	40.5	39.5	38	44
20/4/95	15:20	66	53	45	43	32.5	29	29	28.5	28	43
20/4/95	15:40	73	55	48.5	44.5	33	30	29.5	29	28.5	45
20/4/95	16:00	72	59	48	44	36.5	33.5	32.5	31.5	31	46

Boral quarry operating

4. Weather Conditions

The weather conditions were recorded at various times during the background noise surveys. The results are as follows:-

22/2/95 - 3.00 pm

Temperature

Deg. C Dry 25 Atkins residence

Deg. C Wet 22

Rel. Humidity % 77

Air Pressure mb 1010

Wind knots still

Cloud Cover % clear *temperature down to 15 deg. overnight

23/2/95 - 11.15 am

Atkins/King residence

Temperature

Deg. C Dry 18

Deg. C Wet 16

Rel. Humidity % 82

Air Pressure mb 1008

Wind knots 0 - 5 knots S.E.

Cloud Cover % 100 med. * wind dropped to still over night temp down to 12 deg

24/2/95 - 10.32 am

King residence

Temperature

Deg. C Dry 22

Deg. C Wet 20

Rel. Humidity % 83

Air Pressure mb 1010

Wind knots still

Cloud Cover % 70% medium

18/4/95 - 4.30 pm

Aberglasslyn House

Temperature

Deg. C Dry 22

Deg. C Wet 20

Rel. Humidity % 83

Air Pressure mb 1022

Wind knots 0 - 2 N.W.

Cloud Cover % clear * still overnight temperature down to 7 deg.

19/4/95 - 4.46 pm

Aberglasslyn/Hancock residence

Temperature

Deg. C Dry 19

Deg. C Wet 17

Rel. Humidity % 82

Air Pressure mb 1020

Wind knots 0 - 5 knots

Cloud Cover % 15% high * still overnight temp. down to 11 deg.

24/2/95 - 10.32 am

Hancock residence

Temperature

Deg. C Dry 26

Deg. C Wet 24

Rel. Humidity % 85

Air Pressure mb 1010

Wind knots 0 - 2 S.E.

Cloud Cover % 80% high

5. Equipment Noise Levels

The sound power levels of the equipment used on-site is given below in octave bands:-

Source No : 1

Source TITLE: Boral Country - Oakhampton Quarry - Tertiary Screen
Information

Tertiary Screen measured at 12 metres

Type = POINT

Coordinates

x = 2152.13, y = 1776.2, z = 17.8

encl =

section =

TITLE:

PWL

FREQUENCY HZ										
31.5	63	125	250	500	1k	2k	4k	8k	16k	
109.5	101.4	107.6	107.5	98.8	97.7	96.9	94.4	91.1	85.2	

Source No : 2

Source TITLE: Boral Country - Oakhampton Quarry - Tromel & Screen
Information

Scrubber with screen above measured at 7 metres

Type = POINT

Coordinates

x = 2152.13, y = 1776.2, z = 17.8

encl =

section =

TITLE:

PWL

FREQUENCY HZ										
31.5	63	125	250	500	1k	2k	4k	8k	16k	
105.8	102.0	103.8	99.5	104.6	100.7	98.4	97.0	93.6	87.4	

Source No : 3
Source TITLE: Boral Country - Oakhampton Quarry - Sand Cone & Pump
Information
Sand Cone & cyclone pumps measured at 7 metres

Type = POINT

Coordinates
x = 2152.13, y = 1776.2, z = 16.8
encl =
section =
TITLE:

PWL

FREQUENCY HZ									
31.5	63	125	250	500	1k	2k	4k	8k	16k
99.0	97.0	98.9	98.6	97.7	99.0	103.2	93.3	83.7	70.5

Source No : 4
Source TITLE: Boral Country - Oakhampton Quarry - Front-end loader Sales
Information
Cat 966 sales front-end loader measured at 6 metres

Type = POINT

Coordinates
x = 2145.76, y = 1718.87, z = 17.8
encl =
section =
TITLE:

PWL

FREQUENCY HZ									
31.5	63	125	250	500	1k	2k	4k	8k	16k
96.6	99.3	102.5	103.0	104.6	104.3	100.1	94.5	91.3	84.4

Source No : 5
Source TITLE: Boral Country - Oakhampton Quarry - Primary Section
Information
Tromel screen and pump measured at 14 metres from centre line

Type = POINT

Coordinates
x = 2188.79, y = 1870.91, z = 11.8
encl =
section =
TITLE:

PWL

FREQUENCY HZ									
31.5	63	125	250	500	1k	2k	4k	8k	16k
96.7	101.2	96.5	96.3	97.6	97.7	95.4	94.1	95.1	82.9

Source No : 6
Source TITLE: Boral Country - Oakhampton Quarry - Dredge
Information
Dredge measured at 46 metres

Type = POINT

Coordinates

x = 2231.27, y = 1993.13, z = 1

encl =

section =

TITLE:

PWL

FREQUENCY HZ

31.5	63	125	250	500	1k	2k	4k	8k	16k
107.8	127.0	117.4	105.2	104.5	98.8	96.0	92.7	85.6	81.9

Source No : 7

Source TITLE: Boral Country - Oakhampton Quarry - Front-end loader No.2
Information

Cat 966C front-end loader measured at 7 metres up ramp

Type = POINT

Coordinates

x = 2100.2, y = 1849.52, z = 11.8

encl =

section =

TITLE:

PWL

FREQUENCY HZ

31.5	63	125	250	500	1k	2k	4k	8k	16k
96.7	101.5	108.5	103.8	107.0	106.5	105.4	99.3	93.5	86.8

Appendix H

REFERENCE LIST

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- Allen, G.R. (1989).
Freshwater Fishes of Australia. T.F.H. Publications, Brookvale.
- Arthrington, A.H., Milton, D.A. and McKay, R.J. (1983)
Effects of urban development and habitat alterations on the distribution and abundance of native and exotic freshwater fish in the Brisbane region, Queensland. Australian Journal of Ecology, 8, 87-101.
- Brawshaw, H. (1984)
- Briggs, I.C. (1980)
Family Clupeidae. Herrings. In: *Freshwater Fishes of South-eastern Australia* (ed. R.M. McDowell) pp. 48-50. A.H. and A.W. Reed Pty Ltd, Sydney.
- Bryce, M.N. (1977)
A Study of Sediment Movements Downstream from a Hydraulic Dredge. Bachelor of Arts Thesis, University of New South Wales.
- Campbell, I.C., James, K.R., Hart, B.T. and Devereaux, A. (1992)
Allochthonous coarse particulate organic material in forest and pasture reaches of two south-eastern Australian streams. I. Litter accession. *Freshwater Biology*, 27, 341-52.
- Chang, H.H. (1987)
Modelling fluvial processes in streams with gravel mining. In: *Sediment Transport in Gravel-Bed Rivers* (eds C.R. Thorne, J.C. Bathurst & R.D. Hey) pp. 977-985. John Wiley and Sons, Chichester.
- Chessman, B.C. (1995)
Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family level identification and a biotic index. *Australian Journal of Ecology*, 20, 122-129.
- Chessman, B.C. and Growns, J.E. (1994)
Williams River Aquatic Macroinvertebrate Study. Australian Water Technologies report No. 94/84.

- Chessman, B.C. and Robinson, D.P. (1987)
Some effects of the 1982-83 drought on water quality and macroinvertebrate fauna in the La Trobe River, Victoria. Australian Journal of Marine and Freshwater Research, 38, 289-299.
- Day, D.G. (1982)
Water use issues in the upper Hunter Valley, NSW. Cres. Working Paper CP/WP7, Australian National University, Canberra.
- Department of Planning (1989)
Hunter Regional Environmental Plan.
- Elliot, G.L. and Veness R.A. (1981)
Selection of Topdressing Material for Rehabilitation of Disturbed Areas in the Hunter Valley. J.Soil. Con. NSW 37: 37-40.
- Erskine, W.D. (1986)
River Metamorphosis and Environmental Change in the Hunter Valley, New South Wales. Ph.D. Thesis, University of New South Wales.
- Erskine, W.D. (1990)
 Environmental impacts of sand and gravel extraction on river systems. In: *The Brisbane River: A Source Book for the Future* (eds P. Davie, E. Stock and D. Low Choy) pp. 295-302. Australian Littoral Society Inc. and Queensland Museum, Brisbane.
- Erskine, W.D. (1992).
Channel response to large-scale river training works: Hunter River, Australia. Reg. Rivers, 7, 261-278.
- Erskine, W.D. and Bell, F.C. (1982)
 Rainfall, floods and river channel changes in the upper Hunter. *Australian Geographical Studies*, 20, 183-196.
- Erskine, W.D. and Warner, R.F. (1988)
 Geomorphic effects of alternating flood- and drought-dominated regimes on NSW coastal rivers. In: *Fluvial Geomorphology of Australia* (ed R.F. Warner) pp. 223-244. Academic Press Australia, Sydney.
- Erskine, W.D., Geary, P.M. and Outhet, D.N. (1985)
Potential impacts of sand and gravel extraction on the Hunter River, New South Wales. Australian Geographical Studies, 23, 71-86.

- Fisher, S.G., and Likens, G.E. (1973)
Energy flow in Bear Brook, New Hampshire: an integrative approach to stream ecosystem metabolism. Ecology, 43, 421-39.
- Galay, V.J. (1983)
Causes of river bed degradation. Water Resources Research, 19, 1057-1090.
- Gammon, J.R. (1970)
The effect of inorganic sediment on stream biota. USEPA Water Pollution Control Research Series 18050 DWC 12/70 141pp.
- Garman, D.E.J. (1980)
The Hunter River Valley - Water quality - present and future. Symposium on Hunter Environment, Department of Geography, University of Newcastle, NSW.
- Gomon, M.F., Glover, J.C.M. and Kuitert, R.H. (eds) (1994)
The Fishes of Australia's South Coast. The Flora and Fauna of South Australia Handbooks Committee, Adelaide.
- Gorman, O.T. and Karr, J.R. (1978)
Habitat structure and stream fish communities. Ecology, 59, 507-15.
- Harden, G.J. (ed.) (1990)
Flora of New South Wales. Volume 1. New South Wales University Press, Sydney.
- Harden, G.J. (ed.) (1991)
Flora of New South Wales. Volume 2. New South Wales University Press, Sydney.
- Harden, G.J. (ed.) (1992)
Flora of New South Wales. Volume 3. New South Wales University Press, Sydney.
- Harden, G.J. (ed.) (1993)
Flora of New South Wales. Volume 4. New South Wales University Press, Sydney.
- Harris, J.H. (1986). Reproduction of the Australian Bass, *Macquaria novemaculeata* (Perciformes, Percichthyidae) in the Sydney Basin. *Australian Journal of Marine and Freshwater Research, 37, 209-235.*

- Harris, J.H. (1988)
Demography of Australian Bass, *Macquaria novemaculeata* (Perciformes, Percichthyidae) in the Sydney Basin. *Australian Journal of Marine and Freshwater Research*, 39, 355-369.
- Hawking, J. (1993)
A Preliminary Guide to Keys and Zoological Information to Identify Invertebrates from Australian Freshwaters. Cooperative Research Centre for Freshwater Ecology, Albury, Identification Guide No. 2.
- Jacobs, S.W.L. (1990)
Cabombaceae. In: *Flora of New South Wales. Volume 1* (ed. G.J. Harden) pp. 148-149. New South Wales University Press, Sydney.
- James, P. (1995)
Quarrying and ESD: Changes to NSW's Environmental Planning and Assessment Legislation. Quarry Australia, Vol. 3, No. 4, 1995.
- Koehn, J.D. and O'Connor, W.G. (1990)
Biological Information for Management of Native Freshwater Fish in Victoria. Department of Conservation and Environment, Arthur Rylah Institute for Environmental Research, Melbourne.
- Lamp, C. and Collet, F. (1989)
Field Guide to Weeds in Australia. Inkata Press, Sydney.
- Lagasse, P.F., Winkley, B.R. and Simons, D.B. (1980)
Impact of gravel mining on river system stability. *Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings American Society of Civil Engineers*, 106, 389-404.
- Large, A.R.G. and Petts, G.E. (1994)
Rehabilitation of river margins. In: *The Rivers Handbook. Hydrological and Ecological Principles. Volume 1*. (eds P. Calow and G.E. Petts) pp. 401-419. Blackwell Scientific Publications, Melbourne.
- Lenat, D.R., Penrose, D.L. and Eagleson, K.W. (1981)
Variable effects of sediment addition on stream benthos. *Hydrobiologia*, 79, 187-194.
- McClelland, W.T. and Brusven M.A. (1980)
Effects of sedimentation on the behavior and distribution of riffle insects in a laboratory stream. *Aquatic Insects*, 3, 161-169.

- McDowell, R.M. (1980)
Freshwater Fishes of South-eastern Australia. A.H. and A.W. Reed Pty Ltd., Sydney.
- Maitland City Council (1988)
Rural Lands Study
- Maitland City Council (1993)
Maitland Local Environmental Plan
- Maitland City Council (1995)
Community Profile
- Merrick, J.R. and Schmida, G.E. (1984)
Australian Freshwater Fishes. Biology and Management. Griffin Press, Netley.
- Mitchell, B. and Pigram, J. (1988)
Integrated Catchment Management and the Hunter Valley, N.S.W. Occasional Paper No. 2, University of New England, Armidale.
- Nanson, G.C. and Erskine, W.D. (1988)
 Episodic changes of channels and floodplains on coastal rivers in New South Wales. In: *Fluvial Geomorphology of Australia* (ed. R.F. Warner) pp. 201-221. Academic Press Australia, Sydney.
- Parfait, A. (1988)
Sediment transport and stream pattern Hunter River. NSW Department of Water Resources, Catchment Management, Muswellbrook, February 1988.
- Parfait, A. (1995)
Personal Communication from Department of Water Resources.
- Pearson, R.G. and Jones, N.V. (1975)
 The effects of dredging operations on the benthic community of a chalk stream. *Biological Conservation*, 7, 273-285.
- Peterson, R.C. Jr (1992)
 The RCE: a riparian, channel and environmental inventory for small streams in the agricultural landscape. *Freshwater Biology*, 27, 295-306.

- Pollock, B.R., Weng, H. and Morton, R.M. (1983)
The seasonal occurrence of postlarval stages of yellowfin bream, *Acanthopagrus australis* (Günther), and some factors affecting their movement into an estuary. *Journal of Fish Biology*, 22, 409-415.
- Public Works Department (1972)
Hunter Valley flood mitigation: Hexham Swamp, environmental impact report. Department of Public Works.
- Quinn, J.M., Davies-Colley, R.J., Hickey, C.W., Vickers, M.L., and Ryan P.A. (1992)
Effects of clay discharges on streams. 2. Benthic invertebrates. *Hydrobiologia*, 248, 235-247.
- Resource Planning (1982)
Environmental Impact Statement for the Extraction and Processing of Sand and Gravel from the Hunter River, Singleton. Prepared for Pioneer Concrete (N.S.W.) Pty Ltd.
- Resource Planning Pty Limited (1983)
Environmental impact statement of the extension of extraction operations in the Hunter River, Maitland Vale. Prepared for Rosebrook Sand and Gravel Pty Limited.
- Richardson, B. (1984)
Instream Flow Requirements in Relation to the Biology and Ecology of Freshwater Fishes in the Tweed River, Northern New South Wales. M. Sc. Thesis, Macquarie University.
- Robinson, M. (1994)
A Field Guide to Frogs of Australia. Reed Books Australia, Sydney.
- Rogan, P. (1977)
Maintaining wildlife values in streams. *Victoria's Resources*, 19, 24-26.
- Sainty, G.R. and Jacobs, S.W.L. (1994)
Waterplants in Australia. A Field Guide. 3rd edn. Sainty and Associates, Sydney.
- SPCC (1984)
Sand and Gravel Extraction in the Upper Hawkesbury River. State Pollution Control Commission, Sydney.

- Thompson, J.M. (1955)
The movements and migrations of mullet (*Mugil cephalus* L.). *Australian Journal of Marine and Freshwater Research*, 6, 328-347.
- Wagener S.M. and La Perriere, J.D. (1985)
Effects of placer mining on the invertebrate communities of interior Alaska streams. *Freshwater Invertebrate Biology*, 4, 208-214.
- Water Resources Commission (1988)
Water Resources Inventory. Water Resources Commission, Sydney.
- Webb, A. (1989)
History and impacts of sand and gravel extraction from the Hunter River at Oakhampton, NSW. Boral Resources (NSW) Pty Limited.
- Webb, McKeown and Associates Pty Limited (1994)
Determination of the flood standard - Maitland
- Williams, S. (1994)
Macroinvertebrate Survey of the Hawkesbury-Nepean River and Selected Tributaries. Australian Water Technologies report No. 94/188.

Appendix I

EIS CERTIFICATE – FORM 2

**SUBMISSION OF ENVIRONMENTAL IMPACT
STATEMENT (EIS)**

PREPARED UNDER THE ENVIRONMENTAL PLANNING AND
ASSESSMENT ACT 1979 - SECTION 77

EIS PREPARED BY

Name:

Steven O'Connor

Qualifications:

BTP (Hons), MSc (Hons)

Address:

PO Box 388, East Maitland, 2323

in respect of:

DEVELOPMENT APPLICATION

Applicant Name:

Boral Resources (Country) Pty Limited

Applicant Address:

trading as Boral Country Concrete and Quarries
PO Box 42, Wentworthville, NSW, 2145

Land to be developed: Address

Bed of Hunter River at Oakhampton

Lot No. DP/MPS, Vol/Fol etc.

Lot 13, 14 & 20 DP 37580, Lot 193 & 196 DP 246309,
Lot 1-3 & 5 DP 217178, Lot 8 DP 248331, Lot 41 DP 611238
and Lot 324 DP 835231, Parish of Maitland, County of
Northumberland

Proposed Development

Extension of sand and gravel quarrying and associated
processing and transport.

**ENVIRONMENTAL IMPACT
STATEMENT**

An environmental impact statement (EIS) is attached

CERTIFICATE

I certify that I have prepared the contents of this Statement
and to the best of my knowledge

- it is in accordance with clauses 51 and 52 of the
Environmental Planning and Assessment Regulation
1994, and
- it is true in all material particulars and does not, by
its presentation or omission of information,
materially mislead.

Signature:

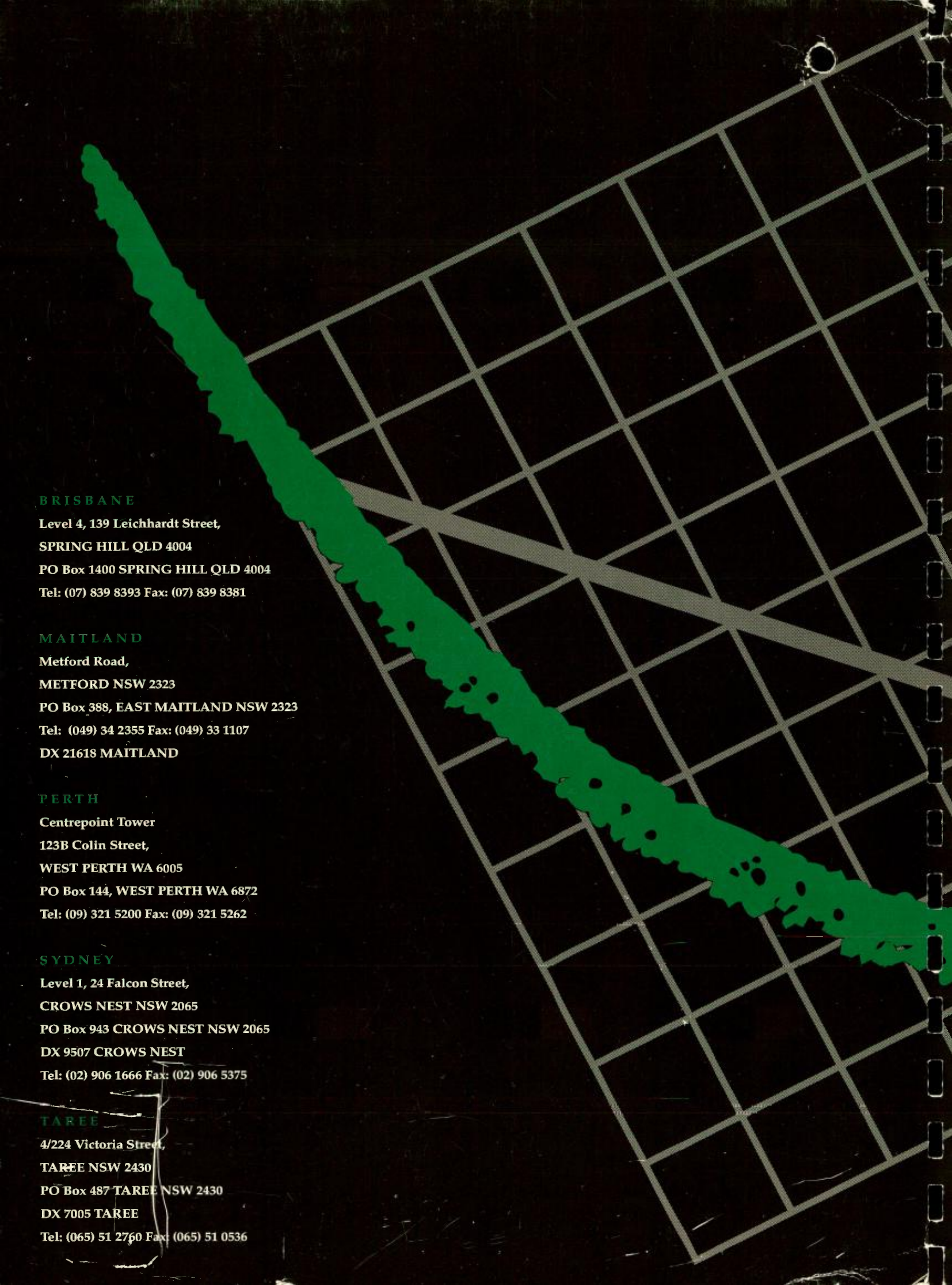
Stephen O'Connor

Name:

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13 / 6 / 95



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