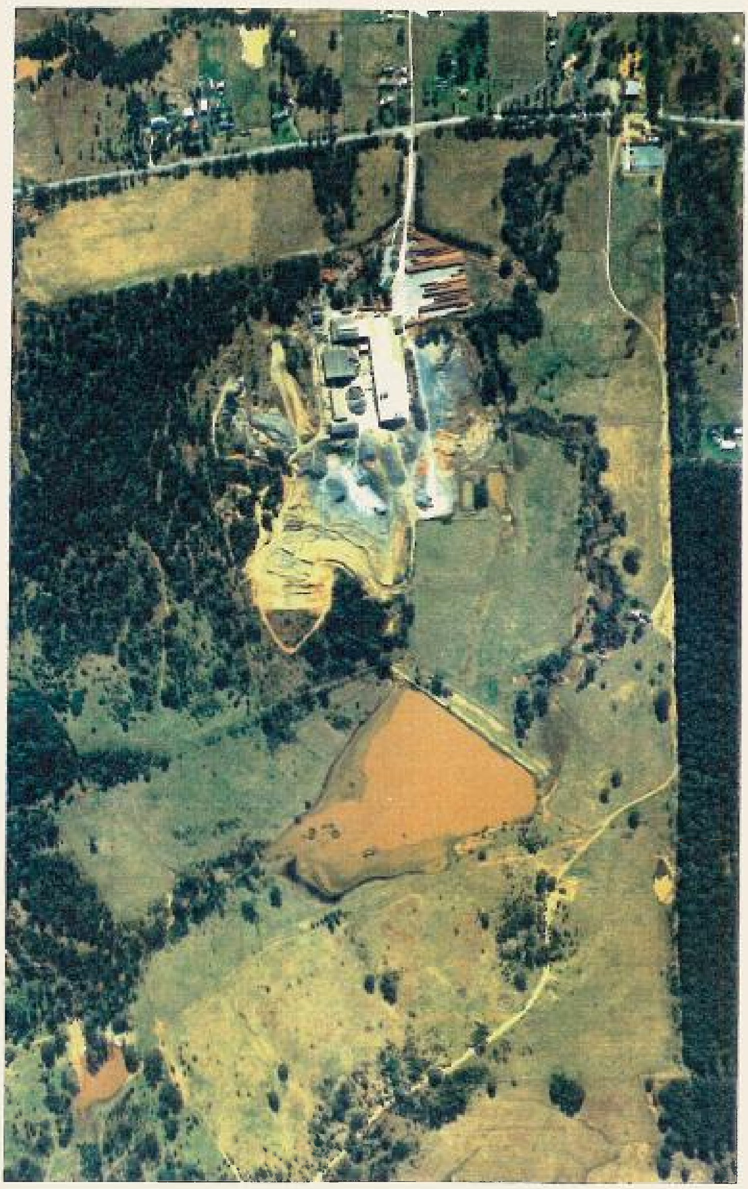
EIS 1077

AB019712

Environmental impact statement for the upgrading of the Bringelly brick and paver manufacturing plant, Greendale Road, Bringelly

BORAL BRICKS (NSW) PTY LIMITED

ENVIRONMENTAL IMPACT STATEMENT FOR THE UPGRADING OF THE BRINGELLY BRICK AND PAVER MANUFACTURING PLANT GREENDALE ROAD, BRINGELLY



RESOURCE PLANNING PTY LIMITED

L90/0556

BORAL BRICKS (NSW) PTY LIMITED

ENVIRONMENTAL IMPACT STATEMENT FOR THE UPGRADING OF THE BRINGELLY BRICK AND PAVER MANUFACTURING PLANT GREENDALE ROAD, BRINGELLY

PREPARED BY:

RESOURCE PLANNING
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March 1991

Form 4.

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979 (SECTION 77 (3) (d)).

ENVIRONMENTAL IMPACT STATEMENT.

This Statement has been prepared by or on behalf of Boral Bricks (NSW) Pty. Limited being the applicant making the development application referred to below.

The Statement accompanies the development application made in respect of the development described as follows:—

Upgrading of the Bringelly brick and paver manufacturing and quarrying operations - extensions to "extractive industry"

The development application relates to the land described as follows:—

No. .... Street Greendale Road

Locality/suburb Bringelly

Real property description Lot 2, DP 733115, Parish of Cook County of Cumberland

(e.g. Lot, D.P./M.P.S., vol./fol., Parish, Portion)

The contents of this statement, as required by clause 34 of the Environmental Planning and Assessment Regulation, 1980, are set forth in the accompanying pages.

Name, Qualifications and Address of person who prepared Environmental Impact Statement: Valerie Smith B.Sc. (Hons) M.Sc., Hort.Cert. P.O. Box 388, East Maitland, 2323

Certificate.

I, Valerie Smith, of Resource Planning Pty Limited hereby certify that I have prepared the contents of this Statement in accordance with clauses 34 and 35 of the Environmental Planning and Assessment Regulation 1980.

Valerie Smith

Signature

8th March 1991

Date

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

1.0 SUMMARY

1.1 OBJECTIVES AND OUTLINE OF THE DEVELOPMENT

*Boral Bricks (NSW) Pty Limited seeks Development Consent from Camden Municipal Council to upgrade the Company's existing clay products plant located in Greendale Road, Bringelly, shown on **Figure 1**.*

The upgrading proposal is "designated development" within the meaning of the Environmental Planning and Assessment Act, 1979 and Regulations, 1980. Accordingly, the Development Application to Council must be accompanied by an Environmental Impact Statement. Resource Planning Pty Limited has been engaged by Boral Bricks (NSW) Pty Limited to prepare the statement on its behalf.

The existing Bringelly plant was commissioned in 1968 to produce bricks and pavers principally for the housing market. Technology used in the plant is now obsolete, maintenance costs are high, and the operation only marginally viable. Upgrading is necessary for the Company to continue to maintain its competitiveness in the market place.

Proposals include extensions to the quarry area, modifications to raw material handling, construction of a new brick and paver manufacturing plant, enlargement of product stockpile areas, and general overall improvement to site layout, facilities, and environmental controls.

The quarry will be deepened and extended to the south and west of the existing excavation. Extractive operations are, and will continue to be undertaken on a campaign basis with production increasing from 60,000 tpa to 200,000 tpa. Raw material will be stockpiled in a new stockpile area located southeast of the plant. The material will be crushed and conveyed to the new manufacturing plant constructed immediately adjacent to, and east of the existing plant. The new state-of-the-art plant will permit production of pavers and pressed bricks to increase from 51,500 tpa to 160,000 tpa. The increased production will be stockpiled on an expanded final product area for despatch to market.

Other changes include reconstruction of the existing car park, improvements to runoff and waste water disposal systems, refurbishment of the existing office building, and landscaping and screen planting of the site works.

The objective of the proposal is to upgrade the existing Bringelly operations to a modern and efficient manufacturing plant which will continue to provide high quality bricks and pavers to the Sydney Region. The upgrading proposal presents an opportunity to improve an outmoded and inefficient plant to one which is economically and environmentally compatible with its surrounding environment. This is achieved by the incorporation of modern, efficient and effective environmental controls. The Company proposes to utilise the optimum environmental management procedures in the extraction and manufacturing process and will carry out its activities in accordance with the requirements of State and Local authorities.

1.2 JUSTIFICATION FOR THE DEVELOPMENT

The existing Bringelly plant was commissioned in 1968 to manufacture standard textured clay bricks for the housing market. The capacity of the plant at that time was approximately 15.5 million bricks per year.

The technology used in the plant is now outdated and its viability is marginal. Due to high manufacturing and maintenance costs, the plant has been shut down and employees temporarily retrenched on four separate occasions during the past 20 years. These closures coincided with market down turns, low selling prices and high manufacturing costs.

To maintain its market position, the plant now specialises in the manufacture of pavers and a limited range of architectural bricks, e.g., green tumbled; bypassing the more competitive standard brick market.

Upgrading of the existing plant has not occurred because of the large economic costs involved. Installation of the new plant, as outlined in this document, demonstrates that improvements to the environmental quality of the site will occur.

The regional importance of the Bringelly plant and site has been identified in the Sydney Regional Environmental Plan No. 9 (Extractive Industry) and Planning Report (1986) prepared by the Department of Environment and Planning. The Bringelly site is listed in Schedule 1 of the Plan. This schedule includes "sites which contain existing extractive operations and potential resource areas of regional significance. Priority is given to the continuation of existing operations." The site is an important resource of clay/shale to meet the future demands of the Sydney metropolitan area.

Within the Boral Bricks group, the Bringelly site is of strategic importance. It is one of the group's largest holdings in the Sydney region close to future population growth areas and the labour market. Geological exploration has demonstrated that large reserves of high quality clay/shale suitable for brick and paver manufacture occur on this site and that these constitute the best reserves of all existing Boral New South Wales plants.

With the introduction of a new Australian Standard for pavers in the near future, Boral Bricks considers that the paver products presently manufactured at Bringelly will not comply with the requirements of the new code. The new standard will specifically address factors of quality which the existing equipment and methods of production would have difficulty in satisfying.

In order to manufacture a superior and more widely accepted product, and to maintain its competitiveness in the market place, it is essential that the existing operation be expanded by the introduction of new methods, new equipment, and the latest technology.

1.3 ENVIRONMENTAL MANAGEMENT PROCEDURES

1.3.1 Erosion and Sedimentation Controls

Before commencement of site works, the bund wall adjacent to Thompsons Creek will be established using excavated material from sedimentation basin construction. Catch drains will direct all runoff generated by construction disturbance into sedimentation dams.

To minimise the rate of sheet and rill erosion, vegetation clearing ahead of the topsoil stripping operation will be restricted to 50m for slopes less than 7.5% and 25m for slopes greater than or equal to 7.5%.

Temporary vegetative stabilisation will be employed if topsoil is exposed for greater than 30 days. Vegetation will be stacked and burned during the cooler months to minimise fire hazard.

1.3.2 Soil Stripping and Stockpiling

Topsoil will be removed by dozer or grader and stockpiled within the void of the preceding stage to avoid major internal flow lines. In most cases, the topsoil will be respread immediately on prepared rehabilitation sections to maintain the viability of any seed stock. Stockpiled topsoil will be temporarily stabilised using a suitable pasture mix.

1.3.3 Water Management

*A series of runoff controls will be employed to manage and divert clean water away from the active quarry area and exposed soil surfaces. (see **Section 7.2**).*

Primary and secondary sedimentation dams will be employed to collect runoff from disturbed areas, to provide water for dust suppression, and to contain and treat saline runoff from exposed surfaces.

*The controls will be progressively extended with the quarry stages and details are provided in **Section 7.2**.*

1.3.4 Solid Waste Disposal

Overburden and interburden materials not suitable for brick or paver manufacture will be progressively stripped and emplaced in a worked out section of the quarry, as part of rehabilitation procedures. Production and domestic wastes will be removed by waste contractors.

1.3.5 Dust Controls

Potential sources of dust are the open quarry void, unsealed haul roads traversed by heavy equipment, and stack emissions.

Controls include:

1. *Minimising the areas of disturbance.*

2. *Regular watering of haul roads and trafficked areas.*

3. *Enclosure of the primary crusher and conveyor to the plant.*

4. *Enclosing dust generating manufacturing operations.*

5. *Passing emissions from the plant through a dry scrubber and stack.*

6. *Good housekeeping practices, e.g. sweeping of sealed areas.*

1.3.6 Noise Controls

All mobile equipment external to the buildings will be fitted with standard silencers appropriate for the equipment. The silencer will be kept in good order to ensure minimal noise disturbance.

To attenuate noise from the primary crusher and mobile equipment used in both the manufacturing and quarrying operations, the crusher will be enclosed and a bund wall constructed adjacent to the plant and stockpile areas. The bund will be an earth wall up to 6m in height. The wall will be seeded and planted where possible to act as both an acoustic and visual screen.

The equipment involved in material preparation and brick/paver manufacture (except the primary crusher) will be housed within 2 buildings which significantly attenuate the noise levels emitted.

1.3.7 Protection of Natural and Man-made Features

Detailed environmental studies have shown that there are no unique or unusual natural or man-made features occurring on the site to be disturbed by the upgrading proposals and no special provisions are required.

1.3.8 Visual Controls

The quarrying operations are located to the south and west of the existing plant where they will be principally shielded by the buildings and remnant forest vegetation to be retained along the northern boundary of the property. Most quarrying will be conducted below ground level to an RL of 56m AHD.

A bund wall will be planted along the eastern boundary of the stockpile and new manufacturing plant to serve as both an acoustic and visual screen. The bund wall will be up to 6m in height and will be extensively planted with native trees and shrubs suitable for the area. A second bund wall will be constructed near the entrance to the plant to provide additional visual screening.

It is proposed to progressively rehabilitate the quarry stages with overburden/interburden removed from the quarry, and solid wastes from the manufacturing operation. It is proposed to leave a void in the Stage 1 quarry area to act as a sedimentation dam and runoff control from the disturbed areas of each successive quarry stage.

It is expected that a void will remain at the end of the operations. The void would be ideally suited as a waste disposal facility, or alternatively solid waste fill from alternative off-site sources could be imported to fill the final excavation.

The final void will be left in a stable condition.

1.3.9 Fire, Health and Safety Controls

All site buildings and structures will be of fire resistant or non combustible construction. The office building which is isolated from the plant is brick/concrete tile construction. The manufacturing plant, kiln and associated buildings will be predominantly of metal, concrete, and steel construction supported on concrete floors, pads, and ramps. There will be adequate fire separation between the various site structures and buildings, and good access around all sides of the kiln.

Appropriate bushfire control measures will be both preventative and reactive and will adequately safeguard the development in the event of bushfire.

They include:

1. *Construction of a perimeter road around the quarry stages.*

2. *The use and maintenance of all other tracks as firebreaks.*

3. *Creation of bare fuel–free perimeter strips around the manufacturing plant.*

4. *Regular mowing of the intervening grassed areas between the raw material stockpile and crusher area.*

5. *The use of the road watering tanker as an initial response fire tanker.*

6. *Installation of water hydrants at strategic points around the manufacturing plant.*

Other suitable dry chemical, BCF and foam extinguishers will be installed as required in the new plant. All extinguishers will comply with Australian Standard specifications and will be maintained by an outside fire protection contractor.

The existing fencing will be maintained together with the security gates. Improvement will be made to fencing of the car park area to ensure appropriate security of the plant area and to prevent unauthorised access.

All internal traffic will be required to travel at designated speeds and to comply with internal traffic controls.

1.3.10 Energy Conservation

To ensure efficient energy management, all equipment and plant will be maintained in good condition and operated only as required. Automated control of fuel feed and temperature will ensure minimal fuel use.

1.3.11 Road Upgrading

To ensure that the flow of traffic on Greendale Road is not impeded by traffic entering the Bringelly plant the entrance will be upgraded. A Type B intersection *with a 30m storage length and 30m taper length will be constructed in accordance with Roads and Traffic Authority requirements.*

1.4 ANALYSIS OF ENVIRONMENTAL INTERACTIONS AND IMPACTS

1.4.1 Topography and Slopes

The impact of the proposed development on the primary terrain characteristics of the area will be minimal, as the main ridge and drainage lines will remain intact.

The form of side slopes within the quarried area will be modified, to produce steeper (1 in 4) side slopes above a broad flat valley floor.

The topography and slopes to the east of the plant will remain similar to the present, except for the permanent presence of a large sedimentation dam adjacent to Thompsons Creek. Large dams are common in the Bringelly area, so this does not represent a significant change in the context of local terrain and landuse.

1.4.2 Geology

The quarrying operations will remove up to 4.43 million tonnes of claystone and siltstone which is highly suitable for the production of bricks and pavers. A significant proportion of this material will be light-firing material which is in short supply in the Sydney region. The utilisation of this highly valuable resource is a positive beneficial impact of the development.

1.4.3 Soils and Soil Erosion

The topsoil materials present within the study area are moderately to strongly erodible, and under existing land use practices on the property, there is moderate active sheet, rill and gully erosion.

It is proposed to progressively strip the topsoil from the extended quarry area, and to strip topsoil from the alluvial flats before that area is used for stockpiling of raw material. The stripped topsoil will be stockpiled, and respread during rehabilitation of the quarry area. The net impact on the quality of topsoil present in the area will be minimal.

An important aspect of the proposed management of the area will be implementation of effective runoff controls and efficient sedimentation dams. These will ensure that the sediment yield from the site is minimal.

1.4.4 Hydrology

The proposed development will not affect the hydrology of Thompsons Creek, the main drainage channel which passes through the area. The construction of dams on small tributaries of Bardwell Gully above and below the extraction stages will modify the hydrological characteristics of Bardwell Gully. The dams are designed to ensure that water quality is not detrimentally affected and the minor impact on hydrological characteristics is more than offset by the prevention of detrimental water quality impacts.

1.4.5 Water Quality

*Existing environmental studies have shown that runoff from disturbed areas on-site is saline. **Section 7.2** describes the control measures to be implemented to prevent the discharge of saline water from the site. These measures, together with the diversion of all runoff from the quarry, plant and stockpile areas to sedimentation dams and the recycling of water for dust suppression will ensure that the development does not cause any alteration to water quality downstream of the site.*

1.4.6 Air Quality

The emissions from the kiln stack have been used with the dispersion model AUSPLUME to predict ground-level concentrations of SO_2, NO_2, HCl and HF in the vicinity of the plant. Two sets of meteorological data were available and both were used, but the data from Badgerys Creek was considered more representative of the Brickworks site and results from these runs indicate that a stack height of 17.5m will be sufficient to maintain ground-level concentrations below acceptable levels.

A special modelling run was carried out for HF with the West Hoxton data which predicted that on one day per year the 24-hour VEPA goal for HF would be exceeded at a hilltop within the site boundary. As the land usage at this site is not particularly sensitive to HF emissions, it was considered that no serious impact would occur.

The installation of a scrubber in the new plant will reduce the emission rate of hydrogen fluoride (HF) by about 60%. Thus although the proposed production will be approximately 3.3 times that of the present plant, the mass emission rate of hydrogen fluoride (HF) will increase by only 25% from 1.61 kg/hour to 2.00kg/hour.

The dispersion model DUSTGLC was used to predict increases in long-term ground-level concentrations and fallout rate of dust in the area resulting from the expanded quarrying and related activities. A conservative estimate of dust emissions was made, assuming no dust suppression measures apart from enclosure of the crushing area and watering of the scraper road during haulage of material to the stockpiles. Results of the modelling runs indicated that no houses outside the plant boundary would experience long-term dust deposition levels above the acceptable $2g/m^2$/month.

*The new plant will not add significantly to photochemical smog in the area (see **Appendix 3**).*

1.4.7 Vegetation and Fauna

*Stages 2, 3, and 4 of the proposed quarry will require the clearing of much of the remnant **Eucalyptus mollucana/Eucalyptus tereticornis** woodland on the site. The proposed final land use for the quarry is grazing. The rehabilitation plan for the quarry therefore provides for grassing of the sideslopes and quarry floor with the possibility of small stands of Eucalypts for shade. This represents a reduction of 6 ha of woodland, which represents 35% of the woodland present on the site. Its loss is not considered to constitute a significant detriment to the flora* *and fauna of the site. The existing woodland is surrounded by grazing and hobby farms, and little wildlife remains.*

The three large dams which will be created on-site will provide an opportunity to enhance local wildlife habitat for waterbirds and reptiles.

1.4.8 Bushfire Potential

*The measures proposed in **Section 7.8.4** to prevent the outbreak of bushfires or accidental fires at the plant will ensure that any fires are quickly attended to and extinguished. Impacts will be low.*

1.4.9 Noise Impacts

The redevelopment of the Bringelly Brick manufacturing facility by the installation of more modern and efficient plant and equipment will not alter the noise levels experienced by the surrounding neighbours. The predicted noise levels from the operation will meet the State Pollution Control Commission planning limits for such an operation.

The noise produced by transportation will increase marginally due to the upgraded operation.

1.4.10 Visual Impact

The construction of the acoustic bunds will provide a visual buffer for surrounding properties along the eastern boundary of the site. The walls (up to 6 metres in height) will limit views into the site and mitigate noise impacts of the site activities. Once the trees and shrubs have matured, the views into the site will be of a treed hedge, densely underplanted with varied shrubs.

The views into the site along Greendale Road are limited at the present time due to the groves of trees remaining on the western boundary and along the road frontage. These will provide an ongoing buffer, even when the additional Stages 2 to 4 of the plant are being worked. The construction of the amenity bund at the front gate will improve the Greendale Road streetscape and reinforce the existing planting along the front boundary.

The existing site works and the proposed extensions are set well back from the street frontage and although the entry road rises slightly up to the buildings, the existing trees provide a good screen.

An area of screen planting is proposed around the car park and will ensure that the visual impact of the cars is minimal from Greendale Road.

Some views only of the stacks will be possible from isolated residences.

Visual impacts are rated as low.

1.4.11 Aboriginal Relics

A field survey of the proposed development area identified 4 isolated artefacts within the land to be affected by quarry extensions. The isolated flakes were each located on disturbed ground and had no stratigraphic context. The *archaeological material, which is not considered to have scientific or cultural significance, will be destroyed by quarrying operations. The impact of the proposed development on the cultural resources of the Bringelly area is considered to be minimal.*

1.4.12 Planning

The proposed development is a permitted use with Council consent and the concurrence of the Department of Planning. No rezoning will be necessary to permit the operation.

Studies have shown that all air, noise and water quality impacts will be contained within the property boundaries. External impacts to the site relate principally to traffic and the proposed increases will be adequately catered for by proposed upgrading measures to be implemented. Vehicles will principally use designated main roads. Consequently, the containment of impacts on the site will ensure that there will be no significant impact on future planning proposals.

The utilisation of clay/shale on the site is in keeping with the objectives of Regional Environmental Plan 9 and this is a positive beneficial impact of the development.

1.4.13 Land Use

The land held by the Company is principally for the supply of clay/shale for brick and paver manufacture. The Company has no plans to subdivide the property in the short-term for rural-residential use. The vegetated/grassed paddocks provide a buffer zone to surrounding land uses.

The upgrading will have no direct detrimental impact on existing rural-residential, commercial, or special use land uses or proposals within the vicinity of the site.

1.4.14 Public Utilities

The Company will extend the existing water main in Greendale Road to provide reticulated water to the site principally for fire-fighting purposes, domestic applications, and production purposes. Most dust suppression water requirements will be drawn from on-site dams.

Existing power and telephone services will be augmented for the new development.

Sewage will be disposed of via an intermittent extended aeration activated sludge process which will replace the existing on-site transpiration bed system.

Natural gas which is already supplied to the existing plant will be extended to the new manufacturing plant.

1.4.15 Roads

With the commissioning of the new plant there will be an increase of 278 truck movements per week. Approximately 11% of this traffic will be involved with the importation of raw material from Erskine Park and Prospect to the west of the *plant and the remaining 89% will be generated through delivery of fired ware to markets east of the plant.*

The entrance to the plant is to be upgraded to include a deceleration lane to minimise disturbance to traffic using Greendale Road.

The increase in truck movements will result in a peak increase of 8 trucks per hour entering The Northern Road intersection from Greendale Road.

There will be a net decrease in traffic generated by employees and service vehicles.

1.4.16 Energy Impacts

The additional use of 0.15 x 10^{15} J is 0.01% of the projected energy use by the NSW Clay Products industry in 1986-87. (Department of National Development, 1978) and is a negligible impact on energy use.

1.4.17 Socio-Economic Impacts

The new plant and extensions to the Boral quarry will provide employment for an additional 17 people, a 50% increase on the present workforce at the plant. This in turn accounts for 0.6% of the present workforce of the municipality. Given the rapid population increase which is expected in the municipality, the relative employment contribution by the brickworks will be positive, but very small.

In terms of the economics of providing quality bricks and pavers to a rapidly expanding market in the southwest of the Sydney Metropolitan area, the Boral plant at Bringelly is in a strong position. The brickworks utilizes a large, high quality clay/shale reserve recognised by the State Government in Regional Environmental Plan No. 9 (Extractive Industry).

Camden Council has publicly expressed a community concern that the heritage/rural character of the district should be preserved despite rapid population growth. In this context a cost effective local supplier of clay pavers for footpaths, cul-de-sac surfacing in residential areas and paving of shopping precincts is of considerable value to town planners and landscape architects.

The upgrading will indirectly provide employment for construction and support services, such as equipment suppliers, business services, and retail trades which will be drawn from the local area wherever possible.

The proposed operation will provide a positive and beneficial impact on the local community base.

1.4.18 Cumulative Impacts

The closest similar brickworks operation to the site is the Badgerys Creek brickworks owned by Boral which is approximately 15km northeast of the site. There are no other significant manufacturing industries within 10km of the site that would result in cumulative impacts.

1.5 ALTERNATIVES TO THE DEVELOPMENT

1.5.1 Alternative Sources

The clay/shale resources of the Bringelly site have been identified as of strategic regional importance in Sydney Regional Environmental Plan No. 9 (Extractive Industry) and Planning Report (1986). Detailed geological exploration of the site has confirmed the presence of large reserves of high quality clay/shale suitable for brick and paver manufacture.

*The decision to expand the Bringelly operation was taken after an exhaustive consideration of the advantages and disadvantages of expansion of the Company's other brick plants in New South Wales as discussed in **Section 9.1**.*

1.5.2 Alternative Quarry Plan

The quarry plan proposed is the optimum for the recovery of proven reserves of high quality clay/shale occurring on the site. Considerably more reserves occur on the site to the south of the proposed extractive operation but these currently remain unproven and appropriate approvals will be sought for the extraction of these reserves prior to their development. The extraction plan provides for access to high quality clay/shale with minimal overburden/interburden, close to the plant minimising haulage distances, with a high proportion of light-firing material. The new plant has been located in an area with extensive sandstone interbeds to avoid sterilisation of high quality ceramic materials.

The quarrying method is a proven technique used by Boral to maximise recovery of reserves of clay/shale occurring on the site, is technically very efficient, and provides for progressive rehabilitation. The alternative is to use a dozer, front-end loader and haulage trucks. In addition to being inefficient and expensive, the additional equipment leads to higher environmental noise and dust impacts at nearest residences, and is not considered an acceptable alternative.

1.5.3 Alternative Plant Processes

The Company tendered the supply and installation of the technology to be used in the upgrading proposal. The technology to be selected is the optimum economically and environmentally and represents the most up-to-date available to the industry.

The Company also considered alternative locations for the siting of the new plant, raw material stockpiles and primary crusher. The location selected is considered the optimum for this plant for the following reasons:

a) The requirement of relatively level topography for the siting of the plant.

b) The need to avoid sterilising reserves of high quality clay/shale.

c) The need to be close to the existing buildings for efficient management.

d) Close proximity to access roads and product stockpile areas for transport of products.

1.5.4 Alternative of Not Proceeding

*As discussed in **Section 3.0**, the current technology used in the Bringelly plant is now outdated and its viability marginal. Due to high manufacturing and maintenance costs, the plant has been shut down and employees temporarily retrenched on four separate occasions during the past 20 years. To improve its viability, stabilise its workforce and continue to maintain its market position, upgrading of the plant is essential.*

Should the upgrading proposal not proceed, the plant will continue to experience product difficulties and the temporary retrenchment of staff. The viability of the operation would be questionable and the option of closing the plant would need to be considered.

Given the strategic importance of the site, the extensive reserve of high quality clay/shale, and proximity to future population growth areas and the labour market, the alternative of not proceeding with the development cannot be either justified or warranted.

INTRODUCTION

2.0 INTRODUCTION

2.1 OBJECTIVES AND OUTLINE OF THE DEVELOPMENT

Boral Bricks (NSW) Pty Limited seeks Development Consent from Camden Municipal Council to upgrade the Company's existing clay products plant located in Greendale Road, Bringelly, shown on **Figure 1**.

The upgrading proposal is "designated development" within the meaning of the Environmental Planning and Assessment Act, 1979 and Regulations, 1980. Accordingly, the Development Application to Council must be accompanied by an Environmental Impact Statement. Resource Planning Pty Limited has been engaged by Boral Bricks (NSW) Pty Limited to prepare the statement on its behalf.

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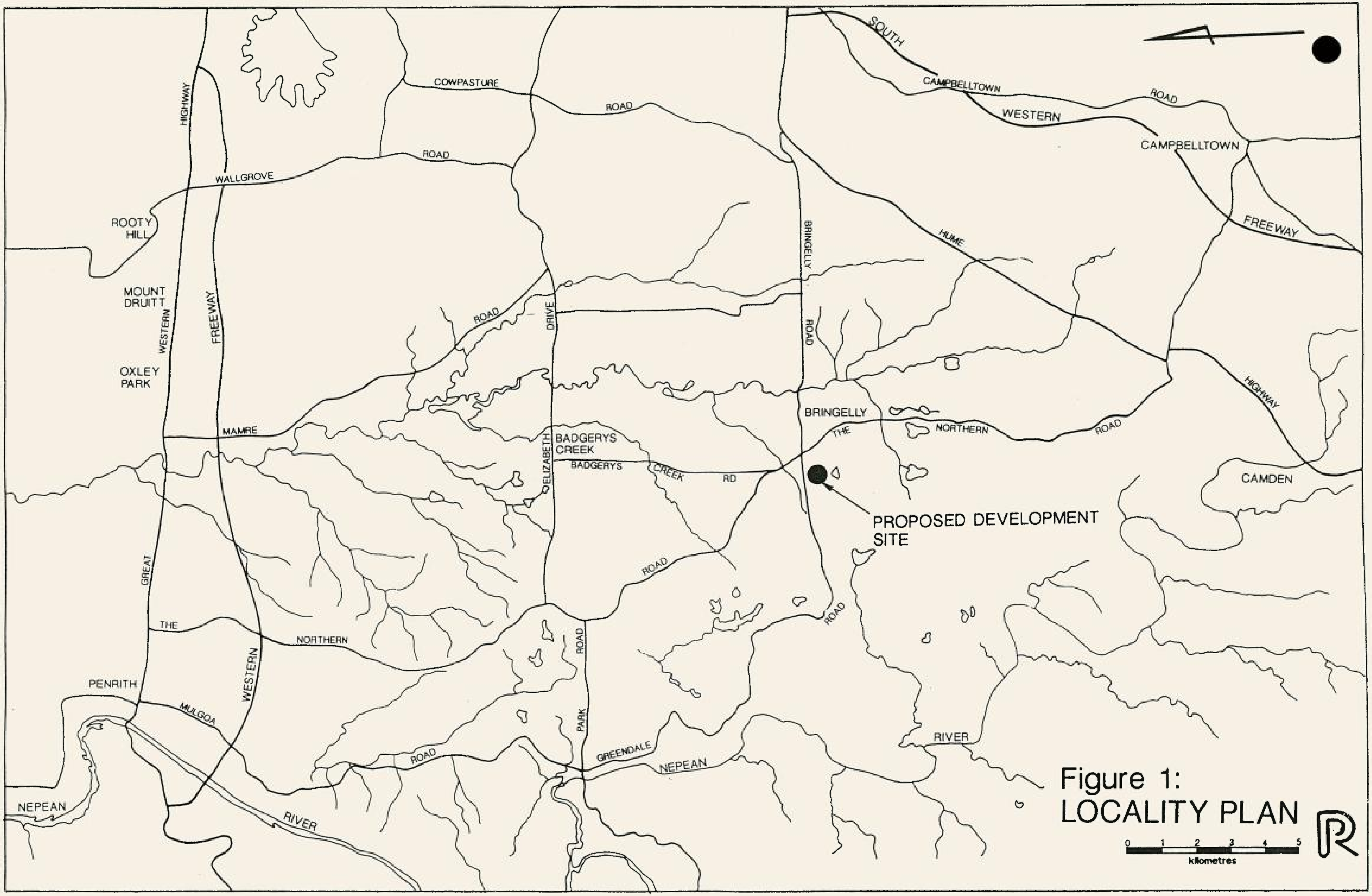


Figure 1:
LOCALITY PLAN

2.2 LAYOUT OF THE IMPACT STATEMENT

The Environmental Impact Statement has been prepared in accordance with Clauses 34 and 35 of the Environmental Planning and Assessment Regulation, 1980. The Director of the New South Wales Department of Planning was consulted as to the required form and content, and these requirements have been taken into account in preparation of the statement. **Appendix 1** presents the requirements of the Department with respect to the proposed development.

The impact statement has been divided into a number of sections to facilitate reading of the document. The sections are inter-related and basic data to support statements or conclusions made in one section of the statement may be found in other parts of the document. The reader is advised to read the Table of Contents carefully to locate all information of interest. As a further aid to locating information in the statement, the following notes outline the layout adopted for the impact statement.

SECTION 1.0 SUMMARY

Section 1.0 summarises the findings of the environmental investigations.

SECTION 2.0 INTRODUCTION

The introduction presents the objectives and brief outline of the proposed development as required by **Clause 34(b)** of the Regulations. The layout of the statement and authorities consulted are presented.

SECTION 3.0 JUSTIFICATION FOR THE PROPOSED DEVELOPMENT

This section outlines uses and demand for pavers and bricks in the region and the justification for the development in terms of environmental, economic and social considerations as required by **Clause 34(f)** of the Regulations.

SECTION 4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

Base-line investigations were carried out to establish the characteristics of the existing environment of the site and its surrounds. This information was used in the design and layout of the extractive operations and processing plant and in the design of the environmental management procedures. This information is essential in assessing the impacts of the proposal.

The section presents a description of the natural, physical and man-made features of the site together with social and economic factors. (**Clause 34(c)** of the Regulations).

Detailed supporting information is attached as appendices to the document.

SECTION 5.0 DESCRIPTION OF THE EXISTING DEVELOPMENT

This section describes the current activities on the site. These include the current quarrying operations, production, plant processes, truck movements, employees, hours of operation, and services.

SECTION 6.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

Section 6.0 describes the proposed upgrading of the plant and the development for which consent is sought. This section describes changes to current quarrying operations, production, plant processes, truck movements, facilities, services, and energy requirements. (**Clause 34(a)** of the Regulations).

SECTION 7.0 ENVIRONMENTAL MANAGEMENT PROCEDURES

This section describes the environmental management procedures to be designed into the project to protect the environment or mitigate adverse impacts on the environment of the site (**Clause 34(g)** of the Regulations). These include measures for the control of dust, air emissions, noise, water quality, visual amenity, traffic, and energy, (**Clause 34(g1)** of the Regulations).

SECTION 8.0 ASSESSMENT OF ENVIRONMENTAL IMPACTS

This section examines the effectiveness of the measures outlined in **Section 7.0** to protect the environment and provides an assessment of the residual environmental effects. Both adverse and beneficial effects are described in accordance with **Clauses 34(d)** and **34(e)** of the Regulations.

The reader should note that Sections 2.0 to 7.0 and appendices provide the basic data to be considered in the assessment of impacts.

SECTION 9.0 REVIEW OF ALTERNATIVES

This section describes the alternatives to the proposed development as required under **Clauses 34(h)** and **34(i)** of the Regulations. Alternatives considered are alternative sources, alternative quarrying proposals, and the alternative of not proceeding with the proposed development.

2.3 AUTHORITY CONSULTATIONS

During preparation of the impact statement, a number of State and local authorities were contacted either by phone, letter, or by way of a meeting. Listed below are authorities and organisations consulted and/or from whom information was obtained. All responses to inquiries are included in **Appendix 1**.

Department of Planning
Soil Conservation Service
Department of Water Resources
Roads and Traffic Authority
Department of Lands
Camden Municipal Council
State Pollution Control Commission
National Parks and Wildlife Service

2.4 PROJECT TEAM

The Environmental Impact Statement was prepared by Resource Planning Pty Limited, Geological and Environmental Consultants, Maitland, New South Wales.

RESOURCE PLANNING PTY LIMITED

Valerie Smith	–	Project Co-ordinator
B.Sc.(Hons), M.Sc.,	–	Environmental Investigations
Hort.Cert.	–	Liaison with Company, and Government agencies
	–	Geological Investigations
	–	Report Writing
Peter Jamieson	–	Hydrological Studies
B.E. (Civil)	–	Roads and Traffic
	–	Report Writing
Pam Dean-Jones	–	Soil and Erosion Studies
B.A.(Hons)(Geomorph)	–	Archaeological Investigations
Dip.Soc.Sci.	–	Base-line Studies
	–	Report Writing
Geoff Love	–	Sedimentation Controls
B.E. (Civil) (Hons)	–	Water Management
B.Nat.Res.(Hons)	–	Report Writing
Megan Dewsnap		
B.Land.Arch.	–	Screening and Landscaping

METFORD LABORATORIES PTY LIMITED

Liz Ling	–	Water and Dust Analyses
Chem.Cert., High Chem. Cert.		

BORAL RESEARCH

John Cotterill	–	Noise Investigations
B.E. M.A.A.S.		

NIGEL HOLMES AND ASSOCIATES

Nigel Holmes	–	Air quality Assessment
B.Sc.(Hons) Physics, Ph.D. Physics		

JUSTIFICATION FOR THE DEVELOPMENT

3.0 JUSTIFICATION FOR THE DEVELOPMENT

3.1 ECONOMIC CONSIDERATIONS

3.1.1 The Existing Operation

The existing Bringelly plant was commissioned in 1968 to manufacture standard textured clay bricks for the housing market. The capacity of the plant at that time was approximately 15.5 million bricks per year.

The technology used in the plant is now outdated and its viability is marginal. Due to high manufacturing and maintenance costs, the plant has been shut down and employees temporarily retrenched on four separate occasions during the past 20 years. These closures coincided with market down turns, low selling prices and high manufacturing costs.

To maintain its market position, the plant now specialises in the manufacture of pavers and a limited range of architectural bricks, e.g., green tumbled; bypassing the more competitive standard brick market.

Upgrading of the plant is essential for the Company to improve its viability, stabilise its workforce, and continue to maintain its market position.

3.1.2 Products and Markets

The Company currently produces 51,500 tpa of pavers and bricks. Three ranges of pavers, and specialised green tumbled bricks are marketed through direct sales, static displays and exhibition walling, authorised agents throughout Sydney and Country areas, and normal advertising media. Customers include architects, project home builders, owner builders, and Government agencies.

The extent of the market supplied is controlled by transport costs but it is estimated that 70% of the products are sold into the Sydney Metropolitan market and the remaining 30% sold into country New South Wales through local agents.

3.1.3 The Importance of the Site

The regional importance of the Bringelly plant and site has been identified in the Sydney Regional Environmental Plan No. 9 (Extractive Industry) and Planning Report (1986) prepared by the Department of Environment and Planning. The Bringelly site is listed in Schedule 1 of the Plan. This schedule includes "sites which contain existing extractive operations and potential resource areas of regional significance. Priority is given to the continuation of existing operations." The site is an important resource of clay/shale to meet the future demands of the Sydney metropolitan area.

Within the Boral Bricks group, the Bringelly site is of strategic importance. It is one of the group's largest holdings in the Sydney region close to future population growth areas and the labour market. Geological exploration has demonstrated that large reserves of high quality clay/shale suitable for brick and paver manufacture occur on this site and are the best reserves of all existing Boral New South Wales plants.

Investigations have shown that upgrading of the Bringelly plant can be undertaken with fewer environmental impacts than upgrading of the Company's other Sydney-based plants. (see **Section 9.1**). Clearly, these attributes are important economic considerations in the decision to upgrade the Bringelly plant.

3.1.4 Growth in Demand and the Need to Upgrade

Clay paving has for a number of years been popular with home owners in pool surrounds and general walkways. However, the market is undergoing expansion as a result of recent trends in paver use as a replacement for the more traditional concrete or bitumen surfacing. Some examples of this use are:

1. Local Government authorities are now replacing old deteriorated pavement with new clay or concrete pavers.

2. Large public areas in new shopping mall developments are being laid in pavers.

3. Local Government authorities are encouraging the use of pavers for light vehicular carriageways such as cul-de-sacs, shop service entrances, etc.

4. Promenades and esplanades previously generally laid with the more traditional surfaces such as concrete and bitumen are now being laid with pavers.

With the introduction of a new Australian Standard for pavers in the near future, Boral Bricks consider that the paver products presently manufactured at Bringelly will not comply with the requirements of the new code. The new standard will specifically address factors of quality which the existing equipment and methods of production would have difficulty in satisfying.

In order to manufacture a superior and more widely accepted product, and to maintain its competitiveness in the market place, it is essential that the existing operation be expanded by the introduction of new methods, new equipment, and the latest technology.

3.2 SOCIAL CONSIDERATIONS

The upgrading of the operations at Bringelly will have a beneficial impact on employment in the western suburbs of Sydney, and no detrimental impact on population growth and structure in the area.

Not only will the upgrading stabilise the existing workforce of 33 through reduction in plant shut downs, but the increased production from the quarrying and manufacturing operations will result in a 50% growth in the workforce. Indirectly the proposal will provide employment for support services, such as equipment suppliers, business services, and retail trades, which will be drawn from the local area whenever possible.

The proposed operation will provide a positive and beneficial impact on the local community base.

3.3 ENVIRONMENTAL CONSIDERATIONS

The environmental issues raised by the Department of Planning and other Government agencies, and those required to be addressed under the Environmental Planning and Assessment Act 1979 and Regulations 1980 have been dealt with in this document.

The upgrading proposal provides an opportunity to provide environmental improvements to an outmoded and inefficient plant. The new controls will ensure that air quality, noise, visual and water quality are protected and improved. Despite more than a 3 times increase in production emission levels increase only marginally and present no impact on surrounding residences.

Potential adverse environmental impacts on the natural and man–made environments as a result of the upgrading proposal have been mitigated by the planning proposals, design, and management procedures as outlined in this environmental impact statement.

DESCRIPTION OF THE EXISTING ENVIRONMENT

4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 LAND OWNERSHIP

The Bringelly site is described as Lot 2, DP 733115, Parish of Cook, County of Cumberland and comprises a total area of 385.55 hectares. The land is freehold and owned by Boral Bricks (NSW) Pty Limited.

4.2 TOPOGRAPHY AND SLOPES

Two quite distinct terrain types occur in the Bringelly area. Southwest of Greendale Road, the terrain is moderately undulating to hilly, and dissected by a dense network of low order streams. Local relief is 20m to 40m, and side slopes are short (100m to 250m) with gradients of up to 27%. The highest point in the district is Birling Trig (158m).

East of Bringelly, the terrain is gently undulating, and drainage densities decrease. Drainage lines of 3rd and 4th order with well developed floodplains are separated by low ridges with local relief less than 20m and side slope lengths of 500m to 750m. Side slope gradients are less than 5%.

The Boral quarry and plant are situated within the catchment of Thompsons Creek at the boundary between the two terrain classes. The existing quarry operates within a prominant east-northeast oriented spur from Birling Trig. The spur has side slopes of 250m length to the north, with gradients of approximately 10%. The existing plant is located close to the break of slope between the footslope terrace of Thompsons Creek to the east of the spur. Extensions to the plant, and additional stockpiles, will be located partially on natural low gradient terrain (2% to 5%) and partly on existing fill.

Figure 2 shows the topography of the site.

4.3 GEOLOGY

4.3.1 Regional

The Bringelly site is located within a sequence of interbedded claystone, siltstone, laminite, and sandstone known as the Middle Triassic Wianamatta Group, which crops out over a wide area to the west of Sydney. The group forms the topmost part of the Permo-Triassic sequence which comprises the Sydney Basin sediments and is divided into three formations, the Bringelly Shale, Minchinbury Sandstone, and Ashfield Shale.

4.3.2 Geological Evaluation

The Bringelly site has been subject to extensive geological evaluation. In 1984, Corkery and Co. Pty Limited (1984) drilled a total of 14 diamond drill holes to the west of the existing quarry and provided information on the stratigraphy to a maximum depth of 37m below the ridges that dominate the holding.

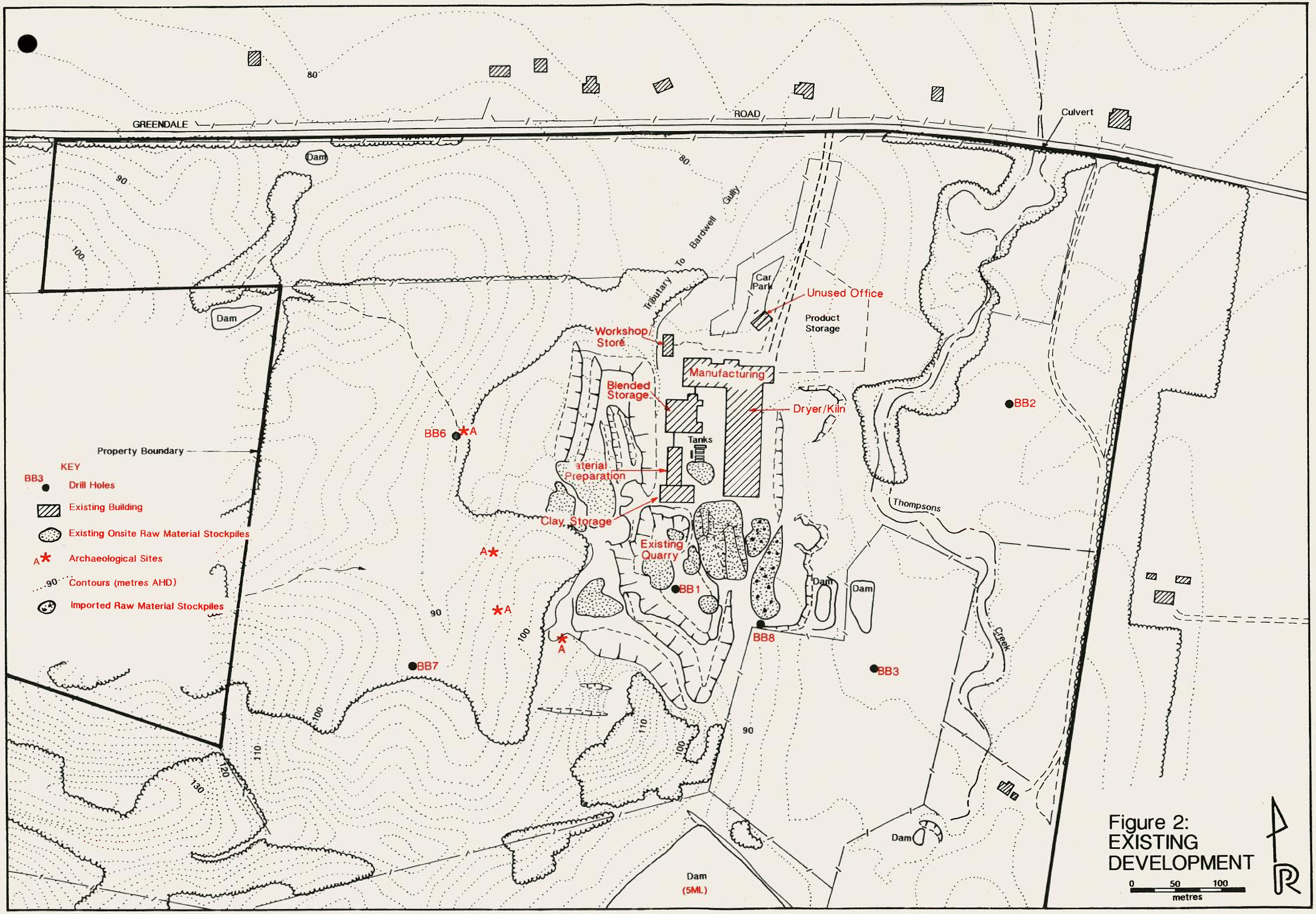


Figure 2: EXISTING DEVELOPMENT

In early 1989, five cored holes were drilled by Resource Planning (1989a) in the eastern and southern parts of the property. These holes were designed to test the cream–burning potential of units below the 80m AHD. In late 1989, drilling was extended to the west of the existing quarry where three cored holes were sunk. (Resource Planning, 1989b).

4.3.3 Site Geology

The evaluation showed that the site is underlain by the lower 75m–150m of the Bringelly Shale which comprises claystone, siltstone, laminite and sandstone. The base of the sequence in this area is defined by the Cobbitty Claystone, a thin (maximum 6cm) persistent layer of weathered tuff. **Figure 2** shows the location of the nearest six drill holes sunk during the 1989 campaign. The remaining two were drilled in the southern part of the holding.

4.3.4 Reserves

The initial drilling by Corkery and Co. Pty Limited (1984) delineated reserves of 10.7 million tonnes of dominantly red–burning material above the 80m AHD.

The 1989 drilling campaigns by Resource Planning (1989a and b) identified 16.3 million tonnes of suitable claystone/siltstone in the eastern part of the area, and 4.43 million tonnes in the western area between the 56m AHD and 86m AHD.

Because of a constraining 10m thick sandstone unit in the eastern part of the area, a western extension of the quarry was considered the optimum for maximising reserves of brickmaking materials. The area proposed for quarrying shown on **Figure 3**, contains 4.43 million tonnes of claystone/siltstone interbedded with 1.05 million tonnes of laminite and 0.26 million tonnes of sandstone.

4.3.5 Quality

Drill core from the above exploration programmes was fired in the existing Bringelly plant to determine firing characteristics. The testing showed that claystone/siltstone units fired to attractive colours and possessed shrinkage and other drying and firing characteristics similar to material currently extracted from the existing quarry. Approximately 50% of usable material is light firing and the balance is red firing. This material is highly suitable for brick and paver manufacture. Chemical characteristics important in determining emissions levels are given in **Appendix 3.**

4.4 SOILS

The soil landscapes of the western Cumberland Plain and lower Blue Mountains have been mapped at 1:100,000 scale by the Soil Conservation Service. Three soil landscapes occur in the Bringelly area. These are:

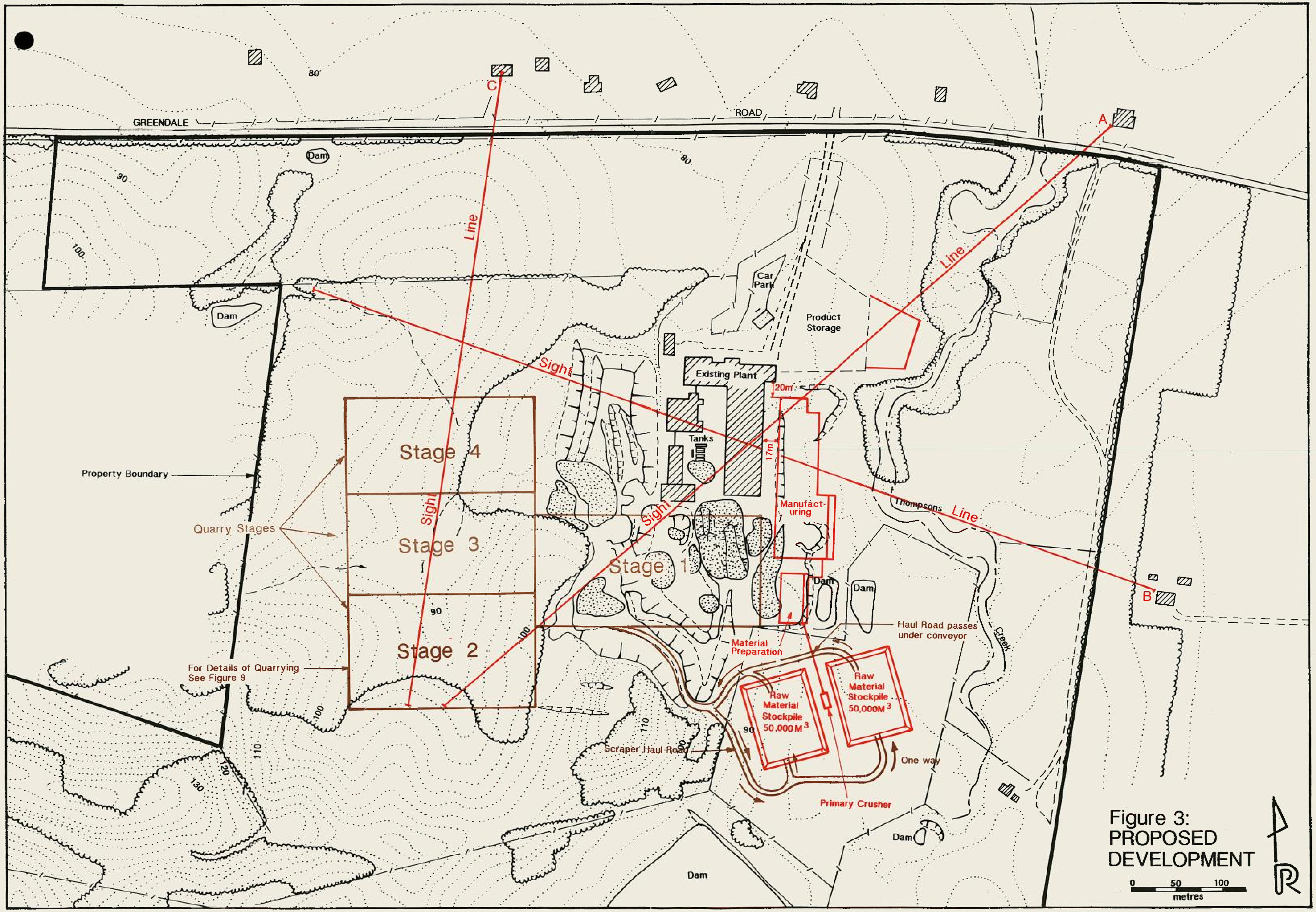


Figure 3: PROPOSED DEVELOPMENT

South Creek

Floodplains, valley flats and terraces and drainage depression of the channels of the Cumberland Plain. Usually flat with incised channels.

Soil types include structured plastic clays (Uf 6.12), structured loams (Um 6.1), red and yellow podsolics (Dr 5.11, Dy 2.41, Dr 2.21).

Blacktown

Gently undulating rises on Wianamatta Group shales.

Local relief up to 30m, slopes usually <5%, broad rounded crests and ridges.

Soils are shallow to moderately deep, hardsetting, mottled texture contrast, red and brown podsolic Dr 3.21, Dr 3.31, Db 2.11, Db 2.22 on crests, grading to yellow podsolic Dr 2.11, Dy 3.11 on lower slopes.

Luddenham

Undulating to rolling low hills on Wianamatta group shales, often associated with Minchinbury Sandstone.

Local relief 50–80m, slopes 5–20%. Narrow ridges, hillcrests and valleys.

Soils are shallow dark podsolics, Dd 3.5, massive earthy clays Uf 6.7, red podsolics Dr 2.11, Dr 2.41, Dr 3.11, and yellow podsolics Dy 4.22, Prairie soils Gn 3.26 on hillslopes.

The existing quarry and plant are located within the Blacktown Soil landscape. The remainder of the property to the east is part of the South Creek soil landscape. A large area of Luddenham Soil landscape extends to the southwest of the study area.

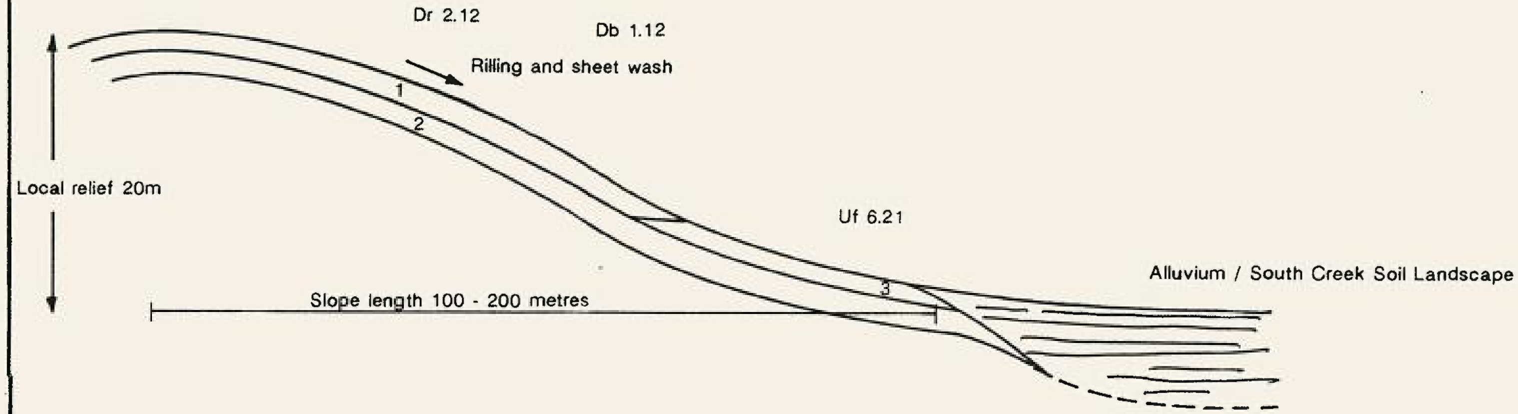
Full soil profile descriptions have been undertaken at four locations to the west of the existing quarry pit and plant.

Profiles 1 to 4 sample soils developed in ridge crest, upper slope, lower slope and tributary drainage lines on the Wianamatta Shale. A schematic toposequence is presented in **Figure 4**. Two Great Soil groups are represented: Non calcic brown Dr 2.12, Db 1.12 on upper slopes, and structured plastic clay (Euchrozem) Uf 6.21 on the lower footslopes. Full soil profile descriptions for these soil types are presented in **Appendix 2**.

The soils on the middle and upper slopes are characteristically texture contrast profiles with fine sandy clay loam topsoil overlying red brown medium to heavy clay subsoils. The profiles are pedal throughout, with rough faced polyhedral peds of moderate consistence in the topsoil, and smooth faced, dense, subangular blocky peds of strong consistence in the subsoil. Cracks 2–5mm wide are common in the dry subsoil.

Soils on the lower slopes have light to medium clay textures throughout the profile. There is a diffuse buff mottle in the subsoil. Cracks to 10mm wide are

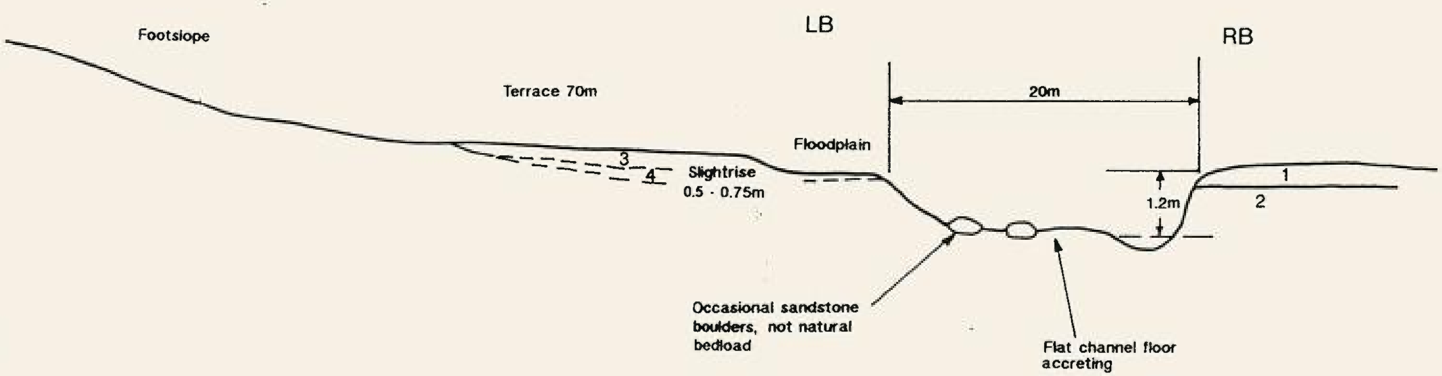
West of Brickworks



Soil Forming Materials

1. Topsoil brown fine sandy clay loam, weakly pedal, rough faced peds
2. Subsoil reddish brown medium - heavy clay, strongly pedal, smooth faced peds
3. Topsoil brown light clay, moderate pedality, rough faced

East of Brickworks to Thompsons Creek



Soil Forming Materials

1. As with footslope topsoil
2. As for footslope subsoil
3. Weakly pedal fine sandy loam, brittle
4. Bleached, weakly pedal light sandy clay loam, brittle

Figure 4:
SCHEMATIC SOIL TOPOSEQUENCE

present in the subsoil. Profiles are pedal throughout: rough faced polyhedral in the topsoil and smooth faced subangular blocky in the subsoil.

The area east of the plant comprises floodplain and terrace alluvium associated with Thompsons Creek. A schematic cross section of this area is shown in **Figure 4**. Much of this area has been cultivated for improved pasture. A profile exposed in the eastern (RB) bank of the creek comprises weakly pedal buff fine sandy loam with fine stones, concretions, abruptly overlying red brown strongly pedal clay. This is equivalent to footslope soil profiles to the west of the plant and Thompsons Creek comprise dull grey brown weakly pedal fine sandy loam with weak diffuse mottling. The topsoil also displays weak, brittle consistence. pH is 6.0–6.5. The upper soil unit is 12cm thick, and overlies bleached light sandy clay loam which also displays weak structure and weak brittle consistence.

4.5 SOIL EROSION

4.5.1 Existing Erosion Status

The soils of the Blacktown and Luddenham Soil landscapes have moderately reactive, highly plastic subsoils, intermittent poor soil drainage due to heavy clay subsoils, and are highly susceptible to sheet and rill erosion on the steeper slopes.

There is evidence of four main types of soil erosion within the present study area.

* Sheet erosion – on upper and mid slopes, and within the existing quarry.

* Rill erosion – widespread on tracks through bushland, along the western drainage line, and on existing stockpiles between the quarry, plant and the drainage line.

* Gully erosion – there is minor gullying of small tributaries to the western drainage line, and some gully headwall retreat within the western drainage line upstream of the existing dam.

* Stream bank erosion – there is minor stream bank erosion along sections of the eastern drainage line.

Much of the landholding has been cleared for agricultural land uses for many years, including both drainage flats and upper slopes prior to acquisition by the Company.

Within the western drainage line, and its small tributaries, there is evidence of relatively recent accumulation of stratified subangular gravels (including clay ironstone) in a silt/clay matrix. These sediments are attributed to erosion of hillslopes within the catchment, with a substantial contribution from rilling of tracks, and clay/shale overburden stockpiles.

4.5.2 Erodibility and Erosion Hazard

Soils on hillslopes within the area generally have low infiltration capacities due to relatively shallow, hardsetting topsoil overlying highly plastic, medium to heavy clays. Poor subsoil drainage is common. Soils within the Luddenham Soil landscape are attributed higher erodibility than the Blacktown Soil landscape because of greater local relief, and steeper and longer slopes.

The soils within the area have moderate to high inherent erodibility. Erosion hazard is increased by land management practices which increase the area of exposed soil and which increase runoff rates.

High erosion hazard is associated with exposed faces of the quarry, with stockpiles of quarried material, and with all unsealed tracks, particularly those in mid slope positions where relatively high runoff velocities are experienced.

There is a relatively low erosion hazard associated with soils on floodplain and terrace deposits east of the plant and quarry. Within this eastern drainage line there is evidence of considerable recent channel floor accretion.

4.6 HYDROLOGY

4.6.1 Surface Drainage

The existing site is drained by Thompsons Creek and a tributary of Bardwell Gully shown on **Figure 2**. Bardwell Gully flows into Thompsons Creek some 2km downstream of the site. Thompsons Creek is a major tributary of South Creek which flows into Eastern Creek which enters the Hawkesbury River downstream of Windsor.

The drainage system described drains rural, rural-residential and urban areas situated on the western outskirts of the Sydney metropolitan area. Much of this area has been cleared and used for agricultural purposes for in excess of 150 years.

The site is situated in the headwaters of the Thompsons Creek catchment and both the tributaries that drain the site flow intermittently. Thompsons Creek has a catchment area of approximately 1.58km^2 at the downstream boundary of the site which is delineated by Greendale Road. At this point Thompsons Creek is serviced by three 600mm by 1800mm concrete box culverts.

A large dam of approximately 5ML capacity has been constructed across Thompsons Creek, 1250m upstream of Greendale Road. The dam has a catchment area of approximately 1.26km^2.

At the downstream boundary of the site the Bardwell Gully tributary has a catchment area of 0.39km^2.

4.6.2 Existing Runoff Controls

Runoff from the site at present is to a large extent poorly controlled. Much of the site runoff is collected in the quarry from where it is pumped into a long retention drain located on the western side of the plant and then allowed to trickle feed into a marsh area that forms part of the Bardwell Gully tributary. Stormwater runoff from the plant either finds its way into the retention drain described above or flows unchecked into Thompsons Creek.

There are two small sedimentation dams located on the eastern side of the plant. These dams collect runoff from the material stockpile areas located on the eastern portion of the plant site (see **Figure 2**).

4.6.3 Flooding

The plant site is located at a height of approximately 85m AHD and is well above the effects of regional flooding. The Thompson Creek culvert on Greendale Road has a full flow capacity of approximately 13.3m^3/s which could be exceeded during high intensity, long duration storms and result in local flooding. Greendale Road at its lowest point near the site has a height of 76.4m AHD and for flood levels above this height would act as a broad–crested weir augmenting the capacity of the culvert. Without the 5ML dam on Thompsons Creek, a peak discharge of approximately 15.5m^3/s could be expected from a 1% Annual Exceedance Probability storm event. The additional 2.2m^3/s above culvert capacity represents a flow depth of less than 100mm over Greendale Road. From these considerations, the maximum flood height for a 1% Annual Exceedance Probability flood event of less than 77m AHD can be inferred for the site. The 5ML dam would serve to drastically attenuate the peak discharge and thus make the 77m AHD estimate an upper limit flood level. Details of calculations are provided in **Appendix 6.**

4.6.4 Groundwater

The quarry is currently about 7m deep and only contains water after receiving runoff from the site. This reflects the generally low permeability of the strata.

During the geological drilling programme no groundwater reserves were encountered and although the underlying strata could be expected to contain some groundwater it is anticipated that it would be of a negligible amount.

Water samples taken from the quarry show that the geological strata of the area contain significant amounts of salts (see **Section 4.7**) and as a consequence it is expected that any groundwater accessions to the quarry would be highly saline.

4.7 WATER QUALITY

Surface water samples have been collected from eight locations around the plant and quarry. **Figure 5** shows the location of monitoring sites and **Table 4.1** presents results.

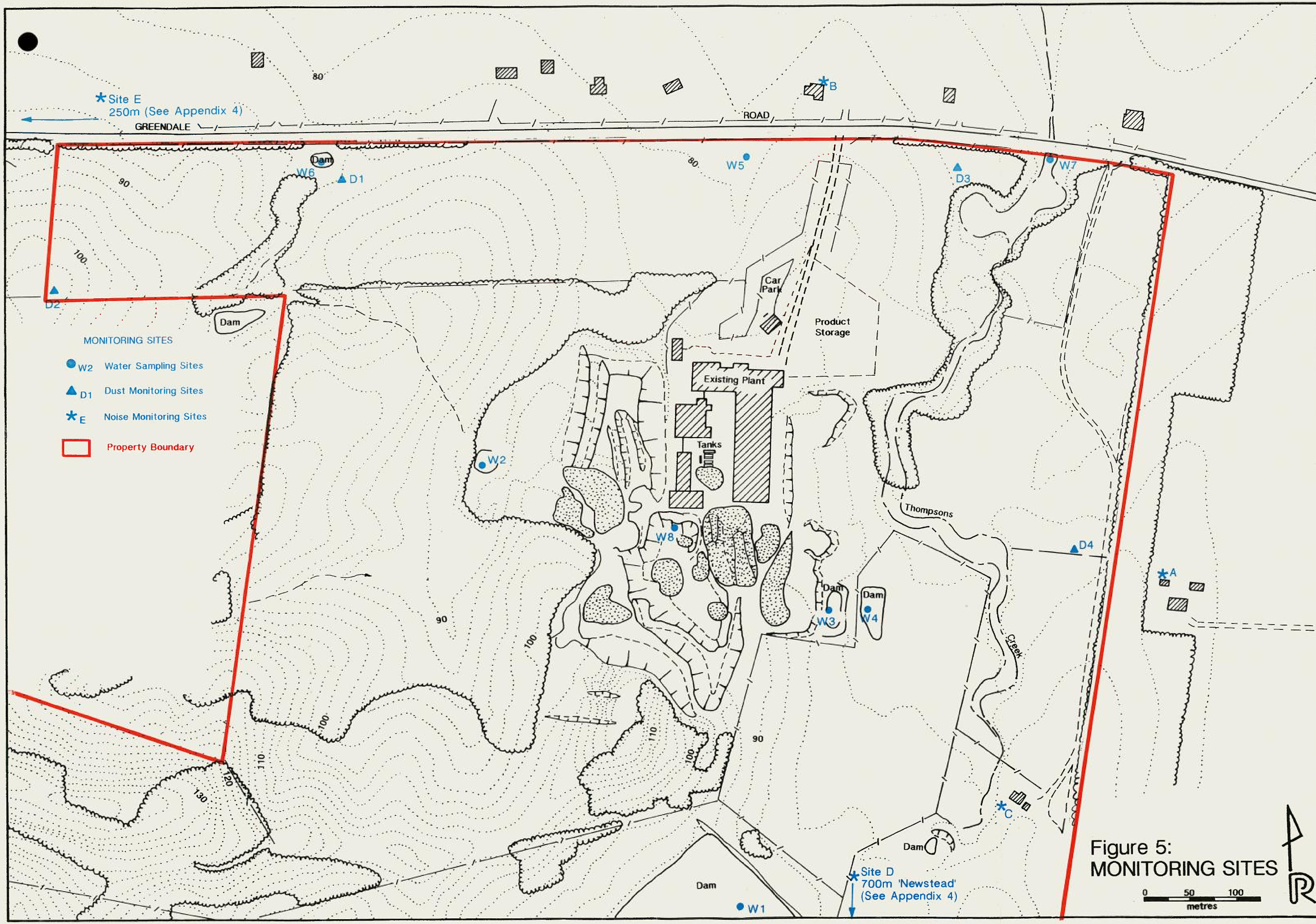


Figure 5:
MONITORING SITES

TABLE 4.1
WATER QUALITY

Location	Date	Parameters pH	Conductivity (µs/cm)	TSS (mg/L)	TDS (mg/L)	Oil (mg/L)
W1	10/8/90	7.05	150	22.5	142	ND
	18/9/90	7.03	150	109.5	113	1.0
	26/10/90	7.16	144	20	88	ND
W2	10/8/90	6.60	120	73.5	179	ND
	18/9/90	6.64	130	282	89	NA
	26/10/90	6.81	1528	30	88	ND
W3	10/8/90	7.15	220	7.0	171	ND
	18/9/90	7.12	160	16.5	131	ND
	26/10/90	7.18	620	4	299	ND
W4	10/8/90	7.19	1080	22	644	ND
	18/9/90	7.24	1020	11	507	ND
	26/10/90	7.42	1555	3	801	ND
W5	10/8/90	7.59	490	23	406	ND
	18/9/90	7.53	1410	63	768	ND
	26/10/90	7.83	2320	2	1329	ND
W6	10/8/90	6.74	140	31	132	ND
	18/9/90	6.74	160	49	129	2.0
	26/10/90	6.97	157	8	69	ND
W7	10/8/90	7.62	1390	9.5	859	ND
	18/9/90	7.15	1750	21	949	ND
	26/10/90	7.66	3820	5	2121	1.0
W8	10/8/90	8.27	5620	4.5	3282	ND
	26/10/90	8.26	15090	5	9330	ND

NOTE: **TSS: Total Suspended Solids (mg/L)**
TDS: Total Dissolved Solids (mg/L)
ND: Not Detected
NA Not Available

Source: **Metford Laboratories Pty Limited**

The table shows that pH levels are in the neutral range of 6 to 8, with most sites tending to slightly alkaline. Conductivity levels are generally moderate and consistent except for sharp rises in W2 and W5 on 26/10/90. W2 and W5 receive runoff waters from exposed strata and from water pumped from the quarry. W4 also shows rising conductivity levels and it receives runoff water from the plant site. Very high conductivity levels have been recorded for water ponded on the quarry floor (W8) particularly after prolonged dry periods. High conductivities presented in **Table 4.1** correspond to low readings for Total

Suspended Solids indicating that the water at sampling sites has not received sediment laden runoff for some time. During this time salt levels would also undergo concentration through evaporation. Total dissolved solid levels parallel conductivity levels indicating that salts released from exposed units within the quarry and from stockpiled material are the likely cause of high conductivity and salt levels.

Suspended solid levels are variable and probably relate to disturbing activities in the catchment. Notably sharp increases were recorded in the dams W1 and W2 on 18th September, 1990.

In summary, the monitoring has shown that control of discharges from the quarry floor, exposed units, and stockpiled material, will be necessary to prevent increases in salt levels downstream of the site.

4.8 METEOROLOGY

The following discussion is a generalised description of climate parameters derived from the official meteorological station at Camden Airport. Detailed meteorological data for dispersion modelling of particulates and plant emissions has been obtained from Mascot, Badgerys Creek, and West Hoxton and details are presented in **Appendix 3**. Data from these stations is more detailed and contains measurements of specific parameters for dispersion modelling (see **Appendix 3**).

4.8.1 Temperature and Humidity

The annual mean maximum and minimum temperatures recorded at the official meteorological station at Camden Airport are 23.4°C and 10.0°C, respectively. Highest temperatures occur in December (daily mean 29.4°C) and lowest in July (daily mean 3.1°C).

Mean relative 9:00am and 3:00pm humidity for the year is 71% and 52%, respectively.

4.8.2 Rainfall

Rainfall for the area is given in **Table 4.2**.

TABLE 4.2
RAINFALL
(mm)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Rainfall Mean (mm)	162	128	61	68	33	31	26	34	21	115	79	29	787
Raindays Mean (no)	14	16	11	8	8	10	6	10	7	18	12	9	129

Source: Bureau of Meteorology

The average annual rainfall is 787mm which falls on an average of 129 days each year. Highest falls occur in January (mean 162mm) with a secondary peak in October (mean 115mm). Lowest falls occur in September (mean 21mm).

4.8.3 Wind Speed and Direction

Wind speed and direction for each month of the year are shown by the wind roses on **Figure 6**. Strongest and most frequent winds occur in the afternoon and consequently the 3:00pm readings for Camden Airport are illustrated.

At the beginning of summer (December), winds with speeds up to 50km per hour blow from the west for about one–fifth of the month. At other times during December, winds blow from the east, northeast, and southeast but rarely attain speeds greater than 30km/hour. In late summer, (February) more than 40% of winds blow from the east with speeds up to 30km/hour.

Autumn is a transitional period, when winds swing from the northeast and east, to the west and southwest.

In winter, southwesterly and westerly winds predominate and reach speeds up to 50km/hour. Secondary winds blow from the northwest but rarely exceed 30km/hour.

In spring, there is a transition from southwesterly to southeasterly winds.

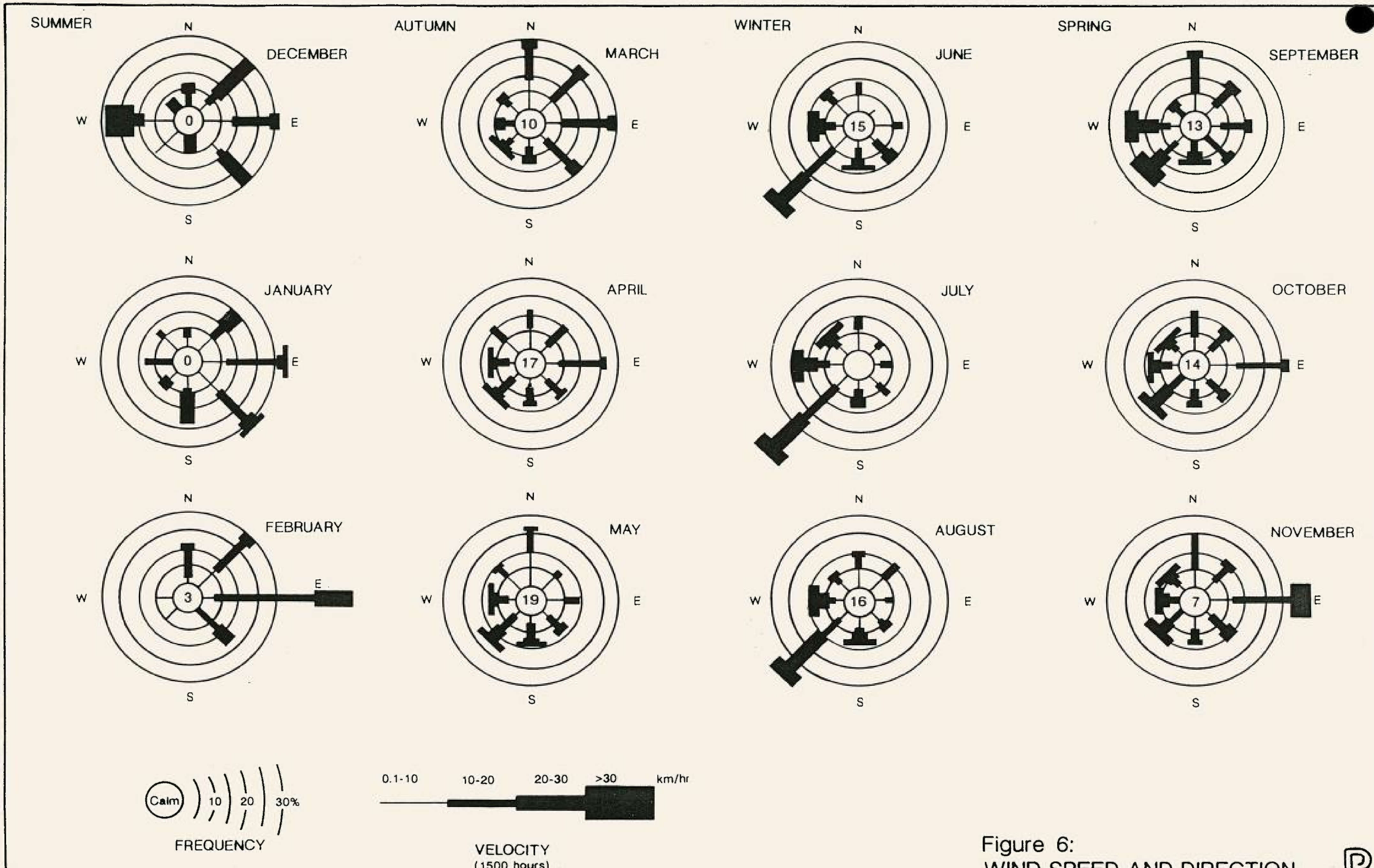
4.8.4 Inversions and Fogs

Due to cold air movement in the Cumberland Basin during night and early morning periods, an inversion layer occurs and is identified by the brown photochemical smog. This layer is most common during the mid–autumn–winter early spring seasons.

The duration of the inversion layer is directly proportional to the prevailing winds and specifically, to the heat penetration into the inversion layer in the early morning which tends to diminish the photochemical smog from about 10:00am and through late morning to midday depending upon cloud cover and prevailing winds. Inversions are generally dissipated by noon in this area.

4.9 AIR QUALITY

Four dust monitoring stations were installed around the site in mid August 1990 at the locations shown on **Figure 5**. Samples have been collected monthly and results are shown in **Table 4.3**.



Source: Bureau of Meteorology - Camden Airport

Figure 6:
WIND SPEED AND DIRECTION

TABLE 4.3
AIR QUALITY
(g/m^2/month)

Station	Aug-Sep 1990	Sep-Oct 1990	Oct-Nov 1990	Nov-Dec 1990	Jan-Feb 1990
D1					
Insoluble Solids	0.40	0.12	0.39	0.84	0.65
Ash	0.29	0.04	0.24	0.53	0.45
Organic Matter	0.12	0.08	0.17	0.31	0.20
D2					
Insoluble Solids	0.40	0.34	0.36	*N/A	0.99
Ash	0.28	0.11	0.15	N/A	0.60
Organic Matter	0.13	0.23	0.21	N/A	0.39
D3					
Insoluble Solids	0.70	0.63	0.55	*N/A	1.63
Ash	0.55	0.44	0.33	N/A	0.97
Organic Matter	0.16	0.18	0.22	N/A	0.66
D4					
Insoluble Solids	0.92	0.45	0.70	1.43	0.95
Ash	0.76	0.29	0.45	0.93	0.63
Organic Matter	0.16	0.17	0.25	0.50	0.32

* **Equipment Vandalised**

Source: **Metford Laboratories Pty Limited**

Results show that dust levels (Insoluble Solids) range from 0.12 to 1.63 g/m^2/month which are lower than typical dust deposition rates in rural areas of 1.17 to 1.95 g/m^2/month (Senate Select Committee on Air Pollution, 1969). These results have been used in air quality modelling; details of which are presented in **Appendix 3**.

4.10 VEGETATION AND FAUNA

Forster et al (1977) report that medium woodlands dominated by **Eucalyptus moluccana/Eucalyptus tereticornis** occupy a large part of the Cumberland Basin. The association occurs on low to undulating hills on a variety of clay soils. The woodland may also include various Ironbarks (**Eucalyptus spp.**),

Eucalyptus maculata, **Angophora floribunda**, **Casuarina sp.** and **Exocarpus sp**. The dominant species in the shrub stratum is **Bursaria spinosa**, occasionally in dense clumps, associated with **Acacia decurrens** and **Acacia parramattensis**. In poorly drained areas **Melaleuca decora**, **Melaleuca linarifolia** and **Melaleuca styphelioides** occur.

Extensive clearing of this woodland association throughout the distribution has led to severe restriction of the species diversity of the shrub layer. Of sixteen species recorded as common understorey elements in 1947, only four or five are now common, and **Bursaria sp.** is clearly dominant.

A general field assessment of the plant communities present in the study area has been carried out. Much of the land has been cleared at some time in the past, and has subsequently been infested with the weed species **Olea africana** (Olive) and **Ligustrum sinense** (Privet). A stand of Eucalypt woodland remains along the drainage line and low ridge to the west of the existing plant and quarry. This area has been partially cleared.

The most common tree species in the closed woodland are **Eucalyptus mollucana** (Grey Box), **Eucalyptus acmenioides** and **Eucalyptus tereticornis** (Forest Red Gum). The understorey is dominated by **Bursaria spinosa** and **Olea africana** both of which are opportunistic species and are indicative of understorey disturbance. **Acacia maidenii** is also common.

Only a small area of Eucalypt woodland remains on the site which is surrounded by cleared grazing land and exhibits considerable weed infestation. This vegetation provides limited habitat for native fauna. The general land use context of the area; agricultural and horticultural land, rural residential and low density urban/village; indicates that feral dogs and cats would be common on the site. The presence of these animals would also be detrimental to native fauna.

4.11 BUSHFIRE HAZARD

The assessment of bushfire hazard on the proposed development site is based on the Department of Environment and Planning Circular No. 74 (1984). The Bringelly site lies within the Macarthur Fire Zone within the Eastern Fire zone, where forest fires predominate. The natural vegetation of the area comprises dry sclerophyll woodland/forest. The woodland has been cleared from much of the area which is currently grassed agricultural land, or former agricultural land now infested with dense stands of the weeds Olea and Privet. The land is generally undulating with gently sloping areas adjacent to creeks.

On this basis, the bushfire hazard of the study area is scored at medium to high.

Although the grassed pasture is assessed at moderate fire hazard, it does not pose a threat to the operation of the quarry or plant because the grassland is readily managed to reduce fuel loads (e.g., by mowing).

4.12 BACKGROUND NOISE ENVIRONMENT

A detailed noise impact investigation of the proposed development has been undertaken by Boral Research and results presented in **Appendix 4**. Details of the background noise environment is presented in the appendix and the following is a summary of the information.

Background noise levels were recorded at nearest residences or sites surrounding the site as shown on **Figure 5**. Residences C and D are Company owned residences within the property holding. Instrumentation used, procedures followed and levels recorded are presented in **Appendix 4**.

Levels recorded on 29th September, 1990 are presented in **Table 4.4**.

TABLE 4.4
BACKGROUND NOISE LEVELS

Residence	L_{90} (dBA)	Average (dBA)
A	40 to 48	43.5
B	39 to 42	40.4
C	43	43
D	33	33
E	39	39

At residences between the plant and the Northern Road (Residences A, B, and C) principal noise sources were traffic on the Northern Road and Greendale Road, the operating brick plant, aircraft, birds and wind. At residences more distant from the site (D and monitoring site E), principal noise sources were distant traffic, aircraft, and birds.

4.13 VISUAL ASPECTS

The visual catchment of the existing plant is defined by a series of ridges extending northeast from Birling Trig. The relief of these ridges declines to the east. The plant is situated at an elevation of approximately 85m, on the lower sideslopes of a spur forming the upper catchment of Thompsons Creek. In general, the plant is visible from points to the east and northeast, although some screening is provided by vegetation along Thompsons Creek.

The visual impact of the existing quarry and plant is summarised below:

(a) The plant is partially visible from the entrance in Greendale Road. This partially screened view is also obtained by residents immediately opposite the entrance. Existing screen planting along the entrance road, and along Thompsons Creek restrict visibility of the plant to glimpses from points further east along Greendale Road.

(b) The existing plant and quarry are clearly visible from the access road to "Newstead" which follows an elevated ridge to the southeast of the plant. Boral are the owners of this property, which is currently leased for horse agistment. There is no public access along the access road.

(c) The plant and quarry are not visible from the Bringelly Community Centre, or from Bringelly Public School because of existing vegetation.

(d) The plant and quarry are visible from The Northern Road, just south of Bringelly shopping centre. At this point, the plant is 750m away, and is partially screened by remnant stands of Eucalypts.

(e) The plant is clearly visible from residences at the western end of Loftus Road (see **Photo 1**). These residences are 400m from the existing plant, which is partially screened by remnant Eucalypt vegetation.

(f) Glimpses of the plant and quarry are also obtained from residences in elevated positions to the north of Greendale Road.

4.14 ABORIGINAL PREHISTORY

A regional review of the distribution of Aboriginal sites across the Cumberland Plain has been undertaken by L.J. Smith (1988).

Approximately 1000 Aboriginal archaeological sites are known in the Macarthur region. Many of these are concentrated in the sandstone plateau area, but large numbers of sites, including dense artefact scatters have also been recorded within the undulating terrain of the Cumberland Plain.

The National Parks and Wildlife Service has indicated that an archaeological survey of the present site is required, because it lies within the shale areas of the western Cumberland Plain which are regarded as having considerable archaeological potential although few sites have yet been recorded.

An archaeological survey of the area to be affected by the proposed development has been carried out by Pam Dean-Jones, archaeologist. The area lies at the boundary of the Daruk and Tharawal Local Aboriginal Land Councils. Discussions were held on-site with representatives of Daruk Local Aboriginal Land Council, and Alan Anderson from Tharawal Local Aboriginal Land Council carried out a site inspection with the archaeologist.

Four isolated artefacts were identified during the field survey at the locations shown on **Figure 2**. These artefacts, 2 flakes, one flaked piece and one core were all located on tracks in the woodland to the west of the existing plant where there is considerable exposure of disturbed and eroded ground surface. Raw materials utilized were red silcrete and pink indurated siltstone.

Inspection along the left bank of Thompsons Creek provided no evidence of Aboriginal occupation. This area is regarded as having a relatively high archaeological potential, but high flood frequencies and cultivation are likely causes of site destruction.

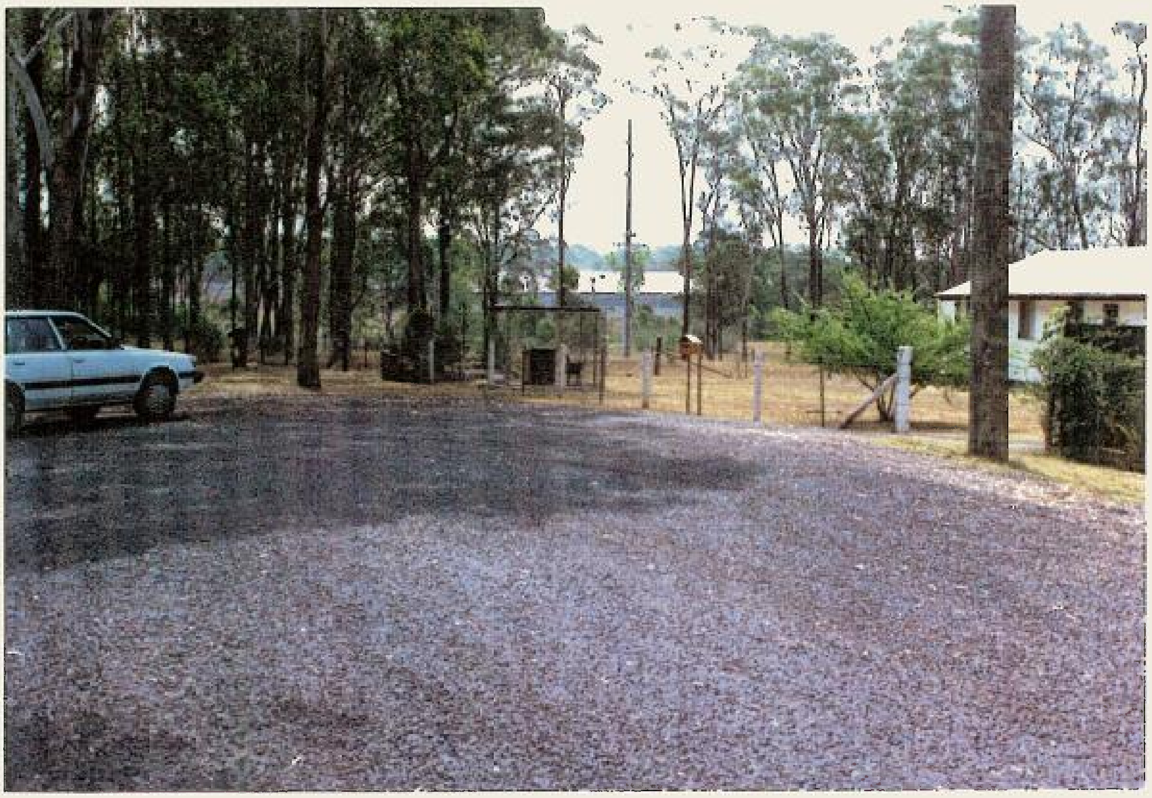


Photo 1: View of existing plant from the end of Loftus Road.

Photo 2: View of plant from the private track to 'Newstead'.

Ground surface visibility in this area is also restricted.

None of the archaeological material identified during this survey is considered to be of scientific or cultural significance, and given the land use history of the area, the small amount of material is considered to be a realistic indication of the preservation of archaeological evidence. No further archaeological investigations are required.

A detailed report on the archaeological survey is provided in **Appendix 5.**

4.15 ZONING AND PLANNING PROPOSALS

The plant and quarry lie within the planning jurisdiction of the Municipality of Camden. However, the Municipal boundary follows the centre line of Greendale Road, and the area to the north is within Liverpool Municipal Council. **Figure 7** shows zoning of the site and surrounds.

The Boral holding is zoned Rural 1(a) (40 hectare) under Interim Development Order No. 7. Camden Municipal Council has advised that the property is not currently affected by any local environmental plans or development control plans.

The properties immediately adjacent are also zoned Rural 1(a) (40 hectares) except for areas adjoining to the east which are zoned Rural 1(b) (2 hectares) under Interim Development Order 7, as amended by Camden Local Environmental Plan No. 21.

Land to the north of Greendale Road, within Liverpool Municipal Council, is zoned Rural 1(a) under Interim Development Order No. 74, except for the Community Hall, Public Recreation Reserve and Bringelly Public School.

Camden Municipal Council currently has a Draft Local Environmental Plan (No. 48) which when gazetted, will replace Interim Development Order 7. Under the Draft Local Environmental Plan No. 48, the area remains Rural A (40 hectares).

The objectives of Rural A zoning are to prevent the fragmentation of productive rural holdings, and to maintain the rural landscape which characterizes much of Camden Municipality. Extractive industries are a permitted use only with development consent, the concurrence of the Department of Planning, and provided they are carried out in an environmentally sensitive manner.

Both the plant and the quarry fall within the definition of "designated development" under Schedule 3 of the Environmental Planning and Assessment Regulation (1980). The plant is also covered under Schedule 1 of SEPP 11, (traffic generating development) and a traffic impact statement is required. This is included in **Sections 4.18, 5.4, 6.7, 7.10, and 8.15.**

Because of the potential for major land use conflicts in the rapidly developing western Cumberland Plain and Hawkesbury/Nepean region, the Department of Planning has prepared a Draft Regional Environmental Plan for extractive industries (REP 9, 1986). This Regional Plan has the following main objectives.

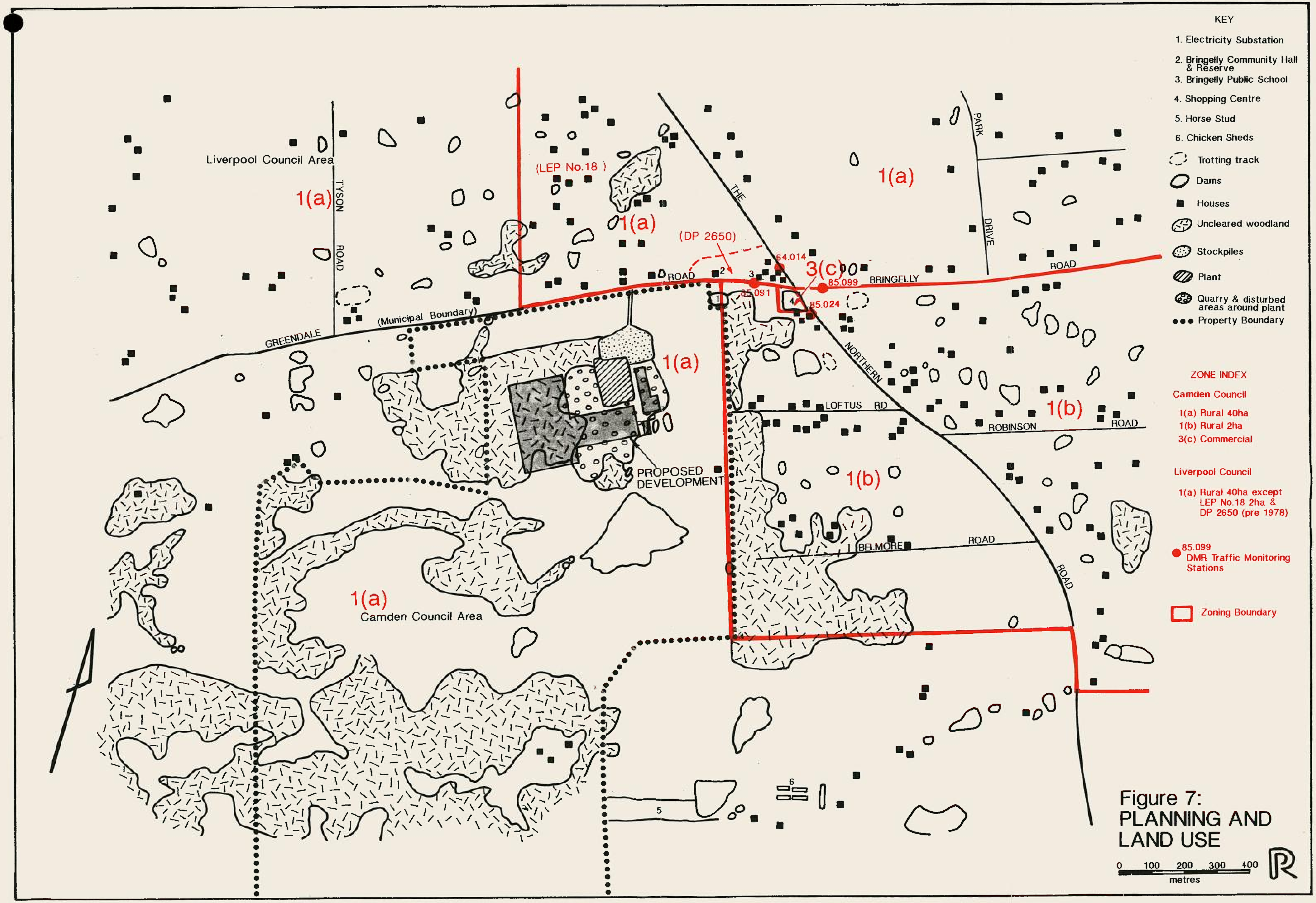


Figure 7:
PLANNING AND LAND USE

1. Cost effective supply of extractive resources to the Sydney metropolitan area by:

   (a) Identifying land containing extractive material of regional significance and ensuring that any interim development is not incompatible with future extraction.

   (b) Ensuring that encroachment by urban development does not prevent the full potential of existing extractive industries being utilized.

2. Permit development of extractive industries on certain lands and prohibit development of extractive industries in other areas.

3. Ensure that extractive industries are carried out in an environmentally acceptable manner.

The existing Greendale Road clay/shale deposit is listed as an extraction area of regional significance. (Schedule 1). Regional Environmental Plan 9 gives priority for continuation of extraction from sites listed in Schedule 1. The land immediately north of Greendale Road in Liverpool Municipality is listed under Schedule 2 of Regional Environmental Plan 9. The Department of Minerals and Energy has advised that under Clause 11 of Regional Environmental Plan 9, it is necessary to ensure that extensions to the plant do not result in unnecessary sterilisation of the clay/shale resource. This issue is addressed in **Section 9.2** of the impact statement.

The MaCarthur Regional Environmental Study expresses similar aims to Regional Environmental Plan 9 with respect to the management of extractive resources. In particular, the study aims to ensure that areas with extractive resource potential remain available for future evaluation and utilisation.

The implication of these planning instruments is that the clay/shale resource at Bringelly is a significant brickmaking resource, and that continued operation of the quarry and plant within environmental guidelines, is a preferred land use.

In 1988, the Department of Planning identified the South Creek Valley, within which the quarry and plant are located, as an area with potential for urban development. A city with accommodation for up to 200,000 people is proposed. Only preliminary planning information is currently available, and environmental studies to identify planning issues and specific constraints to urban development are in progress. An interim report is due for publication late in 1991.

It is currently proposed that the first stage of the South Creek project would commence in 1992. The Department of Planning has advised, in general terms only, that urban development is likely to encroach on the margins of the Boral site by 2000-2005.

4.16 LAND USE

4.16.1 Rural–Residential Land Use

The distribution of land uses adjacent to the existing quarry and plant is shown on **Figure 7**.

The site of the existing plant and quarry, and much of the adjoining agricultural land, was used for sheep grazing prior to 1968 and extensively cleared. The alluvial flats adjacent to Thompsons Creek have been cultivated for the production of fodder.

The Boral property contains the existing quarry, plant, raw material and product stockpiles. The remainder of the property is either unused degraded bushland (mostly hillslopes), or is extensively cleared and used for cattle grazing and horse breeding and agistment, (lower slopes and drainage flats). These land uses continue to the west of the Boral property.

To the east of the Boral property and north of Greendale Road, rural–residential properties, and rural land uses including horses, dog kennels, and small scale horticulture predominate. There are numerous small dams in this area, providing stock and irrigation water. Other land uses in the general area include horse breeding (e.g., at 5 on **Figure 7**), chicken sheds (at 6 on **Figure 7**) and cut flowers/vegetables.

The nearest residences to the existing quarry and plant are shown on **Figure 5**. These include a group of houses north of Greendale Road, opposite the entrance to the existing quarry and plant at a distance of 370m to 430m. A second group of residences, east of the property boundary in Loftus Road are 500m to 760m from the existing plant.

4.16.2 Commercial Land Use

The commercial centre of Bringelly is a small group of shops serving the local community situated at the intersection of Greendale Road and The Northern Road, 700m from the existing plant. The centre includes a supermarket, bottle shop, chemist, take–away food, post office, and petrol station, and is accessed from The Northern Road (entry) and Greendale Road (exit). There are also a few small roadside stalls along The Northern Road selling local produce.

4.16.3 Special Uses

There are several specific land uses located a short distance from the existing quarry and plant. These are:

* Bringelly Community Centre in Greendale Road (Shown as 2 in **Figure 7**), 305m east of the entrance to the plant.

* An electricity substation, in Greendale Road (1 in **Figure 7**), located 317m east of the entrance to the existing operation which was formerly part of the Boral site.

* Bringelly Public School, at the intersection of Greendale Road and The Northern Road (3 in **Figure 7**), 512m east of the plant entrance.

4.17 PUBLIC UTILITIES

The site is serviced by power, telephone, and natural gas. Water for plant processes is obtained from on-site dams while water for employee facilities is purchased and brought in by tankers. Waste water from site facilities is disposed of via a transpiration bed sewage system.

4.18 ROADS AND TRAFFIC

Access to the site is from Greendale Road, a two-lane sealed thoroughfare with gravel shoulders which connects Wallacia with Bringelly. Greendale Road connects with The Northern Road (MR 154) which is the main arterial road between Penrith in the north and Camden in the south.

Traffic levels have been recorded by the Roads and Traffic Authority (formerly Department of Main Roads) on Greendale Road, at the location shown on **Figure 7** on Greendale, The Northern and Bringelly Roads. Recorded AADT (Annual Average Daily Traffic) figures for these roads are given in **Table 4.5**.

TABLE 4.5
ANNUAL AVERAGE DAILY TRAFFIC

Road	Station	1979	1981	1983	1985	1987	1990 (Predicted)
Greendale	85.091	1140	1150	1020	1125	1324	1396
The Northern (North of Bringelly)	64.014	–	–	–	–	9147	9621
(South of Bringelly)	85.024	–	–	–	–	6697	7044
Bringelly Road	85.099	–	–	–	–	2915	3066

Source: Department of Main Roads (1987)

The table shows that traffic levels on Greendale Road have been increasing at 1.7% per annum. The estimated 1990 AADT for Greendale Road is 1396 based on past growth figures. Given the likely variable traffic flows on Greendale Road over a year, a short term traffic survey was not seen as providing sufficient representative data on existing traffic activities.

4.19 SOCIO ECONOMIC ENVIRONMENT

The Camden district has been settled by Europeans since the early 19th Century. Camden Municipality, which extends north to Leppington and Bringelly has been a Local Government administration area since 1889. The area is historically rural, and Council has attempted to maintain a heritage and rural atmosphere in the development of the Municipality.

The population for Camden Municipality at the 1983 Census was 18,870, and its current population is approximately 23,000. The population of the Municipality is likely to rise to 60,000 by the turn of the Century, and as much as 240,000 by 2010. This massive population growth will derive from planned urbanisation of the South Creek catchment. This rapid population growth will place considerable strain on the community infrastructure of the Municipality.

The planned growth of the district will also lead to major shifts in population age, structure, employment patterns, and may introduce land use conflicts because of existing industrial uses which are not necessarily compatible with urban development. At the 1986 Census, 18.9% of the population was aged 10–19. This is a relatively high proportion of the population and indicates a considerable pool of local labour. The workforce structure indicates a concentration in trades (16.5%), clerical positions (16.7%), and labourers (12.9%). The plant currently employs 33 people, or 0.04% of the workforce of the Municipality.

However, given predictions of a 3 fold increase in total population, mostly by immigration over the next 10 years, existing labour market indicators are irrelevant.

The proposed plant redevelopment and quarry extensions will provide a modest increase in employment opportunities. Of greater importance to an area where massive population growth is planned, is the ability to produce high volumes of reasonably priced construction materials for use in the expanding housing market.

DESCRIPTION OF THE EXISTING DEVELOPMENT

5.0 DESCRIPTION OF THE EXISTING DEVELOPMENT

The existing quarrying and manufacturing operations are part of the "existing environment" of the site and are the currently approved land uses. This section provides a general overview of these existing operations to put into context the proposed developments described in **Section 6.0** for which development consent is sought.

Figure 2 shows the general layout of the existing plant which comprises a series of steel clad interconnected buildings, an underutilised brick office building, car park, raw material stockpiles and the existing quarry. The existing plant has a total floor area of 25,445m^2.

5.1 EXISTING QUARRYING OPERATIONS

5.1.1 Quarrying Methods

Raw materials currently used at the plant are obtained from the existing quarry on-site and from other clay/shale quarries in the region. The existing quarry immediately adjoins the southern side of the plant and covers an area of approximately 4.5 hectares to a maximum depth below ground of 7m. (i.e., to an RL of 77m AHD).

Extraction is conducted on a "campaign" basis, i.e., approximately 3 to 4 times a year for periods of approximately 3 weeks using contractors.

Excavation and stockpiling is carried out using a single 15 tonne self elevating scraper and dozer. This equipment is the optimum for the selective removal and stockpiling of the various types of clays and shales which occur throughout the quarry. The scraper strips the clays and shales from benches within the quarry and lays them in horizontal bands in a longitudinal stockpile. This technique produces the desired clay/shale blends for the manufacture of pavers and bricks. The dozer assists by ripping hard horizons and for shaping raw material stockpiles as required.

In addition to clays and shales extracted from the Bringelly quarry, material from the Erskine Park quarry at Erskine Park, and the Boral quarry at Prospect are imported and used in blends at the plant. The location of these sites is shown on **Figure 8**. These materials are also temporarily stockpiled on-site at the locations shown on **Figure 2** and used to improve the range and/or workability of the Bringelly material.

5.1.2 Production

On-site quarrying operations produce in the order of 60,000 tpa of raw material. Each campaign would result in approximately 15,000 tonnes being removed over a period of approximately 3 weeks, i.e., an average of 5000 tonnes per week.

5.1.3 Material Handling and Stockpiling

Material won on-site and imported is stockpiled in open longitudinal stockpiles on the southern side of the plant. Some covered storage is provided at the

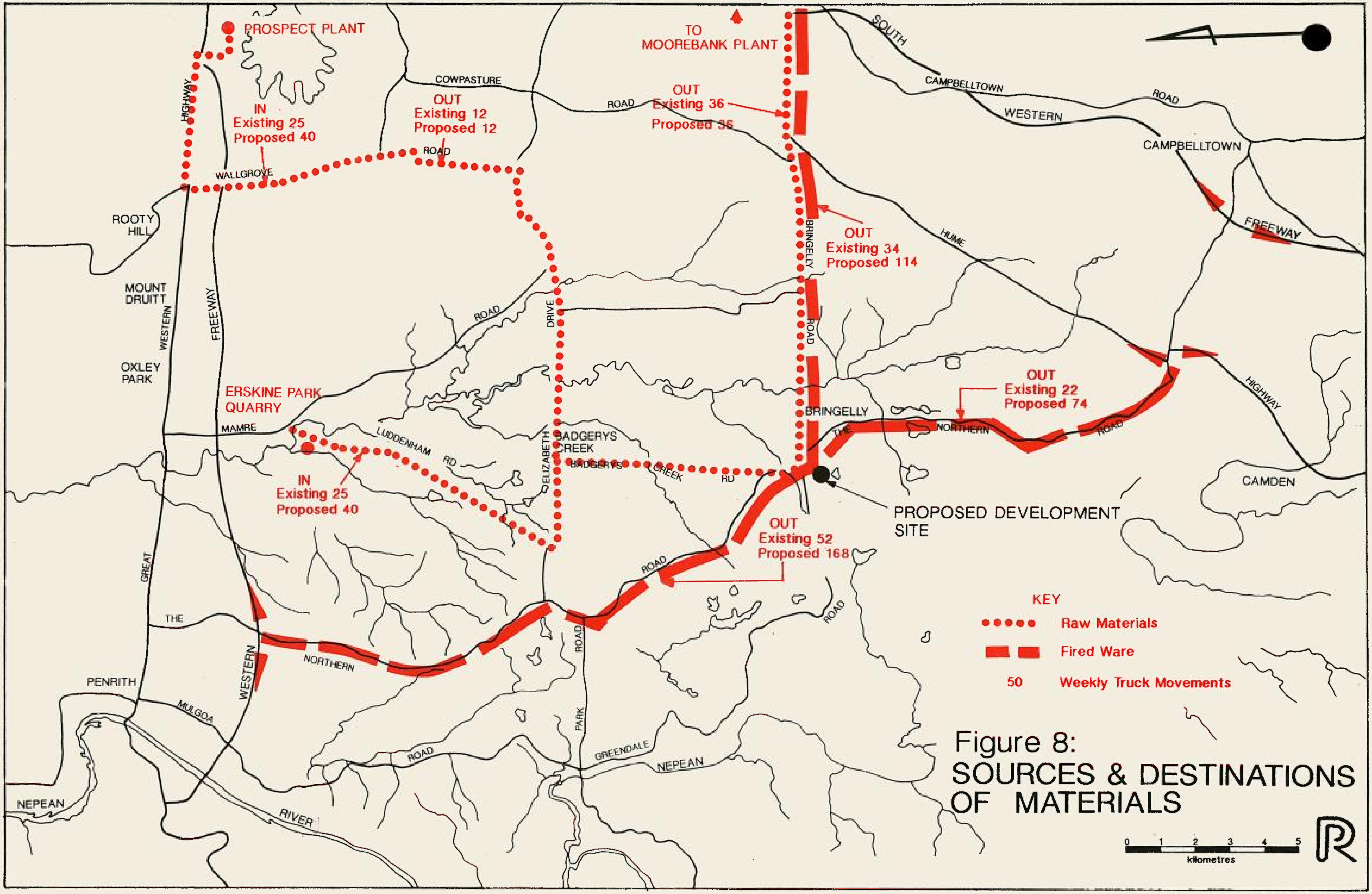


Figure 8:
SOURCES & DESTINATIONS OF MATERIALS

southwest corner of the existing complex to serve as an emergency should prolonged wet periods prevent access to open stockpiles by the loader. (see **Figure 2**).

Material from the stockpiles is transported to the primary apron feeder of the plant by a rubber–tyred front–end loader of approximately 3.5m^3 capacity.

5.2 PLANT PROCESSES

5.2.1 Preparation of "Green" Ware

Raw material from the stockpiles are reduced by primary and secondary crushing, and screened to produce a dry grind of approximately –2.5mm. This material is stockpiled under cover in partitioned bunkers; the various blends kept separate for future use.

The dry grind blends are reclaimed from the partitioned bunkers by a rubber–tyred front–end loader and deposited into a box feeder. The blend passes via a troughed, rubber belt conveyor to a pug mixer where water is added to raise the moisture of the mix from 10–11% to 17–18%. The clay/shale blend is thoroughly mixed and conveyed through the pug mixer by a series of knives angularly mounted on a rotating shaft.

The mix passes through a vacuum chamber (to reduce all air entrained within the clay mix) to the extruder which is also under negative pressure.

The extruder further increases the density of the mix by forcing the compressed clay through a restricted opening at the outfeed end of the extruder barrel. The shape of the opening is determined by the shape and size of the product to be manufactured.

The extruded column travels through a cutting machine which cuts the column into pieces of the required length which is determined by the thickness of the product being manufactured. The cut pieces, now brick or paver shape, are transported by a flat rubber belt conveyor to a position where the "green" product is hand set into waiting kilncars.

5.2.2 Drying Process

The hand set kilncars which are loaded with green ware are propelled to and stored at the entrance to the drying tunnels; a tunnel–like structure sealed at each end with automatically opening and closing doors.

The temperature and humidity within the sealed tunnels is carefully controlled. The purpose of this stage of manufacture is to reduce the moisture contained in the green ware. Travel through the dryers is at a controlled rate; when the kilncar at the exit end is ready for removal, the exit door opens and the kilncar is automatically pushed out of the dryer. Similarly, at the entrance door, a new kilncar loaded with green ware is automatically pushed into the dryer.

5.2.3 Firing Process

After the drying cycle is complete, the kilncars, now loaded with dried ware are passed into the tunnel kiln by the same operation of automatically opening and closing doors.

The kilncars are propelled through the kiln at a pre-determined rate with the entire cycle taking appropriately 57 hours. During this time the cars pass through various kiln zones, e.g., airlock, preheating, firing at approximately 1050°C, reduction, flashing, oxidising, rapid cool, cooling.

Heat from the cooling processes is reclaimed for use in the drying tunnels.

5.2.4 Product Handling and Storage

After the kilncars exit the kiln, the bricks and pavers are unloaded by hand, sorted, graded and packaged. The fired ware is stored on pallets on an asphalt pad near the entrance to the plant awaiting despatch. Forklifts are used to transport the pallets of fired ware from the kiln to the despatch area and to load trucks.

5.3 SOLID WASTE DISPOSAL

The processing operation produces five types of solid wastes. These are brick batts, green extruded waste, multi-wall paper sacks, lunchroom waste, broken pallet timber, and steel fabrication waste.

Brick batts and some extruded green waste is used on site as landfill or, where suitable, recrushed and mixed back into the raw material. Broken pallet timber is temporarily stockpiled and made available to the public as firewood. Multi-wall paper sacks and lunchroom waste are removed by waste contractors. Steel fabrication waste is sold to scrap metal merchants.

5.4 VEHICLE MOVEMENTS

5.4.1 Truck Traffic

Truck traffic includes raw materials and operating supplies entering the site, raw materials and fired ware leaving the plant. Trucks hauling raw materials and fired ware consist of Company owned 8 wheelers with a gross weight of 26 tonnes, 8 wheelers towing trailers with a gross weight of 41 tonnes, and contractor vehicles comprising tri-axle semi-trailers. Operating supply vehicles include table-tops, normal highway trucks, and other light commercial vehicles.

Light and commercial vehicles are utilised for the delivery of operating supplies to the site.

Most Company owned trucks are garaged away from the Bringelly site and come to the plant site for their second load of the day. Some trucks would be left on site from time to time depending on the jobs being worked but the number of trucks left on site overnight is seldom in excess of 3.

5.4.2 Imported Raw Materials

The claystones and siltstones currently being quarried on the Bringelly site have particular extrusion and fired characteristics. To increase the range of fired colours and clay products, claystones and siltstones are imported to the site from existing quarries in the Sydney region. Light-burning claystone and siltstone is imported from the Erskine Park quarry to increase the colour range of a specific product. Dark-firing claystone and siltstone is imported from the Company's Prospect quarry to enhance colour, processing, and drying/firing characteristics.

The total volume imported each year is approximately 31,000 tonnes resulting in an average of 50 truck movements per week equally divided between the Prospect and Erksine Park sites. **Figure 8** shows routes used by these trucks.

All loading and deliveries are made between the hours 6:00am to 6:00pm, Monday to Friday, and 6:00am to 12 noon Saturdays. No deliveries are made on Sundays.

5.4.3 Operating Supplies

Operating supplies include pallet deliveries, general parts and stores, and additives used in production (see **Section 6.3.4**). These deliveries are made in commercial vehicles between 6:00am and 6:00pm Monday to Friday and 6:00am to 12 noon Saturdays.

Delivery of supplies generates an average of 32 vehicle movements per week.

5.4.4 Exported Raw Materials

As with imported raw materials, the particular characteristics of the Bringelly claystones/siltstones are of importance in enhancing the clay products manufactured at the Company's Moorebank and Prospect operations. Consequently, claystones and siltstones from the Bringelly site are exported to Moorebank and Prospect. Trucks hauling the claystone and siltstones are the same as those described in **Section 5.4.1** and routes are shown in **Figure 8**. These deliveries are made during the same time periods as described above.

Approximately 30,000 tpa of claystone and siltstone is despatched from the Bringelly site to Moorebank (23,000 tpa) and Prospect (7,000 tpa) operations, resulting in an average of 24 loads (48 movements) per week. Of these, 6 loads travel to Prospect and 18 along routes to Moorebank.

5.4.5 Fired Ware

Approximately 51,500 tonnes of fired ware leaves the Bringelly plant annually. The products are hauled in trucks as described in **Section 5.4.1** between the hours of 6:00am to 6:00pm Monday to Friday and 6:00am to 12 noon Saturdays. No loading or deliveries are made on Sundays.

An average of 54 loads (108 truck movements) are made weekly delivering fired ware. It is emphasised that this is an average weekly figure based on expected annual deliveries.

In November–December 1990 the Company conducted a survey of fired ware truck deliveries from the Bringelly plant. During this period 21% of delivery trucks travelled south on The Northern Road, 32% travelled east via Bringelly Road and 47% travelled north on The Northern Road.

5.4.6 Summary of Truck Movements

Table 5.1 summarised existing average weekly truck and commercial vehicle movements associated with the Bringelly operation.

TABLE 5.1
AVERAGE TRUCK MOVEMENTS

Raw Material In	50 movements/week
Operating Supplies In	32 movements/week
Raw Materials Out	48 movements/week
Fired Ware Out	108 movements/week
	238 movements/week

It is estimated that 80% of truck and commercial vehicle movements (190) occur between the hours of 6:00am to 12 noon MOnday to Saturday. Assuming these 190 movement are equally distributed over the six days, a peak of 7 vehicle movements/hour over this period is achieved. The remaining truck movements (i.e., 48) occur between 12 noon and 4:00pm Monday to Friday inclusive, i.e., 2.5 movements/hour. It is emphasised that there is no loading or haulage of material between 12 noon Saturday and 6:00am Monday.

5.4.7 Employee Traffic

Up to 33 people are employed at the Bringelly plant. Assuming all personnel drive to work, daily employee vehicle movements number 66. This figure does not take into account any car pooling arrangements and could be expected to be a maximum. Allowing for visitor and service vehicles of 10 movements/day maximum, daily vehicle movements are estimated at 76.

5.4.8 Truck Delivery Routes

Figure 8 shows truck routes for all materials for both the existing and proposed plant.

5.5 SITE FACILITIES

Other on–site facilities include an underutilised brick office near the entrance to the plant, a car park with accommodation for 35 vehicles, and a workshop building. Because of the shift arrangements discussed in **Section 5.6**, the car park is of adequate size for the workforce.

5.6 EMPLOYEES

The plant provides employment for 33 people. Of these 4 kiln operators work a continuous shift, 2 are employed as crusher operators between 1500 hours and 2300 hours and the remaining 27 work between 0600 hours and 1430 hours. Of the 33 employees, 2 are management staff.

5.7 HOURS OF OPERATION

Hours of operation for the existing quarrying and production processes are given below.

Quarry	0600 hours to 1430 hours Monday to Friday
Production	0600 hours to 1430 hours Monday to Friday
Material Preparation	1500 hours to 2300 hours Monday to Friday
Kiln	Continuous
Transport	0600 hours to 1800 hours Monday to Friday 0600 hours to 1200 hours Saturday

The plant operates 5.5 days per week for 50 weeks of the year continuously. There is no site activities or truck haulage on Sundays, only the kiln runs continuously.

5.8 SERVICES

5.8.1 Water

Water for plant production processes is drawn from on-site dams at a rate of 4125kL/year. Domestic water is purchased by the Company and delivered by contractors to storage tanks on the plant site. Approximately 1360kL/year is used for domestic purposes.

5.8.2 Gas

The plant uses 181,430 GJ of natural gas per year as fuel for the drying and firing processes.

5.8.3 Electricity

Electricity use is estimated at 2,526,300 kWh per year.

5.8.4 Sewerage

All sewage is disposed of via an on-site transpiration bed system.

5.8.5 Fuel

LPG is stored on-site in a 4000 litre above ground tank.

DESCRIPTION OF THE PROPOSED DEVELOPMENT

6.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

This section describes the development for which consent is sought. The existing approved operations are outlined in **Section 5.0**. Details of controls and safeguards are described in **Section 7.0**.

6.1 OUTLINE OF THE PROPOSED UPGRADING

Upgrading of the Bringelly operation involves a number of components as listed below:

(a) Expansion of the quarry to the west and southwest to encompass an additional 12.5 hectares.

(b) Deepening of the quarry to 56m AHD.

(c) Increasing quarry production from 60,000 tpa to 200,000 tpa.

(d) Construction of a new raw material stockpile area southeast of the plant for the storage of up to 200,000 tonnes of material.

(e) Installation of a new crusher and conveyor system for transport of raw materials to the material preparation section of the new plant.

(f) Construction of a new brick and paver manufacturing plant immediately east of the existing structure.

(g) Increasing fired ware production from 51,500 tpa to 160,000 tpa.

(h) Extension of the product storage area.

(i) Refurbishment of the office complex.

(j) Resurfacing and remarking of the existing car park.

(k) Improvements to runoff and waste water disposal systems.

(l) Landscaping and screen planting of site facilities.

(m) Improvements to water, noise and dust control.

6.2 QUARRYING OPERATIONS

6.2.1 Quarry Plan

The new development involves extension and deepening of the existing quarrying operations to the west and southwest to encompass an additional 12.5 hectares.

The four stages of the quarry plan show the development over the next 20 years which is a realistic time frame for the consideration of environmental impacts. Beyond this time frame, quarrying will continue on the site subject to further planning consent. Actual areas to be quarried beyond the 20 year time frame are yet to be determined.

Each stage of the quarry plan will be worked progressively from Stage 1 to 4 on a campaign basis (see **Figures 2** and **9**). Two campaigns will be conducted each year with each campaign designed to provide sufficient stockpiled material for six months operation of the plant.

6.2.2 Quarrying Method

Quarrying will be undertaken using the same techniques as are currently used in the existing quarry. All horizons, i.e., light-firing, red-firing, and overburden/interburden will be stripped using a bulldozer/self-elevating scraper combination.

Each extraction stage shown on **Figure 9** will be progressively stripped of vegetation and topsoil which will be separately stockpiled. Vegetation will be chipped, and topsoil stockpiled for later respreading on backfilled areas. See **Sections 6.2.5** and **7.1.2** for further discussion on topsoil stockpiling and rehabilitation procedures.

On each bench shown on **Figure 9**, the bulldozer will precede three 15 tonne self elevating scrapers. The dozer will rip hard horizons in advance of the scraper. The self elevating scraper will strip the ripped horizons from the working area and proceed to the relevant stockpile area.

Claystones and siltstones will be stockpiled near the primary crusher as shown on **Figure 3**. The scraper drives over the stockpile releasing the material held in the scrapers "bowls". Material unsuitable for brickmaking use will be immediately deposited in previously worked out stages by the scraper as part of rehabilitation procedures. (see **Section 6.2.5**). Since Stage 1 of the quarry plan commences in the floor of the existing quarry, no overburden will be required to be disposed of in the initial development.

As the scraper works down and across the quarry, benches 5m wide by 5m high with batter slopes of 15° from the vertical are created. The maximum height of the high wall left on the worked out side of the quarry is 10m. This is benched (3m wide) with batter slopes of 15° from the vertical as the quarry deepens.

The quarry will be worked principally between the 56m AHD and 86m AHD since it is within this range that the optimum resource material occurs with minimal overburden and unsuitable material. To ensure adequate manoeuvring areas for scrapers and sufficient length of strip to ensure a full load in the scrapers bowls, a minimum area of 4 hectares needs to be opened at any one time.

Once the maximum depth is achieved, overburden/interburden material from subsequent stages is deposited directly in worked out sections of the quarry together with waste materails from the manufacturing operation. (see **Section 6.2.5**).

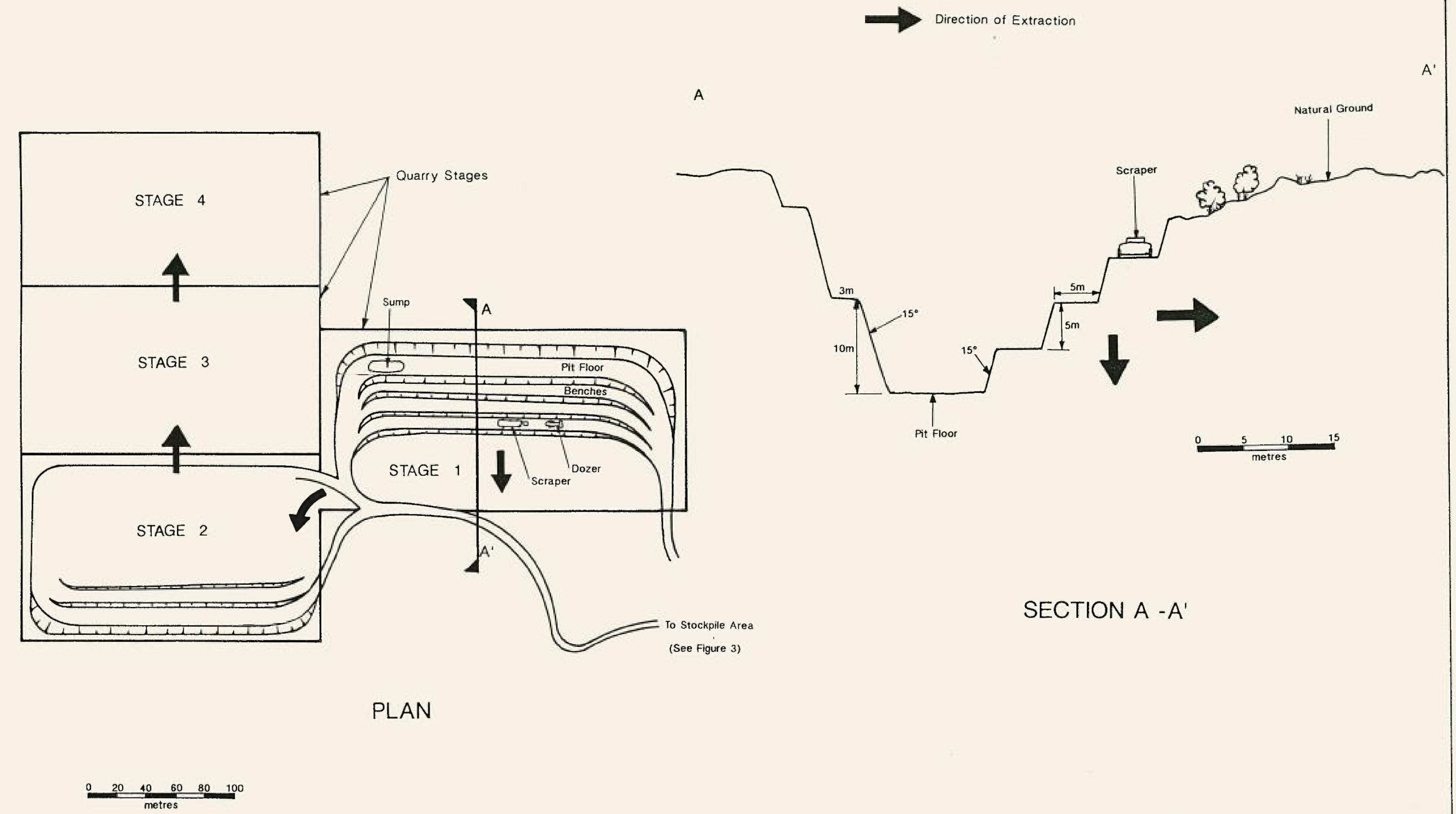


Figure 9:
QUARRY DEVELOPMENT

Photo 3: Existing quarry and sump.

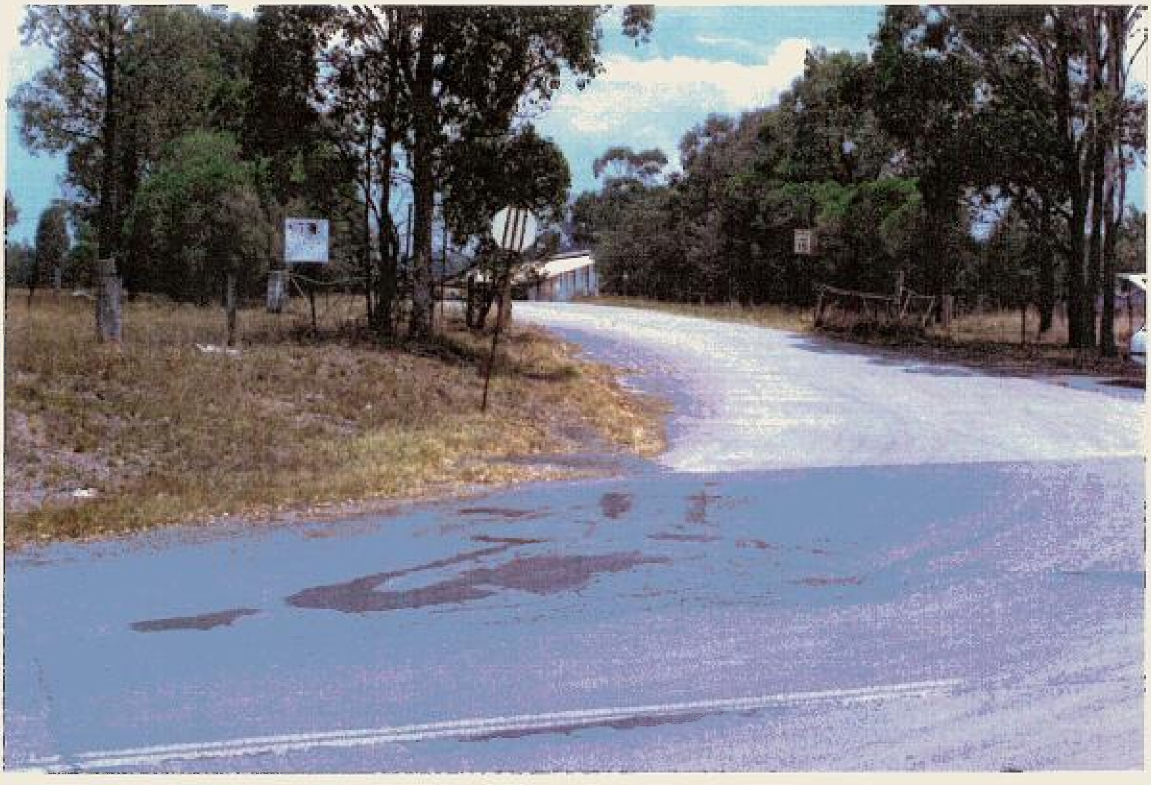


Photo 4: Sealed access to the site showing existing tree screening.

Imported material from the Erskine Park and Prospect quarries are deposited directly on the two main stockpiles near the crusher by tip truck. A grader trims the raw material stockpiles as they are constructed by the scrapers.

Abundant clay/shale resources occur on the holding to the south of the proposed extraction area. These reserves need to be further assessed to define future quarry plans and when required, appropriate approvals will be sought for the exploitation of these resources prior to development. It is expected that quarrying will continue on the Bringelly site beyond the 20 year time frame of the current quarrying proposals, to ensure adequate supply of material to the Bringelly plant and the Company's operations in the Sydney Region.

6.2.3 Material Handling and Stockpiling

As shown on **Figure 3**, a new raw material stockpile area will be constructed southeast of the plant. Two longitudinal stockpiles each of 100,000 tonnes (50,000m^3) will be constructed by the scrapers during progressive extractive operations on site. The stockpiles are approximately 100m long by 75m wide by 6m high with light–firing material and red–firing material stockpiled separately.

Imported material from the Erskine Park and Prospect operations will be unloaded directly onto the mix stockpiles during quarrying/stockpiling campaigns and not stockpiled separately. A grader will trim the material stockpiles as they are constructed by the scrapers.

Material is reclaimed from the pre–blended stockpiles by rubber tyred front–end loader and deposited in the primary crusher as shown on **Figure 10**. The primary crushed material will be conveyed to the grinding room on an enclosed rubber belted conveyor for further preparation where the material will be reduced to a particle size of approximately 1mm diameter.

With the exception of the activities of the front–end loader, all unloading and stockpiling activities are conducted on the stockpiles eliminating the need for heavy vehicle activities around the stockpiles. The Company will instigate a one–way system of heavy vehicle movements for stockpile construction during campaigns.

6.2.4 Production

Quarry production will increase from 60,000 tpa to 200,000 tpa. This increase is achieved by introducing two additional scrapers, and although the number of extraction campaigns will be reduced to 2, the campaign period will be extended to a total of 25 on–site days per year in 2 campaigns.

6.2.5 Backfilling and Rehabilitation

Extraction will proceed progressively from Stage 1 to Stage 4. Overburden and interburden from each subsequent stage will be emplaced in the proceeding void together with solid wastes from the manufacturing operations (Brick batts and some extruded green waste).

The four stages will yield in the order of 1.05 million tonnes of laminite and 260,000 tonnes of sandstone for disposal in the worked out voids. This material is relatively evenly distributed between the four stages. Two pit basins will be

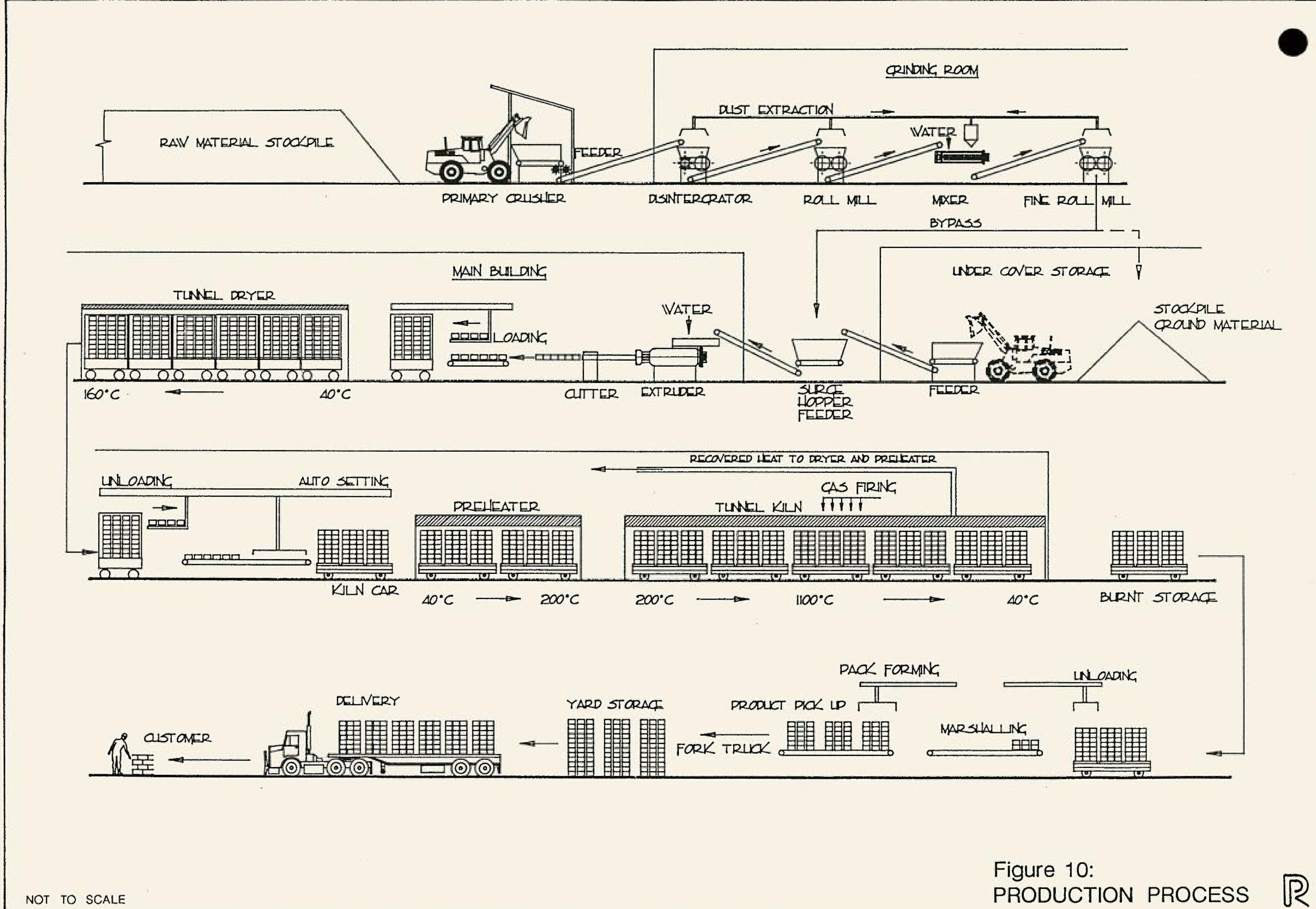


Figure 10:
PRODUCTION PROCESS

retained in the Stage 1 and Stage 3 areas to aid water management on the site (see **Section 7.2**).

Manufacturing wastes generated annually are in the order of 4,000 tonnes/year. In addition expected quarry waste from operations is expected to be 20,000 tonnes/year. Each stage will be progressively backfilled to the proposed final landform as material becomes available. Due to variations in demand and production rates, specific timing of backfilling operations cannot be made.

Additional material to meet final proposed landforms, should a short-fall arise, will be derived from on-going quarry campaigns beyond the 20 year time frame or will be imported to fill the excavation.

It is expected that a void will remain at the end of operations in the Stage 1 area. The void would be ideally suited as a waste disposal facility, or as outlined above, backfilled from material derived elsewhere on site or imported. **Figure 20** shows the final landform and gradients to the final void. Gentle gradients (1 in 4) will be achieved and slopes will be grassed and planted to ensure a stable landform.

Quarrying is expected to continue beyond the 20 year time frame in areas adjoining to the south and consequently progressive rehabilitation of worked out areas will be on-going.

6.3 PLANT UPGRADING

It is proposed to construct a new brick and paver manufacturing plant immediately east of the existing structure. The new plant will house new material preparation, drying and firing equipment to enable production to increase from 51,500 tpa to 160,000 tpa of finished ware.

It is expected that the old plant will continue during the first six months operation of the new plant to ensure continuity of production while all start-up difficulties with the new equipment are overcome.

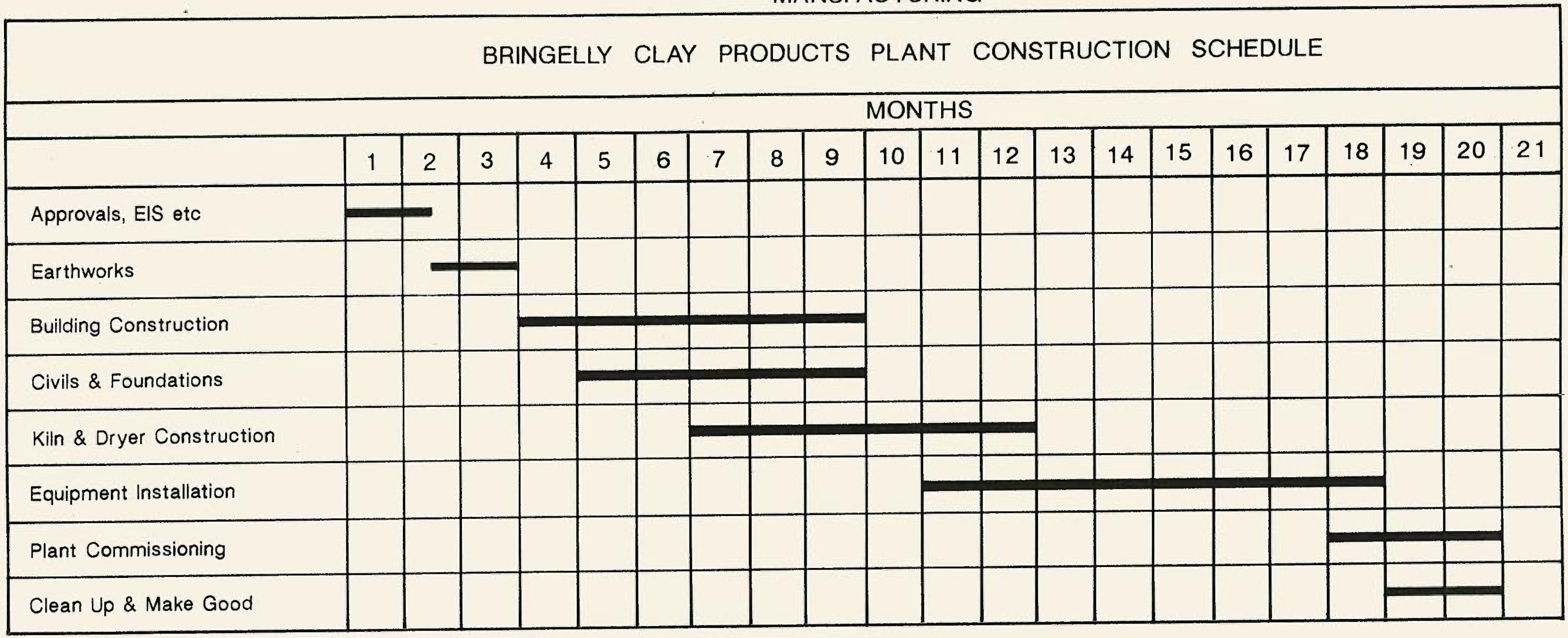
6.3.1 Construction Schedule

Figure 11 shows the expected construction schedule for the new manufacturing plant. The plant is expected to be commissioned and operational within 18 months of consent and the life of the manufacturing operation will be in the order of 50 years.

6.3.2 Plant Architecture

The plant will be constructed on a level concrete pad floor. Frames will be of structural steel and the cladding and roof of colorbond sheeting of a natural earth tone to blend with the surroundings. The building will be a maximum height of 11m except for the stack which will be 17.5m high with a diameter of 1.5m. The main plant will have a total floor area of 8,760m^2 and the preparation building a total floor area of 1,200m^2.

MANUFACTURING



NOTE:
The exact commencement date and duration of the construction schedule will be determined by several factors as outlined below .

a. Completion of the E.I.S. document
b. Approval of E.I.S. by various government bodies
c. Processing of E.I.S. through local council
d. Processing of the various local council approvals (B.A., D.A.) etc
e. Weather
f. Industrial Relations

Figure 11:
CONSTRUCTION SCHEDULE

6.3.3 Manufacturing Process

In general principles, the new manufacturing process is similar to the existing process. However, new technology and equipment to be installed in the new plant will ensure higher efficiencies and environmental control, allowing production to increase from 51,500 tpa to 160,000 tpa of finished ware.

Figure 10 shows diagrammatically the manufacturing process while **Figure 12** is a flow chart of equipment and processes. The layout of the plant and preparation buildings are shown on **Figures 13** to **15**.

Within the grinding room, the material is reduced to a very stiff fine grained paste by passing through roll mills and a mixer. At this point the material can be stored within the building or continue to a surge hopper/feeder in the main building. The material that is stored can be sent to the surge feeder at a later stage by loading it into a feeder with a front-end loader.

From the surge feeder the material is conveyed to a second mixer where the final water is added and then to the extruder cutter and press where the brick or paver is formed. The newly formed brick or paver is loaded into dryer cars and passed through one of two tunnel dryers. After the dryer, the dry product is removed from the dryer car and placed onto kiln cars automatically.

The kiln cars travel on rail tracks through a pre-heater to remove the final few percent of water and then pass through the tunnel kiln. While the process of "firing" takes place within the tunnel kiln on a continuous basis, the total time spent within the tunnel is 2 days, during which time the temperature of the product is increased to 1050°C–1100°C and cooled to room temperature. Air required to cool the product is used to preheat the incoming product and is also ducted to the dryers. As the process of firing and drying is continuous (24hours/day, 7 days a week), the reclaiming of heat results in a very efficient process. Products of combustion pass through a dry limestone absorption scrubber prior to the stack.

The fired product is transported on the kiln car to an unloading machine, where the finished product is automatically lifted from the kiln car and formed into packs suitable for delivery to the customers site.

6.3.4 Additives

Occasionally an additive, manganese dioxide is added to give variation to the brick texture and overall appearance. This material is delivered in 1 tonne bulk bags or 20kg sacks and stored under cover in the manufacturing building. Up to 10 tonnes may be stored at any one time.

6.3.5 Product Handling and Storage

The automatically formed packs will be transported by forklift from the plant to an enlarged fired ware storage area in the area shown on **Figure 3**.

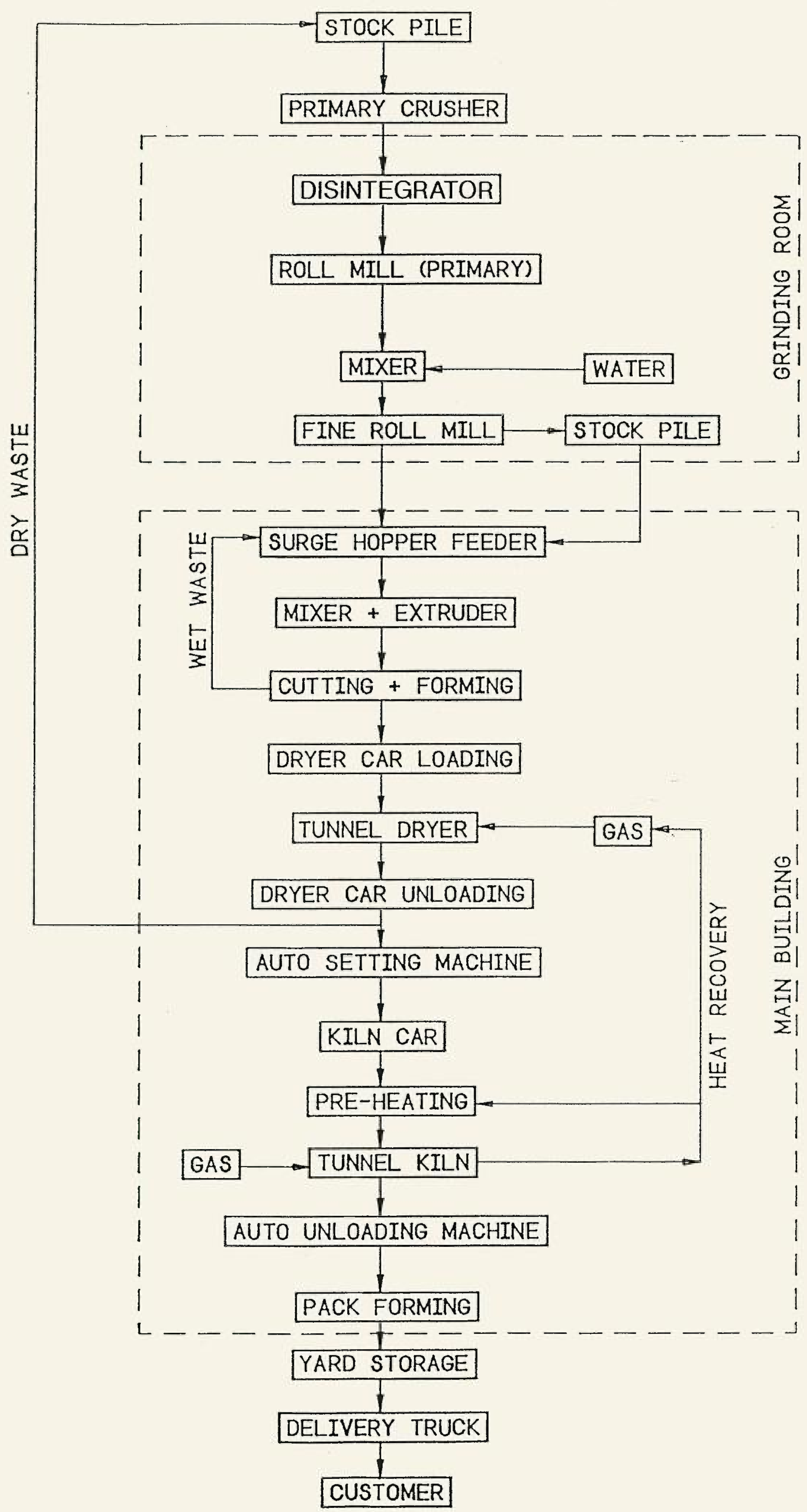


Figure 12:
FLOW CHART

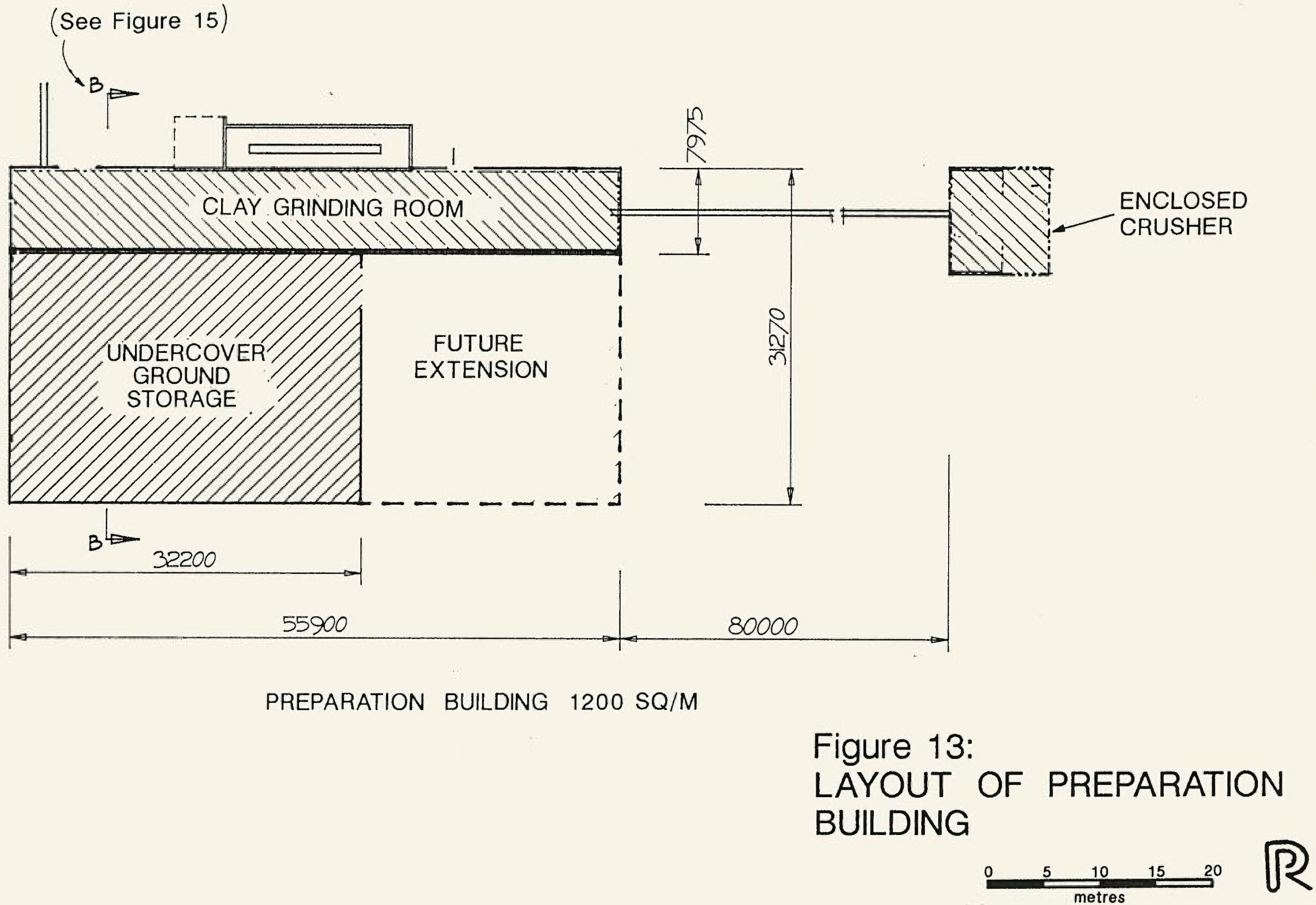


Figure 13:
LAYOUT OF PREPARATION BUILDING

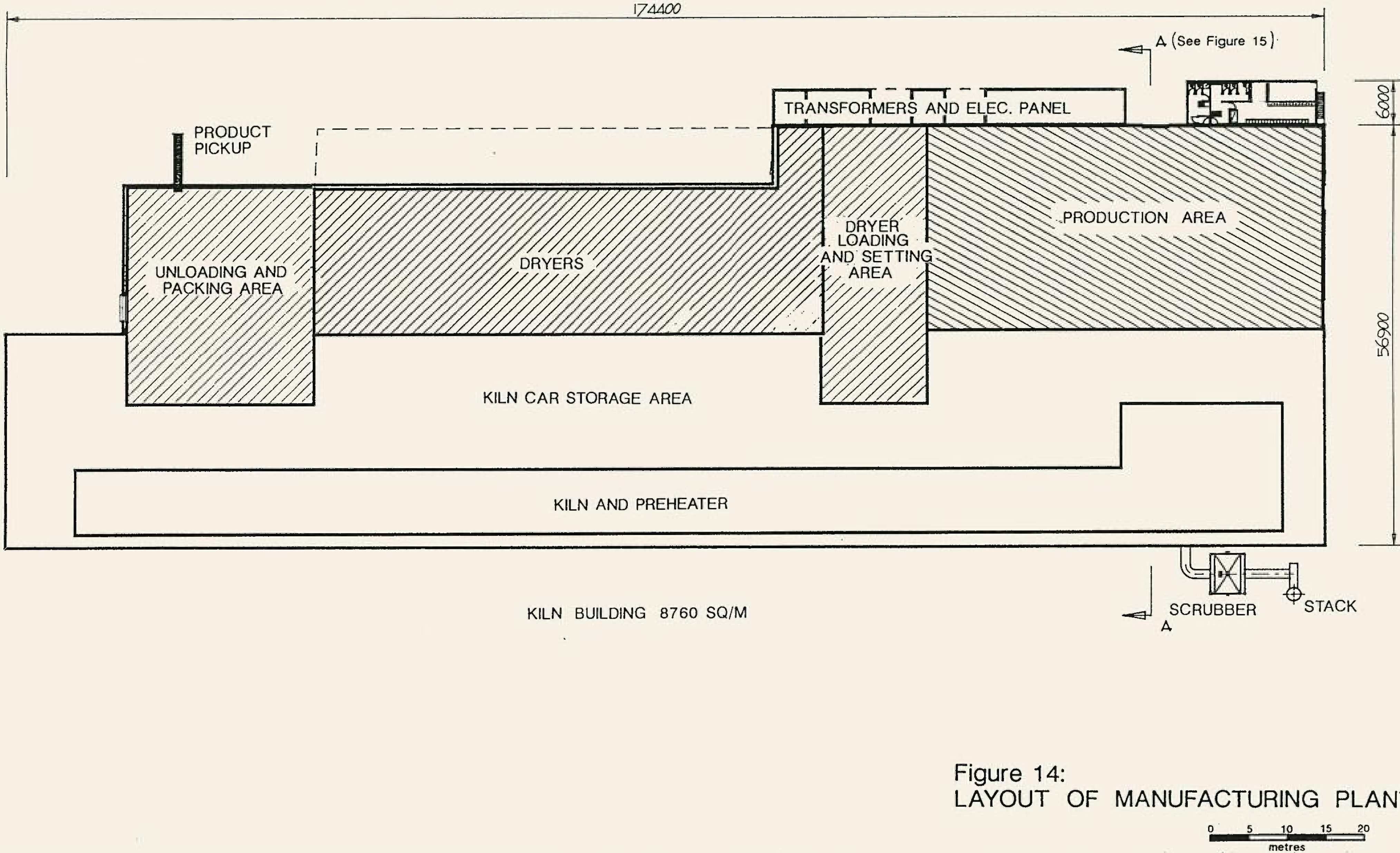
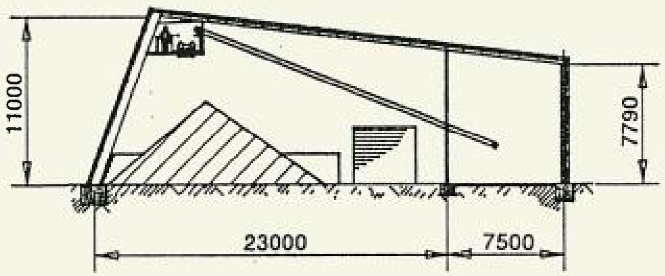
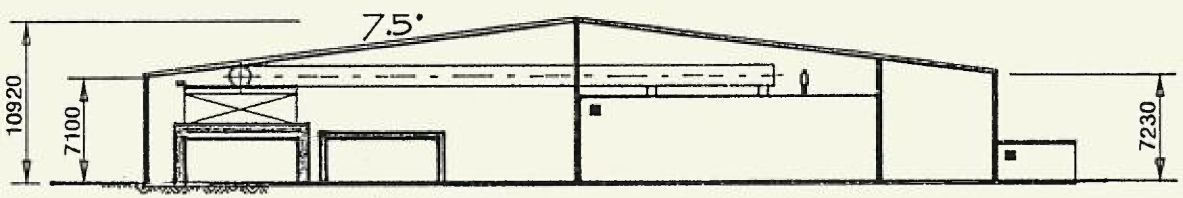


Figure 14:
LAYOUT OF MANUFACTURING PLANT



MATERIAL PREPARATION

SECTION B-B



MANUFACTURING

SECTION A-A

Figure 15:
SECTIONS

0 5 10 15 20
metres

6.4 MOBILE EQUIPMENT

Table 6.1 lists existing and proposed mobile equipment to be used on the Bringelly site.

TABLE 6.1
MOBILE EQUIPMENT

	Number	
	Existing	**Proposed**
Scraper	1	3
Dozer	1	1
Front-end Loader	1	1
Forklifts	3	6
Water Truck	–	1
Sweeper	–	1
Grader	–	1

The scrapers and dozer are used in material extraction, the front-end loader in material handling, and forklifts in transporting and stacking of fired ware. The water truck and sweeper are used to suppress dust on haul roads and working areas and the grader for trimming stockpiles and maintaining haul roads.

6.5 SOLID WASTE DISPOSAL

Similar solid wastes will be produced as per the existing operation (see **Section 5.3**) except that the total volume of waste to be generated will increase. Brick batts and some extruded green waste to be used as landfill will be disposed of in the worked out parts of the quarry to aid rehabilitation procedures. (see **Section 6.2.5**).

6.6 USE OF EXISTING BUILDINGS

It is proposed to retain the existing buildings on-site in the following capacities.

After successful commissioning of the new facility the existing plant would be closed and put in a "Standy-by" situation with the exception of the clay preparation/grinding plant which would be operated on an "as needed" basis to cover existing roadbase filler needs and breakdown emergencies in other facilities, including the new plant.

It is envisaged that the residual existing buildings would be used for ancillary activities such as special shapes forming, finished product warehousing and warehousing of operating supplies.

Any plans to re-equip the existing facility to meet future market needs would be subject to appropriate approvals with a supporting Environmental Impact Statement at the time.

6.7 VEHICLE MOVEMENTS

6.7.1 Truck Traffic

Section 5.4.1 describes the size and type of truck traffic currently importing and exporting raw material, stores and products to/from the Bringelly site, and garaging of vehicles. It is expected that these components will not alter in the new development.

Changes to vehicle movements as a result of the new development are described below.

6.7.2 Imported Raw Materials

To continue to provide the variation in fired characteristics of products from the Bringelly plant as described in **Section 5.4.2**, material will continue to be imported from Erskine Park and Prospect.

It is expected that an additional 18,750 tonnes of material will be imported annually, equally sourced from the Prospect and Erskine Park quarries. This increase in tonnage will result in an additional 15 truck trips (30 movements) per week.

As with the existing operation, all deliveries and unloading will be made between the hours 6:00am and 6:00pm, Monday to Friday and 6:00am to 12 noon Saturdays. No deliveries will be made on Sundays.

6.7.3 Operating Supplies

Following completion of plant commissioning and the operation of the facility on a routine basis, the number of vehicle movements delivering operating supplies are not expected to change from the existing situation of 32 movements/week, despite the increase in volume output. Delivery hours will remain unchanged and are the same as presented in **Section 6.7.2**.

6.7.4 Exported Raw Materials

There will be no increases in raw material volumes leaving the site and hence movement and destinations for these vehicles will remain unchanged to that described in **Section 5.4.4**.

6.7.5 Fired Ware

The increase in fired ware production from 51,500 tonnes/week to 160,000 tonnes/week will result in an increase in fired ware delivery movements from 108 to 356 (average) per week.

A detailed analyses of future destinations of fired ware has been undertaken by the Company. It is expected that 21% of fired ware traffic will travel south on The

Northern Road (Camden, Campbelltown, Expressway) 32% east on Bringelly Road (Sutherland, Sydney City) and 47% north on The Northern Road (Penrith, Expressway).

All deliveries will be made between 6:00am and 6:00pm Monday to Friday and 6:00am to midday on Saturday. No vehicle loading and deliveries are made on Sundays.

6.7.6 Summary of Truck and Commercial Vehicle Movements

Table 6.2 summaries existing and expected average weekly truck movements associated with the Bringelly plant upgrade.

TABLE 6.2
AVERAGE TRUCK AND COMMERCIAL VEHICLE MOVEMENTS/WEEK

	Existing	**Proposed**	**Increase**
Raw Material In	50	80	30
Operating Supplies In	32	32	0
Raw Material Out	48	48	0
Fired Ware Out	108	356	248
	---	---	---
	238	**516**	**278**

As with the existing plant it is estimated that 80% of truck movements occur between the hours of 6:00am to 12 noon Monday to Saturday. Assuming these movements are equally distributed over the six days, a peak increase of 8 truck movements/hour will occur. It is emphasised that there will be no loading or haulage of material between 12 noon Saturday and 6:00am Monday.

6.7.7 Employee Traffic

The number of employees is expected to increase from 33 to 50 made up of 43 production personnel, 3 managerial staff and 4 sales/office personnel. Assuming all employees will drive to work and ignoring any car pooling arrangements, and since only half the number of production personnel are present daily working under the proposed roster (see **Section 6.9**), daily employee vehicle movements will decrease to 56, i.e., a 15% reduction on existing levels. Allowing for visitor and service vehicles, future maximum daily vehicle movements are estimated at 66.

6.7.8 Truck Destinations

Truck routes and destinations are shown on **Figure 8** for the proposed operation.

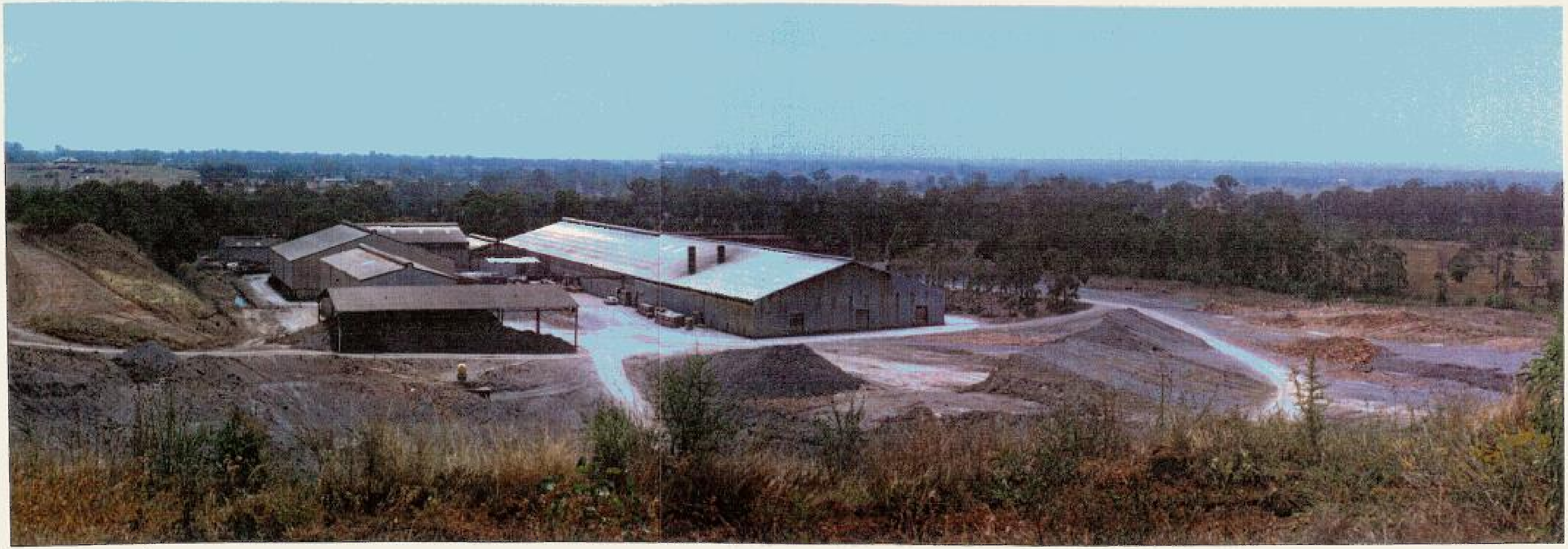


Photo 5: Panorama of existing plant viewed from above the existing quarry. The new plant will be located adjacent to the existing buildings on the right of the photo.

Photo 6: View of Greendale Road east from the plant entrance.

Photo 7: View of Greendale Road west from the plant entrance.

6.8 SITE FACILITIES

An existing underutilised brick office occurring on the site will be refurbished to serve as the office for the new plant.

The existing car park will be resurfaced and remarked to make more effective use of available space and to provide accommodation for the new employees. With the exception of 4 day and 3 management staff, employees are engaged on a roster basis with only approximately half the number of production employees being at the plant at any one time.

There will be no changes to the workshop/maintenance building.

6.9 EMPLOYEES

Employee levels will rise from 33 to 50. Production personnel will number 43 which will be employed on a four day on, four day off roster basis.

6.10 HOURS OF OPERATION

Proposed hours of operation are listed below.

Quarry	0600 hours to 1800 hours Monday to Saturday
Production	0600 hours to 1800 hours Monday to Sunday
Material Preparation	0600 hours to 1800 hours Monday to Sunday. In emergency situations, material preparation could extend to midnight. If this arises prior notification will be made to the relevant persons and authorities.
Kiln	Continuous
Transport	0600 hours to 1800 hours Monday to Friday 0600 hours to 1200 hours Saturday

There will be no truck haulage on Sundays.

6.11 SERVICES

6.11.1 Water

The Company proposes to extend a water main from the existing line in Greendale Road to provide water for domestic, fire fighting, and production purposes. The maximum production water requirement is expected to be 12240kL/year which will be drawn from the new reticulated supply. This is twice the current production water use. At times when insufficient capacity exists in the service, water will be stored in a surge tank to supply water supply needs.

Domestic water use will increase from 1360kL/year to 1860kL/year.

Water requirements for dust suppression are estimated at 5500kL/year, landscaping 330kL/year, and equipment washing 1650kL/year. Water for these purposes is expected to be drawn from on-site dams.

6.11.2 Gas

The new plant will consume in the order of 301,248GJ of natural gas per year. This is a 66% increase on current gas use.

6.11.3 Electricity

Electricity use is expected to rise to 11,200,000kWh per year which is 4 times the existing on-site power use.

6.11.4 Sewage

The existing septic system will be replaced by an intermittent extended aeration activated sludge process.

6.11.5 Fuel

Existing LPG storage described in **Section 5.8.5** will not be expanded.

CORRECTION

PAGE NUMBERING IS INCORRECT

PAGES 54 TO 64 DO NOT EXIST

ENVIRONMENTAL MANAGEMENT PROCEDURES

7.0 ENVIRONMENTAL MANAGEMENT PROCEDURES

7.1 EROSION AND SEDIMENTATION CONTROLS

7.1.1 Erosion of Sediment Controls During Plant Construction

Before the commencement of earthworks and building activities on the site of the new manufacturing plant several measures will be installed to prevent the movement of sediment into the Thompsons Creek system.

Prior to the construction of the bund walls a small toe drain on the downslope side of where the bund walls is to be placed will be formed. This drain will convey runoff to a convenient discharge point where sediment will be retained by a section of silt fence constructed on a 20m level weir outlet (see **Appendix 6**).

The toe drain and silt fence will be retained until vegetative stabilisation of the bund walls is achieved. Following the establishment of the toe drain/silt fence the screening bund/flood levee system adjacent to Thompsons Creek will be established using excavated material from the Secondary Sediment Basin 2 (see **Figure 16**). This will allow for the early vegetative stabilisation of the bund as well as providing a storage for settling out any sediment generated by construction disturbance. The northern section of the bund incorporating a catch drain on the upslope toe will direct site runoff to Primary Basin 1 and thence to the Secondary Basin; whilst the southern bund/levee will convey runoff from the stockpile areas directly to the Secondary Basin.

During the construction of the new manufacturing plant site disturbance will be kept to the minimum necessary for the building to proceed. The downslope margins of the site will be controlled by a temporary graded bank which will divert runoff to the Primary Sediment Basin 3. The regrading of this downslope section will also be completed as a priority to enable early vegetative stabilisation with appropriate grass species. Grassed batters which will become a permanent feature will be constructed at no steeper than 2.5:1 cross slope. Batters vegetated with trees and shrubs will be constructed no steeper than 2:1 cross slope.

7.1.2 Vegetation Clearing

No vegetation clearing will be required for quarry Stage 1. This stage involves the deepening and expansion of the existing quarry.

A potential adverse impacts from the extension to the existing quarry activity into Stages 2, 3, and 4 will be the loss of vegetative cover and the consequent increase in sheet and rill erosion on the exposed soil surfaces. It is important from a quarry management point of view to limit sediment generation during the clearing phase. As the rate of sheet and rill erosion is strongly dependent on the length of exposed slope it will be necessary to limit the amount of vegetation cleared in advance of the topsoil operation to a practical minimum. Where practicable, the slope length cleared in advance of the winning of topsoil shall be restricted to:

(a) 50m for slopes less than 7.5%.

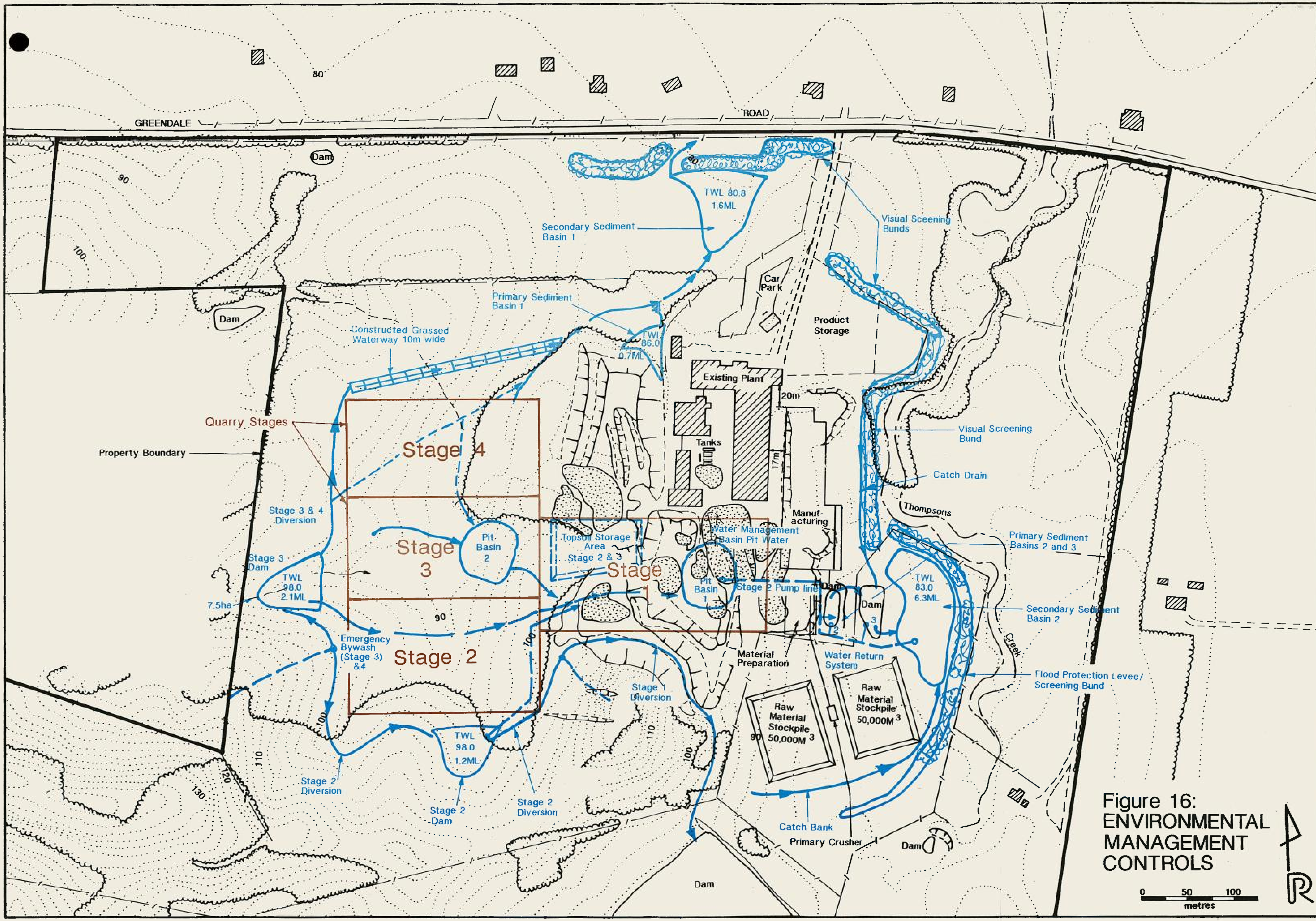


Figure 16: ENVIRONMENTAL MANAGEMENT CONTROLS

(b) 25m for slopes greater than or equal to 7.5%.

Where vegetation is cleared and a significant delay is anticipated, i.e., if the time of exposure is going to be greater than 30 days before topsoil is stripped, temporary vegetative stabilisation of the exposed surfaces will be employed.

Similarly a margin of 10m will be cleared outside of the quarry stage boundaries. This zone will reduce the potential for slope instability at the top of the pit batter. Vegetative stabilisation of this zone will be undertaken using appropriate pasture species and fertilizer applications.

The large tree species will only be removed by the dozer in the clearing operation. These will be disposed of by stacking within the previous cleared areas, (e.g., to the eastern side of Stage 2) in windrows constructed on the contour and sold as firewood. Care will be taken to avoid the inclusion of large amounts of soil in the windrows. Clearing will be restricted to dryer months to limit the amount of sediment generated. Understorey vegetation will be removed with the topsoil.

Any extraneous debris including logs, stumps, rubbish and rocks which may interfere with the removal of topsoil will be removed as part of the clearing process.

7.1.3 Soil Stripping and Stockpiling

Topsoil will be removed by a dozer or grader and stockpiled within the void of the preceding stage in a suitable position so as to avoid major internal flow lines. In some cases this topsoil may be respread immediately on prepared rehabilitation sections of proceeding stages. This will be encouraged as the viability of any seed stock within the topsoil will not be diminished. Longer term storage within a proceeding void area will serve to reduce the wind speed at the stockpile and hence decrease particle entrainment and the consequent dust nuisance. Where longer term stockpiling is envisaged, temporary stabilisation will be achieved by the use of a suitable pasture mix (e.g., Rhodes Grass, Couch and Lucerne at 15kg/hectare dressed with Starter 15 fertilizer at about 200kg/hectare).

To ensure maximum viability of the seed stock, the topsoil will be removed in two parts. The A_1 will be removed to a depth of about 50mm and stored separately. The lower A_1, and A_2 will then be removed and stockpiled. Stockpiles will be constructed with a maximum gradient of 3:1 and will be located as close as practicable to the anticipated area of reuse.

Where necessary soil conservation measures such as upstream diversion banks and surface protection (mulching, etc.,) shall be employed to minimize the generation of sediment.

Every endeavour will be made to keep the soil stockpile period to a minimum.

7.1.4 Quarrying Operations

The development of the quarry stages will include measures to mitigate against the generation of sediment. In the benching operation within the pit it is proposed to restrict longitudinal grades to less than 10%.

Whilst operation on one bench proceeds, runoff will be diverted around the top of the active face by use of a catch bank and batter drain system. Active benches will also be graded transversely so as to retain runoff against the toe of the back face. See **Figure 16** for details of runoff control layout.

Generally velocities in table drains and catch banks will be restricted to less than 2m/s. Where considerable depth of flow occurs and velocities are excessive, it may be necessary to provide a system of cross drains (on the more permanent haul roads for example) to restrict velocities.

Additionally, if necessary, hay bale structures will be employed to limit velocities in table drains.

The effective protection of the quarry workings against excess runoff will revolve around the early implementation of the water site controls. **Section 7.2.1** gives details of the various controls and their sequence of implementation.

The location of haul roads within each stage will be such as to promote the effective establishment of runoff controls and make the management of dust more efficient. Table drains will be employed to manage surface runoff and to maintain the stability of the road formation. The section of the haul road from the quarry adjacent Stages 1 and 2 will be a permanent operational feature which will also incorporate a small diversion channel (see **Figure 16**). Where necessary, depending on the area of surface catchment, sub-tended cross drainage will be employed to feed to the diversion channel. This drainage will be constructed of 375mm diameter "Z" class RCP with headwalls and on a minimum grade of 1%.

7.1.5 Site Management

The generation of dust and consequently sediment around the existing plant will be mitigated by the sealing of storage areas. In addition, it will be possible to divert runoff and general surface runoff through either the primary sedimentation basin located to the northwest of the existing plant or through the primary basins to the southeast (see **Figure 16** for details of basin location).

Surface runoff from the new plant and storage areas will be directed to the southeast basins via a large diversion channel occurring roughly parallel to the creek on the inside of the bund wall. Final sedimentation treatment will be afforded in both cases by larger basins with significantly longer detention times.

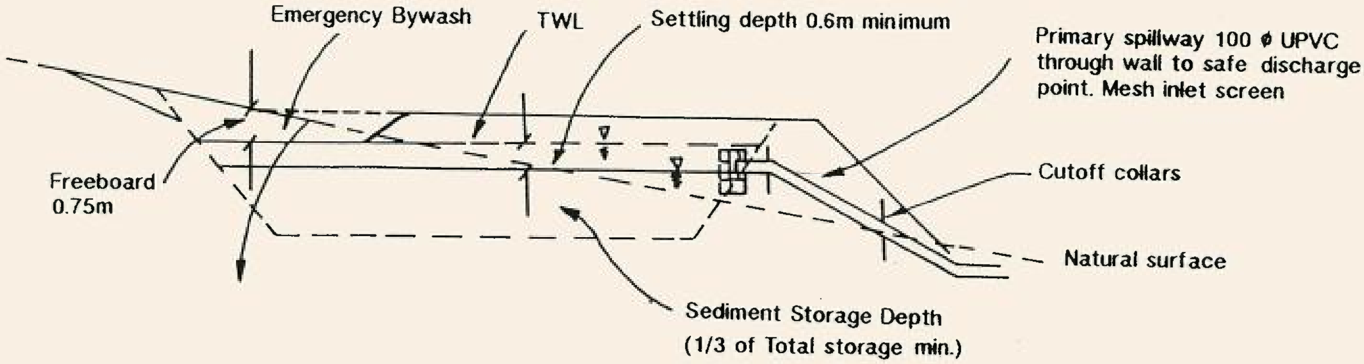
7.1.6 Maintenance and Rehabilitation of Sediment and Erosion Control Works

Surface cover vegetation, e.g., pasture growth on cleared margins will need to be maintained by annual application of fertilizer and additional sowing if necessary, depending on the state of cover. Watering by the site tanker may also be necessary during dry periods to obtain successful establishment and persistence of the vegetative cover.

Regular mowing of waterways and diversion channels will be undertaken to ensure a low compact sward with good erosion resistance. Similarly, it may be necessary during dry times to water these structures to maintain a competent vegetative cover. Water for irrigation will be drawn from the existing farm dam upstream of the site and not drawn from saline collection dams.

Sediment control structures i.e., hay bale silt traps and sedimentation basins will be maintained on a regular basis to ensure both structural stability and efficiency of operation. Hay bale structures may need to be rebuilt on desilting and new filter fabric installed. Sediment basins will be desilted when the sediment storage volume is full. See below for details of a typical sedimentation basin configuration.

TYPICAL ARRANGEMENT OF PRIMARY SEDIMENTATION BASIN



(Length / Width ratio should be at least 2)

Development and final design of sediment control structures will conform to the Technical Handbook No. 2, "Urban Erosion and Sediment Control Handbook" of the Soil Conservation Service of New South Wales and the relevant requirements of the State Pollution Control Commission for industrial sites.

Desilting of the primary sedimentation structures will be achieved by taking the basin out of service temporarily. Runoff will by-pass the primary basins whilst desilting of the sediment volume is undertaken. The basins will be desilted by the use of a long reach excavator with an appropriate silt scoop bucket fitted. Prior to desilting the water content of the silt will be reduced by pumping from an appropriately filtered sump. This can either be a permanent basin feature or a lightweight transportable sump designed for the purpose.

Care will be exercised in the disposal of the decanted liquid and the silt. The decanted water will be directed to the larger sedimentation basins whilst the silt will be placed in the worked out pit as part of rehabilitation procedures.

7.2 WATER MANAGEMENT

The objectives of the water management plan are:

1. To prevent clean surface runoff flowing over disturbed areas.

2. To control and treat sedment–laden runoff, ensuring that there is no increase in downstream sedimentation as a consequence of the upgrading proposal.

3. To control and treat saline quarry water ensuring that there is no adverse impacts on downstream water quality. Saline water will be used for dust suppression within an enclosed system and not for irrigation.

4. To ensure that there is no uncontrolled runoff from the raw material stockpile area.

5. To provide adequately designed runoff controls and water storages such that all runoff is conveyed at non–erosive velocities and adequate settling time is provided for sediment–laden runoff.

6. To ensure that sufficient water storage is provided on–site to fulfil water requirements for dust control and other purposes.

7.2.1 Staged Site Controls

The management and diversion of clean water away from the active quarry area and exposed soil surfaces will be the most important aspect of erosion control and site water management. The staging of runoff controls is organised to achieve these ends and is such that controls will be established and vegetatively stabilised prior to a new stage of quarrying being undertaken. See **Figure 16** for details of the staged water management and **Appendix 6** for details of design criteria.

Stage 1 – Controls

This involves the consolidation of existing features and the establishment of others which will be added to as the later stages of the quarry subsequently develop. Details of Stage 1 Controls are as follows:

* Primary sediment basin on 0.7ML will be established to the northwest of the existing plant. Roof and surface runoff will be directed to this basin from the existing plant.

* Existing sediment basins to the southeast will be interconnected to work as primary basins for settlement of material pumped out from the quarry floor.

* A larger basin (secondary settlement) to the southeast will be established downstream of existing basins; excavated material will then be used in the construction of the bund along Thompsons Creek. The bund will extend to about RL89m to ensure all stockpile runoff is directed to the large basin.

* Diversion drain bank upslope from Stage 1 quarry will be established to direct incidental runoff from the crest of the hill around to the existing large dam, (450mm diameter corrugated metal batter drain is indicated).

* Catch bank will be constructed to command the existing plant and proposed manufacturing areas. This bank will also form part of the screening bund adjacent to the creek.

* Screening bunds will be established; the bund adjacent to the product storage area will be graded towards the south and will be constructed with a catch drain on the upslope toe.

* Storage on a tributary to Bardwell Gully will be constructed to provide secondary settlement for runoff from the existing plant. This tributary is not a presribed stream at this location.

* Basin and pump line from quarry Stage 1.

Stage 2 - Controls

Prior to the initiation of clearing and topsoil stripping on the Stage 2 quarry area, a diversion bank and storage will be established to contain the incident runoff from the saddle area to the south, (see **Appendix 6**).

The diversion bank will be designed and constructed to a 1:20 year average recurrence interval standard at a longitudinal grade of 0.5% (a channel width of 1.5m with a bank height of 0.7m is indicated).

The storage will have a top water level of RL 98.5m with a volume of about 1.2ML. The primary outlet to this dam will be a pipe spillway designed to accommodate a 1:10 year average recurrence interval flow, (a 450mm diameter corrugated metal pipe at a minimum grade of 1% is indicated). The pipe spillway will discharge to the corrugated batter drain of the haul road (see Stage 1 controls) and thence to the existing large dam.

An emergency bywash to convey flows in excess of the 1:10 year average recurrence interval flood will be constructed to discharge into the Stage 2 pit area and thence to the Stage 1 pit basin (Pit Basin 1).

During Stage 2 the water management basin will be enlarged to act as a further runoff control capable of storing flows from the 1:100 year average recurrence interval storm (a 1ML storage is indicated).

Stage 3 - Controls

As for Stage 2, the Stage 3 diversion banks and storage will be established and stabilised prior to the commencement of the clearing and topsoil stripping operation.

The storage will have a top water level of RL 98.5m. A primary outlet channel capable of carrying flows up to the 1:20 year average recurrence interval will be constructed. This grassed channel will convey these flows at a maximum grade of 4% through the proposed Stage 4 area to the watercourse in the Bardwell Gully tributary. An emergency bywash set 200mm higher than the primary outlet will direct major flows to the quarry floor (Pit Basin 2) and thence to the pit basin in the Stage 1 void. The use of a concrete or rock flume may be necessary to protect the bywash from scour in which case it will also be necessary to incorporate a stilling basin to safely dissipate excess kinetic energy at the base of the flume.

Stage 4 - Controls

Prior to the initiation of Stage 4 the outlet channel from the Stage 3 storage will be redirected so as to skirt the western edge of the Stage 4 area. The channel will discharge into a constructed grassed waterway which will finally discharge into the Bardwell Gully tributary further to the north. A width of 10m with a bank height of 0.5m is indicated for the grassed waterway.

The location of discharge channels from the Stage 2 and Stage 3 dams will depend upon the shape of the final landform. During the quarrying operation within Stage 2, it may be possible to direct the emergency bywash along one of the benches. Where necessary, drops will be negotiated by the use of a corrugated batter drain.

7.2.2 Water Return System

Runoff from disturbed areas will be managed in a closed system and will be either used for dust suppression or evaporation. The water management basin to be located in the Stage 1 void will provide an opportunity for the management of dust suppression water. It is proposed to install a pump and pipework to remove water from the basin and discharge to the primary sedimentation dams at the east of the site.

Similarly by the use of an interconnected pumping line from the large secondary storage the flow can be reversed and directed back to the pit for use in dust suppression in dry times.

By directing all pit runoff water to a common management basin the water quality of discharges from the pit and raw material stockpiles will be effectively managed.

During dry times, dust suppression water used on haul roads and stockpiles will be largely evaporated leading to a potential overall concentration of salt in the long term on the ground surface. The first flush resulting from subsequent heavy rainfall will be potentially quite saline. The large secondary storage will be drawn down during dry times to allow sufficient volume to store the anticipated first flush thereby avoiding saline discharges to Thompsons Creek. The stored water after sufficient mixing time will then be returned to the pit for further dust suppression. During prolonged wet periods, resulting in both these storages being full, salinity levels will be sufficiently diluted to allow runoff to be discharged to Thompsons Creek. All discharges will comply with State Pollution Control Comission licence conditions and be of an acceptable salinity level.

7.3 SOLID WASTE DISPOSAL

7.3.1 Overburden and Interburden

Material unsuitable for the manufacture of bricks and pavers, e.g., sandstone and sandy laminites, is found interbedded with the usable resource material. These interburden units will be progressively stripped by the dozers and scrapers and deposited in worked out sections of the quarry as backfill. As the Stage 1 workings are located in the existing quarry there will be no need to stockpile overburden/interburden material avoiding the problems associated with secondary handling of material. All waste material will be emplaced in the quarry void.

7.3.2 Brickbatts and Production Waste

As discussed in **Section 5.3, 6.5**, and **6.2.5**, solid wastes such as brick batts and some extruded green waste are used on site as landfill. Where possible, extruded green waste is reused in the manufacturing process. However, where contaminated with floor wastes and/or fired ware, this material is used as landfill aiding site rehabilitation.

7.3.3 Other Waste

Other wastes include multi-wall paper sacks, lunchroom waste, broken pallet timber and steel fabrication waste. As discussed in **Sections 5.3** and **6.5** this material will be removed by waste contractors.

7.4 AIR QUALITY CONTROLS

7.4.1 Dust

Dust control measures are designed to; restrict dust levels to below those that cause inconvenience to employees and surrounding residences, to not reduce air quality, and to prevent damage to vegetation.

Potential sources of dust are the open quarry void, unsealed haul roads traversed by heavy equipment, e.g., scrapers, front-end loader, stockpiles, plant operations, and stack emissions.

Air quality will be protected by preventing or minimising the quantity of dust produced at these potential generation points.

The quarry plan ensures that areas of disturbance are kept to a minimum and worked areas rehabilitated as soon as practicable. A maximum of 4 hectares will be exposed at any one time and most of the workings will be below ground level shielding the quarry from prevailing winds.

Haul roads and trafficked areas in the quarry will be regularly watered during dry periods at an application rate of 1.5L/m^2/day. The detailed air quality impact assessment report presented in **Appendix 3** assumes haul road watering at this rate.

The dust modelling presented in **Appendix 3** found that watering of raw material stockpiles would not be necessary to meet air quality goals. The raw material stockpiles are located on a flat plain well below the level of surrounding terrain and in part protected by surrounding topography. Enclosure of the primary crusher and conveyor to the plant will be undertaken to minimise dust emissions from these sources.

All potentially dusty plant operations are conducted in enclosed buildings. The introduction of water at early stages in the process ensures that dust does not cause inconvenience to workers and there are no impacts on surrounding residences. Emissions to the atmosphere from the dryer and kiln are made by a

1.5m diameter, 17.5m high stack after passing through a Hellmich/Applied 200mm^3 dry scrubber and EVG exhaust fan. The air quality impact assessment report presented in **Appendix 3** has shown that these controls prevent impacts from particulates.

All areas within the plant; the product stockpile area, and areas traversed by forklifts will be sealed to prevent dust emissions and regularly swept to prevent dust build up. The car park will be sealed together with the access road, and extensive bunding and landscaping will reduce visual dust impacts.

7.4.2 Stack Emissions

All stack emissions will pass through a Hellmich/Applied Dry Scrubber of 200m^3 capacity prior to exhaustion of the atmosphere via an ACE 17.5m high stack. Detailed modelling of stack emissions of SO_2, SO_3, NO_X, HCl, HF, and particulates (see **Appendix 3**) has shown that there will be negligible impacts on air quality.

7.5 NOISE CONTROL MEASURES

The results of a detailed noise impact study of the proposed plant upgrading is presented in **Appendix 4**.

All mobile equipment external to the buildings will be fitted with standard silencers appropriate for the equipment. The silencer will be kept in good order to ensure minimal noise disturbance.

To attenuate noise from the primary crusher and mobile equipment used in both the manufacturing and quarrying operations, the crusher will be enclosed and a bund wall constructed adjacent to the plant and stockpile areas as shown on **Figure 16**. The bund will be an earth wall up to 6m in height. The wall will be seeded and planted where possible to act as both an acoustic and visual screen.

The equipment involved in material preparation and brick/paver manufacture (except the primary crusher) will be housed within 2 buildings which significantly attenuate the noise levels emitted.

Further details are provided in **Appendix 4**.

7.6 PROTECTION OF NATURAL AND MAN-MADE FEATURES

Detailed environmental studies presented in **Section 4.0** have shown that there are no unique or unusual natural or man-made features occurring on the site to be disturbed by the upgrading proposals and no special provisions are required.

7.7 VISUAL CONTROLS

7.7.1 Topographic Shielding and Quarrying Method

The quarrying operations are located to the south and west of the existing plant where they will be principally shielded by the buildings and remnant forest vegetation to be retained along the northern boundary of the property shown in **Figure 3**.

Most quarrying will be conducted below ground level to an RL of 56m AHD.

7.7.2 Bund Wall

A bund wall will be planted along the eastern boundary of the stockpile and new manufacturing plant to serve as both an acoustic and visual screen. (See **Figure 16**). The bund wall will be up to 6m in height and will be extensively planted with native trees and shrubs suitable for the area. A second bund wall will be constructed near the entrance to the plant to provide additional visual screening.

7.7.3 Landscaping

As indicated in **Section 7.7.2**, the bund walls will be extensively landscaped and planted with indigenous vegetation. Additional landscaping will also be undertaken around the car park and office area as shown on **Figures 17** and **18**.

The planting within the site has been divided into two sections. The first section comprises the planting on the acoustic and amenity bunds, acting as buffers to the site activities.

The acoustic bunds will be up to 6m high and create a shaped barrier along the eastern side of the works. This will ensure, once the plants have matured, that the adjoining properties have a distinct screen between them and the plant activities.

A cross–section of the acoustic bunds is provided on **Figure 18** and this portrays the plant coverage that would result upon maturity and the screen that is created.

At the entrance to the site a smaller amenity bund wall (height 2m) is proposed to provide a buffer to properties across Greendale Road and to limit the impact of truck movements in and out of the site.

The species recommended for all the bund walls are shown in **Table 7.1**.

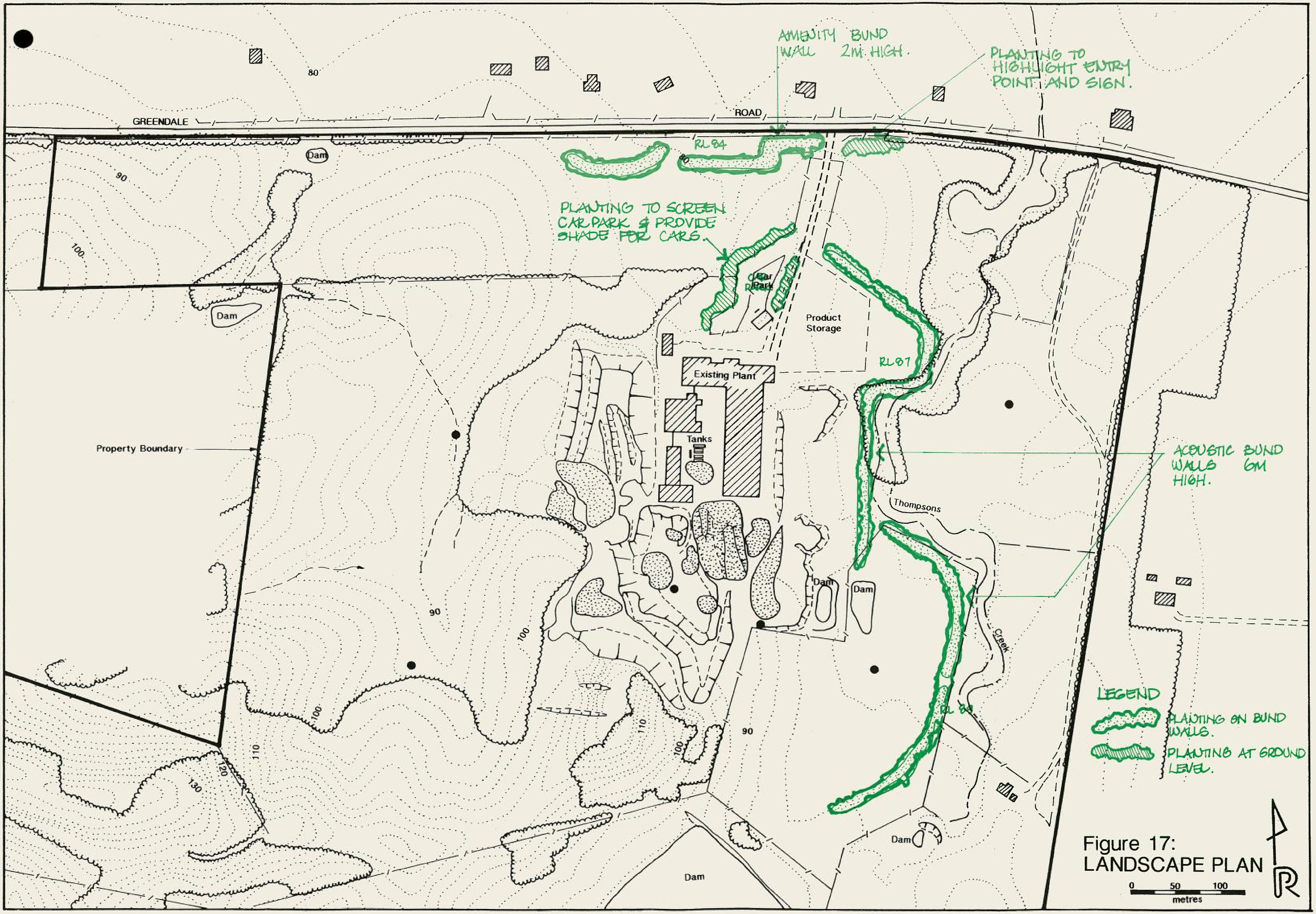


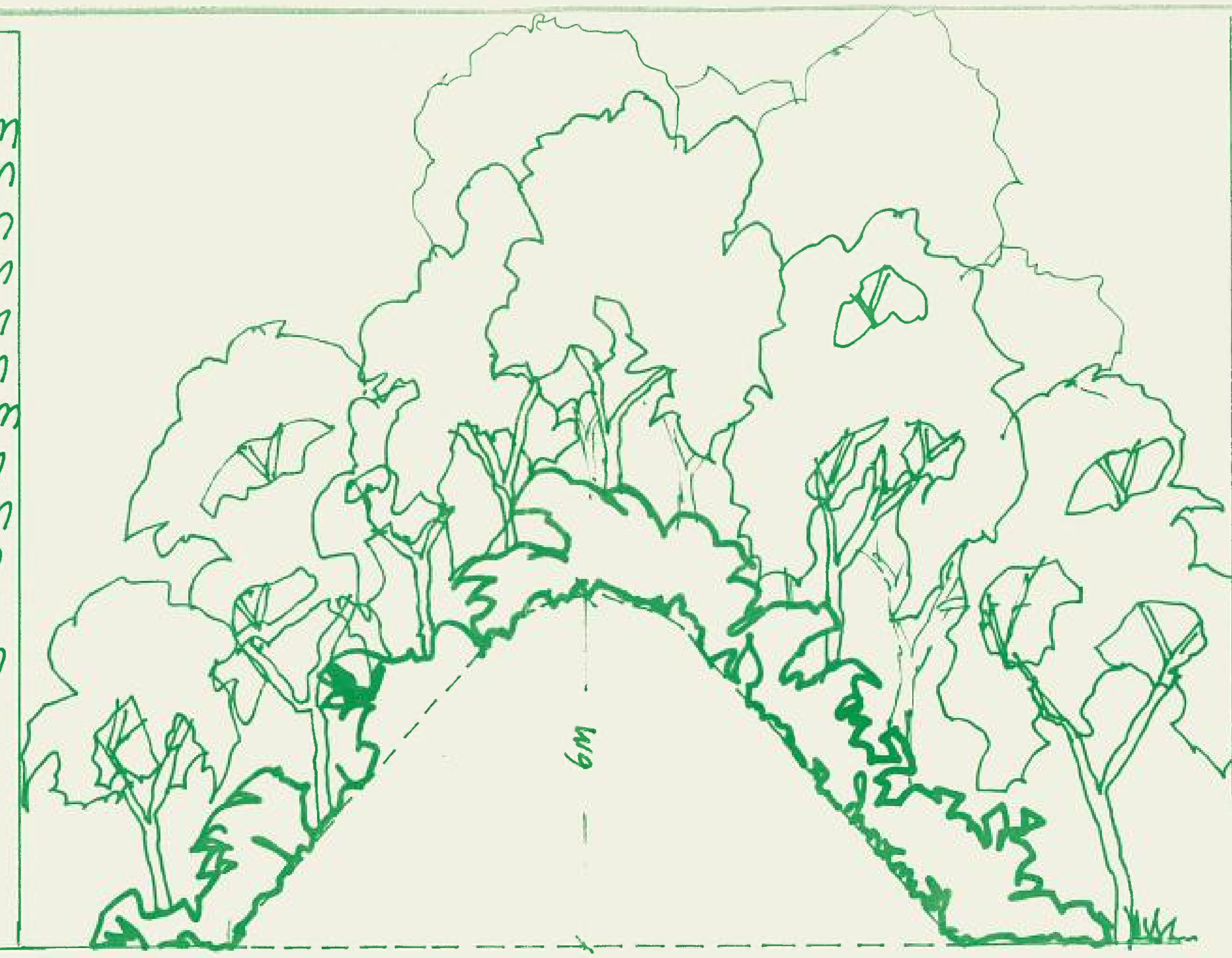
Figure 17: LANDSCAPE PLAN

RECOMMENDED SPECIES FOR BUND WALLS

Acacia baileyana	Cootamundra Wattle	6m
Acacia conferta	Crowded-leaved Wattle	3m
Acacia decora	West. Golden Wattle	1m
Banksia ericifolia	Heath Banksia	2m
Callistemon salignus	Willow Bottlebrush	7m
Casuarina stricta	Drooping Sheoak	6m
Eucalyptus crebra	Narrowleaved Ironbark	20m
Euc. gummifera	Red Bloodwood	12m
Euc. 'paramattensis	Parramatta Red Gum	12m
Hakea laurina	Pincushion Hakea	6m
Leptospermum flavescens	Common Teatree	6m
Melaleuca nesophila	Western Teamyrtle	3m

Also

Hardenbergia violacea	False Sarsaparilla
Grevillea 'Bronze Rambler'	
Kennedia rubicunda	Coral Pea
Myoporum parvifolium	Creeping Boobialla



ACOUSTIC BUND CROSS-SECTION SCALE 1:250
SLOPE 1:2

SPECIES FOR SCREEN PLANTING

Acacia conferta	Crowded leaved Wattle	3m
Acacia decora	West. Golden Wattle	1m
Banksia ericifolia	Heath Banksia	2m
Callistemon 'Hannah Ray'		2m
Cassia eremophila	Desert Cassia	2m
Casuarina stricta	Drooping Sheoak	6m
Euc. crebra	Narrowleaved Ironbark	20m
Euc. gummifera	Red Bloodwood	12m
Grevillea 'Ivanhoe'		2m
Grevillea robusta	Silky Oak	20m
Hakea laurina	Pincushion Hakea	6m
Melaleuca nesophila	West. Teamyrtle	3m

Also ground cover species as for Bund Walls.

SCREEN PLANTING SKETCH OF BORAL BRICKS ENTRY NOT TO SCALE

Figure 18:
LANDSCAPE DETAIL

TABLE 7.1
BUND WALL PLANTING

Scientific Name	Common Name	Mature Height (m)
Acacia baileyana	Cootamundra Wattle	6m
Acacia conferta	Crowded-leaved Wattle	3m
Acacia decora	West. Golden Wattle	1m
Banksia ericifolia	Heath Banksia	2m
Callistemon salignus	Willow Bottlebrush	7m
Eucalyptus crebra	Narrowleaved Ironbark	20m
Eucalyptus gummifera	Red Bloodwood	12m
Eucalyptus parramattensis	Parramatta Red Gum	12m
Hakea laurina	Pincushion Hakea	6m
Leptospermum flavescens	Common Tea Tree	6m
Melaleuca nesophila	Western Tea Myrtle	3m
Groundcovers		
Grevillea "Bronze Rambler"		
Hardenbergia violacea	False Sarsparilla	
Kennedia rubicunda	Coral Pea	
Myoporum parvifolium	Creeping Boobialla	

These species are to be planted in massed groups of 4 to 6 specimens together with the trees (7m+) planted at 3m to 4m centres and the shrubs and groundcovers at 1m centres.

The second section of planting is the two areas of ground-level screen planting at the entrance to the site and around the car park. These trees and shrubs will provide colour and shade and a low-level screen to the site activities. The planting around the site car park will shade the cars and limit their visual impact within the site itself.

A small section of planting at the site entry point will provide a highlight to the information sign and improve the amenity of Greendale Road.

The recommended trees for the two areas of screen planting are listed in **Table 7.2**.

TABLE 7.2
SCREEN PLANTING

Scientific Name	Common Name	Mature Height (m)
Acacia conferta	Crowded-leaved Wattle	3m
Acacia decora	West. Golden Wattle	1m
Banksia ericifolia	Heath Banksia	2m
Callistemon "Hannah Ray"		2m
Cassia eremophila	Desert cassia	2m
Casuarina stricta	Dropping She Oak	6m
Eucalyptus crebra	Narrowleaved Ironbark	20m
Eucalyptus gummifera	Red Bloodwood	12m
Grevillea "Ivanhoe"		2m
Grevillea robusta	Silky Oak	20m
Hakea laurina	Pincushion Hakea	6m
Melaleuca nesophila	Western Tea Myrtle	3m
Groundcovers		
Hardenbergia violacea	False Sarsaparilla	
Kennedia rubicunda	Coral Pea	
Myoporum parvifolium	Creeping Boobialla	

All the recommended plantings throughout the site will ultimately provide an attractive buffer to the surrounding properties, and result in more habitats for the birdlife of the area. In addition, the internal appearance of the site will be improved resulting in a more attractive workplace.

7.7.4 Rehabilitation

Full details of rehabilitation proposals are provided in **Section 6.2.5**.

7.8 MONITORING

Existing dust monitoring stations installed around the plant will be retained and an on-going monitoring programme for the plant will be contracted to outside consultants.

7.9 FIRE, HEALTH AND SAFETY CONTROLS

7.9.1 Building Construction

All site buildings and structures will be of fire resistant or non combustible construction. The office building which is isolated from the plant is brick/concrete tile construction. The manufacturing plant, kiln and associated buildings will be predominantly of metal, concrete, and steel construction supported on concrete floors, pads, and ramps. There will be adequate fire separation between the various site structures and buildings, and good access around all sides of the kiln.

7.9.2 Processes

The dryer and kiln will be fired with natural gas with a maximum operating temperature of 1100°C. These items of equipment are enclosed in heat resistant materials to maintain high heat efficiency and suitable safety controls are installed on all heating systems as standard equipment. These controls will be supervised and maintained on a regular basis by trained staff. The entire process will be automatically controlled and monitored by a microprocessor system.

7.9.3 Common Hazards

All electrical equipment will be designed and installed to comply with Australian Standard 3000 "Electrical Installation of Buildings, Structures and Premises". All control cabins will be air conditioned.

7.9.4 Fire and Bushfire Control

Section 4.11 has identified that the area has a medium to high bushfire hazard and appropriate bushfire control measures will be both preventative and reactive and will adequately safeguard the development in the event of bushfire.

They include:

1. Construction of a perimeter road around the quarry stages.
2. The use and maintenance of all other tracks as firebreaks.
3. Creation of bare fuel-free perimeter strips around the manufacturing plant.
4. Regular mowing of the intervening grassed areas between the raw material stockpile and crusher area.
5. The use of the road watering tanker as an initial response fire tanker.
6. Installation of water hydrants at strategic points around the manufacturing plant.

The Company has engaged Wormald International (Australia) Pty Limited to prepare a fire protection plan for the existing and proposed plants in accordance with AS 2149.1980. The plan provides for the installation of two hydrant ring mains, booster pumps and 120KL water storage tank to be located adjacent to the existing brick office. The fire hydrant system will provide for 14 standpipes and fire hose reel system to protect all buildings (predominantly internally). A 100mm water main will be provided to connect with the Metropolitan Water Sewerage and Drainage Board main in Greendale Road.

Other suitable dry chemical, BCF and foam extinguishers will be installed as required in the new plant. All extinguishers will comply with Australian Standard specifications and will be maintained by an outside fire protection contractor.

7.9.5 Fencing and Security

The existing fencing will be maintained together with the security gates. Improvement will be made to fencing of the car park area to ensure appropriate security of the plant area and to prevent unauthorised access.

7.9.6 Internal Traffic Control

All internal traffic will be required to travel at designated speeds and to comply with internal traffic controls.

7.10 ENERGY CONSERVATION

To ensure efficient energy management, all equipment and plant will be maintained in good condition and operated only as required. Automated control of fuel feed and temperature will ensure minimal fuel use.

7.11 ROAD UPGRADING

To ensure that the flow of traffic on Greendale Road is not impeded by traffic entering the Bringelly plant, the entrance will be upgraded. A Type B intersection with a 30m storage length and 30m taper length will be constructed in accordance with Roads and Traffic Authority requirements (see **Appendix 1**).

Details of the intersection are shown on **Figure 19**. This design has been selected as being appropriate for the level of traffic on Greendale Road, the level of proposed traffic generated by the development, and the destinations of traffic from the site.

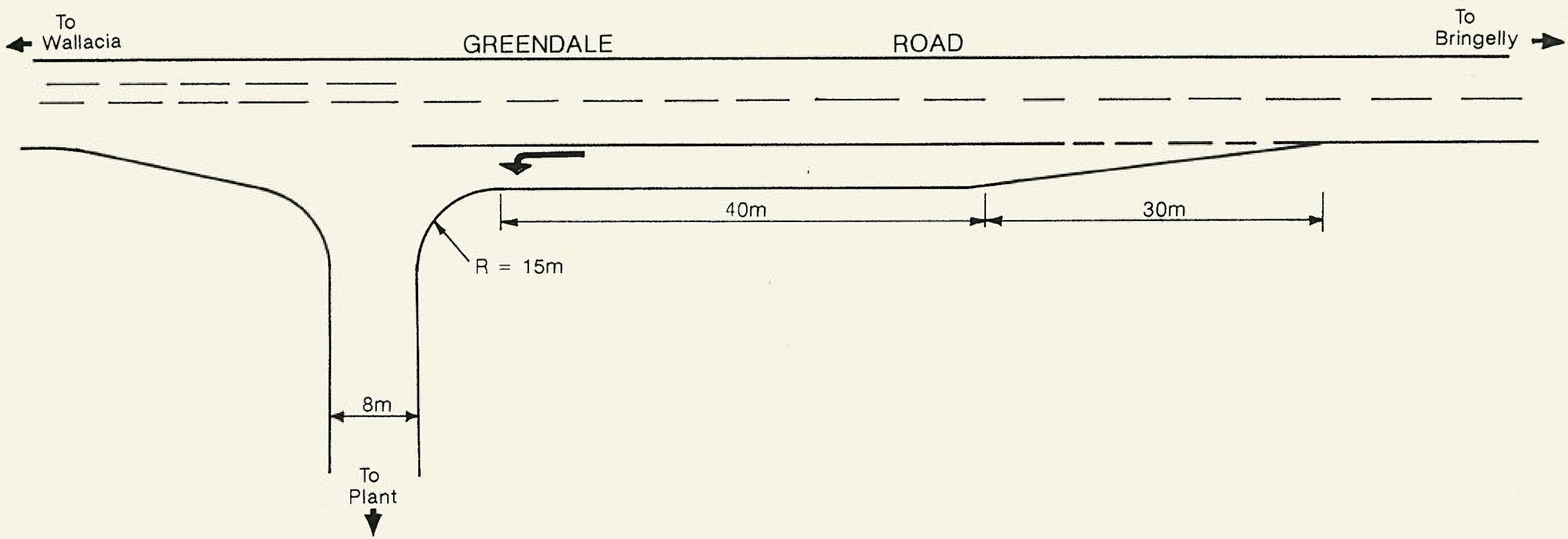


Figure 19:
PROPOSED UPGRADING OF ENTRANCE TO PLANT

ANALYSIS OF ENVIRONMENTAL INTERACTIONS AND IMPACTS

8.0 ANALYSIS OF ENVIRONMENTAL INTERACTIONS AND IMPACTS

8.1 TOPOGRAPHY AND SLOPES

The current quarry extensions will remove clay/shale material in three stages from the slopes of the small catchment to the west of the existing quarry. The crest of the main spur from Birling Trig will remain intact. At the completion of quarrying the void created by extraction Stages 2, 3, 4 will be filled and regraded to side slopes of 1 in 4, with a central flat area (see **Figure 20**). The faces of the retained void will be benched, and a sedimentation dam 100m x 75m maintained in the quarry floor.

The proposed extensions to the plant will be located on existing fill to the east of the present plant. During operation of the quarry and plant, raw material stockpiles will be placed on low gradient slopes adjacent to Thompsons Creek, but will be removed during rehabilitation, to leave an area with slopes similar to the natural form. Downstream of the stockpiles a large sedimentation dam, approximately 160m x 65m, will be retained throughout the life of the operation, and as part of the final landform.

A third permanent sedimentation dam will be located north of the plant adjacent to Greendale Road.

The impact of the proposed development on the primary terrain characteristics of the area will be minimal, as the main ridge and drainage lines will remain intact.

The form of side slopes within the quarried area will be modified, to produce steeper (1 in 4) side slopes above a broad flat valley floor.

The topography and slopes to the east of the plant will remain similar to the present, except for the permanent presence of a large sedimentation dam adjacent to Thompsons Creek. Large dams are common in the Bringelly area, so this does not represent a significant change in the context of local terrain and landuse.

8.2 GEOLOGY

The quarrying operations will remove up to 4.43 million tonnes of claystone and siltstone which is highly suitable for the production of bricks and pavers. A significant proportion of this material will be light–firing which is in short supply in the Sydney region. The utilisation of this highly valuable resource is a positive beneficial impact of the development.

8.3 SOILS AND SOIL EROSION

The topsoil materials present within the area are moderately to strongly erodible, and under existing land use practices on the property, there is moderate active sheet, rill and gully erosion.

Figure 20:
FINAL LANDFORM

It is proposed to progressively strip the topsoil from the extended quarry area, and to strip topsoil from the alluvial flats before that area is used for stockpiling of raw material. The stripped topsoil will be stockpiled and respread during rehabilitation of the quarry area. The net impact on the quality of topsoil present in the area will be minimal.

An important aspect of the proposed management of the area will be implementation of effective runoff controls and efficient sedimentation dams, and will ensure that the sediment yield from the site is minimal.

8.4 HYDROLOGY

Section 4.6 describes the existing hydrological characteristics of the site and **Sections 7.1** and **7.2** describe measures to prevent erosion and sedimentation of these stream courses.

The proposed development will not affect the hydrology of Thompsons Creek, the main drainage channel which passes through the area. The acoustic and visual bund walls are to be constructed above the 1% Annual Exceedance Probability flood event and as such will not impact on upstream or downstream flood levels. In the event of floods of a larger magnitude than the 1% Annual Exceedance Probability the bund walls may marginally reduce on site flood storage levels but due to their open design will not restrict flood flows. The construction of dams on small tributaries of Bardwell Gully above and below the extraction stages will modify the hydrological characteristics of Bardwell Gully. The dams are designed to ensure that water quality is not detrimentally affected and the minor impact on hydrological characteristics is more than offset by the prevention of detrimental water quality impacts.

8.5 WATER QUALITY

Existing environmental studies (**Section 4.7**) have shown that runoff from disturbed areas on–site is saline and that salinity levels increase during dry periods. **Section 7.2** describes the control measures to be implemented to prevent the discharge of saline water from the site. These measures, together with the diversion of all runoff from the quarry, plant and stockpile areas to sedimentation dams and the recycling of water for dust suppression as discussed in **Sections 7.1** and **7.2** will ensure that the development does not cause any alteration to water quality downstream of the site. There is the potential for concentration of salts within the water recycling system after a long period of time. As this is a closed system this will have no impact on downstream water quality. As shown in **Table 4.1** and **Figure 5**, the current operation is affecting salinity levels within Thompsons Creek. The proposed runoff control measures described in **Sections 7.1** and **7.2** will greatly reduce the amount of salt accessing Thompsons Creek and consequently significantly reduce salinity levels within this system.

Saline water will not be used for irrigation. This water will be sourced from the large dam upstream of the site.

8.6 AIR QUALITY

A detailed air quality impact assessment report has been undertaken by Nigel Holmes and Associates and the report is included as **Appendix 3.** The summary and conclusions from that report are reproduced below.

This report has dealt with the air quality impacts of the proposed expansion of the Boral Brickworks at Bringelly. This expansion includes the operation of a new kiln with increased capacity and extension to the quarry area which will increase the amount of material quarried each year from 60,000 tonnes to 200,000 tonnes.

The emissions from the kiln stack have been used with the dispersion model AUSPLUME to predict ground-level concentrations of SO_2, NO_2, HCl and HF in the vicinity of the plant. Two sets of meteorological data were available and both were used, but the data from Badgerys Creek was considered more representative of the Brickworks site and results from these runs indicate that a stack height of 17.5m will be sufficient to maintain ground-level concentrations below acceptable levels.

A special modelling run was carried out for HF with the West Hoxton data which predicted that on one day per year, the 24-hour VEPA goal for HF would be exceeded at a hilltop within the site boundary. As the land usage at this site is not particularly sensitive to HF emissions, it was considered that no serious impact would occur.

The installation of a scrubber in the new plant will reduce the emission rate of hydrogen fluoride (HF) by about 60%. Thus although the proposed production will be approximately 3.3 times that of the present plant, the mass emission rate of hydrogen fluoride (HF) will increase by only 25%; from 1.61kg/hour to 2.00kg/hour.

The dispersion model DUSTGLC was used to predict increases in long-term ground-level concentrations and fallout rate of dust in the area resulting from the expanded quarrying and related activities. A conservative estimate of dust emissions was made, assuming no dust suppression measures apart from enclosure of the crushing area and watering of the scraper road during haulage of material to the stockpiles. Results of the modelling runs indicated that no houses outside the plant boundary would experience long-term dust deposition levels above the acceptable $2g/m^2$/month. (refer **Appendix 3**).

The new plant will not add significantly to photochemical smog in the area. (see **Appendix 3**).

8.7 VEGETATION AND FAUNA

Stages 2, 3, and 4 of the proposed quarry will require the clearing of much of the remnant **Eucalyptus mollucana/Eucalyptus tereticornis** woodland on the site. The proposed final land use for the proposed 4 quarry stages is grazing. As quarrying is expected to continue beyond the 20 year time frame, grazing is considered the most compatible land use for the site. The rehabilitation plan for the quarry therefore provides for grassing of the sideslopes and quarry floor with the possibility of small stands of Eucalypts for shade. This represents a reduction of 6 hectares of woodland, which represents 35% of the woodland present on the site and its loss is not considered to constitute a significant detriment to the flora and fauna of the site. The existing woodland is surrounded by grazing and hobby farms, and little wildlife remains.

The three large dams which will be created on-site will provide an opportunity to enhance local wildlife habitat for waterbirds and reptiles.

8.8 BUSHFIRE POTENTIAL

The measures proposed in **Section 7.9.4** to prevent the outbreak of bushfires or accidental fires at the plant will ensure that any fires are quickly attended to and extinguished. Impacts will be low.

8.9 NOISE IMPACTS

8.9.1 Operational Noise Impacts

A detailed noise impact assessment report has been prepared by Boral Research and is enclosed as **Appendix 4**. The findings of these investigations are provided below:

"The impact the noise from the development will have on the surrounding residences can be assessed with reference to the State Pollution Control Commission - Noise Control Manual - Sections 20 and 21. These sections enable the determination of Recommended Planning levels and Outdoor Background Noise Levels for the area. Extracts from these sections are 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 10dB(A) or more below acceptable level
		*	at least, set maximum planning level 10dB(A) below existing background level
B:	Background is at acceptable level	*	Set maximum planning level 10dB(A) below acceptable level
C:	Background is below acceptable level by	*	Set maximum planning level by:
	1dB(A)		9dB(A) below acceptable limit
	2dB(A)		5dB(A) below acceptable limit
	3dB(A)		3dB(A) below acceptable limit
	4dB(A)		2dB(A) below acceptable limit
	5dB(A)		2dB(A) below acceptable limit
	6dB(A) or more		5dB(A) above background level

RECOMMENDED OUTDOOR BACKGROUND NOISE LEVELS
(FOR USE WITH CHAPTERS 19 AND 20)

Zoning of Noise Receiver Area	Predominant Land Use of Receiver Area	Time Period	L_{90} Background Noise Level dB(A) Acceptable Limit	Extreme Limit
Residential Area	Residential, church hospital, school	Day	45	50
		Night	35	40
	Shop or commercial office	Day	50	55
		Night	40	45
	Light industry	Day	55	60
		Night	45	50 "

In order to determine the recommended planning limit at Residence A, the situation is not as straight forward as usual because the current background includes a contribution from the existing brickmaking facility. This contribution was measured at 42dB(A) during one of the background surveys. The purpose of the planning limit is to avoid the situation of background creep where the background is raised by each successive development.

In this situation the noise contribution made by the existing plant will be removed and the new plant introduced. To avoid background creep, the planning limit should be calculated as follows:

At Residence A:

43.5dB(A) (current average background)	–	42dB(A) (existing brick plant)	=	41.3dB(A) (background without brick plant contribution)

Using the background without the existing brick plant contribution with **Table 20.1** gives.

Recommended Planning Limit – 43dB(A)

It should be noted that the predicted noise level for the total operation of the proposed re-development is 42.2dB(A), which is consistent with the existing noise level of 42dB(A).

Table 8.1 below gives the recommended planning limits and predicted noise levels for Residences A and B.

TABLE 8.1
NOISE LIMITS

Residence	**Average Background L_{90}-dB(A)**	**Acceptable Background L_{90}-dB(A) Day**	**Night**	**Recommended Planning Limit L_{10}-dB(A)**	**Predicted Noise Level Proposed Redevelopment L_{10}-dB(A)**
A	43.5	45	35	43 (See above)	42 – Total operation 38 – manufacturing and kilns 25 – kilns only 35 – Manufacturing and kilns without primary crusher and loader
B	40.4	45	35	43	40 – Total operation 37 – Manufacturing and kilns 25 – Kilns only 35 – Manufacturing and kilns without primary crusher and loader

The table shows that the operation will meet the Planning Limit at both Residences A and B. Operation of the kilns on a continuous basis and manufacturing operations (including materials preparation) at night can be undertaken (if the primary crusher and front-end loader are not used) without disturbance to any neighbours.

The noise level at the school from the redevelopment will be 35dB(A).

Quarrying operations will require the removal of material from above the RL 86m level on a staged basis.

This procedure will raise the contribution of the dozer to 38dB(A) at Residence B and 33dB(A) at Residence A. However, the total noise from the operation will still fall below the relevant planning limit at each residence.

To enable the noise level to be determined at a number of residences surrounding the quarry, a Noise Contour Map for the worst case situation has been produced and is given in **Appendix 4**.

8.9.2 Traffic Noise Impacts

The effect of noise due to increased traffic movement from the proposed redevelopment was considered along Greendale Road. The worst case was deemed to be at the Bringelly Public School where one of the school buildings is very close to the roadway. The building in question is approximately 6m from the edge of the roadway.

The sound exposure level of several trucks and cars were taken and typical values are given below:

Description	Sound Exposure Level dB(A) - at 6m
Brick Truck (Driving past at 6m)	80
Brick Truck (Braking downhill and turning)	71
Brick Truck (Accelerating from stop sign)	70
Car	74

Calculations were made as to the current and predicted noise levels at the school from traffic on Greendale Road using Annual Average Daily Traffic (AADT) data obtained from the Roads and Traffic Authority. The current AADT level for Greendale Road of 1396 vehicles with 10% heavy vehicles was assumed. Trucks from the existing plant represent 7.7% of this AADT, hence the assumption of 10% heavy vehicles is reasonable.

As the traffic flow is relatively low, the equivalent continuous sound level (L_{AEQ}) was used as the descriptor. This descriptor is preferred by the State Pollution Control Commission in the Environmental Noise Control Manual - Section 157 for such situations.

Using the measured sound exposure level data, the L_{AEQ} was calculated for a period of 7 hours from 9:00am to 4:00pm. This was considered to be the time period within which the school room would be predominantly occupied. Using normal assessment procedures, it was assumed that 70% of the AADT flow would occur between these hours. This flow is considered to be a maximum worst case and would not be encountered normally.

Assuming 80% of the proposed brick plant's heavy traffic generation occurs between 6:00am and 12:00 noon, the increase in heavy vehicle movements, between 9:00am and 4:00pm would be 29 movements.

The results of the survey are as follows:

Road Traffic Noise - Greendale Road - School

	Traffic Flow (9:00am-4:00pm) 70% AADT	**% Heavy Vehicles**	**L_{Aeq} Predicted dB(A)**
Current Situation	977	10%	61
After proposed redevelopment	1006	13%	61.5

The State Pollution Control Commission sets a goal for existing situations of 60dB(A). At Bringelly School for the worst case scenario considered, the goal is exceeded in the current situation and will be marginally increased after the proposed redevelopment. The increase in the L_{AEQ} of 0.5dB(A) is quite small and would be difficult to measure in practice.

Noise levels from The Northern Road would exceed the above figures significantly at various positions within the school due to existing traffic conditions and would not be altered by the increase in flow from the upgrading at the plant.

Noise levels from traffic at other residences along Greendale Road east of the brick plant would meet the State Pollution Control Commission goal. (see **Appendix** 4).

Conclusion

The redevelopment of the Bringelly Brick Manufacturing Facility by the installation of more modern and efficient plant and equipment will not alter the noise levels experienced by the surrounding neighbours. The predicted noise levels from the operation will meet the State Pollution Control Commission planning limits for such an operation.

The noise produced by transportation will increase marginally due to the upgraded operation."

8.10 VISUAL IMPACT

The construction of the acoustic bunds will provide a visual buffer for surrounding properties along the eastern boundary of the site. The walls (up to 6 metres in height) will limit views into the site and mitigate noise impacts of the site activities. Once the trees and shrubs have matured, the views into the site will be of a treed hedge, densely underplanted with varied shrubs.

The views into the site along Greendale Road are limited at the present time due to the groves of trees remaining on the western boundary and along the road frontage. These will provide an ongoing buffer, even when the additional Stages 2 to 4 of the plant are being worked. The construction of the amenity bund at the front gate will improve the Greendale Road streetscape and reinforce the existing planting along the front boundary.

The existing site works and the proposed extensions are set well back from the street frontage and although the entry road rises slightly up to the buildings, the existing trees provide a good screen.

An area of screen planting is proposed around the car park and will ensure that the visual impact of the cars is minimal from Greendale Road.

Sight lines from nearest residences are shown on **Figure 21**. As shown, some views only of the stacks will be possible from isolated residences.

Visual impacts are rated as low.

8.11 ABORIGINAL RELICS

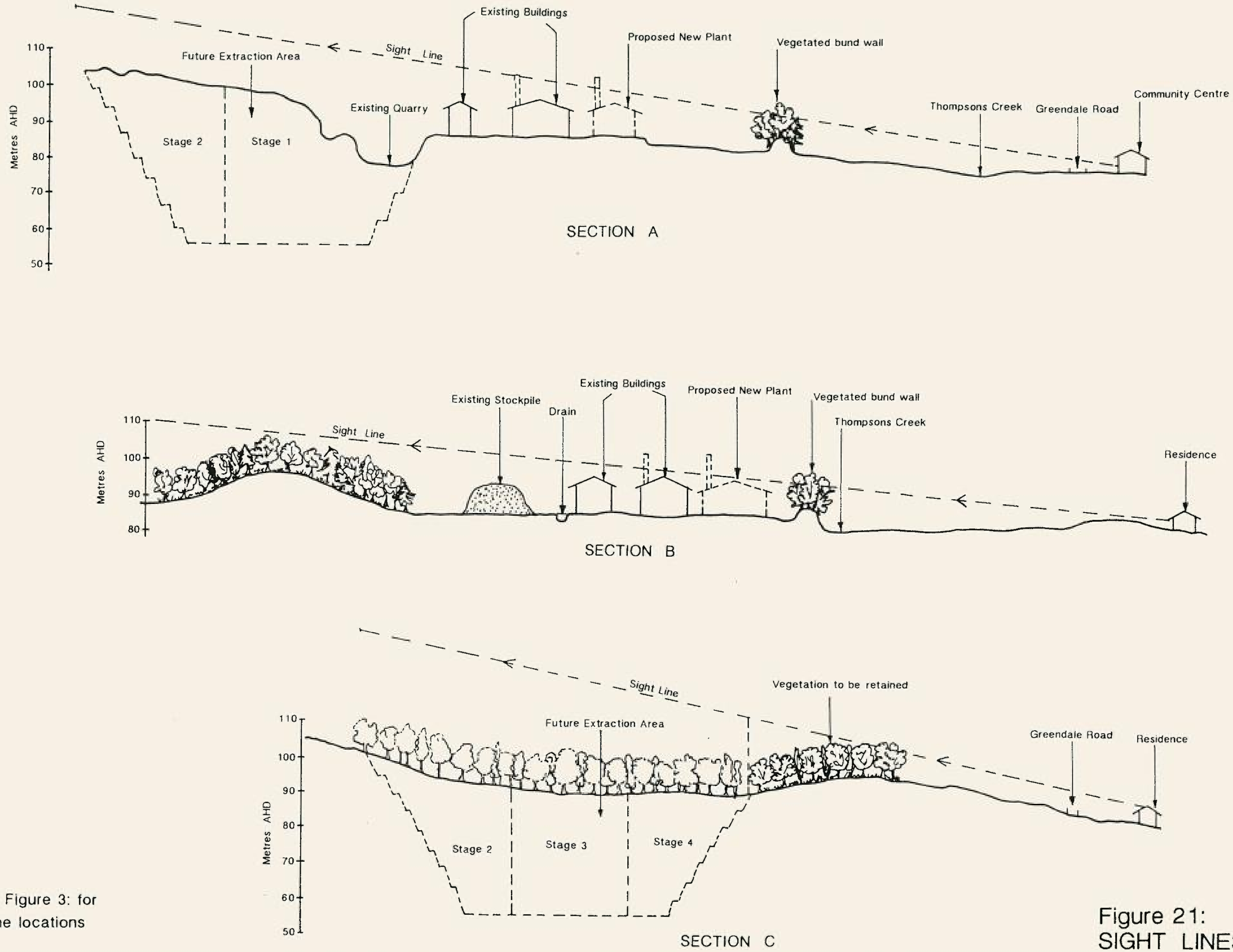
A full archaeological report is presented in **Appendix 5**.

A field survey of the proposed development area identified 4 isolated artefacts within the land to be affected by quarry extensions. The isolated flakes were each located on disturbed ground and had no stratigraphic context. The archaeological material, which is not considered to have scientific or cultural significance, will be destroyed by quarrying operations. The impact of the proposed development on the cultural resources of the Bringelly area is considered to be minimal.

8.12 PLANNING

The proposed development is a permitted use with Council consent and the concurrence of the Department of Planning. No rezoning will be necessary to permit the operation.

Studies have shown that all air, noise and water quality impacts will be contained within the property boundaries. External impacts to the site relate principally to traffic and as discussed in **Sections 7.11** and **8.15**, the proposed increases will be adequately catered for by proposed upgrading measures to be implemented. Vehicles will principally use designated main roads. Consequently, the containment of impacts on the site will ensure that there will be no significant impact on future planning proposals.



Refer to Figure 3: for Sight Line locations

Figure 21: SIGHT LINES

The utilisation of clay/shale on the site is in keeping with the objectives of Regional Environmental Plan 9. (see **Section 4.15**) and this is a positive beneficial impact of the development.

8.13 LAND USE

The land held by the Company is principally for the supply of clay/shale for brick and paver manufacture. The Company has no plans to subdivide the property in the short-term for rural-residential use. The vegetated/grassed paddocks provide a buffer zone to surrounding land uses.

The upgrading will have no direct detrimental impact on existing rural-residential, commercial, or special use land uses or proposals within the vicinity of the site. Impacts from noise, dust, and runoff, on surrounding land uses are discussed in **Sections 8.9**, **8.6**, and **8.5**, respectively.

8.14 PUBLIC UTILITIES

The Company will extend the existing water main in Greendale Road to provide reticulated water to the site principally for fire-fighting purposes, domestic applications, and production purposes. Most dust suppression water requirements will be drawn from on-site dams.

Existing power and telephone services will be augmented for the new development.

Sewage will be disposed of via an intermittent extended aeration activated sludge process which will replace the existing on-site transpiration bed system.

Natural gas which is already supplied to the existing plant will be extended to the new manufacturing plant.

8.15 ROADS

With commissioning of the new plant, approximately 9,000 of additional raw material will be imported to the site. As tabled in **Section 6.7.1** there will be a net increase in heavy truck movements of 258 trucks/week or approximately 48 additional truck movements per day. Based on current operating procedure (see **Section 5.4.1 (4)**) this will generate a peak of 8 additional trucks per hour entering The Northern Road intersection from Greendale Road. This additional traffic would then be evenly distributed on either The Northern Road (north or south) and Bringelly Road (east) (see **Section 5.4.3**).

As stated in **Section 6.7.2** traffic movements generated by employees and visitors will decrease from the present level of approximately 76 vehicle movements per day (maximum) (see **Section 5.4.2**) to 66 vehicle movements per day (maximum) once the new plant is commissioned.

No current traffic composition data is available for Greendale Road. Assuming 10% of the AADT is heavy vehicles, the upgrading of the plant will cause a 23% increase in heavy traffic on Greendale Road and a 2.3% increase in AADT. Heavy traffic on The Northern Road (north and south) and Bringelly Road will be increased by 1.1%, 1.6%, and 3.5% respectively.

The intersection of Greendale Road/Bringelly Road and The Northern Road will receive a peak increase of 8 trucks per hour as a result of the development. Assuming that the 30th highest hourly traffic volume is 10% of AADT, the additional traffic generated by the upgrading of the plant would cause a 5.9% increase in the 30th highest hourly volume of traffic entering the intersection from Greendale Road. The impact on other approaches to and exit from the intersection is negligible.

8.16 ENERGY IMPACTS

Section 7.9 describes measures to be employed to conserve energy on site.

Table 8.2 presents proposed increases in fuel and electrical energy use as a result of the upgrading proposal.

TABLE 8.2
INCREASES IN ENERGY USE

Fuel	Annual Increase In Use	Energy Equivalent
Natural Gas	119,818 GJ	119,818,000 MJ
Electricity	8,673,700 kWh	31,225,320 MJ
	TOTAL	**151,043,320 MJ** **= 15,043 GJ** **= 0.151 x 10^{15} J**

The additional use of 0.15 x 10^{15} J is 0.01% of the projected energy use by the NSW Clay Products industry in 1986–87 (Department of National Development, 1978) and is a negligible impact on energy use. Total energy use by the new plant is 2134.8 MJ/tonne of product.

8.17 SOCIO-ECONOMIC IMPACTS

The new plant and extensions to the Boral quarry will provide employment for an additional 17 people representing a 50% increase on the present workforce at the plant. This in turn accounts for 0.6% of the present workforce of the municipality. Given the rapid population increase which is expected in the municipality, the relative employment contribution by the brickworks will be positive, but very small.

In terms of the economics of providing quality bricks and pavers to a rapidly expanding market in the southwest of the Sydney Metropolitan area, the Boral plant at Bringelly is in a strong position. The brickworks utilizes a large, high quality clay/shale reserve recognised by the State Government in Regional Environmental Plan No. 9 (Extractive Industry).

Camden Council has publicly expressed a community concern that the heritage/rural character of the district should be preserved despite rapid population growth. In this context a cost effective local supplier of clay pavers for footpaths, cul-de-sac surfacing in residential areas, and paving of shopping precincts is of considerable value to town planners and landscape architects.

The upgrading will indirectly provide employment for construction and support services, such as equipment suppliers, business services, and retail trades which will be drawn from the local area wherever possible.

The proposed operation will provide a positive and beneficial impact on the local community base.

8.18 CUMULATIVE IMPACTS

The closest similar brickworks operation to the site is the Badgerys Creek brickworks of Boral which is approximately 15km northeast of the site. There are no other significant manufacturing industries within 10km of the site that would result in cumulative impacts.

ALTERNATIVES

9.0 ALTERNATIVES TO THE DEVELOPMENT

9.1 ALTERNATIVE SOURCES

The clay/shale resources of the Bringelly site have been identified as of strategic regional importance in Sydney Regional Environmental Plan No. 9 (Extractive Industry) and Planning Report (1986). Detailed geological exploration of the site has confirmed the presence of large reserves of high quality clay/shale suitable for brick and paver manufacture.

The decision to expand the Bringelly operation was taken after an exhaustive consideration of the advantages and disadvantages of expansion of the Company's other brick plants in New South Wales.

These considerations are summarised below.

Moorebank

1. Limited reserves; some clays and shales already being imported.

2. Abuts Nuwarra Road, Moorebank on the western boundary. Nuwarra Road is a major thoroughfare in a densely populated residential area, and is an arterial link between Newbridge and Heathcote Roads.

3. Abuts New Brighton Golf Club on the southern boundary.

4. Abuts (in part) Newbridge Road, a main arterial road between Liverpool and the inner Sydney Metropolitan area on the northern boundary.

5. Abuts flood prone land (Georges River) on the eastern boundary.

6. Is surrounded by extensive urban areas.

Prospect

1. Is close to the F4 Freeway on the northern boundary.

2. The plant was constructed in 1962 and has operated continuously since that date. The plant is now considered to be nearing the end of its economic working life.

Woonona

1. Approximately 50km from the Sydney Metropolitan market. Any expansion on this site would necessitate the transport of the product over long distances adding to the cost and eventually the selling price. This alternative is not generally considered viable.

2. The plant is surrounded by residential and partly zoned Scenic Protection land which limits the expansion of this facility.

Kempsey

1. Approximately 480km from the Sydney Metropolitan market. The expansion of this site would necessitate transport of the product over long distances adding to the cost and eventually the selling price. This alternative is not generally considered viable.

Badgerys Creek

1. This plant is the most modern of the New South Wales Boral plants. It operates at maximum capacity and consequently, any reduction from the manufacture of 65 million building bricks per annum to enable the manufacture of 40 million pavers per annum would upset the balance of the Company's manufacturing and marketing strategies.

2. The plant is a specialised brickmaking plant.

9.2 ALTERNATIVE QUARRY PLAN

The quarry plan proposed is the optimum for the recovery of proven reserves of high quality clay/shale occurring on the site. Considerable more reserves occur on the site to the south of the proposed extractive operation but these currently remain unproven and appropriate approvals will be sought for the exploitation of these reserves prior to their development. The extraction plan provides for access to high quality clay/shale with minimal overburden/interburden, close to the plant minimising haulage distances, with a high proportion of light-firing material. The new plant has been located in an area with extensive sandstone interbeds to avoid sterilisation of high quality ceramic materials.

The quarrying method is a proven technique used by Boral to maximise recovery of reserves of clay/shale occurring on the site, is technically very efficient, and provides for progressive rehabilitation. The alternative is to use a dozer, front-end loader and haulage trucks. In addition to being inefficient and expensive, the additional equipment leads to higher environmental noise and dust impacts at nearest residences, and is not considered an acceptable alternative.

9.3 ALTERNATIVE PLANT PROCESSES

The Company tendered for the supply and installation of the technology to be used in the upgrading proposal. The technology to be selected is the optimum economically and environmentally, and represents the most-up-to-date available to the industry.

The Company also considered alternative locations for the siting of the new plant, raw material stockpiles and primary crusher. The location selected is considered the optimum for this plant for the following reasons:

a) The requirement of relatively level topography for the siting of the plant.

b) The need to avoid sterilising reserves of high quality clay/shale.

c) The need to be close to the existing buildings for efficient management.

d) Close proximity to access roads and product stockpile areas for transport of products.

9.4 ALTERNATIVE OF NOT PROCEEDING

As discussed in **Section 3.0**, the technology used in the Bringelly plant is now outdated and its viability marginal. Due to high manufacturing and maintenance costs, the plant has been shut down and employees temporarily retrenched on four separate occasions during the past 20 years. To improve its viability, stabilise its workforce and continue to maintain its market position, upgrading of the plant is essential.

Should the upgrading proposal not proceed, the plant will continue to experience product difficulties and the temporary retrenchment of staff. The viability of the operation would be questionable and the option of closing the plant would need to be considered.

Given the strategic importance of the site, the extensive reserve of high quality clay/shale, and proximity to future population growth areas and the labour market, the alternative of not proceeding with the development cannot be either justified or warranted.

REFERENCES

REFERENCES

R.W. Corkery and Company Pty Ltd, 1984. Geological Report on Recent Diamond Drilling Undertaken Adjacent to the Bringelly Plant. **Prepared for Clark Brick Limited (April 1984).**

Department of Environment and Planning, 1984. Planning in Fire Prone Areas.

Department of Environment and Planning, 1986. Sydney Regional Environmental Plan No.9 (Extractive Industry) and Planning Report.

Department of Main Roads, 1987. Traffic Volumes and Supplementary Data. Sydney, Parramatta and Blacktown Divisions Department of Main Roads.

Department of Planning, 1990. Macarthur South. Background Paper.

Department of Planning, 1990. South Creek Valley. Background Paper.

Forster, G.R., Campbell, D., Benson,D., Moore,R.M., 1977
Vegetation and Soils of the Western Sydney Region of Sydney. **CSIRO Division of Land Use Research, Canberra, Technical Memorandum 77/10.**

Resource Planning 1989a. Resource Evaluation of the Bringelly Brickworks Site. **Prepared for Boral Bricks (NSW) Pty Limited (February 1989).**

Resource Planning 1989b. Resource Evaluation of the Western Portion of the Bringelly Brickworks Site. **Prepared for Boral Bricks (NSW) Pty Limited (June 1989).**

Senate Select Committee on Air Pollution, 1969. Report from the Senate Select Committee on Air Pollution Part 1–Report. **Commonwealth Government Printing Office, Canberra, 1969.**

Smith, L.J., 1988. The Cumberland Plains Project. National Parks and Wildlife Service Report.

Soil Consevation Service of New South Wales. Soil Landscapes of the Penrith 1:100 000 Sheet.

APPENDIX 1

RESPONSES FROM GOVERNMENT AGENCIES

New South Wales Government

Department of Planning

SEP

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

Telephone : (02) 391 2000
Fax No : (02) 391 2111

Contact V.Thomson Ext. 2077

Our reference : W90/0261

Your reference :

Boral Bricks (NSW) Pty Limited
PO Box 42
WENTWORTHVILLE NSW 2145

Dear Sir,

PROPOSED EXPANSION OF CLAY PIT AND BRICKMAKING FACILITIES, LOT 2 DP 733115, PARISH OF COOK.

Thank you for your letter of 20 July, 1990 indicating that you are consulting with the Director with regard to the preparation of an environmental impact statement (EIS) for the above development.

2. As development consent is required for the proposal and it is a designated development within the meaning of Schedule 3 of the Environmental Planning and Assessment Regulation, 1980, as amended, an EIS must accompany the development application to the Camden Municipal 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).

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

- Reference to Macarthur Regional Environmental Study, Macarthur Rural Lands draft R.E.P., Sydney Regional Environmental Plan No. 9, State Environmental Planning Policy No. 11, South Creek Regional Environmental Study;
- Impacts on small rural holdings in the vicinity;
- Impacts of increased truck traffic on Bringelly Road;
- Potential for flooding and/or drainage problems;
- Potential air pollution impacts from brickmaking;
- Results of consultation with NSW Department of Agriculture and Department of Water Resources.

JH

4. 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.

5. In preparing your EIS you should approach the Camden Municipal Council and take into account any comments Council considers may apply to its determination of the proposal.

6. Should you require any further information regarding this matter please do not hesitate to contact us again.

Yours faithfully,

M K Smith 11/9/90

for Barbara Adams
Manager, Assessments Branch
As Delegate for the Director.

DEPARTMENT OF PLANNING
ATTACHMENT NO. 1

STATUTORY REQUIREMENTS FOR ENVIRONMENTAL IMPACT STATEMENTS

In accordance with Part IV of the Environmental Planning and Assessment Act, 1979, an environmental impact statement (EIS) must meet the following requirements.

Pursuant to clause 34 of the Environmental Planning and Assessment Regulation, 1980, as amended, the contents of an EIS shall include the following matters:

(a) full description of the designated development proposed by the development application;
(b) a statement of the objectives of the proposed designated development;
(c) a full description of the existing environment likely to be affected by the proposed designated development, if carried out;
(d) identification and analysis of the likely environmental interactions between the proposed designated development and the environment;
(e) analysis of the likely environmental impacts or consequences of carrying out the proposed designated development (including implications for use and conservation of energy);
(f) justification of the proposed designated development in terms of environmental, economic and social considerations;
(g) measures to be taken in conjunction with the proposed designated development to protect the environment and an assessment of the likely effectiveness of those measures;
(g1) details of energy requirements of the proposed development and measures to be taken to conserve energy;
(h) any feasible alternatives to the carrying out of the proposed designated development and reasons for choosing the latter; and
(i) consequences of not carrying out the proposed development.

The EIS must also take into account any matters required by the Director of Planning pursuant to clause 35 of the Regulation, which may be included in the attached letter.

The EIS must bear a certificate as required by clause 26(1)(b) of the Regulation.

DEPARTMENT OF PLANNING

ATTACHMENT NO. 2

ADVICE ON THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR A CERAMIC WORKS

An EIS is required to be completed, pursuant to paragraph (g), Schedule 3 of the Environmental Planning and Assessment Regulation, 1980, (as amended), for a ceramic works, being works in which more than 200 tonnes per annum of any bricks, tiles, pipes, pottery goods, refractories or glass are manufactured or are capable of being manufactured in furnaces or kilns by any fuel. The reason for designation is that developments of these types have the potential to create considerable public nuisance due to noise, dust, and wastes which affect air and water quality.

(N.B. When determining the capacity of the works in this regard, it is considered reasonable to take into account the daily working hours, the working week and working year normal for such a plant and the maximum production rate of the plant to be installed).

The purpose of this paper is to outline various issues relevant to the preparation and consideration of an EIS for a ceramic works. It is intended to assist the preparation of the EIS. It is the applicant's responsibility to identify and address, as fully as possible, the matters relevant to the specific development proposal in complying with the statutory requirements for EIS preparation (see Attachment No. 1).

The matters nominated in this paper are not intended as a comprehensive identification of all issues which may arise in respect of such work. Some of the issues nominated may not be relevant to a specific proposal. On the other hand, there may be other issues, not included, that are appropriate for consideration in the EIS.

Information provided should be clear, succinct and objective and where appropriate be supported by maps, plans, diagrams or other descriptive detail. The purpose of the EIS is to enable members of the public, the consent authority (usually the Council) and the Department of Planning to properly understand the environmental consequences of the proposed development.

1. Description of the proposal.

The description of the proposal should provide general background information on the location and extent of the works, existing and proposed, an indication of adjacent developments, and details of the site, land tenure, zonings and relevant forward planning proposals and any other land use constraints.

The extent to which the supply of raw materials and access to markets for the finished product has determined the location of the plant in preference to alternative sites should be stated.

This section should provide specific information on the nature, intent and form of the development. It should, as far as possible, include such details as the processes involved, wastes created and landscaping. A description should also be provided of associated operations such as the transport of materials and the use of the end product if such use is likely to have environmental implications.

Particular details that may be relevant include:

- Criteria used in selecting the proposed site .
- Feasible alternatives to the proposal and reasons for their rejection.
- The type of kiln, other machinery and processes to be used.
- Plant capacity.
- Pollution and environmental controls (including monitoring), and details of the quantities and types of any emissions.
- Sources and quantities of raw materials.
- Storage arrangements of raw materials and products, with environmental safeguards proposed.
- Proposed landscaping and building design.
- Transportation arrangements including means of access to site, on-site parking, truck routes, truck and car movements.
- Site drainage and erosion controls.
- Type of fuel to be used to fire furnaces, fuel specification and source.
- A list of any chemicals or hazardous materials used or stored, rate of usage, storage arrangements.
- Workforce requirements, including transport workforce.
- Hours of operation.
- Proposals for future expansion, including staging and likely implementation timing.

2. Description of the Environment

This should provide details of the environment in the vicinity of the development site and also of aspects of the environment likely to be affected by any facet of the proposal. In this regard, physical, natural, social, archaeological and economic aspects of the environment should be described to the extent necessary for assessment of the environment impact of the proposed development.

3. Analysis of Environmental Impacts.

Potential environmental impacts usually associated with these types of operations are listed below. Where relevant to the specific proposal, these should be addressed in the EIS, taking into account the adequacy of safeguards proposed to minimise them.

- Likely noise disturbance caused by the operations, including transport operations, on nearby residents, particularly at night.
- Other impacts of trucking movements, including access across railways and on to highways.
- Potential for air pollution, particulate matter.
- Water management: including water requirements and separating clean and contaminated runoff before discharge; water treatment; quality and quantity of effluent for disposal.
- Treatment and disposal of waste material.
- Effects on the visual environment.

In addition, any potential for fire hazard or risks to public safety and any proposals to monitor and reduce environmental impact should be included.

4. Contact with relevant Government Authorities.

In preparing the EIS, it is suggested that authorities, such as those listed below, should be consulted and their comments taken into account in the EIS.

- The State Pollution Control Commission in regard to air, water and noise impacts and relevant pollution control legislation requirements;
- The Heritage Council of NSW if the proposal is likely to affect any place or building having heritage significance for the State; the National Parks and Wildlife Service if aboriginal places or relics are likely to be affected;
- The Department of Agriculture and Fisheries if prime agricultural land may be affected by the proposal.

It is the responsibility of the person preparing the EIS to determine those Departments relevant to the proposed development.

DEPARTMENT OF PLANNING
ATTACHMENT NO 2

ADVICE ON THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR AN EXTRACTIVE INDUSTRY

A definition of extractive industry may be found in paragraph (n) to Schedule 3 of the Environmental Planning and Assessment Regulation, 1980, (as amended). These industries are operations undertaken for the purpose of mining sand, gravel, clay, turf, soil, rock, stone or similar substances. The definition of extractive industry specifically excludes coal, petroleum or minerals which are prescribed under the Mining Act, 1973. Extractive industries may take the form of dredging operations, quarrying operations, turf farms or various forms of land excavation etc. Processing of extracted material on the same site as the winning of the material may also constitute an extractive industry.

Extractive industries have prompted considerable public controversy in the past since, among other things, they affect visual amenity, generate heavy vehicle movements, raise dust and cause disturbance through noise and blasting. This is the prime reason for designation of extractive industries under the Environmental Planning and Assessment Act, 1979.

The purpose of this paper is to outline various issues relevant to the preparation and consideration of an EIS for extractive industries. It is intended to assist the preparation of the EIS. However, it is the applicant's responsibility to identify and address as fully as possible the matters relevant to the specific development proposal in complying with the requirements for EIS preparation (see Attachment No 1).

The matters nominated in this paper are not intended as a comprehensive identification of all issues which may arise in respect of an extractive industry. Some of the issues nominated may not be relevant to a specific proposal. On the other hand, there may be other issues, not included, that are appropriate for consideration in the EIS.

Information provided should be clear, succinct and objective and where appropriate be supported by maps, plans, diagrams or other descriptive detail. The purpose of the EIS is to enable members of the public, the consent authority (usually the Council) and the Department of Planning to properly understand the environmental consequences of the proposed development.

1. Description of the proposal.

The description of the proposal should provide general background information on the location and extent of the works proposed, an indication of adjacent developments, and details of the site, land tenure, zonings and relevant forward planning proposals and any other land use constraints.

2/...

The EIS should address the compatibility of the proposal with any regional strategy for extractive industries in the area and with the provisions of the Local Environmental Plans for existing and proposed development.

This section should provide specific information on the nature, intent and form of the development. It should, as far as possible, include such details as the processes involved (highlighting any proposed crushing or blasting), disposal of wastes, landscaping and site rehabilitation. A description should also be provided of associated operations such as the transport of materials and use of the end product if likely to have environmental implications.

Particular details that may be relevant include:

- Characteristics and economic significance of the resource.
- Possible availability of alternative resources.
- Quantity of materials to be extracted.
- Details of any blasting and/or crushing.
- Effects of vibrations.
- Type of machinery and equipment to be used for dredging and stockpiling operations and for any processing plant.
- Expected life of the operation.
- Hours of operation.
- Details of necessary stockpiling.
- Access arrangements - truck routes, truck numbers etc.
- Site drainage and erosion controls.
- Proposals for rehabilitation.

2. Description of the Environment.

This should provide details of the environment in the vicinity of the development site and also of aspects of the environment likely to be affected by any facet of the proposal. In this regard, physical, natural, social, archaeological and economic aspects of the environment should be described to the extent necessary for assessment of the environmental impact of the proposed development.

3. Analysis of Environmental Impacts.

Environmental impacts usually associated with extractive industries are listed below. Where relevant to the specific proposal, these should be addressed in the EIS, taking into account the adequacy of safeguards proposed to minimise them.

- The flow of any affected rivers or watercourses.
- The effect of the extraction on the sediment transport rate of any affected rivers or watercourses.
- The bed and bank stability of any affected rivers during and after completion of the operations and any need for recurrent maintenance dredging.
- Any possible siltation, sedimentation or downstream effects of the operation.
- Any likely cumulative effects of the proposed operation when considered together with other operations in the vicinity.

- Details of floods and any likely effects of the operation on flood liability of surrounding lands.
- The possible effects of flooding on the operation.
- Effects on flora and fauna.
- The agricultural viability of the landholding.
- Likely noise/vibration disturbance caused by the operations, including transport operations, on nearby residences.
- Other impacts of trucking movements, including access over railways and onto highways.
- Dust nuisance likely to be caused.
- Effects on water quality of nearby watercourses.
- Disposal of waste material.
- Effects on the visual environment.
- Any likely affectation of sites of Aboriginal archaeological or European heritage value if located in the vicinity of operations.
- Impact of the operations on navigation aspects for all types of shipping (commercial, recreational, etc).

In addition, any potential for hazard or risks to public safety and any proposals to monitor and reduce environmental impacts should be included.

4. Contact with relevant Government Authorities.

In preparing the EIS, it is suggested that authorities, such as those listed below, should be consulted and their comments taken into account in the EIS.

- The State Pollution Control Commission in regard to air, water and noise impacts and relevant pollution control legislation requirements;
- The Department of Minerals and Energy concerning its responsibilities under Sydney REP No 9 Extractive Industry;
- The Department of Water Resources concerning the implications of the proposal on their jurisdiction;
- The Soil Conservation Service regarding appropriate erosion control and rehabilitation procedures;
- The Department of Agriculture and Fisheries if prime agricultural land may be affected by the proposal;
- The Heritage Council of NSW if the proposal is likely to affect any place or building having heritage significance for the State; the National Parks and Wildlife Service if aboriginal places or relics are likely to be affected.
- The Maritime Services Board in relation to navigational aspects of shipping; and
- The Public Works Department in relation to hydrological impacts and relevant legislative requirements.

It is the responsibility of the person preparing the EIS to determine those Departments relevant to the proposed development.

THE COUNCIL OF THE MUNICIPALITY
OF CAMDEN

(Incorporated 1889 — Reconstituted 1949)

Council Office,
37 John Street,
Camden, N.S.W.
DX 5126
Campbelltown
Telephone: (046) 55 2455
(046) 55 2568
Facsimile: (046) 55 2770

- 3 AUG 1990

(OUR REF.:) MEIER:IG:1537/00

(YOUR REF.:)

30th July, 1990

Mr F A Salgado
Manager
Environmental Services
Boral Research
P O Box 42
WENTWORTHVILLE NSW 2145

Dear Sir,

RE: BRINGELLY BRICKWORKS - LOT 2 DP208850 GREENDALE ROAD, BRINGELLY

Reference is made to your letter dated 20th July, 1990 regarding the proposed extension of the abovementioned development and Council's previous letter dated 27th July, 1990, and Council now wishes to advise as follows.

The subject property is zoned Non-Urban (40ha) under Interim Development Order No. 7. The properties immediately adjacent are also zoned Non-Urban (40ha) (I.D.O. 7) with an area adjoining to the north-east being zoned Non-Urban (2ha) also under I.D.O. 7 as amended by Camden Local Environmental Plan No. 21. The subject property is not currently affected by any local environmental plans or development control plans.

Council currently has a draft environmental planning instrument on exhibition, that is, Draft Local Environmental Plan No. 48, which proposed to zone the subject property Rural 'A' (40ha). A copy of the current planning instrument and the draft are enclosed for your information.

In regards to Question 6, as previously advised the proposal falls within the definition of Designated Development under Schedule 3 of the Environmental Planning and Assessment Regulation, 1980, being:

"ceramic works, being works in which more that 200 tonnes per annum of any products such as bricks, tiles, pipes, pottery goods, refractories or glass are manufactured or are capable of being manufactured in furnaces or kilns fired by any fuel;".

...2/

In accordance with the requirements of the Environmental Planning and Assessment Act, 1979 (as amended) and Regulation, the preparation and submission of an Environmental Impact Statement (EIS) is required. Attached for your information is a list of some of the requirements for the preparation of the required EIS, this list is not exhaustive and you are required to contact the Department of Planning to ascertain specific requirements.

In regards to Questions 1, 2 and 3 please find attached the relevant forms and schedule.

Should you have any further enquiries in relation to this matter, please do not hesitate to contact Council's Town Planning Department.

Yours faithfully,

I.R.Pa

I. R. POWER,
CHIEF TOWN PLANNER gp

attch.

A statement of objectives should be prepared as a preamble. Such should state the principal objectives of the proposal and its relative significance in a local and regional context in particular.

(a) Nature and Extent of the Proposal

Description of the proposal focussing in particular upon the physical characteristics so as to facilitate an understanding and assessment of the full implications of the proposal both short and long term.

(b) Description of the Environment

An account of the total environment affected by the proposal, detailing in particular:

i Zoning
ii landuse (existing and proposed)
iii land ownership/location of nearby residents
iv nature of infrastructure (existing and proposed)
v topography
vi hydrology
vii micro climate (rainfall and prevailing winds in particular)
viii air quality
ix soil and geological conditions
x ecology (flora, fauna, significant species or associations)
xi archaeology

(c) Potential Environmental Impacts

An account of the potential environmental impacts and importantly measures to mitigate against adverse impacts.
Examples although by no means exhaustive include:-

* Pollution of natural watercourses (constructions and past constructions)
* Hydrology (in particular impact upon water table and subsurface stability and salinity).
* Air quality (dust etc)
* Noise (in particular relative to existing residents)
* Ecological impacts (flora and fauna)
* Visual impact

(d) Positive Aspects of the Proposal

An account of the positive attributes of the proposal in an environmental context.

(e) Negative Aspects of the Proposal

An account of the negative attributes of the proposal in an environmental context.

(f) Conclusion/Overview

20 JUL 1990

THE COUNCIL OF THE MUNICIPALITY OF CAMDEN

(Incorporated 1889 — Reconstituted 1949)

Council Office,
37 John Street,
Camden, N.S.W.
DX 5126
Campbelltown
Telephone: **(046) 55 2455**
(046) 55 2568
Facsimile: (046) 55 2770

(OUR REF.: PASCOE/BROWN: SL: 1537/00

(YOUR REF.:)

18th July, 1990

Mr J Wallace
Manager Technical Service
Boral Research
P.O. Box 42
WENTWORTHVILLE, NSW, 2145

Dear Sir,

RE: BRINGELLY BRICKWORKS - GREENDALE ROAD, BRINGELLY

Reference is made to your letter dated 26th June, 1990 concerning the upgrading of the existing brickworks situated on the abovementioned property.

I wish to advise that perusal of Councils records has not uncovered any consent issued in respect of the existing development. Notwithstanding this aspect, the matters raised in your letter have been assessed.

It is advised that the proposal falls within the definition of Designated Development under Schedule 3 of the Environmental Planning and Assessment Act, being:-

> "Ceramic works, being works in which more than 200 tonnes per annum of any product such as bricks, tiles, pipes, pottery goods, refractories or glass are manufactured or are capable of being manufactured in furnaces or kilns fired by any fuel".

As such an Environmental Impact Statement should be prepared by a qualified person in the field addressing such matters as existing development; future of existing development; rehabilitation proposals; extent of new work (extraction); noise impact,; visual impact; traffic; air quality; water impact; geology and land management. This list is not exhaustive and Council will be guided by the Department of Planning.

In this regard it will be necessary for your consultant to approach the Department of Planning to ascertain their specific requirements under the Act.

.../2

Should you require any further information please do not hesitate to telephone Mr G Pascoe or Mrs E Treglown of Council's Town Planning Department.

Yours faithfully,

G.G. PASCOE
DEPUTY CHIEF TOWN PLANNER

THE COUNCIL OF THE MUNICIPALITY OF CAMDEN

(Incorporated 1889 — Reconstituted 1949)

Council Office,
37 John Street,
Camden, N.S.W.
DX 5126
Campbelltown
Telephone: **(046) 55 2455**
(046) 55 2568
Facsimile: (046) 55 2770

(OUR REF.:) MEIER:IG:1537/00

(YOUR REF.:)

10th December, 1990

Resource Planning
Fax: 049-331107

ATTENTION: PAM DEAN-JONES/VAL SMITH

Dear Madam,

RE: BRINGELLY BRICKWORKS - LOT 2 DP208850 GREENDALE ROAD, BRINGELLY

Reference is made to your recent enquiries regarding the proposed extension of the abovementioned development and Council wishes to advise as follows.

The subject property is zoned Non-Urban (40 hectares) under Interim Development Order No. 7. Extractive Industries are a permissible use under the relevant zone with Council consent and the concurrence of the Department of Planning. Interim Development Order No. 7 adopts the Model Provisions 1970 which defines extractive industry as follows:

> "Extractive Industry means an industry or undertaking, not being a mine, which depends for its operations on the winning of extractive material from the land upon which it is carried out on."

The proposed expansion of the clay quarry operations and extensions to the existing brickworks would appear to be a permissible use subject to compliance with the "extractive industry" definition of the Model Provisions 1970 and the provisions of Interim Development Order No. 7.

Should you require any further details regarding this matter, please contact Jacqueline Meier of Council's Town Planning Department.

Yours faithfully,

G. G. PASCOE
DEPUTY CHIEF TOWN PLANNER

-8 AUG 1990

New South Wales Government

Soil Conservation Service

Mr F.A. Salgado
Manager, Environmental Services
Boral Research
P.O. Box 42
WENTWORTHVILLE NSW 2145

P.O. Box 651
PENRITH NSW 2751

Phone: (047) 21 0188
Fax: (047) 21 0181

Contact: Neville Pavan

Our reference:

Your reference: FS0074:VC

Dear Mr Salgado,

RE: PROPOSED EXTENSION OF EXISTING CLAY BRICK MANUFACTURING FACILITY - BRINGELLY

I refer to your letter of 24th July, 1990, seeking comment on matters relevant to the Soil Conservation Service, which should be considered during the preparation of an Environmental Impact Statement for the subject proposal.

The Soil Conservation Act, 1938 makes provision for the conservation of soil and water resources and for the mitigation of erosion within New South Wales. Any activity which disturbs the natural ground surface or the protective vegetation cover constitutes an erosion hazard necessitating the adoption of adequate control measures to minimise environmental degradation.

As you are aware, erosion and sediment control is an important environmental consideration prior to and during any activity and/or development. It is essential to minimise on-site erosion, and offsite sedimentation of adjacent properties, streams, waterbodies and the like.

In this context, a progressive erosion and sediment control program should be implemented from the initial operation stage until the proposal has been completed and the site fully stabilised and/or landscaped.

Such a program should consider:

1. Control of surface drainage (especially in main watercourses)

2. Early revegetation of completed development areas (i.e., plant redevelopment and clay pit development areas)

3. The construction of Sediment Trapping Structures (e.g., sediment basins, hay bale and geotextile fences).

Additionally I have enclosed a copy of the Services "Guidelines and Requirements for Urban and Associated Developments" especially prepared to assist with soil conservation sections of Environmental Impact Statements and Environmental Studies.

In respect to the subject proposal, the Service would welcome the opportunity to discuss erosion and sediment control in more detail. For further information or advice, please do not hesitate to contact me at the Service's Penrith Office on (047) 21 0188 which in future will handle enquiries for this area.

Yours faithfully,

Neville Pavan

N. PAVAN
District Soil Conservationist
PENRITH

2nd August 1990

22 AUG 1990

New South Wales Government

National Parks and Wildlife Service

SOUTH METROPOLITAN DISTRICT

Royal National Park
P.O. Box 44
Sutherland, N.S.W. 2232

Boral Resources (NSW) Pty Ltd
P.O. Box 42
WENTWORTHVILLE NSW 2145

Our reference: EAI 14 Sec 284

Your reference: CD:JT

Telephone: 542 0666
Facsimile: 542 1420
Telex: AA178004

Enquiries: C. Davidson

ATTENTION: Environmental Services

Dear Mr. Salgado,

Re: Proposed extension to Clay Brick manufacturing facility - Bringelly.

Thank you for the opportunity to advise at this early stage. The Service requires that the EIS adequately assesses all archaeological aspects of the area. Such assessment will of course be undertaken by an archaeologist. Should you experience any difficulty in engaging an archaeologist the Service's Cultural Resources Co-ordinator, Bronwyn Conyers, at Central Region office would be only too happy to offer further advice and assistance.

Yours faithfully,

J.C. Govan,
for W.J. Gillooly,
Director.

14 August, 1990.

New South Wales Government

State Pollution Control Commission

Civic Tower
Jacobs Street and Rickard Road
Bankstown 2200
PO Box 367
Bankstown 2200

Our reference: 820747 C1 RA: LDZ
[IW.SSRAE001.LTR]

Your reference:

Telephone: (02) 793 0000
Fax: (02) 793 0002

16 JAN 1991

The Manager
Boral Research
P O Box 42
WENTWORTHVILLE NSW 2145

ATTENTION: **Mr F A Salgado**

Dear Sir

<u>PROPOSED EXTENSION OF EXISTING CLAY BRICK MANUFACTURING FACILITY AT BRINGELLY</u>

I refer to your letter dated 20 July 1990, seeking the Commission's comments for the Environmental Impact Statement relating to the above proposal. I apologise for the late reply to this matter.

The premises are currently scheduled under the Clean Air Act and Noise Control Act. The company will need to apply for a Pollution Control Approval before the proposed work can commence.

<u>Air Pollution</u>

The EIS should specify the methods to be employed to control dust emanating from the extraction of clays, stockpiles, crushers, grinding and transportation activities.

Fluorine analysis of the clays and shale from the quarry site will be required. Fluorine, hydrofluoric acid or any inorganic fluorine compound in each cubic metre of residual flue gases after completion of the process and before admixture of air, smoke or other gases shall not exceed the equivalent of 0.05 gram of hydrofluoric acid.

A dispersion model of the flue gases is required to determine the ground level concentrations, and should include wind velocity and direction. The eflux velocity of the flue gases shall not be less than 15 metres per second. The stack height shall be set by the Commission. Monitoring of particulates and gases in the flue stack will be required.

Burners shall be self-proportioning and shall be so adjusted as to supply sufficient air for complete combustion of the gases.

Noise Pollution

A noise impact statement should address the noise levels of all fixed and mobile plant and indicate the predicted noise level at the boundary of the premises and at the nearest residential premise.

Blasting

Air blast overpressure, noise level and vibration, peak velocity limits should also be addressed if blasting is part of the quarrying process.

Water

The Commission would suggest that all stormwater be directed to and collected in holding ponds on site. The water should be used for dust suppression on site and process water where applicable. A licence will be required under the Clean Waters Act for the ponds.

For further information on this matter please contact Mr Rod Aubrey on 793 0145.

Yours faithfully

for 11/1/91

A R G Hewett
REGIONAL MANAGER, SOUTHERN SYDNEY

File Nº:

Our Ref.:

P.Dean-Jones
Resource Planning P/L
Box 388
East Maitland
2323

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

Dear Pam,

Boral Brickworks - Bringelly

Reference is made to your letter of the 22nd October 1990 regarding the need for an archaeological assessment for the abovementioned project. In July 1990 Boral wrote to the Service and were advised by the District that an archaeological survey was required (in a letter dated 14.8.90).

A survey is still considered necessary. We have no record of any Aboriginal sites in the area, but it has not been surveyed previously.

Yours faithfully,

B. Conyers

B.Conyers
for Director
23.10.90

Central Region
10 Valentine Avenue
Parramatta

PO Box 95
Parramatta NSW 2124

Phone: 02 895 7420
Fax: 02 895 7414

16 AUG 1990

New South Wales Government

Water Resources

[JRI346L]

Boral Resources (NSW) Pty Limited
PO Box 42
WENTWORTHVILLE NSW 2145

Attention: F.A. Salgado

Telex: 121188
Facsimile: (02) 895 7281
Telephone: (02) 895 6211
Ext: 7441
Contact Name: Mr J.A. Ross
Our Reference: 0024008
Your Ref: FS0074:VC

8.8.90

Dear Sir/Madam,

Re: E.I.S. Requirements for Proposed Extension - Clay Brick Manufacturing Facility - Bringelly

Thank you for your letter of July 24, 1990, seeking this Department's comments and requirements for the above E.I.S.

Enclosed for your information and retention are the following Departmental documents:

a) "A Guide to Stream Channel Management";

b) "The 7 - Step Method of Controlling Bank Erosion and Sediment Build-Up"; and

c) "General Requirements for Environmental Impact Statements". (This is essentially a checklist of water resources matters to be addressed in the assessment of environmental impacts).

The Department would appreciate being sent a draft copy of the subject E.I.S. for review. It would be worth noting that if multiple copies of the draft document can be made available (even on a loan basis) this helps significantly to expedite the review process.

I trust the above and enclosed information will prove useful.

Yours faithfully,

John A. Ross
for Manager,
Investigations Unit
Technical Services Division

Encl.

Department of Water Resources • 10 Valentine Avenue, Parramatta • P.O. Box 3720, Parramatta NSW 2124.

To Mary K.

DEPARTMENT
OF LANDS

AUG

Boral Resources (NSW) Pty Limited
P O Box 42
WENTWORTHVILLE NSW 2145

YOUR REF
OUR REF AAD-B
CONTACT OFFICER
TELEPHONE NO 671-8857

Dear Sir,

I refer to your letter of 27th July, 1990 regarding proposed extension of existing clay brick manufacturing facility at Bringelly.

The subject land is not Crown land therefore this Office has no comments or requirements regarding your proposal.

Yours faithfully,

2/8/90

J. GREEN
for REGIONAL MANAGER

Level 4/22 Main Street Blacktown NSW Australia 2148 PO Box 878 Blacktown NSW Australia 2148
Telephone (02) 671 8611 Fax (02) 671 8858

NEW SOUTH WALES GOVERNMENT

PJm

22 AUG 1990

Department of Minerals and Energy

NEW SOUTH WALES GOVERNMENT

MINERALS AND ENERGY HOUSE
29–57 CHRISTIE STREET
CORRESPONDENCE PO BOX 536
ST LEONARDS NSW 2065
DX 3324 ST LEONARDS
TELEPHONE (02) 901 8888
FACSIMILE (02) 901 8777

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

Our Ref: L90/0556

ATTENTION: FA SALGADO

Dear Sir

RE: PROPOSED EXTENSION TO EXISTING CLAY BRICK MANUFACTURING FACILITY BRINGELLY

I refer to your letter of the 27th July, 1990 regarding the preparation of an environmental impact statement (EIS) for the proposed extensions to the above brickmaking plant and to the existing quarry.

Although clay/shale is classified as a mineral under the Mining Act (1973), it is likely in this case that the mineral is privately owned. This Department therefore has no statutory control over its extraction apart from its role under the Mines Inspection Act (1901), with respect to safe conduct of quarrying operations, and its role under Sydney Regional Environmental Plan No 9 - (Extractive Industry) (Sydney REP9). This site is identified in Sydney REP9 as containing a clay shale resource of regional significance.

Under the provisions of Clause 11 of Sydney REP9, the concurrence of this Department is required for any development within the site other than for the purposes of extractive industry. Concurrence would not be required for the quarry extension but would be required for the proposed extensions to the manufacturing plant. However provided that the plant extensions do not result in the unnecessary sterilization of significant resources of clay/shale it is expected that concurrence would be granted.

Concurrence cannot be granted until the development application has been formally referred to the Department by the determining authority. However the Department would be able to provide a prior indication of the likelihood of concurrence being granted if you forward details of the impact of the proposed plant extensions on underlying clay/shale resources or a draft copy of the EIS.

The following issues should be addressed in the EIS:

* Characteristics of the resource - geology, size and quality.
* Exploration methods and results (including references to any relevant supporting documentation).
* Method of extraction, plan of operation (including staging).
* Rehabilitation procedures, during and after extraction operations.
* Quantity of material to be extracted.
* Rate of extraction.

* Expected life of the operation.
* Proposed final use of site.
* Disposal of waste materials.
* Location and size of stockpiles.
* Sources and quantities of any raw materials obtained from outside the site.
* Transport routes.
* Assessment of noise, vibration, dust, and visual impacts, proposed measures to minimize these impacts.
* Any likely cumulative impacts of proposal when considered together with similar operations in the vicinity.
* Alternative sources, and their availability.
* Details of any resources which will be sterilized by the proposed plant extensions and justification for their sterilization.
* Justification for the proposal - the need for the proposed operation in a local or regional context.

Any further queries you may have concerning this matter can be directed to Janelle Spackman, Geologist, on (02) 901 8367.

Yours faithfully

SR Lishmund
for Director-General

15/8/90

17 AUG 1990

Our Reference: PS:SB
Mr Steele
831-0936

Roads and Traffic Authority
Sydney Western Region

RTA

83 Flushcombe Road
Blacktown
New South Wales 2148
Telephone (02)831 0911
Facsimile (02)621 5543
PO Box 558
Blacktown NSW 2148
DX 8120

The Manager
Environmental Services
Boral Research
PO Box 42
WENTWORTHVILLE NSW 2145

Attention: Mr F Salgado

PROPOSED EXTENSION OF EXISTING CLAY BRICK MANUFACTURING FACILITY - BRINGELLY.

Dear Sir

I refer to your letter of 31 July 1990 and subsequent discussions and confirm that the Authority would generally like to see an Environmental Impact Statement give consideration to:-

(i) Traffic demands and how that demand is to be accommodated on the existing Regional road network. Information on traffic movements per week, including tonnage, would assist in assessing the impact, if any, of the development on the major road network, and what steps in terms of traffic management measures are required;

(ii) Where traffic generation is high and involving heavy vehicles, consideration could be given to the issue of road maintenance. Following a number of Appeals, including <u>Collin C Donges v Baulkham Hills Shire Council</u> (unreported 4 May 1989), the Authority is pursuing the indexed levy rate of three cents per payload tonne kilometre applied to major heavy truck movements where appropriate; and

(iii) Where intersection layout is poor, what improvements are required in terms of traffic and safety to accommodate turning movements, street signs, parking restrictions, street lighting, pavement condition, etc and the cumulative effect of the proposal with other developments in the area.

I trust the above information assists.

Yours faithfully

P Steele
Strategic Planner

16 AUG 1990

15 AUG 1990

Roads and Traffic Authority
Sydney Western Region

R T A

83 Flushcombe Road
Blacktown
New South Wales 2148
Telephone (02)831 0911
Facsimile (02)621 5543
PO Box 558
Blacktown NSW 2148
DX 8120

Our Reference: 75.5351 AD:KM
Mr Moon
831 0965

The Manager
Environmental Services
Boral Research
PO Box 42
WENTWORTHVILLE NSW 2145

Attention: Mr F Salgado

13 AUG 1990

PROPOSED EXTENSION OF EXISTING CLAY BRICK MANUFACTURING FACILITY. BRINGELLY

Dear Sir

I refer to your letter dated 31 July, 1990 seeking the Authority's requirements for inclusion in an Environmental Impact Statement for the subject site.

The Authority, while noting the anticipated truck movements of 90-110 movements per day, would request that some indication be given into the routes these vehicles will take when leaving the site. The peak arrival and departure times of both commercial and private vehicles would also need to be addressed as well as the hours of operation.

Because of the sites location, the authority would require that a passing lane be provided at the entrance to the site on Bringelly road similar to a NAASRA type B intersection (copy attached). This would allow vehicles to enter and leave the site with a minimum disruption to passing traffic on Bringelly Road.

Yours faithfully

C. Ford.

C Ford
Development & Road Safety Manager

Copy to :: 1. Resource Planning
2. Ray Kerrigan

15/8

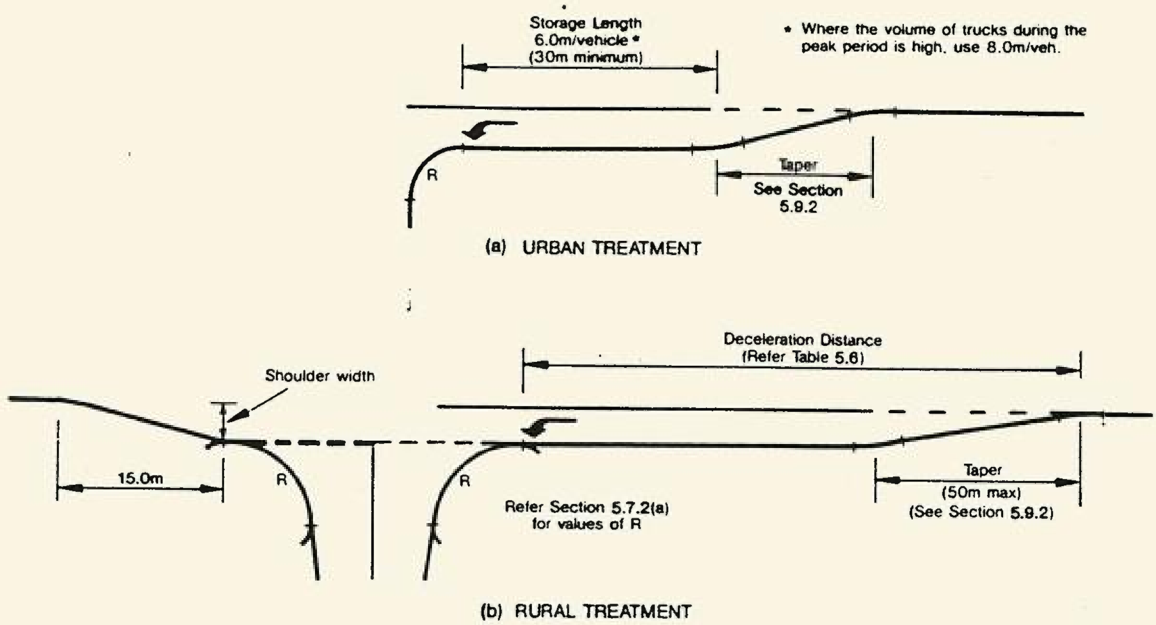


FIGURE 5.17 Left Turn Lanes

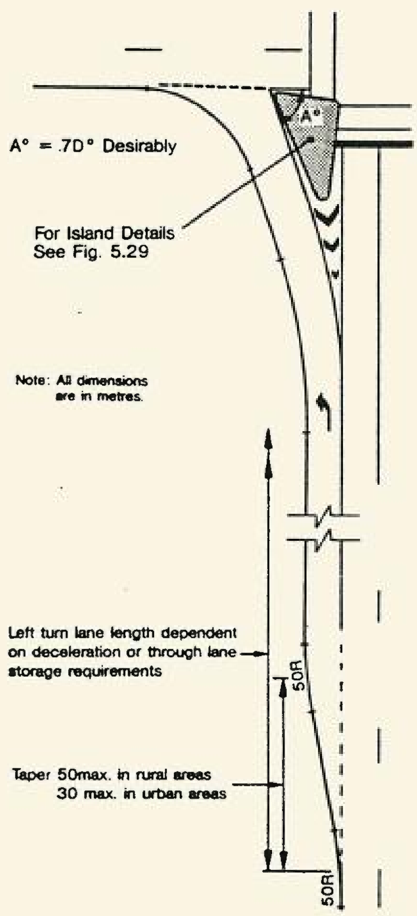


FIGURE 5.18 High Entry Angle Left Turn Slip Lane

TABLE 5.5 Left Turn Slip Lane Radii

V (km/h)	f	Crossfall (m/m) 0.02	0.04	0.06	0.08
		R (m) (see Fig 5.14)			
40	0.36	34	32	30	29
50	0.35	54	51	49	46
60	0.33	80	77	73	70
70	0.31	115	110	105	100
80	0.26	180	170	160	150

Note

1. The values of the radius *R* have been computed using the co-efficients of side friction *f* given in NAASRA 1980 (Table 6.1).
2. A maximum crossfall of 0.08 m/m should be adopted for turning roadways.

The radius of turn adopted should be based on providing for a speed of left turn of desirably 80% (50% minimum) of the through road operating speed. Selection of radius based on design speed can be done using Table 5.5.

5.8 Right Turn Treatments

5.8.1 Introduction

Auxiliary right turn lanes improve road capacity and safety and should be considered:

- at all signalised intersections
- at all median openings on divided urban and rural roads where a sufficiently wide median exists

APPENDIX 2

SOIL PROFILE DESCRIPTIONS

APPENDIX 2
FULL SOIL PROFILE DESCRIPTIONS

Non Calcic Brown, Dr 2.12 (Profile 3)

Mid slope position with western aspect. Profile exposed in margin of eroding (rilling and sheetwash) track. Gradient 10%. Groundcover on the track is zero, elsewhere 100% (grasses, herbs and small shrubs). Surface hardsetting. Clay ironstone float.

Topsoil

0–6cm, Dull brown 7.5 YR 5/4 (d), fine sandy (clay) loam, moderate consistence, crumbly (d), weakly pedal, rough faced <2% stones, roots common. pH 6.5. Sharp boundary.

Subsoil

6–35cm+ (no bedrock exposed). Reddish brown 5 YR 4/8 medium–heavy clay, with faint buff mottle. Strong consistence, crumbly (d). Strongly pedal, subangular blocky, smooth faced peds, some cutans. Few roots, cracks 2–5mm, pH 6.5.

Structured Plastic Clay (Euchrozem), Uf 6.21 (Profile 4)

Lower footslope position, gradient <5%, adjacent to drainage flat. Groundcover 90% and no appreciable erosion. Surface hardsetting.

Topsoil

0–14cm, brown 7.5 YR 4/3 light clay. Moderate consistence, crumbly (dry), moderately pedal, rough faced, polyhedral t2–5cm, 2–10% strongly weathered stones, roots common, cracks 2–5mm, pH 7.0, clear wavy boundary.

Subsoil

14–35cm+, reddish brown 5 YR 4/8 medium clay, with diffuse buff mottle. Strong consistence, crumbly (sl. moist), strongly pedal, smooth faced, subangular blocky, 2–5cm, <2% stones, strongly weathered, cracks to 10mm, non sticky, normal plastic, pH 7.0.

APPENDIX 3

AIR QUALITY ASSESSMENT

Prepared By Nigel Holmes & Associates

AIR QUALITY ASSESSMENT
BORAL BRICKWORKS
BRINGELLY

Prepared

for

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19 February 1991

CONTENTS

FIGURES

1.0 INTRODUCTION

This report has been prepared by Nigel Holmes & Associates for Resource Planning Pty Limited who are acting on behalf of Boral Bricks (NSW) Pty Limited. The report assesses air quality impacts arising from the emissions from a proposed extension to the Boral Brickworks located at Bringelly in the western outskirts of Sydney (see Figure 1).

The evaluation of the impacts is based on the use of a computer-based dispersion model AUSPLUME to predict ground-level concentrations of the flue gases hydrogen fluoride, hydrogen chloride, and oxides of sulphur and nitrogen, emitted from the stack associated with the proposed new kiln.

In addition the report addresses the issue of dust generated by expanded quarrying activities, the transport of raw material to stockpiles and subsequent processing. A computer-based dispersion model DUSTGLC has been used to estimate increases in long-term dust fallout and dust concentrations in the vicinity of the Brickworks.

2.0 DESCRIPTION OF PLANT AND EMISSIONS

2.1 Location of Plant

The Brickworks is located in Greendale Road, Bringelly which is to the west of Sydney approximately 55 km from the coast (see Figure 1). The present operation which produces bricks and pavers principally for the housing market, comprises two gas-fired kilns housed in the largest of the existing buildings (see site plan, Figure 2) each with an exhaust stack. At present only one kiln is operating. Bricks are dried, fired and then removed by forklift operations to a holding yard. A clay shale quarry lies to the south of the Brickworks and material from this pit is used in the manufacture of the bricks. In addition 40 000 tonnes per year of clay is imported.

The Company proposes to upgrade its facilities and the extensions to the existing operations are shown in Figure 2. They consist of a new brick and paver manufacturing plant to be housed in a building to the east of the existing buildings, and an extension to the quarry area which will increase its production from 60 000 tonnes per year to 200 000 tonnes per year. Two stockpiles of raw material transported from the quarry will be located to the south of the new building. Material from these stockpiles will be crushed and conveyed to the manufacturing plant. Production of bricks and pavers is expected to increase from 51 500 to 160 000 tonnes per year.

In the long term only the new kiln will be operating, but there will be a period of approximately six months during which bricks will be fired in both the old and the new kilns. However in this report it has been assumed that the total emissions from the two kilns do not exceed the emissions from the new kiln when it is fully operational. Thus assessing the impact of the new plant represents a worst-case assessment.

2.2 Terrain and Land Usage

The local terrain consists of gently undulating low hills with vegetation comprising scattered bushland with trees up to 10 m high, interspersed with fields cleared for pasture. The land usage is a mixture of agricultural and residential. The Bringelly Public School and village is located approximately 700 m to the northeast of the plant.

2.3 Emissions

Stack Emissions

Firing of bricks in kilns leads to emissions of hydrogen fluoride, hydrogen chloride, oxides of nitrogen and sulphur, carbon dioxide and particulate matter. The nitrogen oxides are a combustion product while the other emissions are mainly from the bricks. The sulphur content of natural gas is very low, so the sulphur oxides emissions would arise predominantly from the heating of the bricks. The emissions from the proposed new kiln will be discharged from a stack whose location is shown in Figure 2 and the emissions data are summarised in Table 1. This information was provided to Nigel Holmes & Associates by Resource Planning (facsimile message from V. Smith, 16 November 1990).

TABLE 1
EMISSIONS DATA FOR BORAL BRICKWORKS

Stack height (m)	17.5
Stack diameter (m)	1.5
Exit temperature (K)	433.
Exit velocity ($m.s^{-1}$)	15.0
Mass emission rate*: ($g.s^{-1}$)	
hydrogen fluoride (HF)	0.556
hydrogen chloride (HCl)	0.556
nitrogen oxides (NO_x)	1.528
sulphur dioxide (SO_2)	1.667
sulphur trioxide (SO_3)	0.278
carbon dioxide (CO_2)	666.7
water vapour	361.1
Dust	2.778
Ridge height of nearest building (m)	11.0

* after scrubbing

The total annual emissions of NO_x, assuming the plant is operating 24 hours a day 7 days a week would be 48.2 tonnes. This should be compared with estimated emissions of nitrogen oxides in Sydney made by Eiser and Koo (1984). They estimated that in 1986 total emissions would be 59 570 tonnes from mobile sources and 16 605 tonnes from stationary sources. Thus the estimated emissions from the proposed kiln would constitute 0.29 % of the estimated total nitrogen oxides from stationary sources and 0.06 % of the total nitrogen oxides in the Sydney Basin (1986 estimate).

The regulations of the Clean Air Act of New South Wales set maximum concentrations of impurities in the air at the point of emission from scheduled premises. These limits apply to residual gases, after the completion of the process and before they are mixed with clean air, smoke or other gases. The standards set for the various emissions are summarised below and compared with the estimated stack concentrations for the proposed new kiln. It should be noted that no limit has been set for sulphur dioxide (except for sulphuric acid plants where the limit is 2.8 $g.Nm^{-3}$) carbon dioxide or water vapour.

Impurity	Concentration $g.Nm^{-3}$ of dry air	Clean Air Regulations Limit $g.Nm^{-3}$ of dry air
HF	0.034	0.05
HCl	0.034	0.4
NO_x	0.094	2.5
SO_2	0.099	no limit
SO_3	0.102	0.1
CO_2	41.03	no limit
Water Vapour	22.22	no limit
Dust	0.171	0.25

Thus all of the stack concentrations are below the maximum levels set by the Clean Air Regulations 1964 for new installations where approval has been sought on or after 1 January 1972.

Dust Emissions

Although some particulate matter will be emitted from the exhaust stack, most of the dust generated at the site will arise from the expanded quarry operations, the transport of material to stockpiles and subsequent crushing and preparation for use in the manufacturing building.

Dust emissions have been estimated by analysing the Brickworks operations assuming that a total of 200 000 tonnes per year of material will be moved. Information about the dust-generating operations which take place at the site (that is, how much material is moved, how far it is moved and so on) has been used with emission factors developed both locally and by the US EPA to estimate the amount of dust produced from each operation. Estimated emission amounts for each activity are presented in Table 2. Details of the calculations are presented in Appendix A.

For the purposes of estimating dust deposition and concentration levels it is also important to know the distribution of particle sizes in the dust from various activities. This information has been taken from research undertaken in the Hunter Valley and in the United States. The distributions used are summarised in Table 3.

3.0 DISPERSION METEOROLOGY OF THE AREA

The dispersion models used to predict ground-level concentrations of gaseous emissions and dust deposition and concentration levels require data on wind speed, wind direction, temperature, mixed-layer height[1] and atmospheric stability[2] class. Typically a year of such hourly data would be used. The data sets used in this report were constructed from wind data recorded close to the site and temperature and cloud cover information recorded for the same period at Mascot. The way in which the parameters required for dispersion modelling have been derived is discussed below.

3.1 Wind Speed and Direction

The meteorological data used were collected at two sites in the area by Macquarie University. The monitoring station at Badgerys Creek, approximately 6 km north-northwest of the Brickworks, with no significant intervening terrain, provides information on wind speed and direction which is likely to be the most representative of the Bringelly area. However this station commenced operation in March 1990 and only 7 months of valid data are available.

The second site is at West Hoxton and is further away (approximately 10 km to the east-northeast of Bringelly) with some low hills between it and the Brickworks. Close to a year of valid data, obtained by combining data from 1980 and 1981, are available.

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[1] The term mixed-layer height, refers to the height above the ground through which ground-based emissions will eventually be dispersed once a plume has been thoroughly mixed. An elevated plume, initially above the mixed-layer height will remain isolated from the ground until such time as the mixed-layer height reaches the height of the plume. In general the mixed-layer height will increase during the day as the sun causes convection to deepen the turbulent layer of the atmosphere close to the ground. Mixed-layer height will also increase if the wind speed increases because higher wind speeds will increase turbulence as the wind blows over the rough ground.

[2] In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme (as used in this study) there are six stability classes, A through to F. Class A relates to unstable conditions, such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

TABLE 2
DUST EMISSIONS INVENTORIES - t.year $^{-1}$

(See Appendix A for details of calculations of the individual emissions and emission factors summarised in this table)

PROCESS	EMISSION FACTOR	DUST EMISSIONS	COMMENTS
PIT AREA			
Scraping	29.0 g/t	5.8	
Haulage	0.53 kg/vehicle km	5.3	50% control-water
Pit erosion	9.6 kg/day/ha	45.6	
PROCESS AREA			
Primary crushing	140 g/t	8.4	70% control-enclosure
Loading unloading by front end loader	20 g/t	8.0	
Conveyors	1.7 g/t	0.34	
REHABILITATION			
Transport	0.53 kg/vehicle km	0.4	
Unloading	20.0 g/t	0.8	
STOCKPILES			
Unloading from scraper	20.0 g/t	4.0	
Unloading from trucks	20.0 g/t	1.4	
Erosion	39.37 kg/day/ha	28.76	
Haulage to and from Greendale Road	300 g/vehicle km	1.26	Industrial Paved road
TOTAL		110.06	

TABLE 3
DISTRIBUTION OF PARTICLE SIZES IN DUST FROM SELECTED BRICKWORKS ACTIVITIES (percent)

PROCESS	% Fine Particles	% Inhalable Particles	% Coarse Particles
PIT AREA			
Scraping	6	48	46
Haulage	6	53	41
Pit erosion	0	67	33
PROCESS AREA			
Primary crushing	20	50	30
Conveyors	0	67	33
Loading unloading of front end loader	4	40	56
REHABILITATION			
Transport	6	53	41
Loading	4	40	56
Unloading	4	40	56
STOCKPILES			
Loading	4	40	56
Unloading	4	40	56
Haulage	6	53	41
Erosion	0	67	33
Haulage to Road	6	53	41

Wind roses for Badgerys Creek and West Hoxton over equivalent periods of the year are shown in Figures 3 and 4 respectively. There are significant differences between the patterns of winds at the two sites. For Badgerys Creek the most common winds are from the southwest followed by the west-southwest. For West Hoxton the winds are shifted more to the north occurring with similar frequencies throughout the southwest to northwest quadrant. The differences are due to the effects of terrain which deflects the wind and generates drainage flows at night.

3.2 Atmospheric Stability

Atmospheric stability can be derived from information on wind speed and cloud cover using a procedure set out by Turner (1970). This has been done using information on cloud cover for Sydney obtained from the Bureau of Meteorology and a stability class has been determined for each pair of wind speed wind direction observations. The overall distribution of stability conditions over the data period is shown in Table 4 for West Hoxton and Badgerys Creek.

TABLE 4
DISTRIBUTION OF ATMOSPHERIC STABILITY CATEGORIES

Stability	Percentage occurrence	
	Badgerys Creek	West Hoxton
A	0.5	2.5
B	8.7	15.3
C	15.1	17.4
D	29.6	15.9
E	19.5	8.1
F	26.4	40.8

The most significant difference between the two sites is the higher frequency of F class (most stable) stability conditions at West Hoxton. This is due to the lower average wind speed experienced at West Hoxton. The annual average wind speed was 3.22 ms^{-1} at the Badgerys Creek site and 2.53 ms^{-1} at West Hoxton.

3.3 Mixed-layer height

Mixing-layer heights are not critical in determining dust concentrations and dust fallout levels but are important for dispersion of gaseous pollutants. They have been provided to the file using procedures developed by Powell (1976), Plate (1971) and Venkatram (1980).

3.4 Temperature

Temperature is not important in determining dust concentrations but is important in dispersion modelling when the stack emissions temperature is higher than ambient. Temperature data from the Bureau of Meteorology has been incorporated into the meteorological data files.

3.5 Rainfall

Although rainfall data are not significant in determining dispersion they are of interest in determining the rate of generation of dust from stockpiles and exposed areas.

Rainfall data from Badgerys Creek Research Station (Latitude 33 degrees 52 minutes south and longitude 150 degrees 44 minutes east, elevation 65.0 m) are presented in Table 5. They represent average values for 49 years of records.

TABLE 5
AVERAGE RAINFALL DATA FOR BADGERYS CREEK

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)													
Mean	94	90	91	59	59	69	32	46	38	60	73	73	784
Median	69	64	68	38	26	45	17	25	34	48	61	48	737
Raindays (no)													
Mean	8	9	8	6	7	6	5	6	6	8	8	7	84

Source: Bureau of Meteorology (1988)

4.0 AIR QUALITY CRITERIA AND EXISTING AIR QUALITY

4.1 Gaseous Emissions

Air quality standards for urban pollutants have not been defined in NSW. However the State Pollution Control Commission (SPCC) of New South Wales adopts objectives for SO_2 and NO_2 set by the National Health & Medical Research Council (NH&MRC). For the purposes of this report the criteria adopted for HCl and HF are those set by the Victorian Environment Protection Authority (VEPA).

The air quality objectives for the different gases are summarised in Table 6.

TABLE 6
AIR QUALITY OBJECTIVES

($\mu g.m^{-3}$)

Gas	Averaging period	Standard	Agency
SO_2	10 minutes	1400	NH&MRC
	1 hour	700	NH&MRC
	Annual mean	60	NH&MRC
NO_2	1 hour	328	NH&MRC
	Annual mean	103	USEPA
		Local objective	
HF	24 hour	2.9	VEPA
	7 days	1.7	VEPA
	90 days	0.5	VEPA
HCl	3 minute	200	VEPA

There are no air quality standards for SO_3, however for the purpose of this report SO_2 and SO_3 emissions have been added together and considered as SO_2. Similarly the only oxide of nitrogen for which air quality criteria have been set is NO_2. Emission rates have been provided for NO_x which at the time of exit from the exhaust stack would comprise approximately 5 % NO_2. Ultimately most of the NO_x will be converted to NO_2, but the rate at which this conversion takes place depends upon atmospheric conditions. However it has been conservatively assumed that all NO_x is in the form of NO_2.

The objectives for HF are to protect vegetation and grazing animals and at these concentrations have no harmful effects on humans. Some plant species, for example grapevines and gladioli, are particularly sensitive to HF in the environment, however these are not an issue at the Brickworks site.

Existing air quality

There are no measurements in the vicinity of the plant of existing ground-level concentrations for the gases discussed above, however the issue of photochemical smog formation is of major importance in the Sydney Basin and will be discussed later in relation to NO_x emissions.

4.2 Particulate matter

Criteria for assessment

To assess the air quality impacts of dust it is necessary to be able to refer to objective air quality standards that can be used for comparison against existing, or predicted future air quality. For the purposes of this report the criteria used are those adopted by the NSW State Pollution Control Commission (SPCC).

To adequately assess impacts it is necessary to have criteria for both long-term (annual) and short-term (24-hour) averaging periods. For long-term averages it is necessary to consider both the deposition of dust (that is the number of grams of dust deposited per square metre per month ($g.m^{-2}.month^{-1}$)) and the concentration of dust in the air (that is the number of micrograms of dust per cubic metre of air ($\mu g.m^{-3}$)). For short term averages it is usually adequate to consider the concentration of dust in the air and there are no short-term criteria for dust deposition rate.

The criteria discussed below relate to health and nuisance impacts on humans. Research into the effects of inert dust on vegetation indicates that there are no detectable adverse impacts at dust levels much higher than those adopted for the protection of health and amenity.

4.2.1 Short-term criteria

Concentration

NSW has no regulations concerning acceptable short-term concentrations of dust in the atmosphere. However the SPCC in assessing the acceptability of projects refers to the US EPA primary and secondary 24-hour goal of 260 $\mu g.m^{-3}$ and 150 $\mu g.m^{-3}$ respectively. The primary standard is designed to protect the public against adverse health effects and is not to be exceeded more than once a year. The secondary standard is designed to protect against" known or anticipated adverse effects of a pollutant" and again is not to be exceeded more than once per year.

Deposition

There are no air quality criteria for short-term dust deposition rates.

4.2.2 Long-term criteria

Concentration

The long-term criteria which the SPCC applies for dust concentration is the National Health & Medical Research Councils (Australia) (NH&MRC) annual average goal for urban areas which is 90 $\mu g.m^{-3}$.

Deposition

In the past the SPCC has considered that residential areas would begin to experience dust related nuisance impacts when annual average dust deposition levels exceeded 4 $g.m^{-2}.month^{-1}$, and that dust impacts would be at unacceptable levels when they reached 10 $g.m^{-2}.month^{-1}$ (SPCC, 1983). However recent research (Mitchell, 1988) has refined these criteria and it is now considered that perceptible degradation of air quality occurs as a result of a specific project, if the project results in dust deposition levels increasing by a certain margin. The increment in fallout levels before the nuisance level is reached depends on the existing dust fallout levels.

Existing Air Quality

The site in question is located in a mixed residential and rural area. Dust deposition monitoring commenced in August 1990 in the vicinity of the Brickworks at the four locations shown in Figure 1 and the results are summarised below.

Dust gauge	Dust fallout rate $g.m^{-2}.month^{-1}$					
	Aug/Sep 1990	Sep/Oct 1990	Oct/Nov 1990	Nov/Dec 1990	Jan/Feb 1991	Mean
D1	0.40	0.12	0.39	0.84	0.65	0.48
D2	0.40	0.34	0.36	no data	0.99	0.42
D3	0.70	0.63	0.55	no data	1.63	0.88
D4	0.91	0.45	0.70	1.43	0.95	0.89

The values range from 0.12 to 1.63 $g.m^{-2}.month^{-1}$ which are fairly typical for this type of environment. The gauges with the highest readings (D3 and D4) are those closest to the Brickworks. They are also located downwind from the plant in the direction of the most common winds as indicated in the Badgerys Creek windrose (Figure 3). The increased dust deposition levels recorded at these gauges are therefore likely to be, at least in part, due to dust emissions from the Brickworks. Sociological studies by Mitchell (1988) indicate that dust deposition levels would be allowed to increase by 2 $g.m^{-2}.month^{-1}$ before a significant degradation in air quality had occurred.

5.0 APPROACH TO ASSESSMENT

5.1 Ground-level concentrations of stack emissions

A computer based dispersion model known as AUSPLUME has been used to predict the ground-level concentrations of the stack emissions under the operating conditions presented in Table 1.

AUSPLUME is an advanced Gaussian dispersion model developed on behalf of the Victorian EPA (VEPA 1986). It is based on the United States Environmental Protection Agency's Industrial Source Complex (ISC) model. It has been improved to include the recommendations of the American Meteorological Society's expert panel on dispersion modelling which are outlined in a paper by Hanna et al (1977). It is widely used throughout Australia and is regarded as a "state of the art" regulatory model.

A full technical description of the model is provided in the user manual for the AUSPLUME (VEPA 1986). Some of its features include:

- allowance for effects of terrain on dispersion
- use of hourly meteorological data
- allowance for building wake effects
- calculation of concentrations averaged over several time intervals, including minutes, hours, days, months and the entire period of the meteorological data.

In its present application AUSPLUME has been used to predict the maximum ground-level concentrations of HCl, HF, SO_2, NO_2 and particulate matter at a regularly spaced set of receptors 100 m apart forming a square grid (2 km by 2 km) with the stack located at its approximate centre. In addition modelling runs were carried out using a coarser grid (250 m spacing) which covered a larger area (5 km by 5 km) than the fine grid. The fine grid was used to determine the maximum ground-level concentrations for the various stack emissions and the coarse grid was used to determine the pattern of dispersion over a wide area.

Allowance was made for nearby building wakes (turbulence in the lee of buildings). A conservative approach has been adopted. Some judgement is required in incorporating building-wake effects into the model and for the present study the recommendations given in the AUSPLUME user's manual have been used. The emissions data which include stack diameter, emission temperature, mass emission rate and speed of emissions are those given in Table 1.

5.2 Dust Levels

The computer-based dispersion model DUSTGLC has been used to predict the increase in annual average long-term dust deposition and dust concentration levels for an area approximately 2 km by 2 km with the Brickworks quarry at its approximate centre
The model has been widely used in the Hunter Valley and a detailed description of its theoretical basis and the results of a model validation study have been presented in the Lemington Open Cut Environmental Impact Statement (CSR 1984).

6.0 RESULTS AND DISCUSSION

6.1 Predicted Ground-Level Concentrations for Gaseous Emissions

As discussed earlier, predicted ground-level concentrations of stack emissions were calculated using AUSPLUME. The modelling runs which were undertaken are as follows:

- prediction of maximum sulphur dioxide and nitrogen dioxide ground-level concentrations for 1-hour and long-term averaging periods (see Figures 5,6,7 and 8), ;

- prediction of maximum sulphur dioxide ground-level concentrations for a 10-minute averaging period (figure not shown)

- prediction of maximum ground-level concentrations of HCl for a 3-minute averaging period (Figure 9);

- prediction of maximum ground-level concentrations of hydrogen fluoride for 24-hour, 7-day and 90-days averaging periods (Figures 10,11 and 12);

- prediction of maximum ground-level concentrations of particulate matter from stack emissions (long-term average, Figure 13).

Meteorological data from Badgerys Creek and West Hoxton were used however only the results from Badgerys Creek are shown in the figures presented in the main body of the report. As discussed earlier, in view of the local topography the wind data from Badgerys Creek is likely to be more representative of the winds at the Brickworks site although the whole years data are not available. Figures for modelling runs with the West Hoxton data are presented in Appendix B.

Apart from HF (24-hour average, West Hoxton meteorological data) all maximum predicted ground-level concentrations for the different effluent gases were below the acceptable levels detailed in Table 6. Table 7 presents the maximum levels obtained for the different averaging periods as well as expressing the values as a percentage of the respective air quality goals.

TABLE 7

RESULTS OF AUSPLUME MODELLING RUNS

	Averaging period	Maximum Ground-level Concentration $\mu g.m^{-3}$		Percentage of Air Quality Goal	
		Badgerys Creek Meteorological Data	West Hoxton Meteorological Data	Badgerys Creek Meteorological Data	West Hoxton Meteorological Data
SO_2	10-minutes	67.2	69.4	4.8	5.0
	1-Hour	48.4	50.1	6.9	7.2
	Long-term	0.55	0.92	0.9	1.5
NO_2	1-Hour	38.0	39.4	11.6	12.0
	Long-term	0.43	0.76	0.4	0.7
HF	24 Hour	1.41	3.99	48.2	137.6
	7-Days	0.6	0.98	35.3	57.6
	3 months	0.2	0.45	40.0	90.0
HCl	3-Minutes	23.8	24.4	11.9	12.2
Particulate matter	Long-term	0.78	1.38	0.9	1.5

HF Emissions

Examination of the output from the HF modelling runs with the West Hoxton data (Appendix C) shows that the maximum predicted 24-hour average ground-level concentrations of 3.99 $\mu g.m^{-3}$ occurred near the top of a 158 m hill approximately 1.6 km southwest of the Brickworks (see Figure 1). A similar pattern of dispersion was seen using the Badgerys Creek meteorological data, showing the influence of terrain on dispersion, but the maximum concentrations reached were below the air quality goal. The differences in the results of the modelling runs using the two sets of meteorological data arise from the higher percentage of F class stability in the West Hoxton data. This stability class is associated with the least dispersive conditions.

A special modelling run was carried out at the receptor which gave the highest ground-level concentrations of HF to see how frequently this level would be reached in a year. The 10 highest values at these points are listed below.

10 Highest Values $\mu g.m^{-3}$
3.99
2.70
1.18
1.12
1.08
1.04
1.00
0.97
0.88
0.84

It can be seen that the 24-hour air quality standard of 2.9 $\mu g.m^{-3}$ for HF is predicted to be exceeded at this location on one day in a year. This exceedance would be most likely to happen during the stable conditions that occur at night.

When considering the impact of HF it should be remembered that industries which cause the most significant HF emissions, such as aluminium smelters have a policy of defining a buffer zone around the plant in which it is recognised that land usage should not include activities which are particularly sensitive to fluoride. These include dairy farming, grape growing and some forms of horticulture. The hilltop which may experience some exceedances of HF air quality goals lies within the plant boundaries and is not used for any activity which is sensitive to HF. It is therefore unlikely that any significant impact would occur. It should also be noted that the installation of gas scrubbers in the new plant will reduce the emission rate of HF by about 60%. Thus although the proposed production will be approximately 3.3 times that of the present plant, the mass emission rate of HF will increase by only 25% from 1.61 kg/hour to 2.0 kg/hour. On this basis operation of the new plant will not result in substantial increases in ground-level concentrations of HF.

Photochemical Smog

While the predicted ground-level concentrations of NO_x are well below the air quality goals set for NO_2, they must be considered in the context of the local air quality issues and the formation of secondary pollutants (photochemical smog) from the interaction of sunlight with primary pollutants such as NO_2 is of major concern in the Sydney airshed.

There are several stages in the production of photochemical smog. Firstly NO is oxidised to NO_2, then ozone is formed by the interaction of sunlight and NO_2. Finally a steady-state is reached where ozone is maintained at or near its maximum concentration. However, the effect of increasing initial NO_x concentrations on ozone formation is not straightforward. Under the action of sunlight, NO_2 reacts with oxygen to form NO and ozone, but NO and ozone react strongly with each other and until the NO is oxidised by other precursors such as reactive hydrocarbons, the concentration of ozone will not build up. The presence of increased amounts of NO will initially delay the onset of ozone production, but with sufficient time and sunlight the maximum concentration of ozone produced will be higher. Thus the production of photochemical smog has a light-limited and a NO_x-limited phase. Which phase predominates will depend upon the weather and the concentrations of the various smog precursors and models have been developed which take these factors into account (Johnson, 1986).

To assess the contribution that the Brickworks would make to photochemical smog in the Sydney Basin, it is helpful to compare the emissions from the plant with other sources of NO_x such as motor vehicles. As discussed in Section 2.3 the annual emissions of NO_x from the proposed new plant are estimated to be 48.2 tonnes which constitutes 0.06% of the estimated total nitrogen oxides in the Sydney Basin (1986 estimate). This would be approximately equivalent to 85 cars travelling at 60 km/hour (assuming an average NO_x emission rate of 1 g/km). It is therefore considered unlikely that the expansion of the Boral Brickworks will significantly add to the photochemical smog in the area.

6.2 Dust concentrations and deposition rates

DUSTGLC modelling runs have been carried out using the emissions inventory summarised in Table 3 and both the Badgerys Creek and West Hoxton meteorological data but only the Badgerys Creek contour plots are presented (Figures 14 and 15). Contour plots from runs using the West Hoxton data show a similar pattern of dispersion and are included in Appendix B. Only long-term dust levels were considered as the area of the dust sources was small and in the case of the quarry pit was below ground-level. It was considered unlikely that any significant short-term impact would occur.

Figure 14 shows the increase in the long-term ground-level concentration of particulate matter which is predicted to occur as a result of the quarrying and related activities at the site. The contour at $80\mu\ g.m^{-3}$ which is just below the NH&MRC long-term goal of $90\mu\ g.m^{-3}$ does not extend beyond the boundaries of the plant and the closest non-company owned houses are predicted to experience increases in dust concentrations between 20 and $40\mu\ g.m^{-3}$.

The predicted increase in long-term dust deposition rate is shown in Figure 15. Increases in dust fallout rates of up to 2 $g.m^{-2}.month^{-1}$ are considered to be acceptable for the area and it can be seen that the contour at 2 $g.m^{-2}.month^{-1}$ falls within the plant boundary. The houses predicted to experience the largest increase in dust fallout are at the western end of Loftus Road close to dust gauge D4 where the highest mean level of dust deposition was recorded during the dust monitoring programme. It is recommended that this programme be continued until a clear indication of the impact of the plant expansion is developed. Assuming that no problems are identified the programme should then be discontinued.

It should be noted that the estimated emissions from the quarrying activities are conservative. Apart from the enclosure of the crushing process and watering of the scraper tyres during haulage of material to the stockpiles, no dust suppression measures have been assumed.

7.0 SUMMARY AND CONCLUSIONS

This report has dealt with the air quality impacts of the proposed expansion of the Boral Brickworks at Bringelly. This expansion includes the operation of a new kiln with increased capacity and extension to the quarry area which will increase the amount of material quarried each year from 60 000 tonne to 200 000 tonne.

The emissions from the kiln stack have been used with the dispersion model AUSPLUME to predict ground-level concentrations of SO_2, NO_2, HCl and HF in the vicinity of the plant. Two sets of meteorological were available and both were used, but the data from Badgerys Creek was considered more representative of the Brickworks site and results from these runs indicate that a stack height of 17.5 m will be sufficient to maintain ground-level concentrations below acceptable levels.

A special modelling run was carried out for HF with the West Hoxton data which predicted that on one day per year the 24-hour VEPA goal for HF would be exceeded at a hilltop within the site boundary. As the land usage at this site is not particularly sensitive to HF emissions, it was considered that no serious impact would occur.

The dispersion model DUSTGLC was used to predict increases in long-term ground-level concentrations and fallout rate of dust in the area resulting from the expanded quarrying and related activities. A conservative estimate of dust emissions was made, assuming no dust suppression measures apart from enclosure of the crushing area and watering of the haul roads during haulage of material to the stockpiles. Results of the modelling runs indicated that no houses outside the plant boundary would experience long-term dust deposition levels above the acceptable 2 $g.m^{-2}.month^{-1}$.

8.0 REFERENCES

Bureau of Meteorology (1988)
"Climatic Averages Australia" p.350. Australian Government Publishing Firm, Canberra.

Eiser C.R. and Koo F. (1984)
"Emission trends for hydrocarbons and nitrogen oxides from stationary sources in Sydney", Proceedings of the Eighth International Clean Air Conference, Melbourne Volume 3, 1047-1064.

Hanna S.R., Briggs G.A., Deardorff J., Egan B.A., Gifford F.A. and Pasquill F. (1977)
"AMS Workshop on stability classification schemes and sigma curves - summary of recommendations", Bulletin of the American Meteorological Society, 5, 1305-1309.

Johnson G.M. (1986)
"A simple model for predicting the ozone concentration of ambient air", Proceedings of the Eighth International Clean Air Conference, Melbourne Volume 2, 715-731.

Mitchell P.A. (1988)
"Derivation of Appropriate Control Standards from Sociological Research" Coal Journal, 20, 1-12.

Plate E.J. (1971)
"Aerodynamic Characteristics of Atmospheric Boundary Layers", Argonne National Laboratory, Argonne Illinois, Available through United States Department of Commerce NTIS, TID-25465.

Powell D.C. (1976)
"A Formulation of Time-Varying Depths of Daytime Mixed Layer and Nighttime Stable Layer for use in Air Pollution Assessment Modes", Annual Report for 1976 Part 3, Battelle PNL Atmospheric Sciences, 185-189.

Turner B.D.(1970)

"Workshop of Atmospheric Dispersion Estimates", United States Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina, Revised 1970, Office of Air Programs Publications Number AP26.

US EPA (1985)

"Compilation of Air Pollution Emission Factors", Volume 1: Stationary point and Area Sources, Office of Air and Radiation, Research Triangle Park, North Carolina 27711.

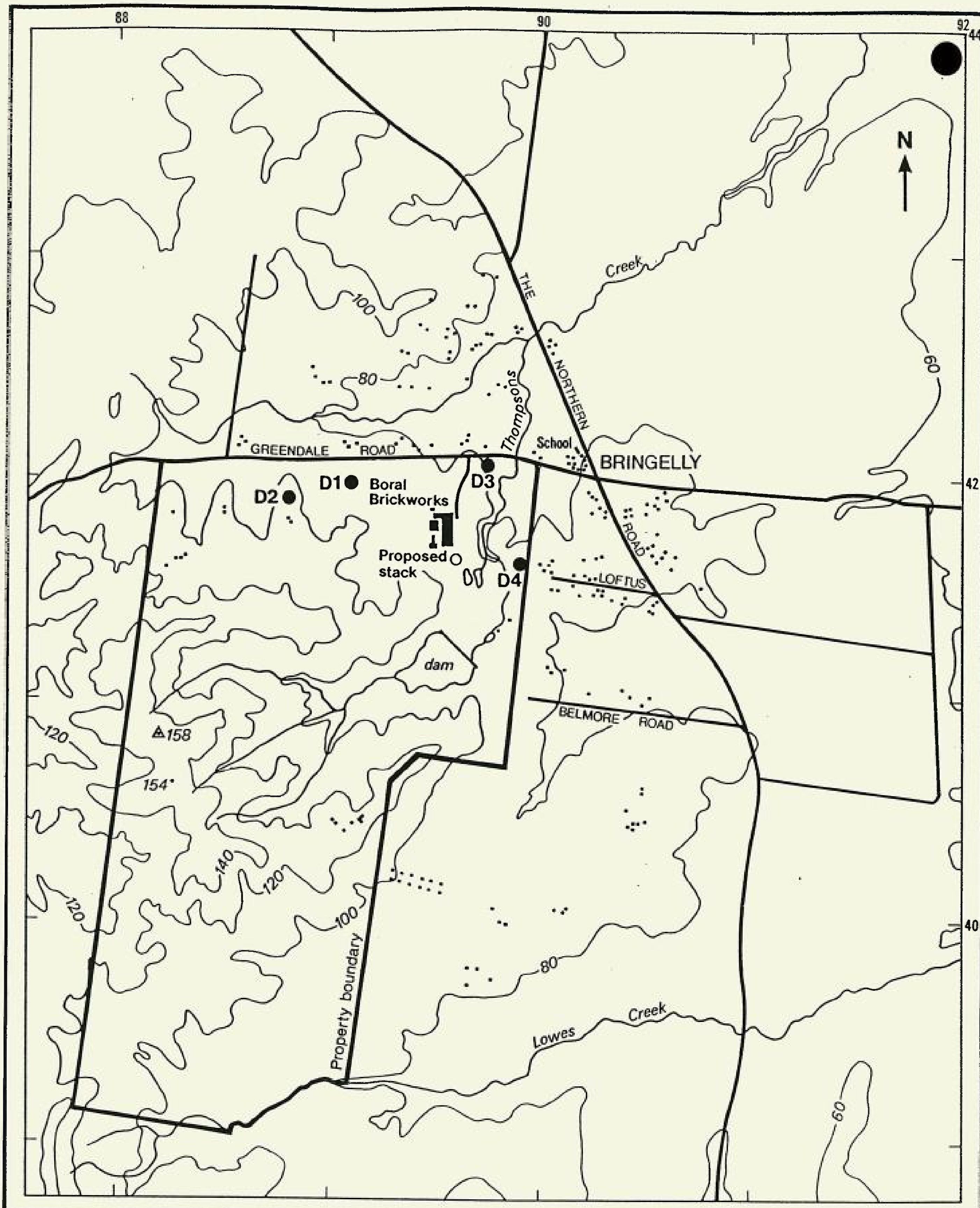
Venkatram A. (1980)

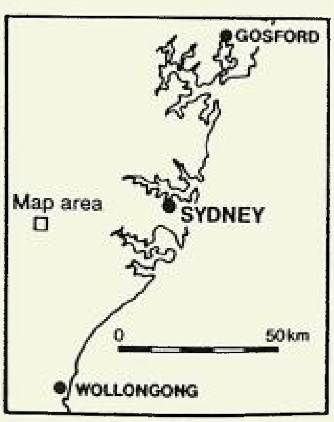
"Estimating the Monin-Obukhov Length in the Stable Boundary Layer for National Technical Information Service, United States Department of Dispersion Calculations", Boundary-Layer Meteorology, Volume 19, 481-485.

VEPA (1986)

"The Ausplume Gaussian Plume Dispersion Model", Environment Protection Authority, Olderfleet Buildings, 477 Collins Street, Melbourne Victoria 3000, Publication Number 264.

FIGURES





D1 Dust gauge

—80— Topographic contour (metres)

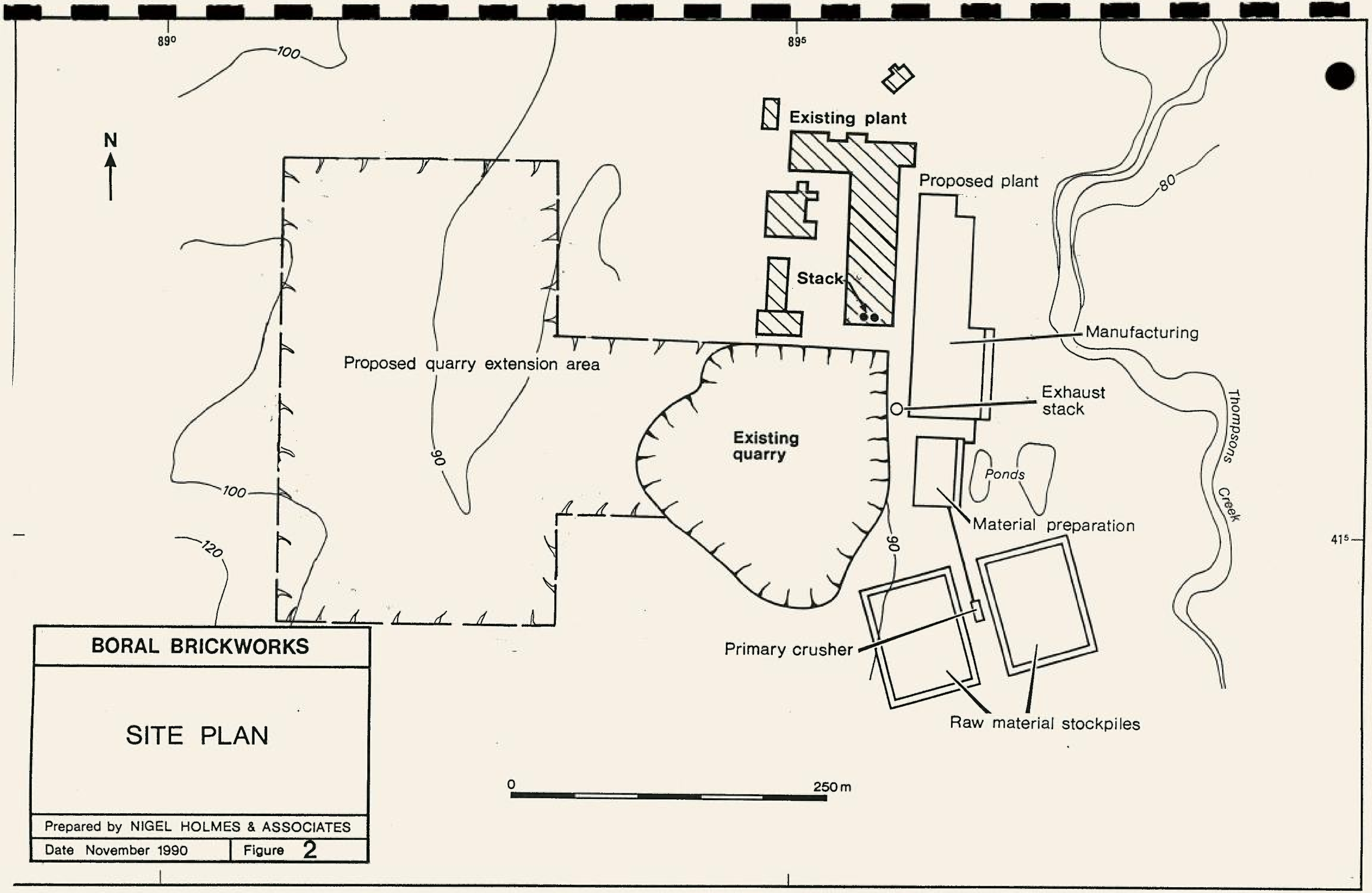
0 1:25 000 1km

BORAL BRICKWORKS

LOCATION MAP

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 1

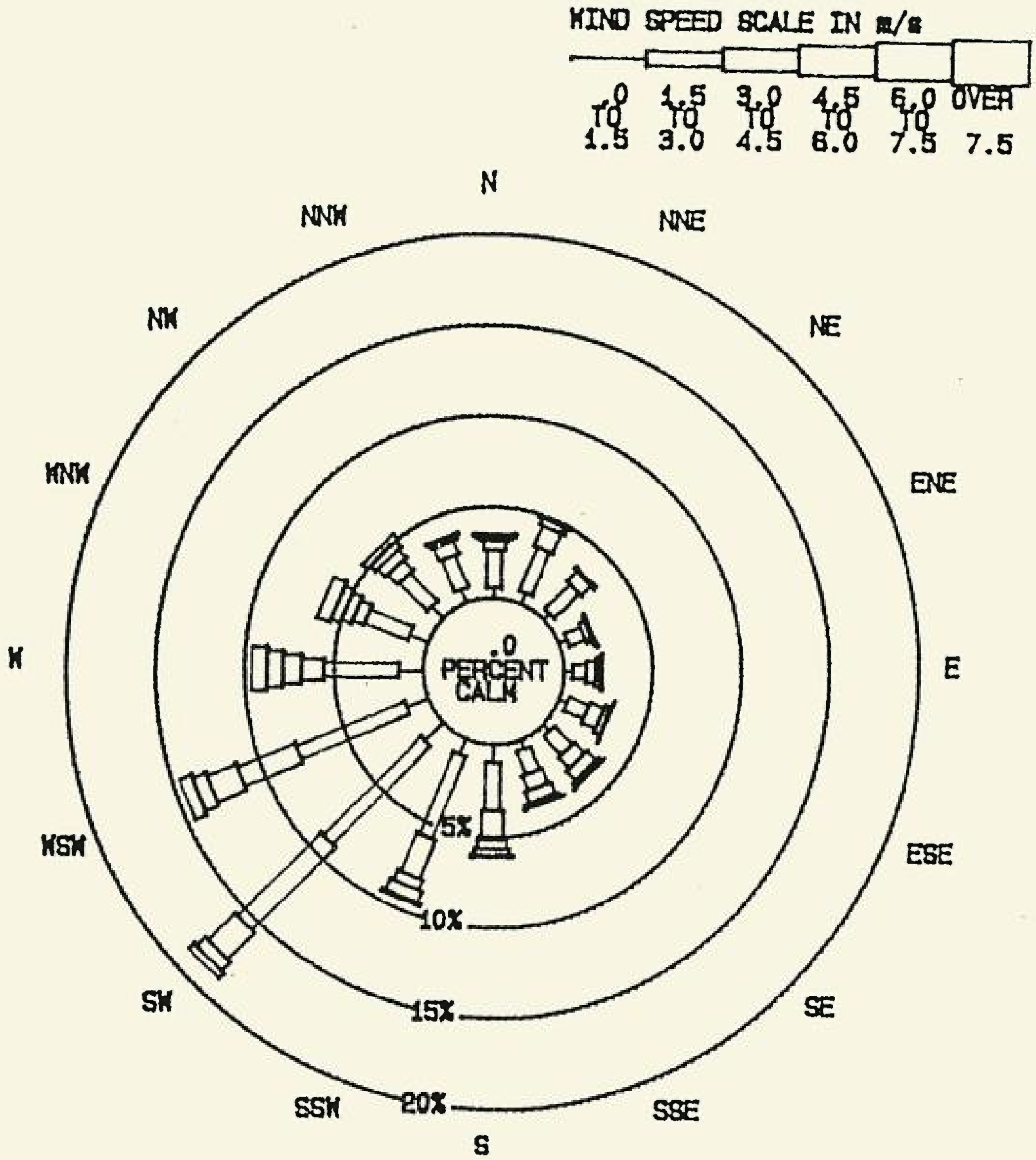


BORAL BRICKWORKS

SITE PLAN

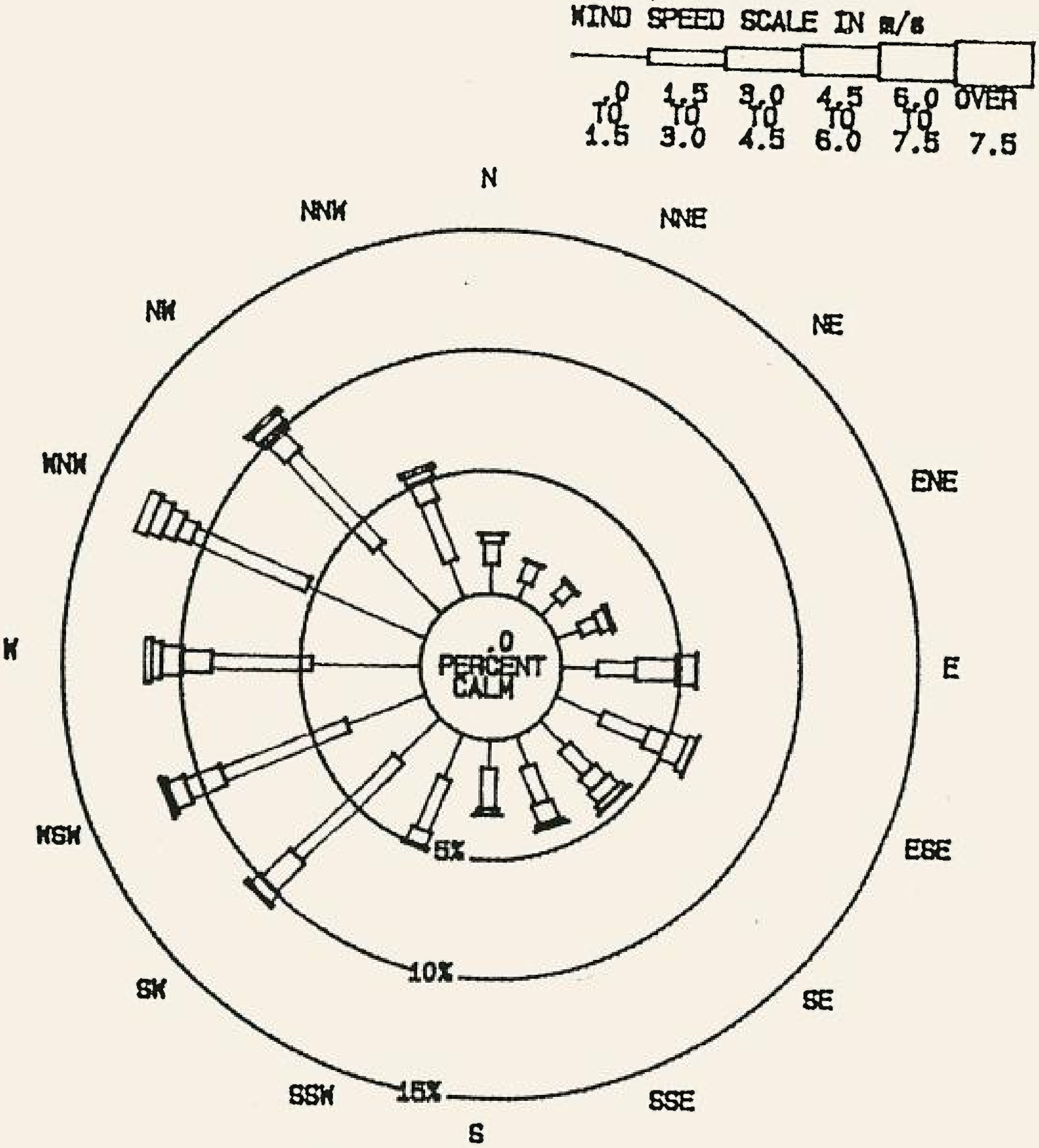
Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 2



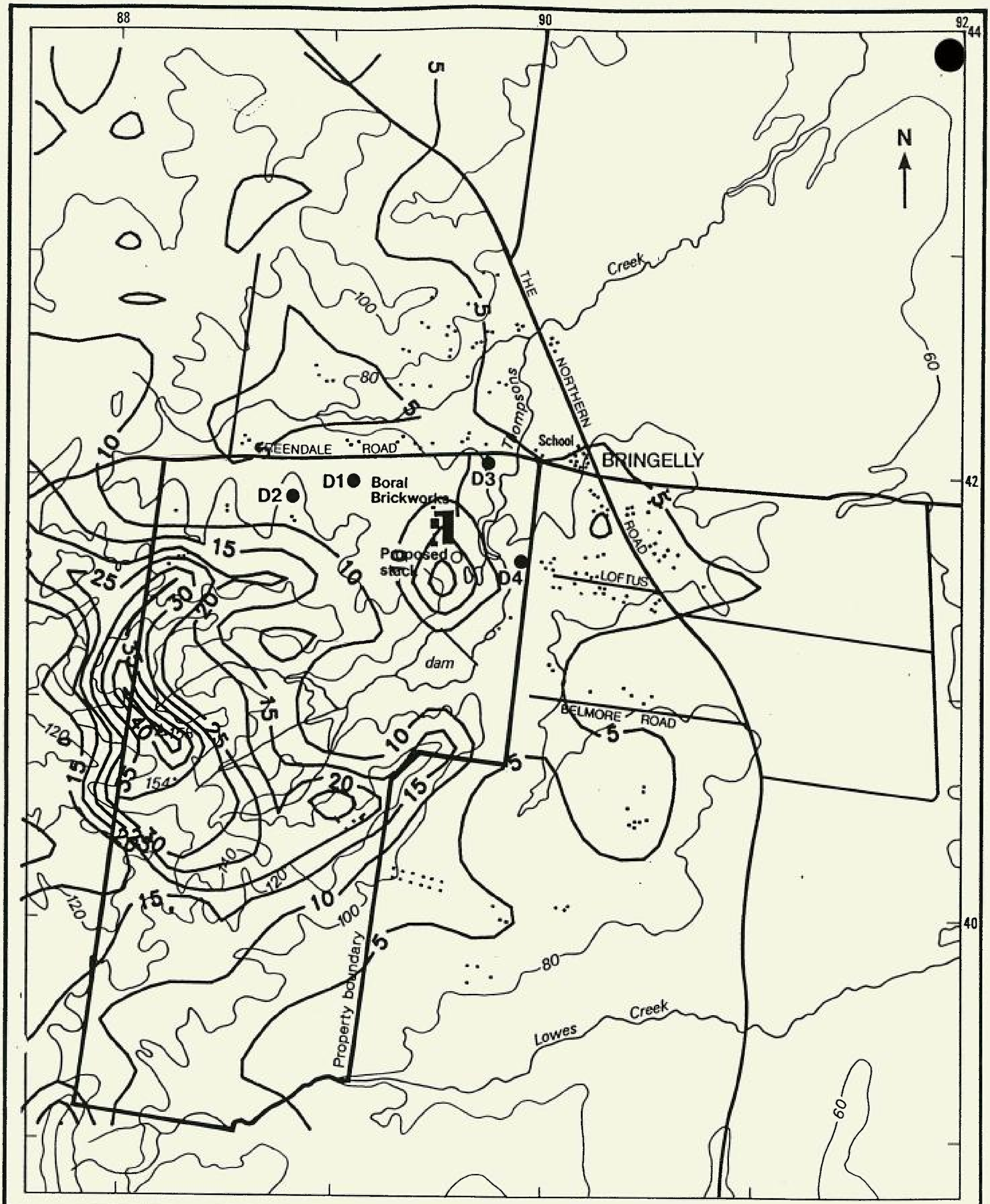
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Badgerys Creek 4/3/90 to 13/10/90

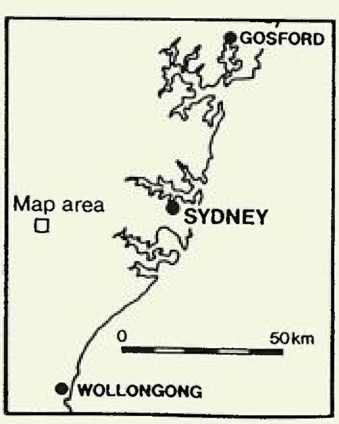
FIGURE 3 - WINDROSE BADGERYS CREEK



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
West Hoxton (Austral) 4/3/80 to 13/10/80

FIGURE 4 - WINDROSE WEST HOXTON





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

BORAL BRICKWORKS

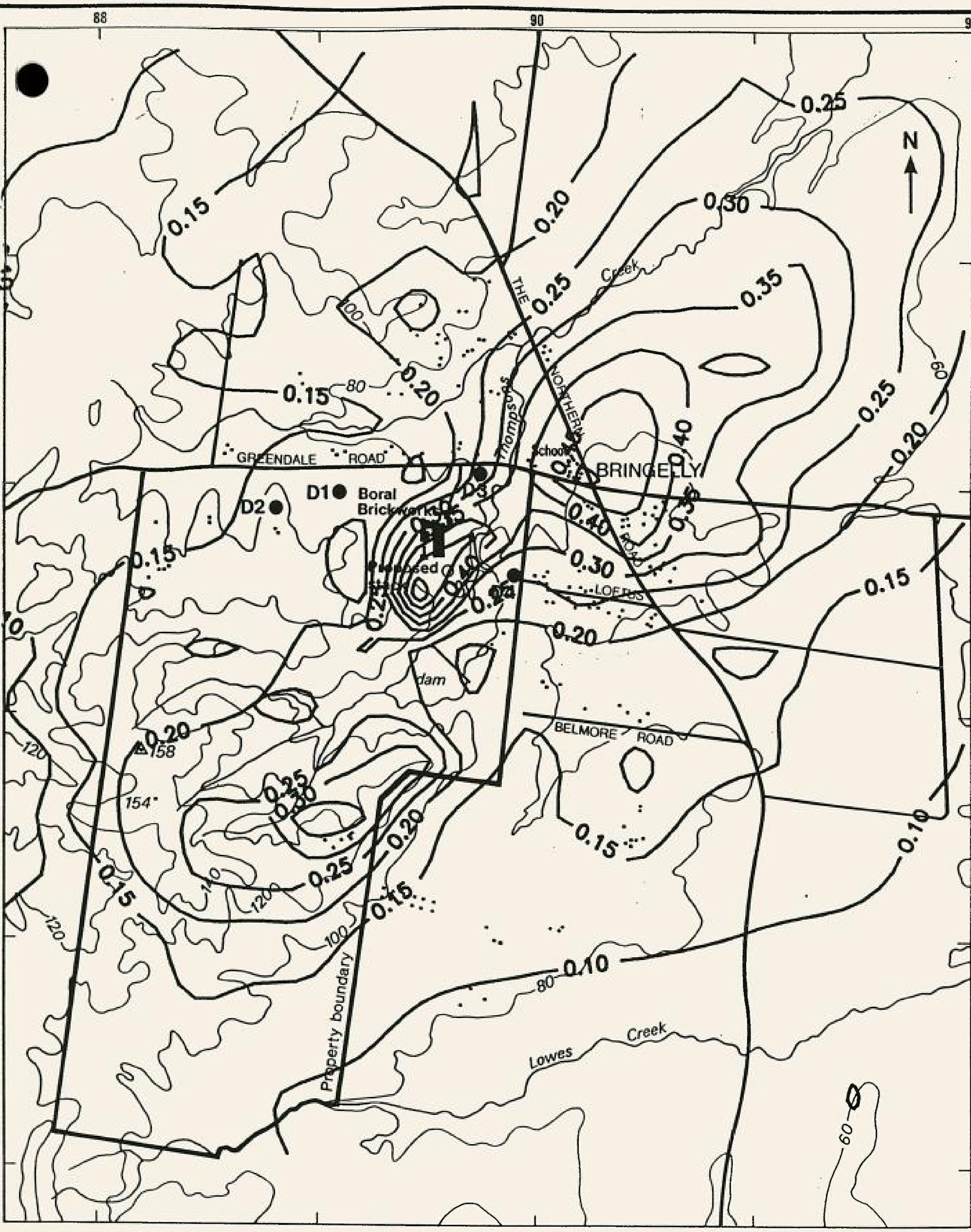
MAXIMUM PREDICTED 1 HOUR AVERAGE GROUND-LEVEL CONCENTRATION OF SO_2

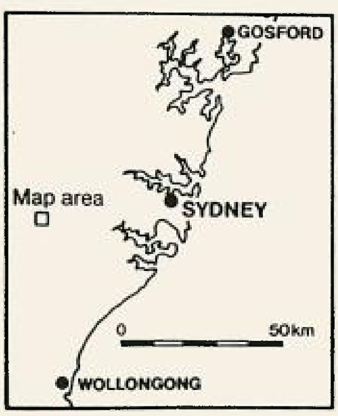
($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990

Figure 5





D1 ● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

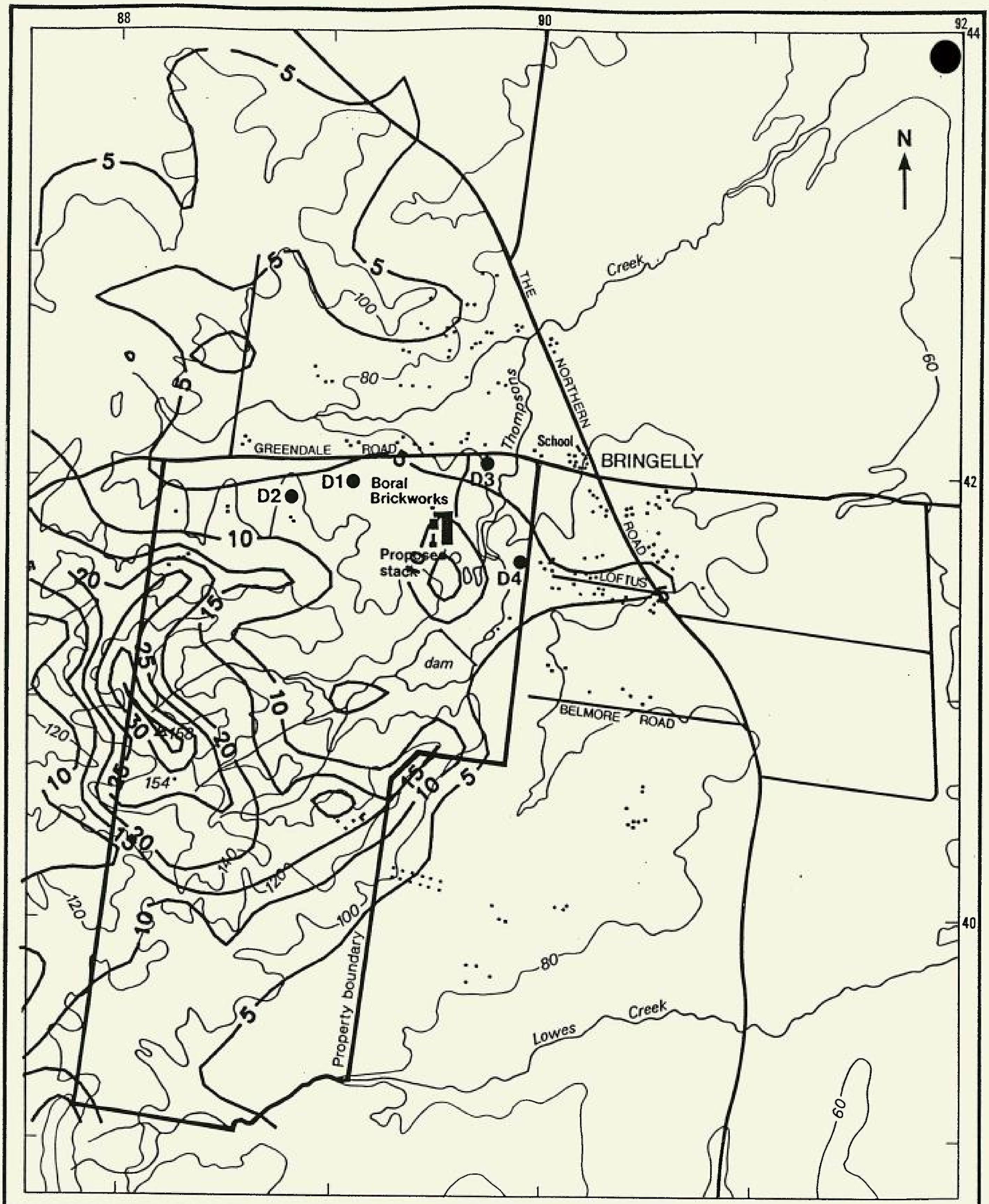
BORAL BRICKWORKS

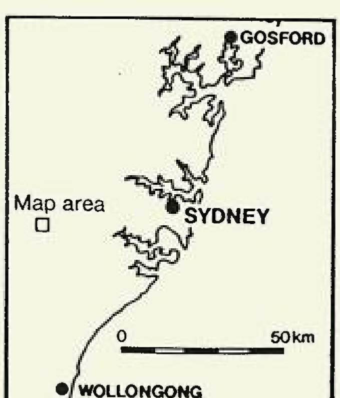
MAXIMUM PREDICTED LONG-TERM AVERAGE GROUND-LEVEL CONCENTRATION OF SO_2

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 6





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1km

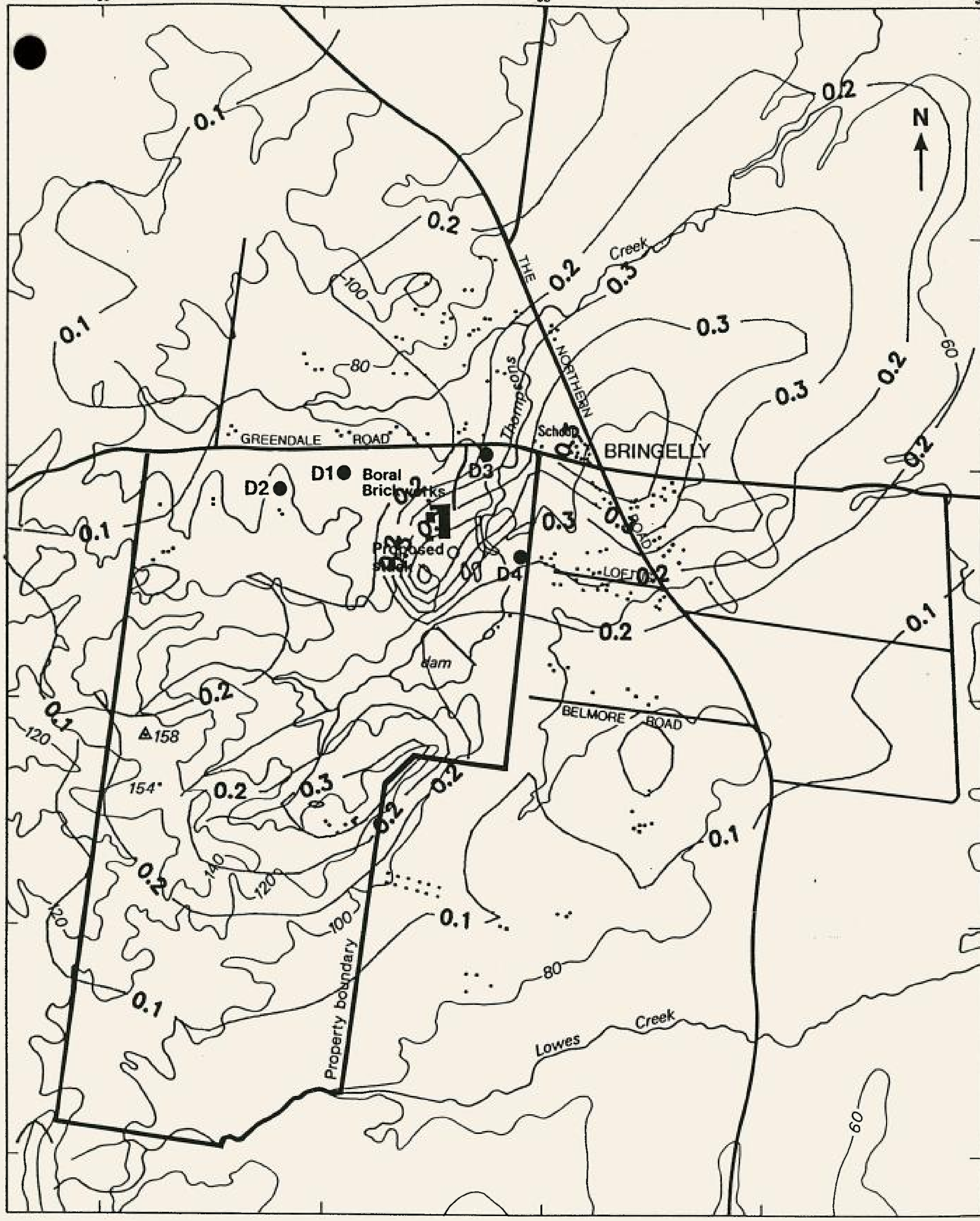
BORAL BRICKWORKS

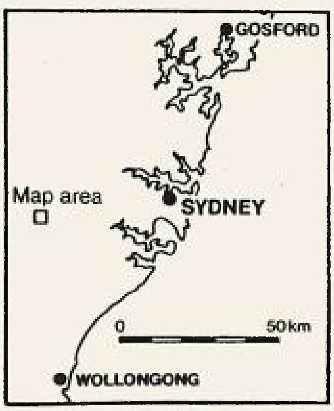
MAXIMUM PREDICTED 1 HOUR AVERAGE GROUND-LEVEL CONCENTRATION OF NO_2

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 7





D1● Dust gauge

—80— Topographic contour (metres)

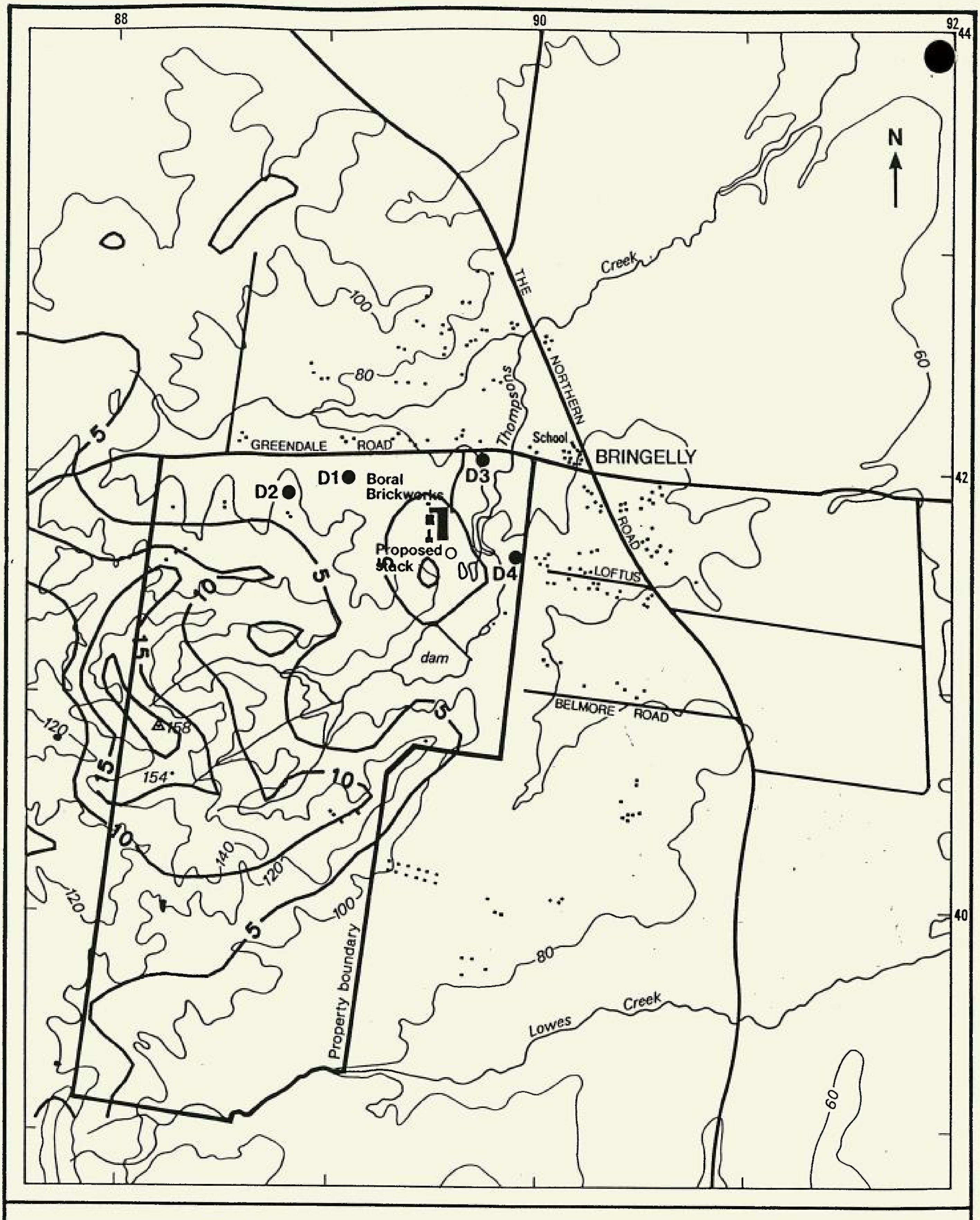
0 1:25 000 1 km

BORAL BRICKWORKS

MAXIMUM PREDICTED LONG-TERM AVERAGE GROUND-LEVEL CONCENTRATION OF NO_2 ($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 8



D1 ● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

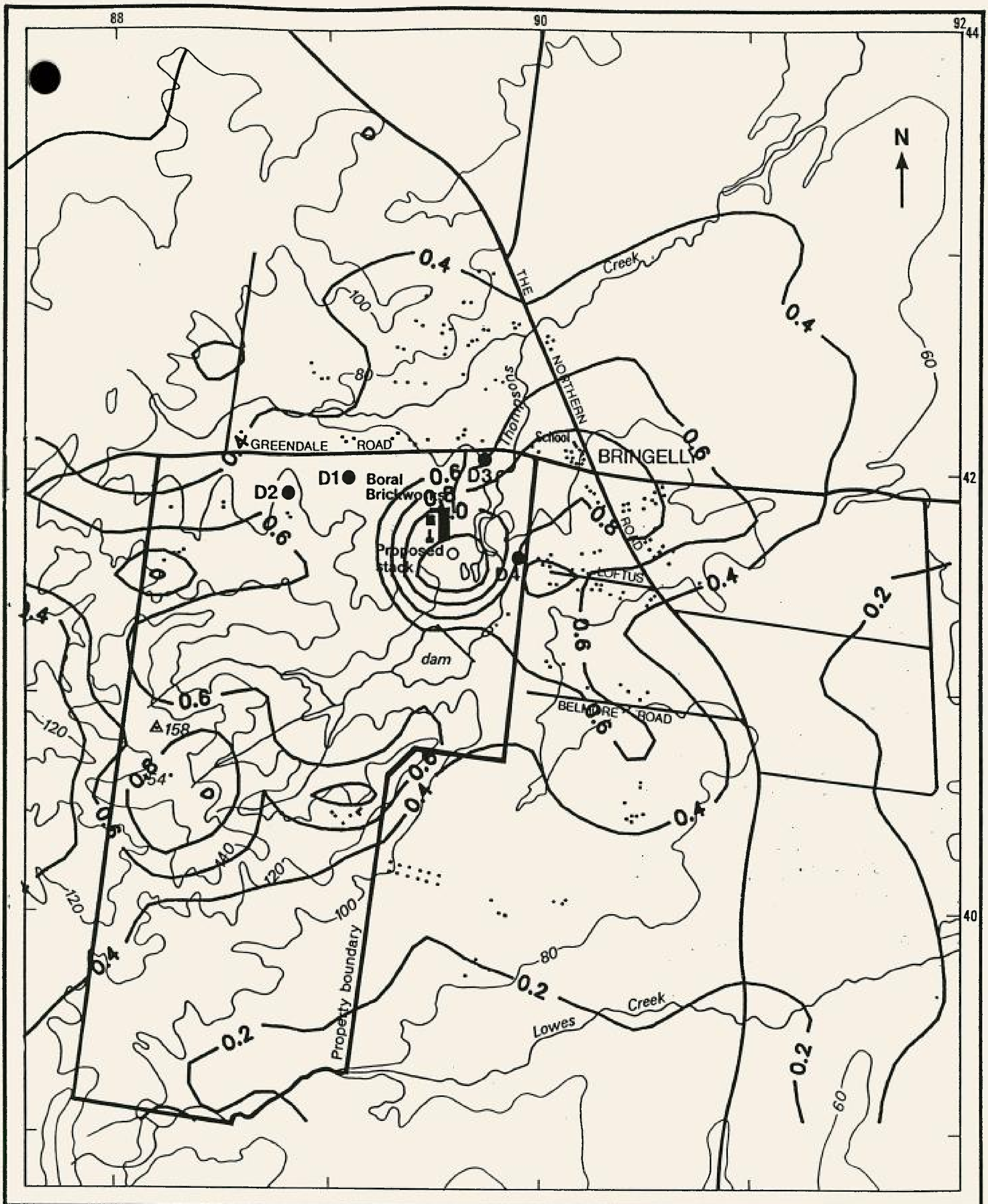
BORAL BRICKWORKS

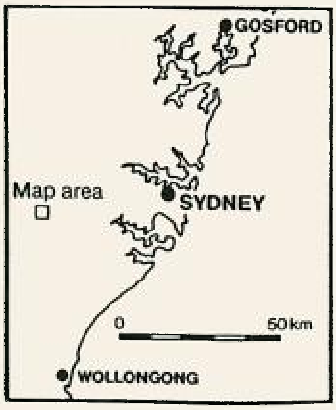
MAXIMUM PREDICTED 3-MINUTE AVERAGE GROUND-LEVEL CONCENTRATION OF HCL

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 9





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

BORAL BRICKWORKS

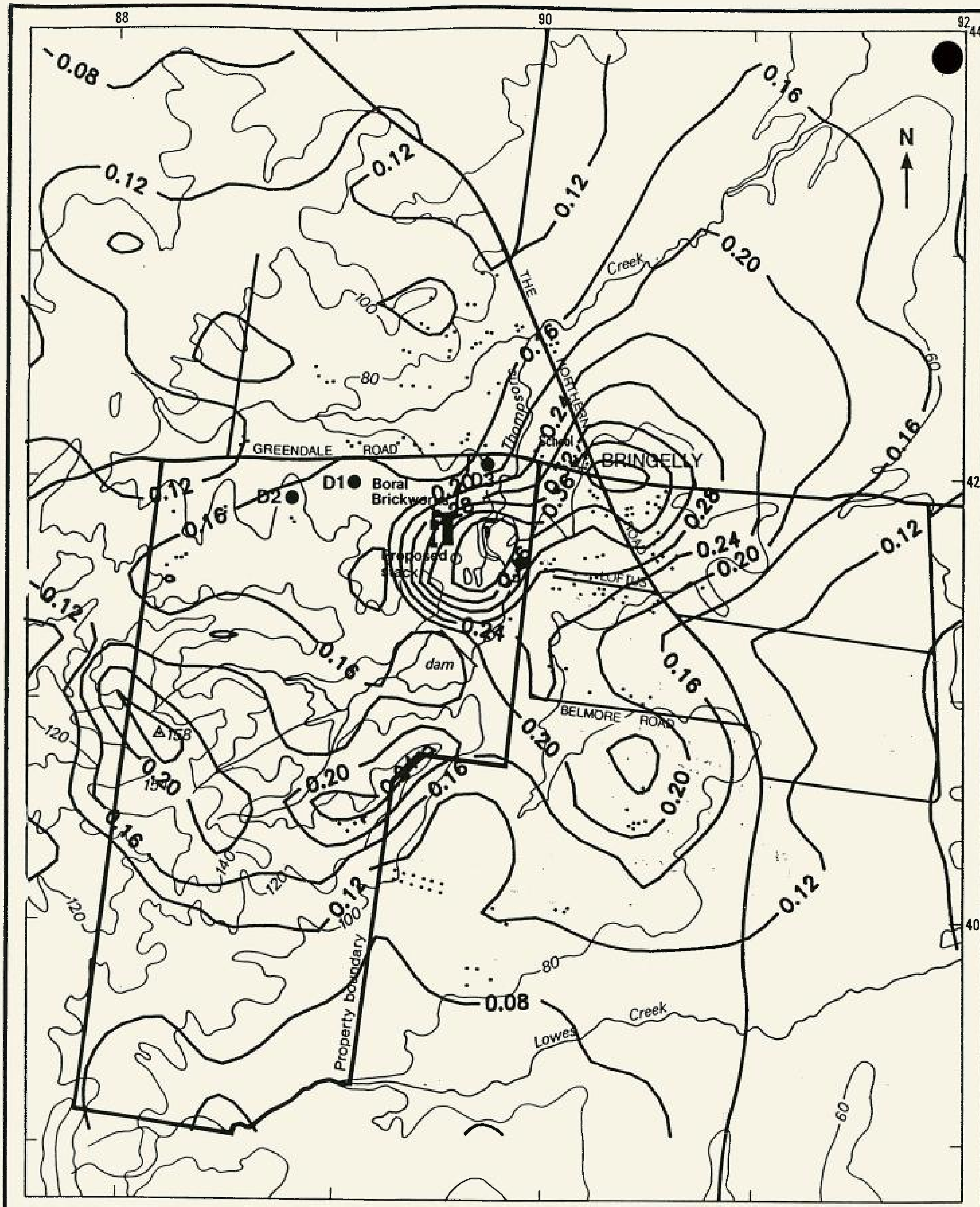
MAXIMUM PREDICTED 24-HOUR AVERAGE GROUND-LEVEL CONCENTRATION OF HF

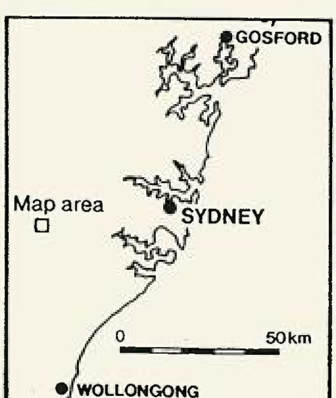
($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990

Figure 10





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

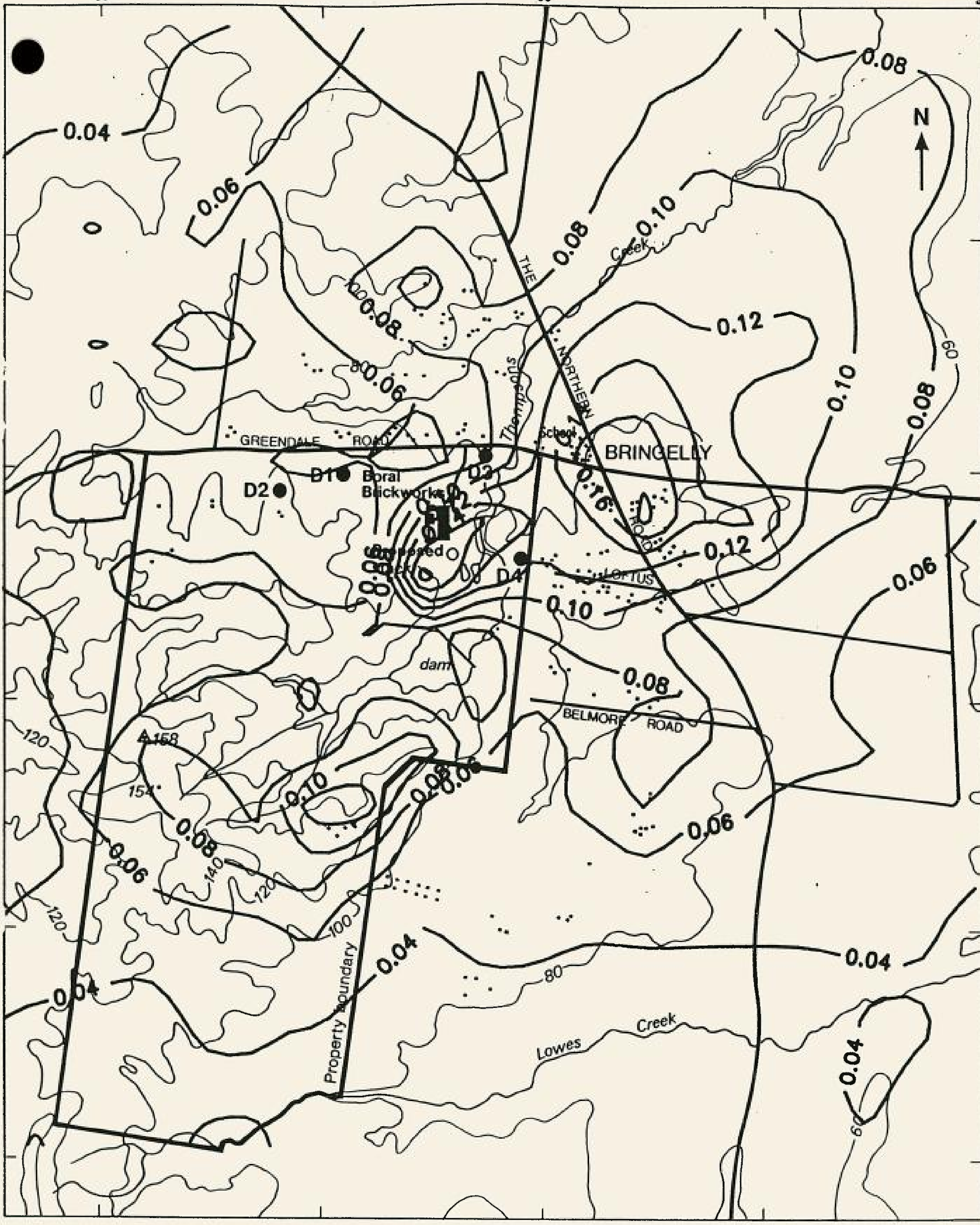
BORAL BRICKWORKS

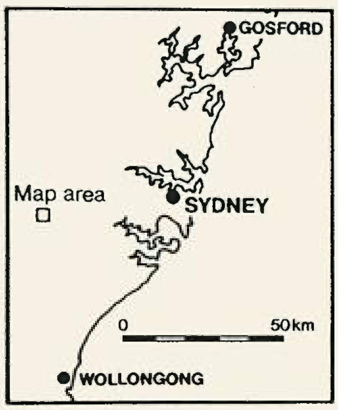
MAXIMUM PREDICTED 7-DAY AVERAGE GROUND-LEVEL CONCENTRATION OF HF

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 11





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

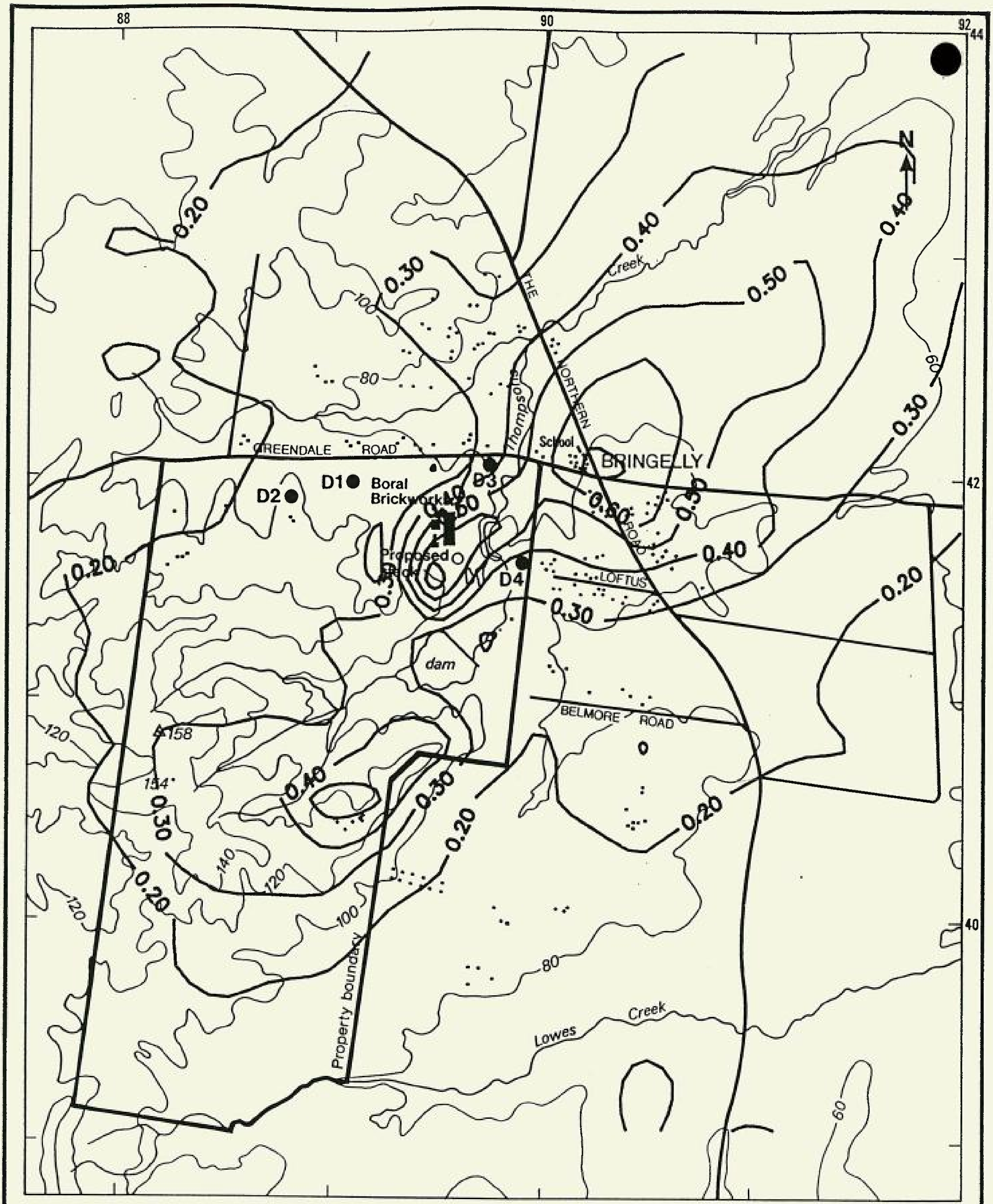
BORAL BRICKWORKS

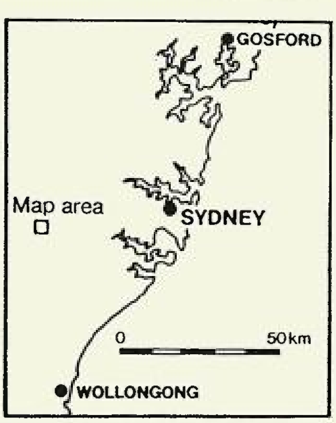
MAXIMUM PREDICTED 3-MONTH AVERAGE GROUND-LEVEL CONCENTRATION OF HF

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 12





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1km

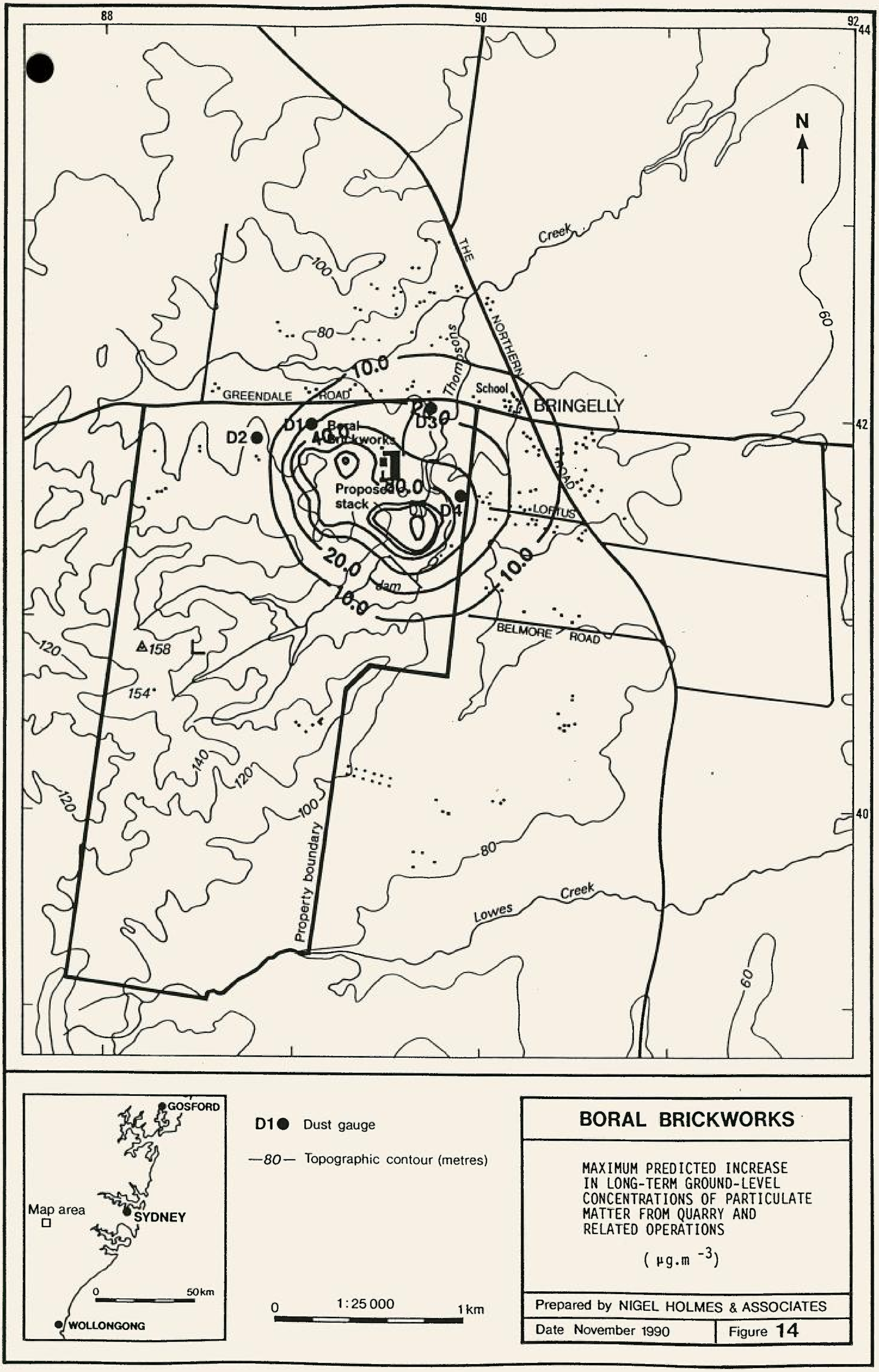
BORAL BRICKWORKS

MAXIMUM PREDICTED LONG-TERM AVERAGE GROUND-LEVEL CONCENTRATION OF PARTICULATE MATTER FROM STACK EMISSIONS

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 13



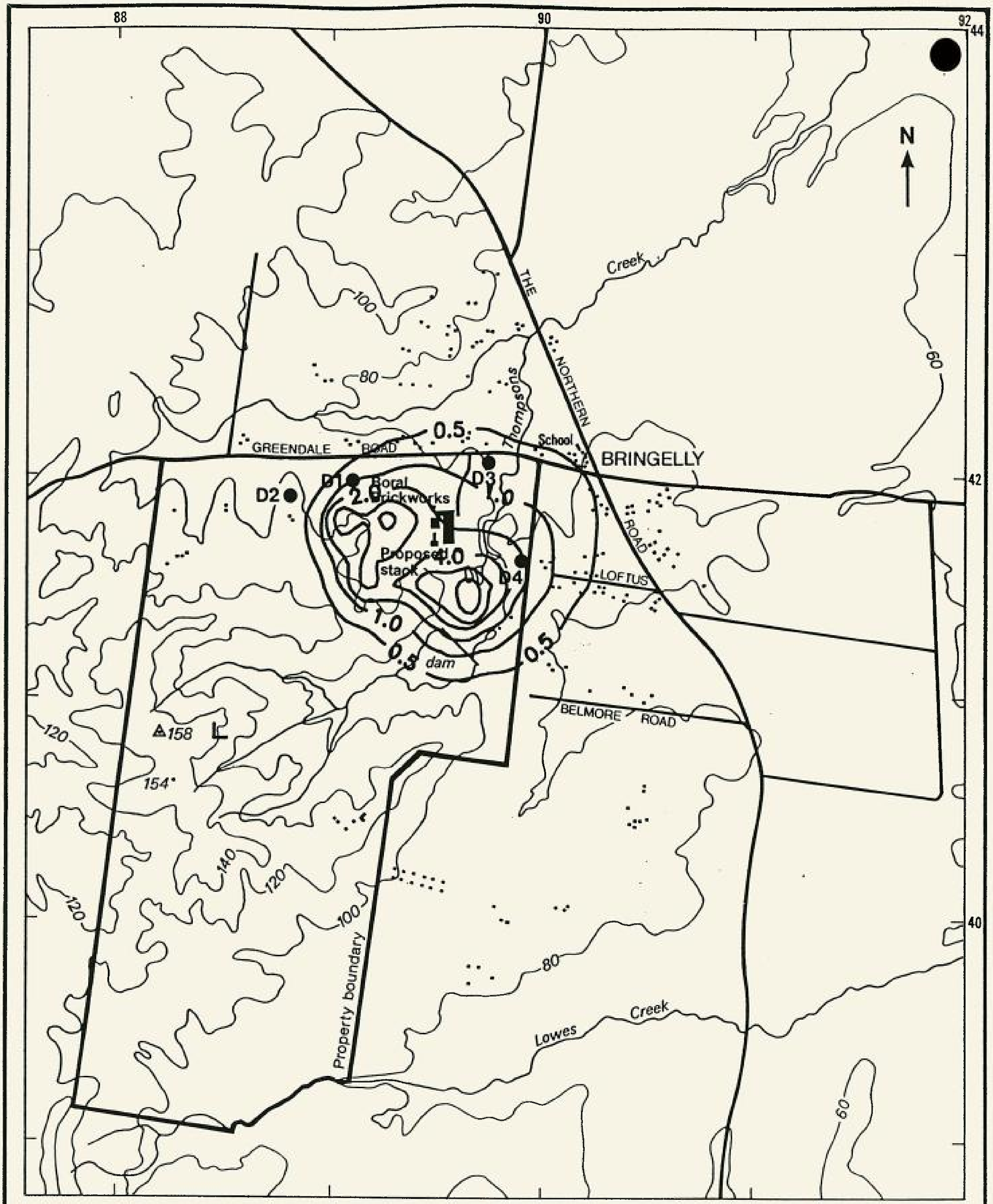
BORAL BRICKWORKS

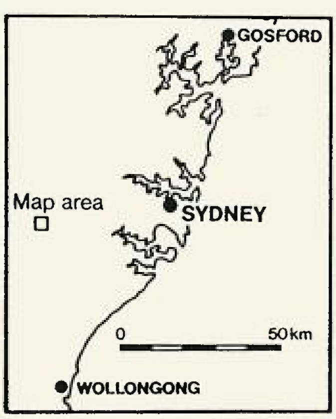
MAXIMUM PREDICTED INCREASE IN LONG-TERM GROUND-LEVEL CONCENTRATIONS OF PARTICULATE MATTER FROM QUARRY AND RELATED OPERATIONS

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 14





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

BORAL BRICKWORKS

MAXIMUM PREDICTED INCREASE IN LONG-TERM DEPOSITION RATES OF PARTICULATE MATTER FROM QUARRY AND RELATED OPERATIONS

($g.m^{-2}.month^{-1}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 15

APPENDIX A

APPENDIX A
DETAILS OF DUST EMISSION ESTIMATES

Production of 200,000 t/year from Clay Shale Quarry

1. Scraping

The production of 200000 t/year from the quarry will be done by three 15 t scrapers which are also used to transport the raw material to the two 50000 m^3 stockpiles shown in Figure 2 of the main document. It has been assumed that the amount of dust generated by scraping is 29 g/t of material quarried (US EPA 1985). The total amount of dust produced in the course of a year is therefore 5.8 t.

2. Haulage to stockpiles and unloading

Raw material is transported from the quarry to the stockplies by scraper. The emission factor for the haulage of material by scraper (US EPA 1985) is given by the equation:

$$E = 9.6 \times 10^{-6} (s)^{1.3} . (W)^{2.4} \qquad \ldots(1)$$

$$= 0.53 \text{ kg/vehicle km}$$

where:

s = material silt content = 30% for clay shale quarrying.
W = weight of scraper in tonne = 15 t.

Assuming an average round-trip of 1.5 km the total distance travelled to haul 200 000 in a year would be 20 000 km. Therefore the total amount of dust produced would be 10.6 t. Suppression of dust by water sprays would reduce this to 5.3 t.

Unloading from scrapers at the stockpiles generates dust at a rate of 0.02 kg/t which would result in an annual level of dust production of 4.0 t.

3. Rehabilitation activity

Some backfilling of waste material takes place but the proportion of waste material to product is not known. For the purposes of this report it has been assumed that approximately 10 % of quarried material is used for backfilling, that is 20,000 tonnes per year. 1333 round trips for the 15 t scrapers are required for the movement of this amount of material. The distance covered is conservatively estimated to be 0.6 km return (average).

Using the emission factor calculated above for the haulage of the material, 0.53 kg/vehicle km, the total dust generated by this activity is estimated to be 0.4 t.

For the loading and unloading of waste material, an emission rate of 0.02 kg/t was used giving a value of 0.8 t for the dust generated in a year.

Therefore the total amount of dust generated by the rehabilitation work is estimated to be 1.2 t/year

4. Crushing and conveying

Material is moved from the stockpiles to the crusher by frontend loader. Loading and unloading operations are assumed to have an emission rate of 0.02kg/t so the total dust produced by moving 200 000 t in a year would be 8.0 t.

Primary crushers have an emission factor of 140 g/t (US EPA 1985) for dry material however enclosure of the crushing process takes place which will reduce the emission factor by 70% to 42 g/t. The total annual dust generated would be 8.4 t.

Conveying of material produces dust at a rate of 1.7 g/t resulting in an annual dust emission of 0.34 t.

5. Wind Erosion from Pit and Product Stockpiles.

There are two stockpiles of 50 000 m^3 each to be located to the south of the material process area. The area of each stockpile is approximately 1 ha. The total area of the pit is assumed to be 13 ha.

Wind erosion from the stockpiles can be calculated in kg/ha/day from the following

$$E = 1.9.(s/1.5).((365-p)/235).(f/15) \qquad \text{....(2)}$$

where:

s = silt content = 30 %.
p = number of wet days = 84.
f = percentage of time that the unobstructed wind speed exceeds 5.4 m/s at the mean pile height = 13.0 %

The emission factor for wind erosion is 39.4 kg/ha/day. The total annual dust emitted from each stockpiles is 14.38 t.

Erosion from exposed pit surfaces has been estimated by the SPCC to take place at the rate of 9.6 kg/ha/day. Using this value, the annual erosion from the Bringelly pit is calculated to be 45.6 t.

7. Loading and unloading of Trucks and Transport to Road

In addition to the material removed from the quarry, the brickworks transports 40 000 t of material into the site every year by 25 t trucks. Approximately 30 000 t of material is removed from the site and transported to the Company's Moorebank and Prospect operations.

The emission factor for loading and unloading of trucks is 0.02 kg/t giving an annual dust emission of 1.4 t.

The emission factor for transport along industrial paved roads (US EPA 1985) was calculated to be 0.3 kg/vehicle km and the total dust emission for the year is 1.26 t (round trip 1.5 km from stockpiles to road, total number of trips 2800).

TABLE 2
DUST EMISSIONS INVENTORIES - t.year $^{-1}$

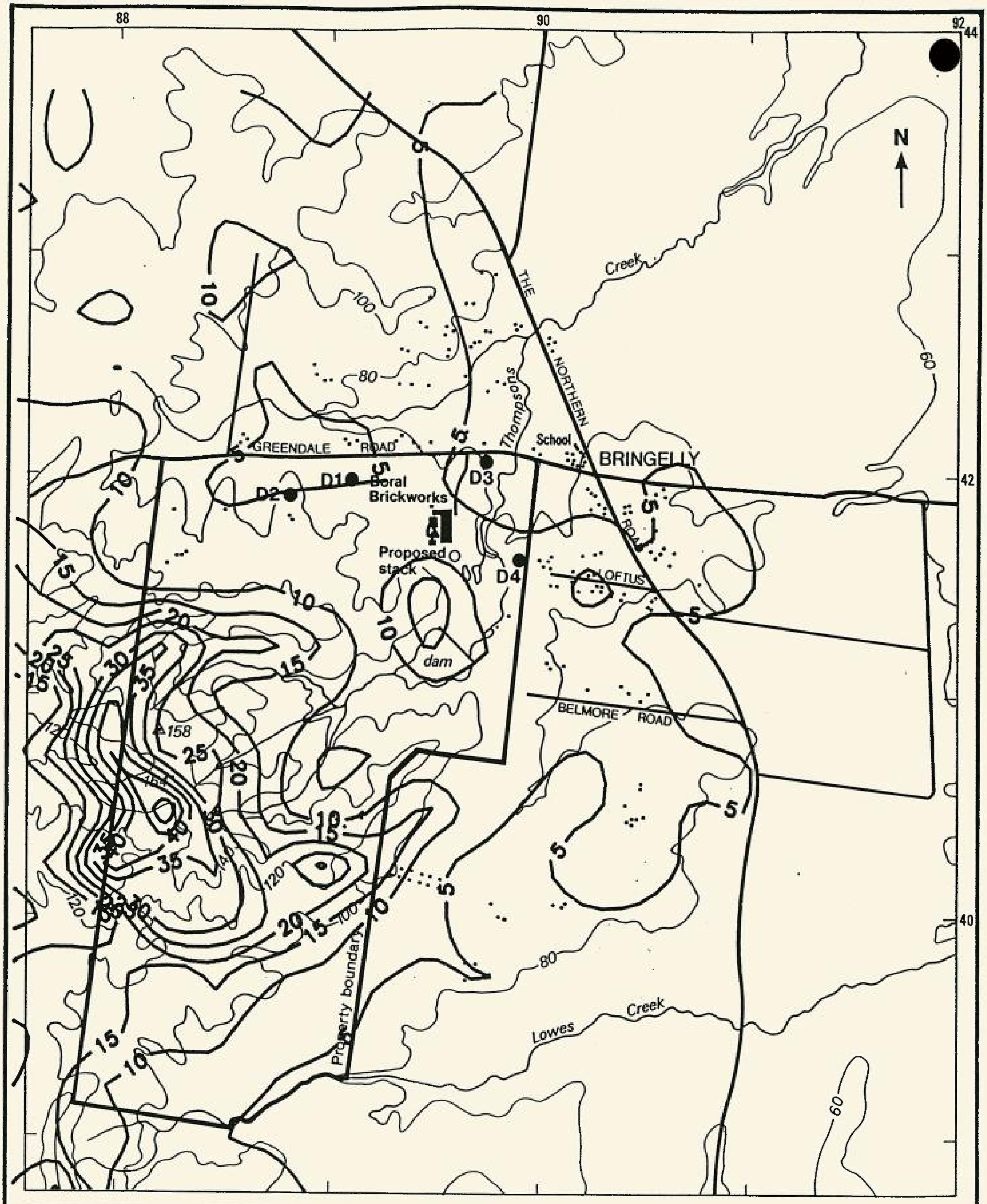
(See Appendix A for details of calculations of the individual emissions and emission factors summarised in this table)

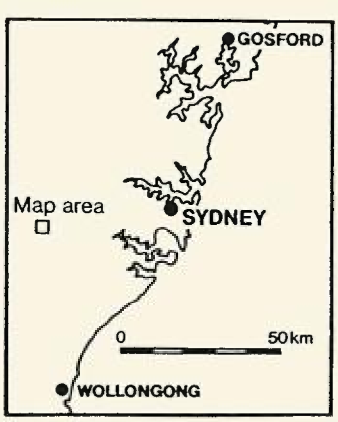
PROCESS	EMISSION FACTOR	DUST EMISSIONS	COMMENTS
PIT AREA			
Scraping	29.0 g/t	5.8	
Haulage	0.53 kg/vehicle km	5.3	50% control-water
Pit erosion	9.6 kg/day/ha	45.6	
PROCESS AREA			
Primary crushing	140 g/t	8.4	70% control-enclosure
Loading unloading by front end loader	20 g/t	8.0	
Conveyors	1.7 g/t	0.34	
REHABILITATION			
Transport	0.53 kg/vehicle km	0.4	
Unloading	20.0 g/t	0.8	
STOCKPILES			
Unloading from scraper	20.0 g/t	4.0	
Unloading from trucks	20.0 g/t	1.4	
Erosion	39.37 kg/day/ha	28.76	
Haulage to and from Greendale Road	300 g/vehicle km	1.26	Industrial Paved road
TOTAL		110.06	

APPENDIX B

CONTOUR PLOTS FROM MODELLING RUNS USING
WEST HOXTON METEOROLOGICAL DATA

FIGURES





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

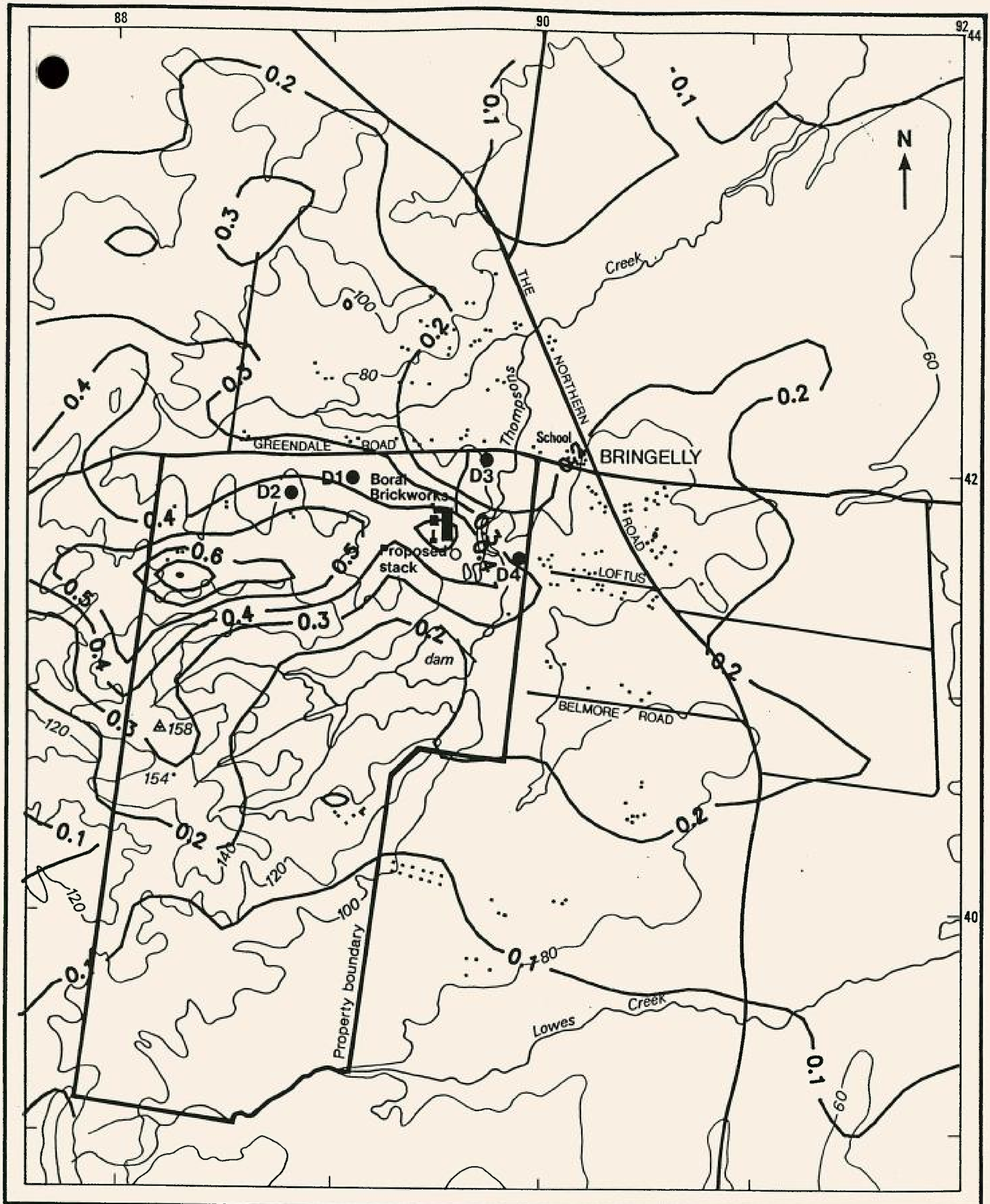
BORAL BRICKWORKS

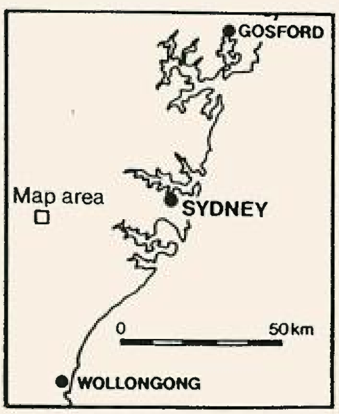
MAXIMUM PREDICTED 1 HOUR AVERAGE GROUND-LEVEL CONCENTRATION OF SO_2

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure **1b**





D1 ● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

BORAL BRICKWORKS

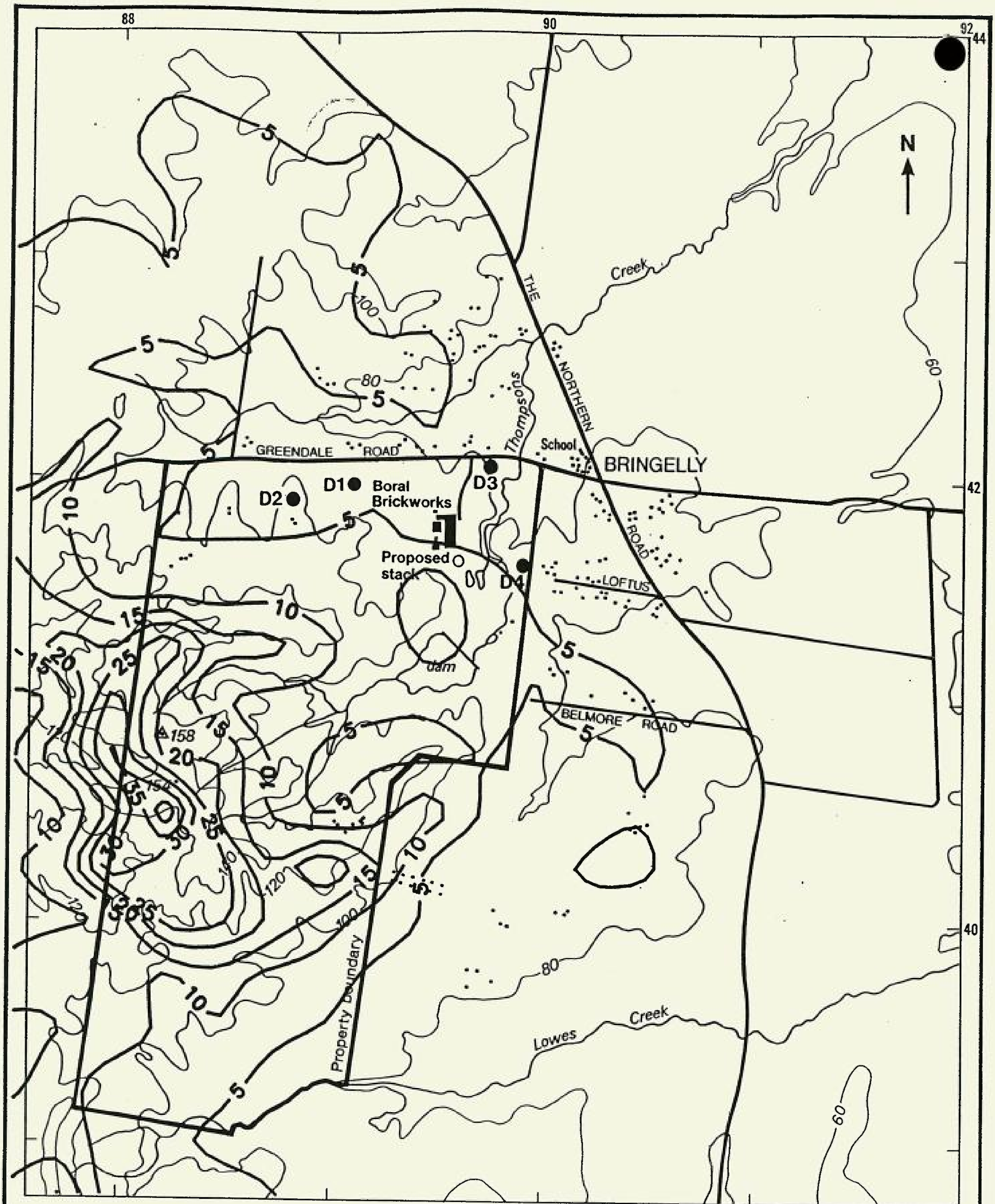
MAXIMUM PREDICTED LONG-TERM AVERAGE GROUND-LEVEL CONCENTRATION OF SO_2

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990

Figure 2b



D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1km

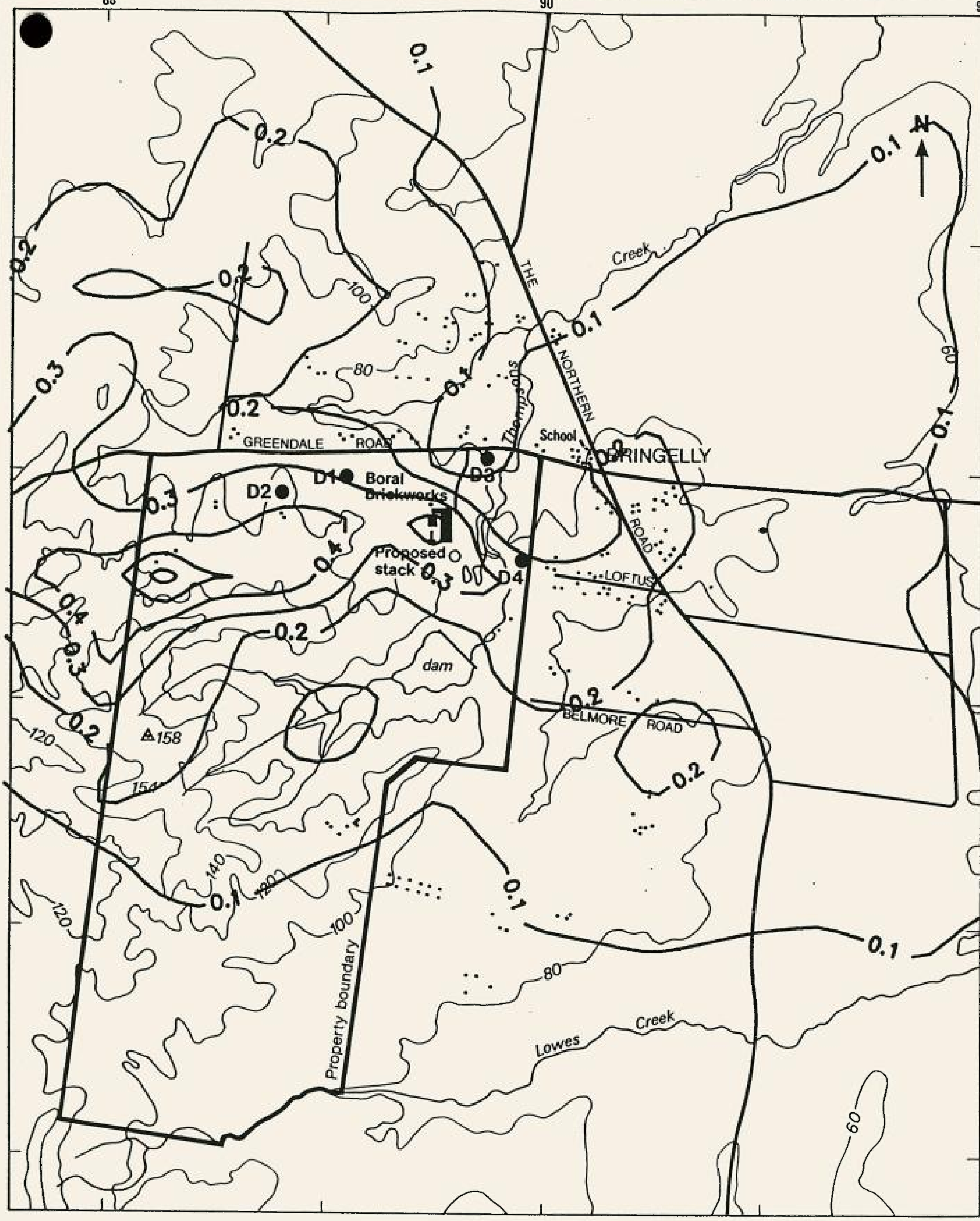
BORAL BRICKWORKS

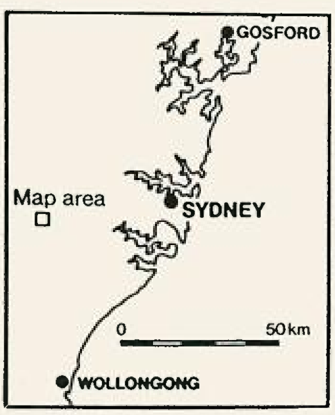
MAXIMUM PREDICTED 1 HOUR AVERAGE GROUND-LEVEL CONCENTRATION OF NO_2

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 3b





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1km

BORAL BRICKWORKS

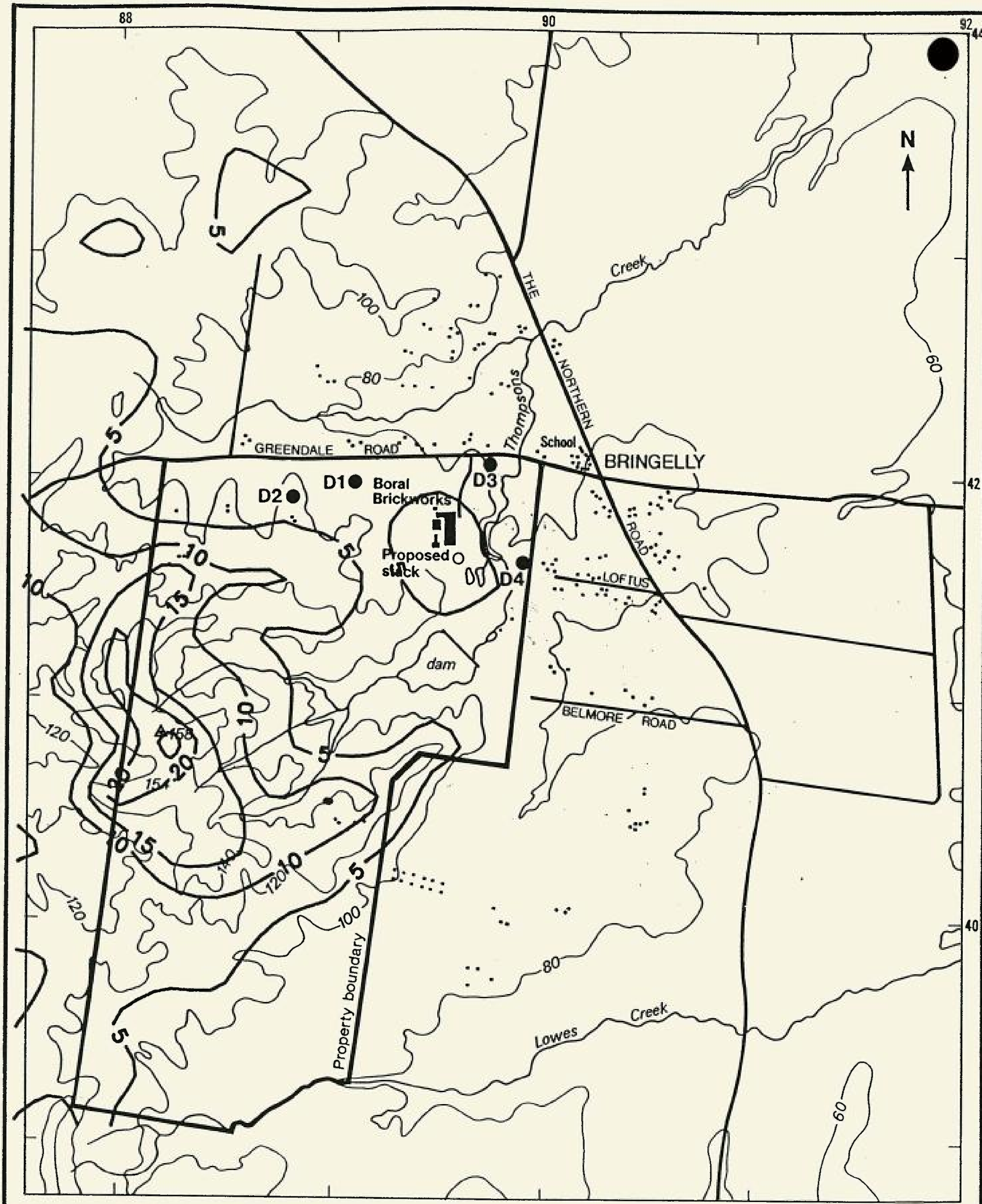
MAXIMUM PREDICTED LONG-TERM AVERAGE GROUND-LEVEL CONCENTRATION OF NO_2

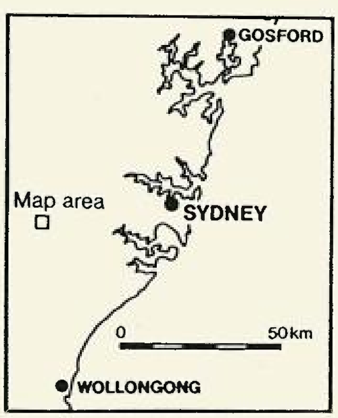
($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990

Figure 4b





D1 ● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1km

BORAL BRICKWORKS

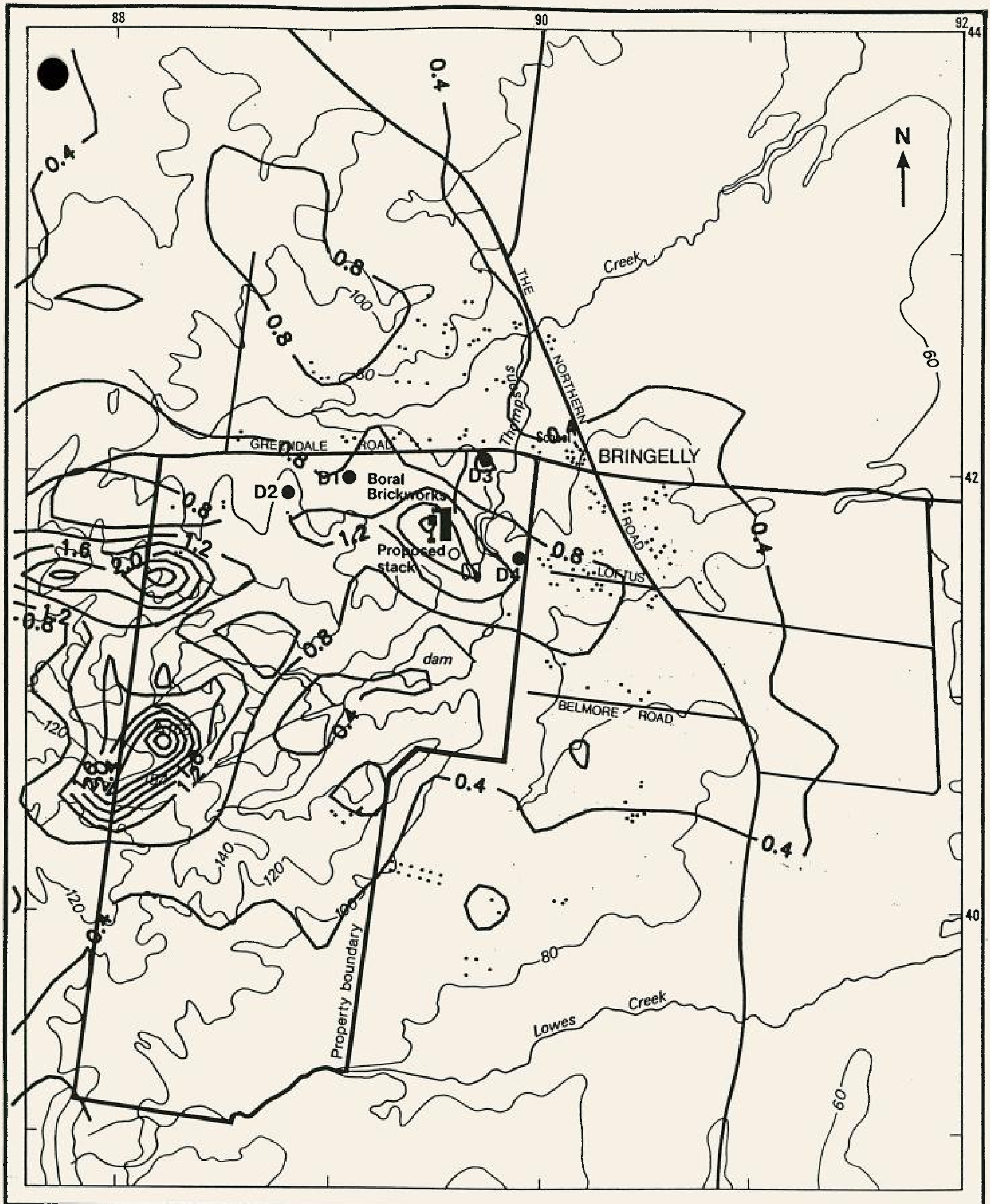
MAXIMUM PREDICTED 3-MINUTE
AVERAGE GROUND-LEVEL
CONCENTRATION OF HCL

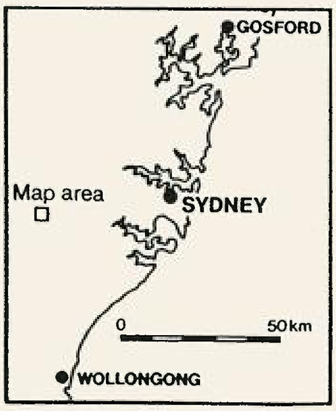
($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990

Figure 5b





D1 ● Dust gauge

—80— Topographic contour (metres)

1:25 000

0 1 km

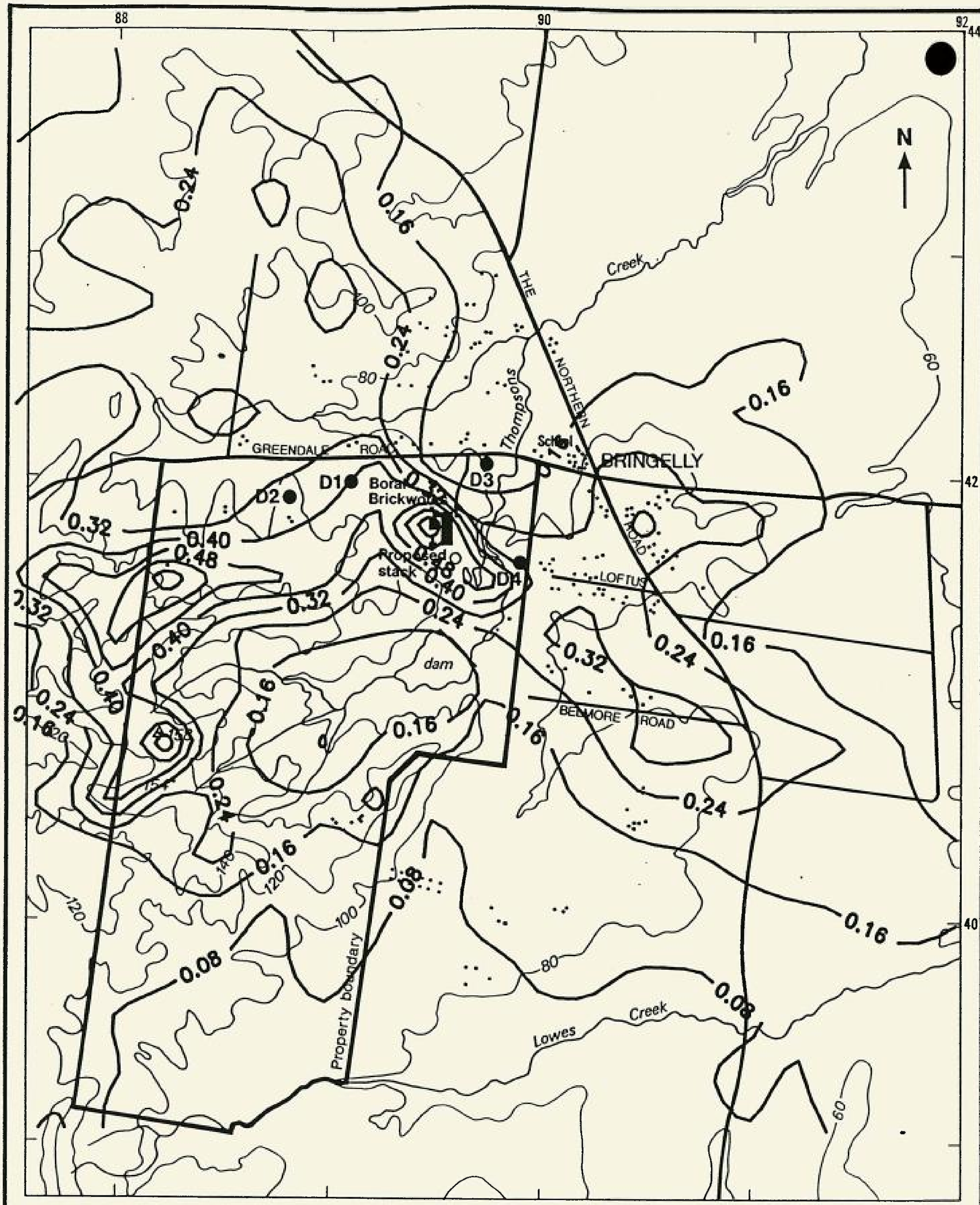
BORAL BRICKWORKS

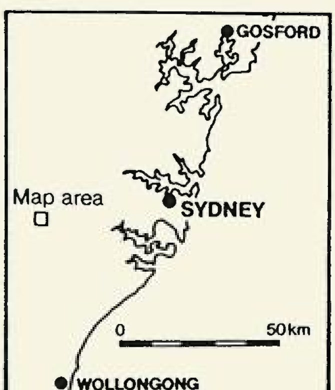
MAXIMUM PREDICTED 24-HOUR
AVERAGE GROUND-LEVEL
CONCENTRATION OF HF

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 6b





D1● Dust gauge

—*80*— Topographic contour (metres)

0 1:25 000 1 km

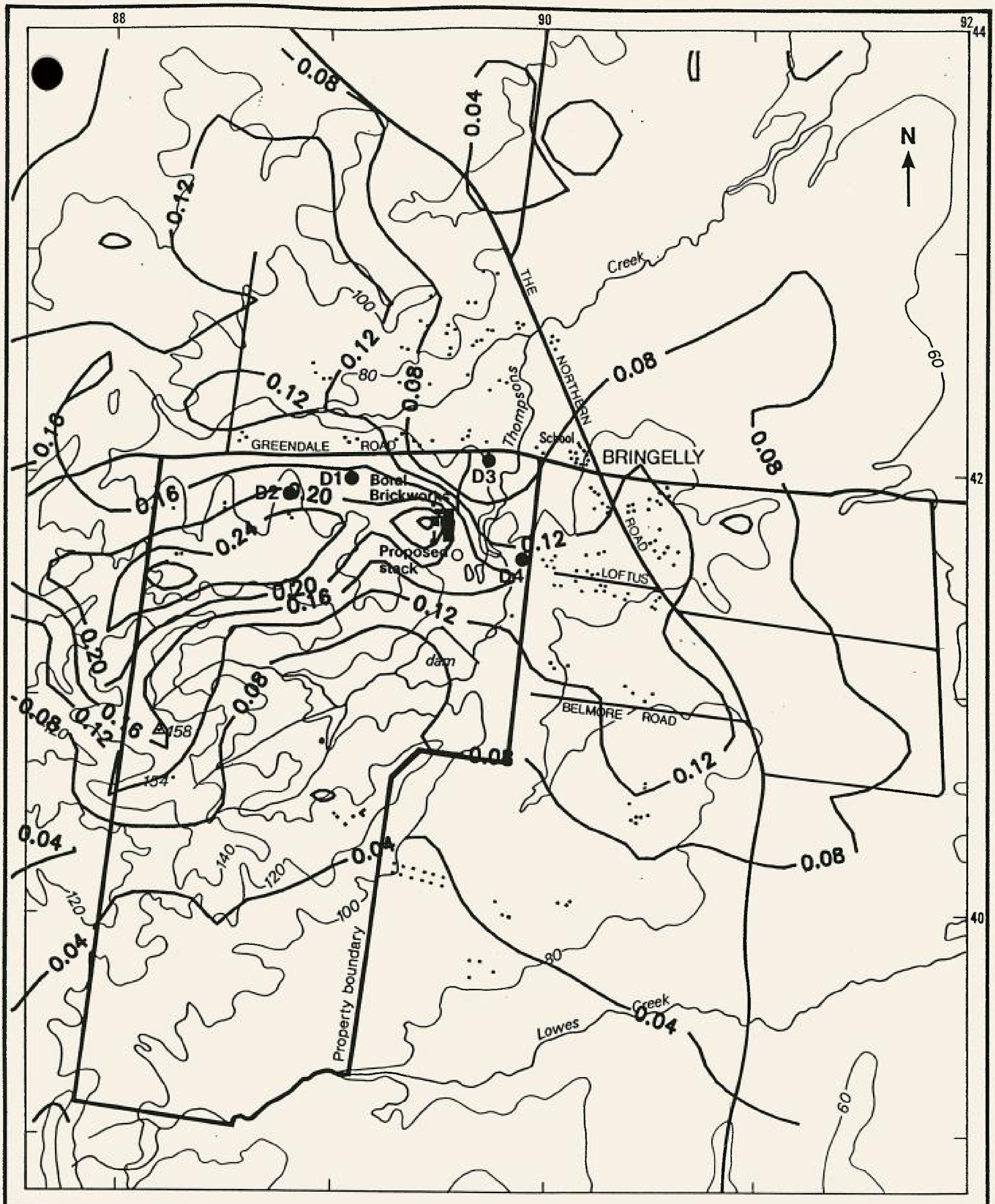
BORAL BRICKWORKS

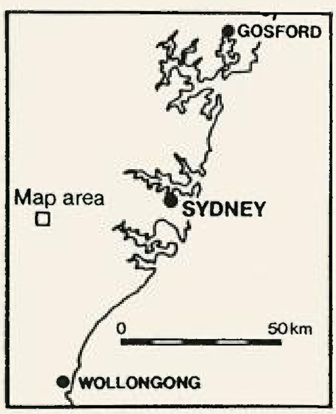
MAXIMUM PREDICTED 7-DAY AVERAGE GROUND-LEVEL CONCENTRATION OF HF

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 7b





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1km

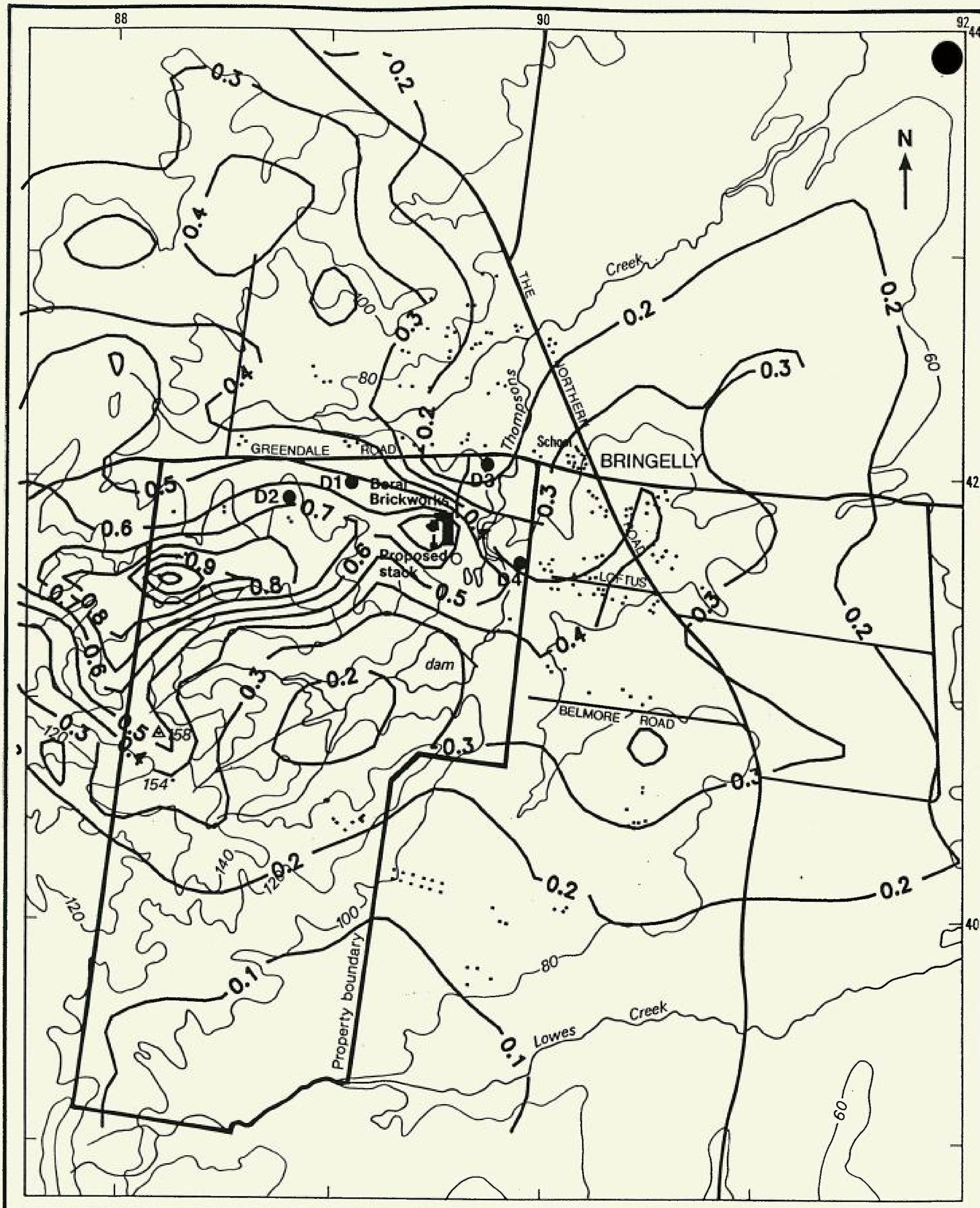
BORAL BRICKWORKS

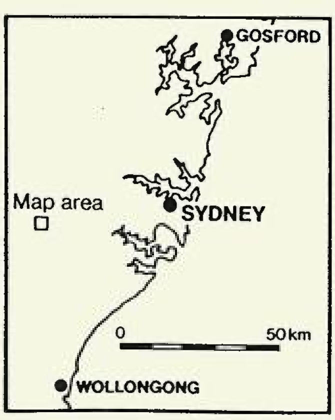
MAXIMUM PREDICTED 3-MONTH AVERAGE GROUND-LEVEL CONCENTRATION OF HF

(µg.m $^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure 8b





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1km

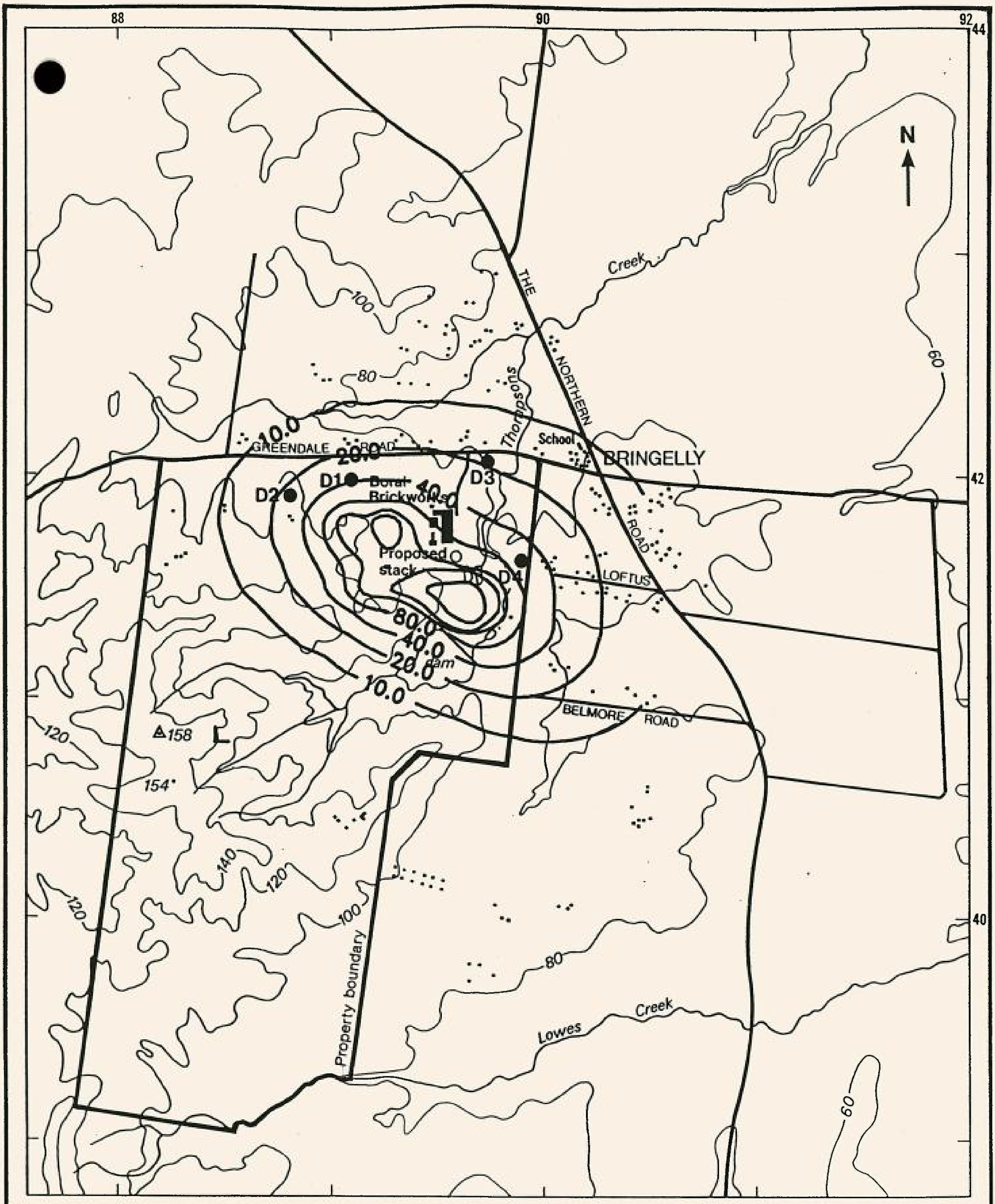
BORAL BRICKWORKS

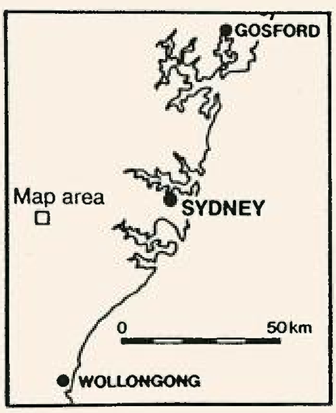
MAXIMUM PREDICTED LONG-TERM AVERAGE GROUND-LEVEL CONCENTRATION OF PARTICULATE MATTER FROM STACK EMISSIONS

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990	Figure 9b





D1● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

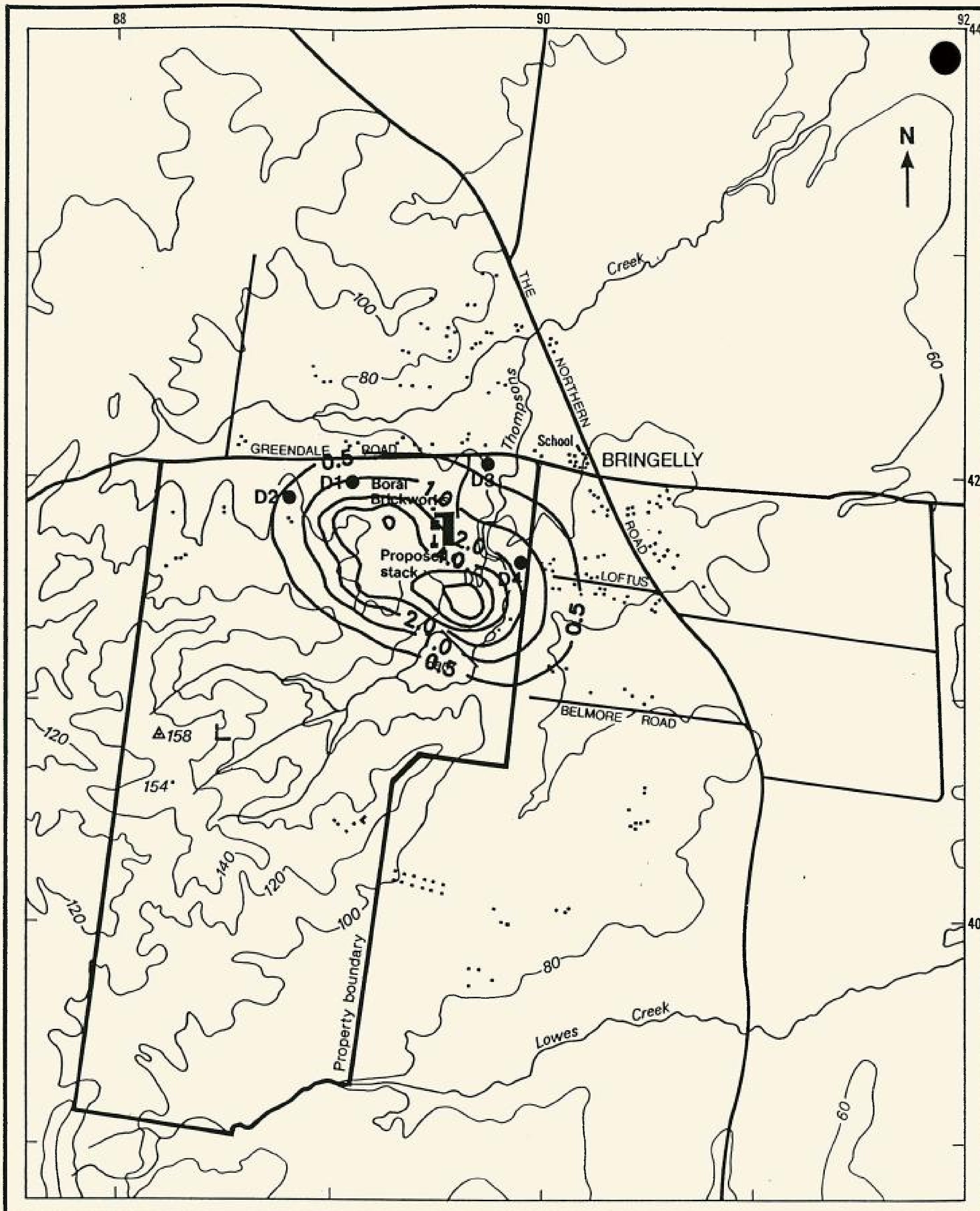
BORAL BRICKWORKS

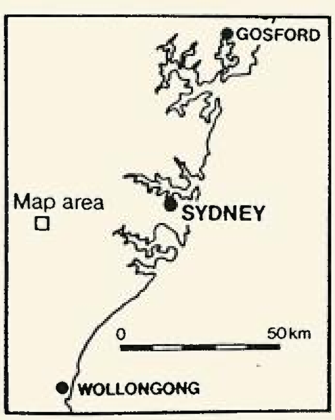
MAXIMUM PREDICTED INCREASE IN LONG-TERM GROUND-LEVEL CONCENTRATIONS OF PARTICULATE MATTER FROM QUARRY AND RELATED OPERATIONS

($\mu g.m^{-3}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990	Figure **10b**





D1 ● Dust gauge

—80— Topographic contour (metres)

0 1:25 000 1 km

BORAL BRICKWORKS

MAXIMUM PREDICTED INCREASE
IN LONG-TERM DEPOSITION RATES
OF PARTICULATE MATTER FROM
QUARRY AND RELATED OPERATIONS

($g.m^{-2}.month^{-1}$)

Prepared by NIGEL HOLMES & ASSOCIATES

Date November 1990 | Figure **11b**

APPENDIX C

OUTPUT FROM AUSPLUME MODELLING RUN FOR HF USING WEST HOXTON METEOROLOGICAL DATA

1

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+---------------------+
|                     |
|  Bringelly New HF   |
|                     |
+---------------------+
```

```
  Concentration or deposition................................ Concentration
  Emission rate units........................................ grams/second
  Concentration units........................................ micrograms/cubic metre

  Units conversion factor.................................... 1.00E+06
  Background concentration................................... 0.00E+00
  Terrain effects............................................ Egan method
  Smooth stability class changes?............................ No
  Other stability class adjustments ("urban modes")........... None
  Ignore building wake effects?.............................. No
  Decay coefficient (unless overridden by met. file).......... .000
  Anemometer height.......................................... 10 m

DISPERSION CURVES
  Horizontal dispersion curves for sources <100m high......... Pasquill-Gifford
  Vertical  dispersion  curves for sources <100m high......... Pasquill-Gifford
  Horizontal dispersion curves for sources >100m high......... Briggs Rural
  Vertical  dispersion  curves for sources >100m high......... Briggs Rural
  Enhance horizontal plume spreads for buoyancy?.............. Yes
  Enhance  vertical  plume spreads for buoyancy?.............. Yes
  Adjust horizontal P-G formulae for roughness height?........ Yes
  Adjust  vertical  P-G formulae for roughness height?........ Yes
  Roughness height........................................... .300m
  Adjustment for wind directional shear...................... None

PLUME RISE OPTIONS
  Gradual plume rise?........................................ Yes
  Stack-tip downwash included?............................... Yes
  Entrainment coefficients for adiabatic & stable lapse rates. .60, .60
  Partial penetration of elevated inversions?................ No
  Disregard temperature gradients in the hourly met. file?.... No

  and in the absence of boundary-layer potential temperature gradients
  given by the hourly met. file, a value from the following table
  (in K/m) is used:
```

Wind Speed Category	Stability Class A	B	C	D	E	F
1	.000	.000	.000	.000	.020	.035
2	.000	.000	.000	.000	.020	.035
3	.000	.000	.000	.000	.020	.035
4	.000	.000	.000	.000	.020	.035
5	.000	.000	.000	.000	.020	.035
6	.000	.000	.000	.000	.020	.035

```
WIND SPEED CATEGORIES
  Boundaries between categories (in m/s) are:  1.54,  3.09,  5.14,  8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Urban" values (unless overridden by met. file)

AVERAGING TIMES
 24 hours
  7 days
  3 months
```

1

```
+--------------------------+
|                          |
|   Bringelly New          |
|                          |
|  SOURCE CHARACTERISTICS  |
|                          |
+--------------------------+
```

STACK No. 1

X(m)	Y(m)	Ground Elevation	Stack Height	Diameter	Temperature	Speed
89570	41640	88m	18m	1.50m	433K	15.0m/s

Adjacent building size: 30m wide x 11m high
(Constant) emission rate = 5.56E-01 grams/second
No gravitational settling or scavenging.

1

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+---------------------+
|                     |
|  Bringelly New      |
|                     |
|  RECEPTOR LOCATIONS |
|                     |
+---------------------+
```

The Cartesian receptor grid has the following x-values (or eastings):
87000.m 87250.m 87500.m 87750.m 88000.m 88250.m 88500.m 88750.m 89000.m 89250.m
89500.m 89750.m 90000.m 90250.m 90500.m 90750.m 91000.m 91250.m 91500.m 91750.m
92000.m

and these y-values (or northings):
39000.m 39250.m 39500.m 39750.m 40000.m 40250.m 40500.m 40750.m 41000.m 41250.m
41500.m 41750.m 42000.m 42250.m 42500.m 42750.m 43000.m 43250.m 43500.m 43750.m
44000.m

METEOROLOGICAL DATA : West Hoxton (Austral) 1980/1981

1 HIGHEST RECORDINGS FOR EACH RECEPTOR (in micrograms/cubic metre)
AVERAGING TIME = 24 HOURS

X (km):	87.000	87.250	87.500	87.750
Y (km)				
44.000	4.41E-01 h24,05/05/80	3.22E-01 h24,07/12/80	3.30E-01 h24,23/11/80	3.91E-01 h24,07/02/81
43.750	3.83E-01 h24,05/05/80	3.77E-01 h24,07/12/80	3.10E-01 h24,07/12/80	3.50E-01 h24,23/11/80
43.500	3.60E-01 h24,06/12/80	3.83E-01 h24,05/05/80	3.14E-01 h24,07/12/80	3.40E-01 h24,23/11/80
43.250	3.69E-01 h24,06/12/80	3.49E-01 h24,06/12/80	3.36E-01 h24,07/12/80	4.78E-01 h24,07/12/80
43.000	4.16E-01 h24,15/05/80	3.77E-01 h24,06/12/80	3.23E-01 h24,06/12/80	4.21E-01 h24,07/12/80
42.750	4.31E-01 h24,09/05/80	5.21E-01 h24,15/05/80	4.15E-01 h24,15/05/80	3.98E-01 h24,06/12/80
42.500	5.52E-01 h24,09/05/80	6.36E-01 h24,06/05/80	6.76E-01 h24,06/05/80	6.35E-01 h24,15/05/80
42.250	5.31E-01 h24,09/05/80	6.71E-01 h24,09/05/80	7.69E-01 h24,09/05/80	9.34E-01 h24,06/05/80
42.000	8.04E-01 h24,17/06/80	8.15E-01 h24,17/06/80	9.47E-01 h24,17/06/80	8.04E-01 h24,04/05/80
41.750	3.95E-01 h24,14/07/80	6.19E-01 h24,14/07/80	9.91E-01 h24,17/06/80	7.89E-01 h24,17/06/80
41.500	6.26E-01 h24,14/07/80	1.06E+00 h24,14/07/80	1.78E+00 h24,14/07/80	2.53E+00 h24,14/07/80
41.250	6.86E-01 h24,14/07/80	6.95E-01 h24,14/07/80	4.98E-01 h24,09/01/81	6.06E-01 h24,18/01/81
41.000	3.03E-01 h24,23/03/81	3.23E-01 h24,09/12/80	5.70E-01 h24,17/11/80	1.10E+00 h24,17/11/80
40.750	3.36E-01 h24,17/11/80	3.73E-01 h24,17/11/80	4.52E-01 h24,13/03/81	5.29E-01 h24,22/10/80
40.500	2.74E-01 h24,13/03/81	5.04E-01 h24,22/10/80	6.69E-01 h24,22/10/80	1.18E+00 h24,22/10/80
40.250	6.13E-01 h24,22/10/80	5.63E-01 h24,22/10/80	6.18E-01 h24,22/10/80	7.48E-01 h24,22/10/80
40.000	8.21E-01 h24,22/10/80	6.12E-01 h24,22/10/80	8.94E-01 h24,22/10/80	5.68E-01 h24,22/10/80
39.750	7.73E-01 h24,22/10/80	7.69E-01 h24,22/10/80	5.47E-01 h24,22/10/80	4.43E-01 h24,21/11/80
39.500	5.80E-01 h24,22/10/80	3.26E-01 h24,22/10/80	4.73E-01 h24,16/01/81	3.34E-01 h24,17/07/80
39.250	2.30E-01 h24,09/12/80	2.71E-01 h24,21/11/80	3.24E-01 h24,17/07/80	3.43E-01 h24,18/04/81
39.000	2.29E-01 h24,21/11/80	3.11E-01 h24,17/07/80	4.09E-01 h24,18/04/81	6.25E-01 h24,20/04/81

Y (km) \ X (km):	88.000	88.250	88.500	88.750
44.000	5.00E-01 h24,07/02/81	5.47E-01 h24,07/02/81	4.81E-01 h24,07/02/81	4.53E-01 h24,05/12/80
43.750	4.85E-01 h24,07/02/81	6.37E-01 h24,07/02/81	6.39E-01 h24,07/02/81	5.91E-01 h24,05/12/80
43.500	4.29E-01 h24,23/11/80	6.14E-01 h24,07/02/81	7.78E-01 h24,07/02/81	6.50E-01 h24,07/02/81
43.250	4.50E-01 h24,23/11/80	5.51E-01 h24,07/02/81	8.77E-01 h24,07/02/81	9.22E-01 h24,07/02/81
43.000	6.61E-01 h24,07/12/80	5.33E-01 h24,23/11/80	8.19E-01 h24,23/11/80	9.65E-01 h24,07/02/81
42.750	3.25E-01 h24,22/11/80	4.63E-01 h24,07/12/80	5.63E-01 h24,23/11/80	8.43E-01 h24,07/02/81
42.500	6.83E-01 h24,15/05/80	4.05E-01 h24,22/11/80	5.49E-01 h24,23/11/80	6.61E-01 h24,23/11/80
42.250	9.15E-01 h24,09/05/80	7.85E-01 h24,09/05/80	5.27E-01 h24,09/05/80	5.15E-01 h24,22/11/80
42.000	8.31E-01 h24,09/05/80	9.40E-01 h24,09/05/80	1.08E+00 h24,09/05/80	1.08E+00 h24,09/05/80
41.750	5.57E-01 h24,17/06/80	5.77E-01 h24,09/05/80	7.77E-01 h24,09/05/80	1.09E+00 h24,09/05/80
41.500	2.19E+00 h24,14/07/80	3.14E+00 h24,14/07/80	1.56E+00 h24,14/07/80	1.08E+00 h24,09/01/81
41.250	1.54E+00 h24,18/01/81	1.32E+00 h24,17/11/80	7.73E-01 h24,17/11/80	6.44E-01 h24,25/03/80
41.000	1.68E+00 h24,17/11/80	1.12E+00 h24,22/10/80	1.76E+00 h24,22/10/80	8.26E-01 h24,22/10/80
40.750	1.71E+00 h24,22/10/80	3.99E+00 h24,22/10/80	1.24E+00 h24,22/10/80	4.09E-01 h24,10/05/80
40.500	2.93E+00 h24,22/10/80	1.34E+00 h24,22/10/80	8.52E-01 h24,21/11/80	6.24E-01 h24,05/11/80
40.250	4.99E-01 h24,22/10/80	7.74E-01 h24,21/11/80	7.48E-01 h24,18/04/81	7.09E-01 h24,20/04/81
40.000	4.04E-01 h24,21/11/80	3.41E-01 h24,10/05/80	4.89E-01 h24,20/04/81	3.69E-01 h24,02/12/80
39.750	3.53E-01 h24,18/04/81	3.22E-01 h24,05/11/80	3.09E-01 h24,20/04/81	3.45E-01 h24,02/12/80
39.500	2.67E-01 h24,10/05/80	2.35E-01 h24,20/04/81	2.57E-01 h24,02/12/80	3.03E-01 h24,02/12/80
39.250	3.26E-01 h24,20/04/81	2.06E-01 h24,20/04/81	2.40E-01 h24,02/12/80	2.75E-01 h24,02/12/80
39.000	2.74E-01 h24,20/04/81	2.00E-01 h24,02/12/80	2.86E-01 h24,02/12/80	3.10E-01 h24,02/12/80

Y (km) \ X (km):	89.000	89.250	89.500	89.750
44.000	3.84E-01 h24,05/12/80	3.93E-01 h24,11/02/81	3.98E-01 h24,24/10/80	3.26E-01 h24,24/10/80
43.750	4.85E-01 h24,05/12/80	4.70E-01 h24,11/02/81	4.10E-01 h24,24/10/80	2.99E-01 h24,24/10/80
43.500	7.43E-01 h24,05/12/80	5.30E-01 h24,30/12/80	4.64E-01 h24,24/10/80	2.89E-01 h24,24/10/80
43.250	8.20E-01 h24,05/12/80	5.48E-01 h24,30/12/80	4.29E-01 h24,30/12/80	2.99E-01 h24,30/01/81
43.000	8.03E-01 h24,07/02/81	6.75E-01 h24,30/12/80	5.54E-01 h24,30/12/80	3.88E-01 h24,30/01/81
42.750	1.09E+00 h24,07/02/81	8.85E-01 h24,30/12/80	7.53E-01 h24,30/12/80	4.56E-01 h24,30/01/81
42.500	9.77E-01 h24,07/02/81	8.01E-01 h24,30/12/80	7.32E-01 h24,30/12/80	5.25E-01 h24,30/01/81
42.250	6.47E-01 h24,23/11/80	7.49E-01 h24,07/02/81	6.69E-01 h24,30/12/80	4.75E-01 h24,30/01/81
42.000	6.56E-01 h24,16/10/80	9.91E-01 h24,01/02/81	6.99E-01 h24,30/12/80	3.67E-01 h24,30/01/81
41.750	1.38E+00 h24,09/05/80	1.22E+00 h24,09/05/80	2.15E+00 h24,07/02/81	9.70E-01 h24,28/10/80
41.500	9.76E-01 h24,09/12/80	6.79E-01 h24,09/12/80	1.26E+00 h24,21/01/81	1.63E+00 h24,30/06/80
41.250	9.23E-01 h24,22/10/80	4.35E-01 h24,21/01/81	4.40E-01 h24,21/01/81	6.22E-01 h24,19/11/80
41.000	2.50E-01 h24,10/05/80	3.94E-01 h24,02/12/80	3.83E-01 h24,17/02/81	6.28E-01 h24,24/04/80
40.750	3.17E-01 h24,02/12/80	7.14E-01 h24,02/12/80	6.65E-01 h24,15/09/80	5.50E-01 h24,19/11/80
40.500	7.64E-01 h24,05/11/80	9.70E-01 h24,02/12/80	2.52E-01 h24,02/12/80	3.51E-01 h24,19/11/80
40.250	6.51E-01 h24,02/12/80	4.99E-01 h24,02/12/80	2.45E-01 h24,15/09/80	2.87E-01 h24,19/11/80
40.000	4.93E-01 h24,02/12/80	3.19E-01 h24,02/12/80	2.15E-01 h24,15/09/80	4.69E-01 h24,11/05/80
39.750	3.83E-01 h24,02/12/80	2.60E-01 h24,02/12/80	1.89E-01 h24,15/09/80	3.16E-01 h24,11/05/80
39.500	2.89E-01 h24,02/12/80	2.04E-01 h24,02/12/80	1.65E-01 h24,15/09/80	2.32E-01 h24,11/05/80
39.250	2.37E-01 h24,02/12/80	1.63E-01 h24,02/12/80	1.42E-01 h24,15/09/80	2.39E-01 h24,11/05/80
39.000	2.27E-01 h24,02/12/80	1.51E-01 h24,02/12/80	2.18E-01 h24,15/09/80	3.43E-01 h24,11/05/80

Y (km) \ X (km):	90.000	90.250	90.500	90.750
44.000	2.59E-01 h24,20/06/80	3.00E-01 h24,30/01/81	2.80E-01 h24,30/01/81	2.32E-01 h24,30/01/81
43.750	2.83E-01 h24,30/01/81	3.05E-01 h24,30/01/81	2.91E-01 h24,30/01/81	2.11E-01 h24,30/01/81
43.500	3.13E-01 h24,30/01/81	2.98E-01 h24,30/01/81	2.64E-01 h24,30/01/81	2.44E-01 h24,12/02/81
43.250	3.29E-01 h24,30/01/81	3.18E-01 h24,30/01/81	2.41E-01 h24,12/02/81	2.89E-01 h24,12/02/81
43.000	3.74E-01 h24,30/01/81	2.83E-01 h24,30/01/81	2.97E-01 h24,12/02/81	3.08E-01 h24,12/02/81
42.750	3.77E-01 h24,30/01/81	2.87E-01 h24,12/02/81	3.25E-01 h24,12/02/81	2.74E-01 h24,12/02/81
42.500	3.86E-01 h24,30/01/81	3.51E-01 h24,12/02/81	3.12E-01 h24,12/02/81	3.08E-01 h24,30/03/80
42.250	3.16E-01 h24,06/06/80	3.46E-01 h24,20/11/80	4.71E-01 h24,28/10/80	4.71E-01 h24,28/10/80
42.000	4.95E-01 h24,20/11/80	7.89E-01 h24,28/10/80	6.88E-01 h24,28/10/80	4.75E-01 h24,28/10/80
41.750	7.29E-01 h24,28/10/80	5.24E-01 h24,11/09/80	6.30E-01 h24,30/10/80	4.60E-01 h24,05/07/80
41.500	9.98E-01 h24,10/09/80	9.80E-01 h24,10/09/80	7.38E-01 h24,10/09/80	5.88E-01 h24,10/09/80
41.250	8.30E-01 h24,29/06/80	8.96E-01 h24,30/06/80	5.98E-01 h24,30/06/80	4.53E-01 h24,10/09/80
41.000	4.64E-01 h24,03/12/80	6.29E-01 h24,29/06/80	7.56E-01 h24,30/06/80	6.84E-01 h24,30/06/80
40.750	4.44E-01 h24,18/09/80	3.82E-01 h24,03/12/80	6.84E-01 h24,29/06/80	6.97E-01 h24,30/06/80
40.500	4.24E-01 h24,24/04/80	4.24E-01 h24,18/09/80	4.30E-01 h24,10/06/80	4.43E-01 h24,29/06/80
40.250	3.85E-01 h24,24/04/80	3.26E-01 h24,18/09/80	2.93E-01 h24,08/09/80	2.79E-01 h24,29/06/80
40.000	3.48E-01 h24,28/06/80	3.66E-01 h24,18/09/80	2.96E-01 h24,18/09/80	2.25E-01 h24,08/09/80
39.750	2.57E-01 h24,28/06/80	2.70E-01 h24,18/09/80	2.49E-01 h24,18/09/80	1.65E-01 h24,18/09/80
39.500	2.06E-01 h24,28/06/80	2.26E-01 h24,24/04/80	2.41E-01 h24,18/09/80	1.88E-01 h24,18/09/80

39.250	2.18E-01 h24,11/05/80	2.15E-01 h24,28/06/80	2.06E-01 h24,18/09/80	2.10E-01 h24,18/09/80
39.000	3.25E-01 h24,11/05/80	2.09E-01 h24,28/06/80	1.93E-01 h24,18/09/80	2.19E-01 h24,18/09/80

X (km):	91.000	91.250	91.500	91.750
Y (km)				
44.000	2.07E-01 h24,20/02/81	2.39E-01 h24,20/02/81	2.48E-01 h24,20/02/81	2.42E-01 h24,20/02/81
43.750	2.49E-01 h24,20/02/81	2.45E-01 h24,20/02/81	2.47E-01 h24,20/02/81	2.12E-01 h24,20/02/81
43.500	2.63E-01 h24,20/02/81	2.74E-01 h24,20/02/81	2.42E-01 h24,20/02/81	2.08E-01 h24,21/06/80
43.250	2.71E-01 h24,20/02/81	2.33E-01 h24,20/02/81	2.08E-01 h24,21/06/80	2.03E-01 h24,22/06/80
43.000	2.59E-01 h24,12/02/81	2.39E-01 h24,21/06/80	2.18E-01 h24,22/06/80	1.96E-01 h24,12/06/80
42.750	2.55E-01 h24,22/06/80	2.81E-01 h24,22/06/80	2.49E-01 h24,28/10/80	2.30E-01 h24,28/10/80
42.500	3.50E-01 h24,28/10/80	3.43E-01 h24,28/10/80	2.90E-01 h24,28/10/80	2.50E-01 h24,28/10/80
42.250	4.04E-01 h24,28/10/80	3.36E-01 h24,28/10/80	2.69E-01 h24,28/10/80	2.10E-01 h24,28/10/80
42.000	3.32E-01 h24,05/07/80	2.99E-01 h24,05/07/80	2.71E-01 h24,05/07/80	2.36E-01 h24,05/07/80
41.750	4.55E-01 h24,30/10/80	3.00E-01 h24,05/07/80	2.54E-01 h24,05/07/80	2.31E-01 h24,05/07/80
41.500	4.55E-01 h24,10/09/80	3.47E-01 h24,10/09/80	2.85E-01 h24,10/09/80	2.47E-01 h24,10/09/80
41.250	4.22E-01 h24,10/09/80	3.95E-01 h24,10/09/80	3.35E-01 h24,10/09/80	2.86E-01 h24,10/09/80
41.000	4.62E-01 h24,30/06/80	3.40E-01 h24,07/11/80	2.84E-01 h24,10/09/80	2.67E-01 h24,10/09/80
40.750	6.15E-01 h24,30/06/80	4.98E-01 h24,30/06/80	3.75E-01 h24,30/06/80	2.72E-01 h24,07/11/80
40.500	4.90E-01 h24,30/06/80	4.07E-01 h24,30/06/80	3.61E-01 h24,30/06/80	2.97E-01 h24,30/06/80
40.250	3.49E-01 h24,29/06/80	4.07E-01 h24,30/06/80	3.77E-01 h24,30/06/80	3.32E-01 h24,30/06/80
40.000	2.27E-01 h24,29/06/80	2.48E-01 h24,29/06/80	2.88E-01 h24,30/06/80	3.10E-01 h24,30/06/80
39.750	1.63E-01 h24,03/12/80	1.97E-01 h24,11/08/80	2.20E-01 h24,11/08/80	2.51E-01 h24,30/06/80
39.500	1.51E-01 h24,03/12/80	1.53E-01 h24,08/09/80	2.34E-01 h24,10/06/80	2.58E-01 h24,11/08/80
39.250	2.05E-01 h24,26/05/80	1.66E-01 h24,08/09/80	2.75E-01 h24,10/06/80	2.03E-01 h24,10/06/80
39.000	2.06E-01 h24,26/05/80	1.61E-01 h24,08/09/80	2.09E-01 h24,08/09/80	1.75E-01 h24,29/08/80

X (km):	92.000
Y (km)	
44.000	2.08E-01 h24,20/02/81
43.750	1.66E-01 h24,20/02/81
43.500	1.57E-01 h24,30/03/80
43.250	1.67E-01 h24,12/06/80
43.000	1.84E-01 h24,28/10/80
42.750	2.08E-01 h24,28/10/80
42.500	2.04E-01 h24,28/10/80
42.250	1.83E-01 h24,05/07/80
42.000	2.21E-01 h24,05/07/80
41.750	1.88E-01 h24,05/07/80
41.500	2.10E-01 h24,10/09/80
41.250	2.46E-01 h24,10/09/80
41.000	2.41E-01 h24,10/09/80
40.750	2.21E-01 h24,07/11/80
40.500	2.25E-01 h24,30/06/80
40.250	2.89E-01 h24,30/06/80
40.000	2.86E-01 h24,30/06/80
39.750	2.58E-01 h24,30/06/80
39.500	2.09E-01 h24,30/06/80
39.250	1.99E-01 h24,11/08/80
39.000	1.76E-01 h24,10/06/80

HIGHEST RECORDINGS FOR EACH RECEPTOR (in micrograms/cubic metre)
AVERAGING TIME = 7 DAYS

X (km):	87.000	87.250	87.500	87.750
Y (km)				
44.000	1.81E-01 h24,26/11/80	1.55E-01 h24,26/11/80	1.38E-01 h24,26/11/80	1.29E-01 h24,28/01/81
43.750	1.73E-01 h24,26/11/80	1.67E-01 h24,26/11/80	1.56E-01 h24,26/11/80	1.39E-01 h24,26/11/80
43.500	1.87E-01 h24,26/11/80	1.88E-01 h24,26/11/80	1.53E-01 h24,26/11/80	1.71E-01 h24,26/11/80
43.250	1.49E-01 h24,26/11/80	1.79E-01 h24,26/11/80	1.85E-01 h24,26/11/80	2.21E-01 h24,26/11/80
43.000	1.68E-01 h24,11/05/80	1.62E-01 h24,11/05/80	1.66E-01 h24,26/11/80	2.45E-01 h24,26/11/80
42.750	1.85E-01 h24,11/05/80	2.19E-01 h24,11/05/80	1.90E-01 h24,11/05/80	1.82E-01 h24,26/11/80
42.500	2.27E-01 h24,11/05/80	2.61E-01 h24,11/05/80	2.93E-01 h24,11/05/80	2.89E-01 h24,11/05/80
42.250	2.13E-01 h24,11/05/80	2.84E-01 h24,11/05/80	3.16E-01 h24,11/05/80	3.83E-01 h24,11/05/80
42.000	2.35E-01 h24,11/05/80	2.63E-01 h24,11/05/80	3.27E-01 h24,11/05/80	3.42E-01 h24,11/05/80
41.750	1.62E-01 h24,11/05/80	2.36E-01 h24,11/05/80	3.50E-01 h24,11/05/80	3.19E-01 h24,11/05/80
41.500	1.59E-01 h24,14/01/81	2.33E-01 h24,14/01/81	3.72E-01 h24,15/07/80	5.31E-01 h24,15/07/80
41.250	1.88E-01 h24,14/01/81	2.17E-01 h24,14/01/81	2.07E-01 h24,21/01/81	2.60E-01 h24,21/01/81

41.000	1.29E-01 h24,21/01/81	1.31E-01 h24,21/01/81	1.90E-01 h24,21/01/81	2.99E-01 h24,21/01/81
40.750	1.02E-01 h24,21/01/81	1.05E-01 h24,21/01/81	1.18E-01 h24,21/01/81	1.27E-01 h24,28/10/80
40.500	7.20E-02 h24,28/10/80	1.19E-01 h24,28/10/80	1.29E-01 h24,28/10/80	1.92E-01 h24,28/10/80
40.250	1.21E-01 h24,28/10/80	9.60E-02 h24,28/10/80	9.70E-02 h24,28/10/80	1.13E-01 h24,28/10/80
40.000	1.30E-01 h24,28/10/80	9.31E-02 h24,28/10/80	1.33E-01 h24,28/10/80	1.06E-01 h24,21/01/81
39.750	1.15E-01 h24,28/10/80	1.15E-01 h24,28/10/80	1.12E-01 h24,21/01/81	1.20E-01 h24,21/01/81
39.500	8.69E-02 h24,28/10/80	7.35E-02 h24,21/01/81	1.25E-01 h24,21/01/81	1.03E-01 h24,21/04/81
39.250	5.48E-02 h24,21/01/81	7.19E-02 h24,21/01/81	9.25E-02 h24,21/04/81	1.17E-01 h24,21/04/81
39.000	6.03E-02 h24,21/01/81	8.73E-02 h24,21/01/81	1.35E-01 h24,21/04/81	1.75E-01 h24,21/04/81

X (km):	88.000	88.250	88.500	88.750
Y (km)				
44.000	1.66E-01 h24,11/02/81	1.92E-01 h24,11/02/81	1.83E-01 h24,11/02/81	1.53E-01 h24,11/02/81
43.750	1.55E-01 h24,11/02/81	2.20E-01 h24,11/02/81	2.34E-01 h24,11/02/81	2.06E-01 h24,11/02/81
43.500	1.64E-01 h24,26/11/80	1.98E-01 h24,11/02/81	2.74E-01 h24,11/02/81	2.50E-01 h24,11/02/81
43.250	2.28E-01 h24,26/11/80	1.98E-01 h24,26/11/80	2.98E-01 h24,11/02/81	3.36E-01 h24,11/02/81
43.000	3.03E-01 h24,26/11/80	2.59E-01 h24,26/11/80	2.94E-01 h24,28/01/81	3.13E-01 h24,11/02/81
42.750	1.93E-01 h24,26/11/80	2.53E-01 h24,26/11/80	2.57E-01 h24,26/11/80	2.47E-01 h24,11/02/81
42.500	3.09E-01 h24,11/05/80	2.46E-01 h24,26/11/80	3.22E-01 h24,26/11/80	2.95E-01 h24,26/11/80
42.250	3.60E-01 h24,11/05/80	2.78E-01 h24,11/05/80	1.79E-01 h24,26/11/80	2.62E-01 h24,26/11/80
42.000	2.87E-01 h24,11/05/80	2.92E-01 h24,11/05/80	3.17E-01 h24,11/05/80	3.03E-01 h24,11/05/80
41.750	2.82E-01 h24,11/05/80	2.79E-01 h24,11/05/80	3.18E-01 h24,11/05/80	3.66E-01 h24,11/05/80
41.500	4.80E-01 h24,14/01/81	6.94E-01 h24,14/01/81	5.23E-01 h24,14/01/81	5.01E-01 h24,10/12/80
41.250	5.92E-01 h24,21/01/81	4.51E-01 h24,21/01/81	2.64E-01 h24,21/01/81	1.96E-01 h24,29/03/80
41.000	4.25E-01 h24,21/01/81	2.73E-01 h24,28/10/80	3.12E-01 h24,28/10/80	1.41E-01 h24,28/10/80
40.750	3.15E-01 h24,28/10/80	6.17E-01 h24,28/10/80	1.96E-01 h24,28/10/80	1.29E-01 h24,21/01/81
40.500	4.38E-01 h24,28/10/80	2.08E-01 h24,28/10/80	2.45E-01 h24,21/01/81	1.74E-01 h24,21/04/81
40.250	8.60E-02 h24,21/01/81	2.15E-01 h24,21/01/81	2.62E-01 h24,21/04/81	1.67E-01 h24,19/11/80
40.000	1.13E-01 h24,21/01/81	9.18E-02 h24,21/04/81	1.29E-01 h24,21/04/81	7.23E-02 h24,03/12/80
39.750	1.14E-01 h24,21/04/81	9.50E-02 h24,21/04/81	7.55E-02 h24,19/11/80	7.14E-02 h24,03/12/80
39.500	8.03E-02 h24,21/04/81	5.99E-02 h24,21/04/81	5.07E-02 h24,03/12/80	6.59E-02 h24,03/12/80
39.250	8.58E-02 h24,21/04/81	5.08E-02 h24,19/11/80	4.93E-02 h24,03/12/80	6.30E-02 h24,03/12/80
39.000	6.42E-02 h24,19/11/80	3.97E-02 h24,03/12/80	6.11E-02 h24,03/12/80	7.56E-02 h24,03/12/80

X (km):	89.000	89.250	89.500	89.750
Y (km)				
44.000	1.31E-01 h24,11/02/81	1.30E-01 h24,11/02/81	1.12E-01 h24,11/02/81	9.19E-02 h24,31/12/80
43.750	1.59E-01 h24,11/02/81	1.61E-01 h24,11/02/81	1.10E-01 h24,11/02/81	8.58E-02 h24,31/12/80
43.500	2.30E-01 h24,11/02/81	1.85E-01 h24,11/02/81	1.24E-01 h24,11/02/81	8.48E-02 h24,31/12/80
43.250	2.73E-01 h24,11/02/81	1.54E-01 h24,11/02/81	1.14E-01 h24,31/12/80	8.29E-02 h24,04/02/81
43.000	3.06E-01 h24,11/02/81	1.95E-01 h24,11/02/81	1.48E-01 h24,31/12/80	1.05E-01 h24,04/02/81
42.750	3.66E-01 h24,11/02/81	2.87E-01 h24,11/02/81	2.02E-01 h24,31/12/80	1.16E-01 h24,04/02/81
42.500	2.85E-01 h24,11/02/81	2.67E-01 h24,11/02/81	1.73E-01 h24,31/12/80	1.24E-01 h24,04/02/81
42.250	2.93E-01 h24,26/11/80	2.41E-01 h24,11/02/81	1.44E-01 h24,31/12/80	1.03E-01 h24,04/02/81
42.000	3.32E-01 h24,26/11/80	4.30E-01 h24,26/11/80	1.39E-01 h24,31/12/80	1.01E-01 h24,25/02/81
41.750	4.22E-01 h24,31/12/80	3.88E-01 h24,31/12/80	7.20E-01 h24,26/11/80	2.43E-01 h24,05/11/80
41.500	4.31E-01 h24,10/12/80	2.52E-01 h24,10/12/80	3.70E-01 h24,21/01/81	5.45E-01 h24,01/07/80
41.250	1.77E-01 h24,29/03/80	1.59E-01 h24,21/01/81	1.41E-01 h24,21/01/81	2.08E-01 h24,17/12/80
41.000	9.93E-02 h24,21/01/81	1.08E-01 h24,21/01/81	1.11E-01 h24,03/12/80	1.64E-01 h24,19/11/80
40.750	7.58E-02 h24,21/01/81	1.68E-01 h24,03/12/80	1.83E-01 h24,03/12/80	1.44E-01 h24,02/09/80
40.500	1.76E-01 h24,16/06/80	2.62E-01 h24,03/12/80	8.39E-02 h24,03/12/80	9.55E-02 h24,02/09/80
40.250	1.39E-01 h24,03/12/80	1.38E-01 h24,03/12/80	7.30E-02 h24,03/12/80	8.35E-02 h24,02/09/80
40.000	1.14E-01 h24,03/12/80	8.77E-02 h24,03/12/80	5.89E-02 h24,03/12/80	9.41E-02 h24,02/09/80
39.750	9.37E-02 h24,03/12/80	7.37E-02 h24,03/12/80	4.86E-02 h24,03/12/80	6.57E-02 h24,02/09/80
39.500	7.29E-02 h24,03/12/80	5.88E-02 h24,03/12/80	4.08E-02 h24,03/12/80	4.98E-02 h24,02/09/80
39.250	6.16E-02 h24,03/12/80	4.78E-02 h24,03/12/80	3.47E-02 h24,03/12/80	4.56E-02 h24,02/09/80
39.000	6.22E-02 h24,03/12/80	4.64E-02 h24,03/12/80	3.83E-02 h24,16/09/80	5.33E-02 h24,11/05/80

X (km):	90.000	90.250	90.500	90.750
Y (km)				
44.000	8.81E-02 h24,04/02/81	1.06E-01 h24,04/02/81	9.05E-02 h24,04/02/81	9.31E-02 h24,16/06/80
43.750	9.07E-02 h24,04/02/81	9.72E-02 h24,04/02/81	9.03E-02 h24,16/06/80	9.25E-02 h24,16/06/80
43.500	9.39E-02 h24,04/02/81	8.58E-02 h24,04/02/81	9.10E-02 h24,16/06/80	9.74E-02 h24,16/06/80
43.250	9.11E-02 h24,04/02/81	9.38E-02 h24,23/06/80	8.96E-02 h24,16/06/80	1.04E-01 h24,25/02/81
43.000	9.86E-02 h24,04/02/81	9.38E-02 h24,23/06/80	1.04E-01 h24,25/02/81	1.18E-01 h24,25/02/81
42.750	1.05E-01 h24,23/06/80	1.03E-01 h24,23/06/80	1.22E-01 h24,25/02/81	1.24E-01 h24,09/06/80
42.500	1.27E-01 h24,23/06/80	1.33E-01 h24,25/02/81	1.50E-01 h24,09/06/80	1.52E-01 h24,23/06/80
42.250	1.32E-01 h24,23/06/80	1.66E-01 h24,09/06/80	1.90E-01 h24,23/06/80	1.68E-01 h24,08/07/80

42.000	1.42E-01 h24,09/06/80	2.35E-01 h24,08/07/80	2.65E-01 h24,08/07/80	2.22E-01 h24,08/07/80
41.750	2.24E-01 h24,08/07/80	2.40E-01 h24,08/07/80	3.41E-01 h24,08/07/80	2.57E-01 h24,08/07/80
41.500	3.06E-01 h24,23/09/80	3.06E-01 h24,23/09/80	2.36E-01 h24,23/09/80	1.99E-01 h24,23/09/80
41.250	3.17E-01 h24,01/07/80	3.36E-01 h24,01/07/80	2.55E-01 h24,01/07/80	1.63E-01 h24,16/09/80
41.000	1.97E-01 h24,02/09/80	2.82E-01 h24,01/07/80	3.25E-01 h24,01/07/80	3.12E-01 h24,01/07/80
40.750	1.44E-01 h24,02/09/80	2.01E-01 h24,01/07/80	3.45E-01 h24,01/07/80	3.52E-01 h24,01/07/80
40.500	1.21E-01 h24,02/09/80	1.70E-01 h24,02/09/80	2.16E-01 h24,01/07/80	2.29E-01 h24,01/07/80
40.250	1.17E-01 h24,02/09/80	1.05E-01 h24,02/09/80	1.37E-01 h24,01/07/80	1.52E-01 h24,01/07/80
40.000	1.20E-01 h24,02/09/80	1.11E-01 h24,02/09/80	1.16E-01 h24,02/06/80	1.17E-01 h24,01/07/80
39.750	8.61E-02 h24,02/09/80	8.73E-02 h24,02/09/80	7.95E-02 h24,02/09/80	8.02E-02 h24,01/07/80
39.500	7.01E-02 h24,02/09/80	7.38E-02 h24,02/09/80	7.37E-02 h24,02/09/80	6.84E-02 h24,02/06/80
39.250	6.41E-02 h24,02/09/80	7.58E-02 h24,02/09/80	6.49E-02 h24,02/09/80	7.53E-02 h24,02/06/80
39.000	7.31E-02 h24,02/09/80	7.57E-02 h24,02/09/80	6.72E-02 h24,02/09/80	7.97E-02 h24,02/06/80

X (km):	91.000	91.250	91.500	91.750
Y (km)				
44.000	9.69E-02 h24,16/06/80	8.74E-02 h24,16/06/80	8.18E-02 h24,25/02/81	8.30E-02 h24,25/02/81
43.750	9.88E-02 h24,16/06/80	8.45E-02 h24,25/02/81	8.75E-02 h24,25/02/81	8.30E-02 h24,25/02/81
43.500	9.39E-02 h24,25/02/81	9.91E-02 h24,25/02/81	9.67E-02 h24,25/02/81	1.04E-01 h24,09/06/80
43.250	1.04E-01 h24,25/02/81	9.99E-02 h24,25/02/81	1.10E-01 h24,09/06/80	1.07E-01 h24,23/06/80
43.000	1.15E-01 h24,09/06/80	1.28E-01 h24,09/06/80	1.15E-01 h24,23/06/80	1.03E-01 h24,23/06/80
42.750	1.31E-01 h24,09/06/80	1.51E-01 h24,23/06/80	1.27E-01 h24,23/06/80	1.02E-01 h24,23/06/80
42.500	1.70E-01 h24,23/06/80	1.63E-01 h24,23/06/80	1.27E-01 h24,08/07/80	1.18E-01 h24,08/07/80
42.250	1.56E-01 h24,08/07/80	1.53E-01 h24,08/07/80	1.42E-01 h24,08/07/80	1.23E-01 h24,08/07/80
42.000	1.87E-01 h24,08/07/80	1.65E-01 h24,08/07/80	1.48E-01 h24,08/07/80	1.29E-01 h24,08/07/80
41.750	2.77E-01 h24,08/07/80	1.71E-01 h24,08/07/80	1.45E-01 h24,08/07/80	1.37E-01 h24,08/07/80
41.500	1.55E-01 h24,23/09/80	1.17E-01 h24,16/09/80	1.03E-01 h24,08/07/80	9.80E-02 h24,08/07/80
41.250	1.45E-01 h24,16/09/80	1.46E-01 h24,23/09/80	1.24E-01 h24,23/09/80	1.05E-01 h24,23/09/80
41.000	2.32E-01 h24,01/07/80	1.94E-01 h24,01/07/80	1.27E-01 h24,01/07/80	1.11E-01 h24,01/07/80
40.750	3.08E-01 h24,01/07/80	2.72E-01 h24,01/07/80	2.36E-01 h24,01/07/80	1.59E-01 h24,01/07/80
40.500	2.53E-01 h24,01/07/80	2.08E-01 h24,01/07/80	1.92E-01 h24,01/07/80	1.70E-01 h24,01/07/80
40.250	1.87E-01 h24,01/07/80	2.23E-01 h24,01/07/80	2.11E-01 h24,01/07/80	1.86E-01 h24,01/07/80
40.000	1.28E-01 h24,01/07/80	1.42E-01 h24,01/07/80	1.62E-01 h24,01/07/80	1.77E-01 h24,01/07/80
39.750	9.46E-02 h24,01/07/80	1.10E-01 h24,01/07/80	1.27E-01 h24,01/07/80	1.46E-01 h24,01/07/80
39.500	7.63E-02 h24,01/07/80	8.80E-02 h24,01/07/80	1.13E-01 h24,01/07/80	1.33E-01 h24,01/07/80
39.250	8.70E-02 h24,02/06/80	7.58E-02 h24,01/07/80	1.07E-01 h24,02/09/80	9.69E-02 h24,01/07/80
39.000	7.84E-02 h24,02/06/80	7.27E-02 h24,02/06/80	8.56E-02 h24,02/09/80	7.99E-02 h24,01/07/80

X (km):	92.000
Y (km)	
44.000	7.84E-02 h24,25/02/81
43.750	8.24E-02 h24,09/06/80
43.500	8.54E-02 h24,09/06/80
43.250	8.89E-02 h24,23/06/80
43.000	9.15E-02 h24,23/06/80
42.750	8.80E-02 h24,08/07/80
42.500	9.69E-02 h24,08/07/80
42.250	1.05E-01 h24,08/07/80
42.000	1.22E-01 h24,08/07/80
41.750	1.07E-01 h24,08/07/80
41.500	8.65E-02 h24,08/07/80
41.250	8.84E-02 h24,23/09/80
41.000	9.68E-02 h24,23/09/80
40.750	1.15E-01 h24,01/07/80
40.500	1.38E-01 h24,01/07/80
40.250	1.71E-01 h24,01/07/80
40.000	1.63E-01 h24,01/07/80
39.750	1.49E-01 h24,01/07/80
39.500	1.23E-01 h24,01/07/80
39.250	1.04E-01 h24,01/07/80
39.000	8.50E-02 h24,01/07/80

1

HIGHEST RECORDINGS FOR EACH RECEPTOR (in micrograms/cubic metre)
3-MONTH RUNNING AVERAGES

X (km):	87.000	87.250	87.500	87.750
Y (km)				

44.000	7.53E-02 h24,30/02/80	6.95E-02 h24,30/02/80	6.94E-02 h24,30/02/80	6.87E-02 h24,30/02/80
43.750	7.06E-02 h24,30/11/80	6.94E-02 h24,30/02/80	6.97E-02 h24,30/02/80	6.99E-02 h24,30/02/80
43.500	8.37E-02 h24,30/11/80	7.74E-02 h24,30/11/80	6.37E-02 h24,30/02/80	7.63E-02 h24,30/02/80
43.250	8.05E-02 h24,30/11/80	8.34E-02 h24,30/11/80	7.66E-02 h24,30/11/80	9.11E-02 h24,30/02/80
43.000	8.29E-02 h24,30/11/80	8.77E-02 h24,30/11/80	8.26E-02 h24,30/11/80	1.06E-01 h24,30/11/80
42.750	7.78E-02 h24,30/11/80	1.00E-01 h24,30/11/80	9.63E-02 h24,30/11/80	1.02E-01 h24,30/11/80
42.500	9.04E-02 h24,30/11/80	1.06E-01 h24,30/11/80	1.25E-01 h24,30/11/80	1.34E-01 h24,30/11/80
42.250	9.27E-02 h24,30/11/80	1.21E-01 h24,30/11/80	1.32E-01 h24,30/11/80	1.60E-01 h24,30/11/80
42.000	1.17E-01 h24,30/11/80	1.29E-01 h24,30/11/80	1.57E-01 h24,30/11/80	1.62E-01 h24,30/11/80
41.750	9.11E-02 h24,30/11/80	1.27E-01 h24,30/11/80	1.81E-01 h24,30/11/80	1.74E-01 h24,30/11/80
41.500	7.98E-02 h24,30/11/80	1.11E-01 h24,30/11/80	1.59E-01 h24,30/11/80	2.13E-01 h24,30/11/80
41.250	9.00E-02 h24,30/02/80	1.06E-01 h24,30/02/80	1.04E-01 h24,30/02/80	1.23E-01 h24,30/02/80
41.000	5.95E-02 h24,30/02/80	6.03E-02 h24,30/02/80	8.19E-02 h24,30/02/80	1.28E-01 h24,30/11/80
40.750	4.65E-02 h24,30/02/80	5.15E-02 h24,30/11/80	6.44E-02 h24,30/11/80	6.27E-02 h24,30/11/80
40.500	3.90E-02 h24,30/11/80	5.40E-02 h24,30/11/80	5.17E-02 h24,30/11/80	6.25E-02 h24,30/11/80
40.250	4.65E-02 h24,30/11/80	3.46E-02 h24,30/11/80	3.21E-02 h24,30/11/80	3.87E-02 h24,30/11/80
40.000	3.90E-02 h24,30/11/80	2.89E-02 h24,30/11/80	4.46E-02 h24,30/11/80	4.79E-02 h24,30/11/80
39.750	3.33E-02 h24,30/11/80	4.03E-02 h24,30/11/80	4.82E-02 h24,30/11/80	4.09E-02 h24,30/11/80
39.500	3.29E-02 h24,30/11/80	3.17E-02 h24,30/11/80	4.14E-02 h24,30/11/80	3.25E-02 h24,30/11/80
39.250	2.36E-02 h24,30/11/80	2.52E-02 h24,30/11/80	2.99E-02 h24,30/11/80	3.09E-02 h24,30/11/80
39.000	2.12E-02 h24,30/11/80	2.77E-02 h24,30/11/80	3.40E-02 h24,30/11/80	4.45E-02 h24,30/11/80

X (km):	88.000	88.250	88.500	88.750
Y (km)				
44.000	7.90E-02 h24,30/02/80	8.48E-02 h24,30/02/80	8.18E-02 h24,30/02/80	7.15E-02 h24,30/02/80
43.750	8.20E-02 h24,30/02/80	1.03E-01 h24,30/02/80	1.06E-01 h24,30/02/80	9.83E-02 h24,30/02/80
43.500	8.40E-02 h24,30/02/80	9.95E-02 h24,30/02/80	1.26E-01 h24,30/02/80	1.15E-01 h24,30/02/80
43.250	1.01E-01 h24,30/02/80	1.03E-01 h24,30/02/80	1.49E-01 h24,30/02/80	1.55E-01 h24,30/02/80
43.000	1.24E-01 h24,30/02/80	1.14E-01 h24,30/02/80	1.57E-01 h24,30/02/80	1.40E-01 h24,30/02/80
42.750	8.46E-02 h24,30/11/80	1.03E-01 h24,30/02/80	1.11E-01 h24,30/02/80	1.22E-01 h24,30/02/80
42.500	1.62E-01 h24,30/11/80	1.20E-01 h24,30/11/80	1.30E-01 h24,30/02/80	1.26E-01 h24,30/02/80
42.250	1.55E-01 h24,30/11/80	1.31E-01 h24,30/11/80	1.02E-01 h24,30/02/80	1.12E-01 h24,30/02/80
42.000	1.35E-01 h24,30/11/80	1.36E-01 h24,30/11/80	1.49E-01 h24,30/11/80	1.60E-01 h24,30/11/80
41.750	1.65E-01 h24,30/11/80	1.73E-01 h24,30/11/80	2.03E-01 h24,30/11/80	2.45E-01 h24,30/11/80
41.500	2.21E-01 h24,30/11/80	3.12E-01 h24,30/11/80	2.63E-01 h24,30/11/80	2.69E-01 h24,30/02/80
41.250	2.44E-01 h24,30/02/80	1.89E-01 h24,30/02/80	1.27E-01 h24,30/02/80	1.02E-01 h24,30/02/80
41.000	2.07E-01 h24,30/11/80	1.32E-01 h24,30/11/80	1.21E-01 h24,30/11/80	6.67E-02 h24,30/11/80
40.750	1.14E-01 h24,30/11/80	1.73E-01 h24,30/11/80	8.32E-02 h24,30/11/80	5.02E-02 h24,30/11/80
40.500	1.21E-01 h24,30/11/80	9.10E-02 h24,30/11/80	8.45E-02 h24,30/11/80	5.97E-02 h24,30/11/80
40.250	4.17E-02 h24,30/11/80	7.26E-02 h24,30/11/80	7.33E-02 h24,30/11/80	6.56E-02 h24,30/11/80
40.000	4.01E-02 h24,30/11/80	3.10E-02 h24,30/11/80	4.42E-02 h24,30/11/80	3.51E-02 h24,30/11/80
39.750	3.55E-02 h24,30/11/80	3.05E-02 h24,30/11/80	3.30E-02 h24,30/11/80	2.48E-02 h24,30/11/80
39.500	2.45E-02 h24,30/11/80	2.40E-02 h24,30/11/80	2.38E-02 h24,30/11/80	1.87E-02 h24,30/11/80
39.250	2.75E-02 h24,30/11/80	2.29E-02 h24,30/11/80	1.76E-02 h24,30/11/80	1.61E-02 h24,30/11/80
39.000	2.41E-02 h24,30/11/80	1.90E-02 h24,30/11/80	1.93E-02 h24,30/11/80	1.81E-02 h24,30/11/80

X (km):	89.000	89.250	89.500	89.750
Y (km)				
44.000	6.23E-02 h24,30/02/80	5.69E-02 h24,30/02/80	4.83E-02 h24,30/02/80	4.44E-02 h24,30/02/80
43.750	7.65E-02 h24,30/02/80	7.19E-02 h24,30/02/80	4.86E-02 h24,30/02/80	3.85E-02 h24,30/02/80
43.500	1.18E-01 h24,30/02/80	8.51E-02 h24,30/02/80	5.52E-02 h24,30/02/80	3.71E-02 h24,30/02/80
43.250	1.34E-01 h24,30/02/80	6.95E-02 h24,30/02/80	4.88E-02 h24,30/02/80	3.63E-02 h24,30/02/80
43.000	1.36E-01 h24,30/02/80	8.82E-02 h24,30/02/80	6.43E-02 h24,30/02/80	4.60E-02 h24,30/02/80
42.750	1.56E-01 h24,30/02/80	1.32E-01 h24,30/02/80	8.90E-02 h24,30/02/80	4.94E-02 h24,30/02/80
42.500	1.30E-01 h24,30/02/80	1.13E-01 h24,30/02/80	7.05E-02 h24,30/02/80	5.22E-02 h24,30/02/80
42.250	1.21E-01 h24,30/02/80	1.08E-01 h24,30/02/80	5.96E-02 h24,30/02/80	4.57E-02 h24,30/02/80
42.000	1.56E-01 h24,30/02/80	1.61E-01 h24,30/02/80	5.83E-02 h24,30/02/80	4.26E-02 h24,30/03/80
41.750	2.61E-01 h24,30/11/80	2.16E-01 h24,30/11/80	2.96E-01 h24,30/02/80	9.73E-02 h24,30/08/80
41.500	2.22E-01 h24,30/11/80	1.34E-01 h24,30/11/80	1.84E-01 h24,30/11/80	1.81E-01 h24,30/08/80
41.250	9.89E-02 h24,30/02/80	7.43E-02 h24,30/11/80	8.25E-02 h24,30/11/80	1.09E-01 h24,30/10/80
41.000	4.35E-02 h24,30/02/80	5.25E-02 h24,30/11/80	6.78E-02 h24,30/11/80	9.72E-02 h24,30/09/80
40.750	3.98E-02 h24,30/11/80	5.50E-02 h24,30/11/80	8.47E-02 h24,30/11/80	8.34E-02 h24,30/09/80
40.500	8.46E-02 h24,30/11/80	6.66E-02 h24,30/11/80	4.48E-02 h24,30/09/80	5.71E-02 h24,30/09/80
40.250	4.69E-02 h24,30/11/80	3.88E-02 h24,30/11/80	3.87E-02 h24,30/09/80	4.61E-02 h24,30/09/80
40.000	3.03E-02 h24,30/11/80	2.78E-02 h24,30/11/80	3.17E-02 h24,30/09/80	4.42E-02 h24,30/09/80
39.750	2.36E-02 h24,30/11/80	2.49E-02 h24,30/11/80	2.64E-02 h24,30/09/80	3.25E-02 h24,30/09/80
39.500	1.89E-02 h24,30/11/80	2.13E-02 h24,30/11/80	2.23E-02 h24,30/09/80	2.54E-02 h24,30/09/80
39.250	1.66E-02 h24,30/11/80	1.83E-02 h24,30/11/80	1.90E-02 h24,30/09/80	2.25E-02 h24,30/09/80
39.000	1.74E-02 h24,30/11/80	1.88E-02 h24,30/11/80	2.01E-02 h24,30/09/80	2.31E-02 h24,30/09/80

X (km):	90.000	90.250	90.500	90.750
Y (km)				
44.000	4.07E-02 h24,30/02/80	4.61E-02 h24,30/02/80	3.99E-02 h24,30/02/80	4.01E-02 h24,30/05/80
43.750	4.01E-02 h24,30/02/80	4.14E-02 h24,30/02/80	4.30E-02 h24,30/05/80	3.97E-02 h24,30/05/80
43.500	4.03E-02 h24,30/02/80	3.76E-02 h24,30/02/80	4.15E-02 h24,30/05/80	4.44E-02 h24,30/05/80
43.250	3.88E-02 h24,30/02/80	4.08E-02 h24,30/02/80	4.31E-02 h24,30/05/80	4.99E-02 h24,30/05/80
43.000	4.30E-02 h24,30/02/80	4.10E-02 h24,30/03/80	4.90E-02 h24,30/05/80	5.61E-02 h24,30/05/80
42.750	4.44E-02 h24,30/02/80	4.86E-02 h24,30/03/80	5.76E-02 h24,30/03/80	6.55E-02 h24,30/06/80
42.500	5.34E-02 h24,30/03/80	6.43E-02 h24,30/03/80	7.86E-02 h24,30/06/80	8.56E-02 h24,30/06/80
42.250	6.03E-02 h24,30/03/80	8.47E-02 h24,30/06/80	1.06E-01 h24,30/06/80	9.33E-02 h24,30/06/80
42.000	7.53E-02 h24,30/07/80	1.15E-01 h24,30/07/80	1.21E-01 h24,30/07/80	9.95E-02 h24,30/07/80
41.750	9.48E-02 h24,30/08/80	1.06E-01 h24,30/08/80	1.48E-01 h24,30/08/80	1.15E-01 h24,30/08/80
41.500	1.50E-01 h24,30/08/80	1.60E-01 h24,30/08/80	1.34E-01 h24,30/08/80	1.19E-01 h24,30/08/80
41.250	1.30E-01 h24,30/08/80	1.39E-01 h24,30/08/80	1.32E-01 h24,30/08/80	1.03E-01 h24,30/08/80
41.000	1.16E-01 h24,30/08/80	1.20E-01 h24,30/08/80	1.24E-01 h24,30/08/80	1.28E-01 h24,30/08/80
40.750	8.72E-02 h24,30/08/80	1.09E-01 h24,30/08/80	1.52E-01 h24,30/08/80	1.29E-01 h24,30/08/80
40.500	6.97E-02 h24,30/09/80	1.03E-01 h24,30/08/80	1.22E-01 h24,30/08/80	1.00E-01 h24,30/08/80
40.250	6.06E-02 h24,30/09/80	6.22E-02 h24,30/08/80	8.31E-02 h24,30/08/80	7.68E-02 h24,30/08/80
40.000	5.41E-02 h24,30/09/80	5.93E-02 h24,30/08/80	6.71E-02 h24,30/08/80	6.72E-02 h24,30/08/80
39.750	3.97E-02 h24,30/09/80	4.41E-02 h24,30/08/80	4.64E-02 h24,30/08/80	4.75E-02 h24,30/08/80
39.500	3.18E-02 h24,30/09/80	3.56E-02 h24,30/08/80	4.00E-02 h24,30/08/80	4.11E-02 h24,30/08/80
39.250	2.77E-02 h24,30/09/80	3.32E-02 h24,30/08/80	3.30E-02 h24,30/08/80	3.84E-02 h24,30/08/80
39.000	2.84E-02 h24,30/08/80	3.07E-02 h24,30/08/80	3.11E-02 h24,30/08/80	3.64E-02 h24,30/08/80

X (km):	91.000	91.250	91.500	91.750
Y (km)				
44.000	4.07E-02 h24,30/05/80	3.99E-02 h24,30/05/80	3.88E-02 h24,30/05/80	4.12E-02 h24,30/05/80
43.750	4.47E-02 h24,30/05/80	3.96E-02 h24,30/05/80	4.25E-02 h24,30/05/80	4.48E-02 h24,30/05/80
43.500	4.43E-02 h24,30/05/80	4.82E-02 h24,30/05/80	5.33E-02 h24,30/05/80	5.99E-02 h24,30/06/80
43.250	4.96E-02 h24,30/05/80	5.38E-02 h24,30/06/80	6.31E-02 h24,30/06/80	6.43E-02 h24,30/06/80
43.000	6.26E-02 h24,30/06/80	7.41E-02 h24,30/06/80	6.77E-02 h24,30/06/80	6.05E-02 h24,30/06/80
42.750	7.50E-02 h24,30/06/80	8.79E-02 h24,30/06/80	7.35E-02 h24,30/06/80	6.04E-02 h24,30/06/80
42.500	9.73E-02 h24,30/06/80	9.54E-02 h24,30/06/80	7.15E-02 h24,30/06/80	6.44E-02 h24,30/07/80
42.250	8.03E-02 h24,30/07/80	7.72E-02 h24,30/07/80	7.21E-02 h24,30/07/80	6.22E-02 h24,30/07/80
42.000	8.44E-02 h24,30/07/80	7.56E-02 h24,30/07/80	6.95E-02 h24,30/07/80	6.08E-02 h24,30/07/80
41.750	1.25E-01 h24,30/08/80	7.92E-02 h24,30/08/80	6.84E-02 h24,30/08/80	6.47E-02 h24,30/08/80
41.500	9.85E-02 h24,30/08/80	7.67E-02 h24,30/08/80	6.57E-02 h24,30/08/80	6.09E-02 h24,30/08/80
41.250	9.18E-02 h24,30/08/80	8.89E-02 h24,30/08/80	7.54E-02 h24,30/08/80	6.44E-02 h24,30/08/80
41.000	1.09E-01 h24,30/08/80	1.01E-01 h24,30/08/80	7.95E-02 h24,30/08/80	7.35E-02 h24,30/08/80
40.750	1.16E-01 h24,30/08/80	1.12E-01 h24,30/08/80	1.06E-01 h24,30/08/80	8.19E-02 h24,30/08/80
40.500	9.59E-02 h24,30/08/80	8.17E-02 h24,30/08/80	7.89E-02 h24,30/08/80	7.51E-02 h24,30/08/80
40.250	8.34E-02 h24,30/08/80	8.70E-02 h24,30/08/80	8.07E-02 h24,30/08/80	7.31E-02 h24,30/08/80
40.000	6.54E-02 h24,30/08/80	6.45E-02 h24,30/08/80	6.68E-02 h24,30/08/80	6.82E-02 h24,30/08/80
39.750	5.16E-02 h24,30/08/80	5.61E-02 h24,30/08/80	5.96E-02 h24,30/08/80	6.19E-02 h24,30/08/80
39.500	4.45E-02 h24,30/08/80	4.85E-02 h24,30/08/80	6.25E-02 h24,30/08/80	6.65E-02 h24,30/08/80
39.250	4.49E-02 h24,30/08/80	4.55E-02 h24,30/08/80	6.51E-02 h24,30/08/80	5.40E-02 h24,30/08/80
39.000	3.71E-02 h24,30/08/80	4.00E-02 h24,30/08/80	5.14E-02 h24,30/08/80	4.76E-02 h24,30/08/80

X (km):	92.000
Y (km)	
44.000	4.30E-02 h24,30/05/80
43.750	4.70E-02 h24,30/06/80
43.500	5.07E-02 h24,30/06/80
43.250	5.29E-02 h24,30/06/80
43.000	5.36E-02 h24,30/06/80
42.750	5.25E-02 h24,30/06/80
42.500	5.18E-02 h24,30/07/80
42.250	5.32E-02 h24,30/07/80
42.000	5.89E-02 h24,30/07/80
41.750	5.15E-02 h24,30/08/80
41.500	5.26E-02 h24,30/08/80
41.250	5.51E-02 h24,30/08/80
41.000	6.33E-02 h24,30/08/80
40.750	6.53E-02 h24,30/08/80
40.500	6.58E-02 h24,30/08/80
40.250	7.08E-02 h24,30/08/80
40.000	6.28E-02 h24,30/08/80
39.750	5.84E-02 h24,30/08/80
39.500	5.31E-02 h24,30/08/80

39.250	5.22E-02 h24,30/08/80
39.000	4.70E-02 h24,30/08/80

1

SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR (in micrograms/cubic metre)
AVERAGING TIME = 24 HOURS

X (km):	87.000	87.250	87.500	87.750
Y (km)				
44.000	4.39E-01 h24,07/12/80	2.81E-01 h24,23/11/80	2.99E-01 h24,07/02/81	3.54E-01 h24,23/11/80
43.750	3.70E-01 h24,07/12/80	3.32E-01 h24,05/05/80	2.98E-01 h24,23/11/80	3.41E-01 h24,07/02/81
43.500	3.60E-01 h24,05/05/80	3.78E-01 h24,07/12/80	2.49E-01 h24,23/11/80	3.30E-01 h24,07/12/80
43.250	3.11E-01 h24,26/06/80	3.09E-01 h24,26/06/80	3.13E-01 h24,05/05/80	3.95E-01 h24,05/05/80
43.000	3.36E-01 h24,06/12/80	3.53E-01 h24,15/05/80	2.63E-01 h24,26/06/80	4.15E-01 h24,05/05/80
42.750	3.88E-01 h24,06/05/80	4.60E-01 h24,09/06/80	3.89E-01 h24,09/05/80	3.36E-01 h24,09/05/80
42.500	5.47E-01 h24,06/05/80	6.09E-01 h24,09/05/80	6.56E-01 h24,09/06/80	6.21E-01 h24,09/05/80
42.250	4.79E-01 h24,04/05/80	6.47E-01 h24,06/05/80	7.35E-01 h24,06/05/80	9.06E-01 h24,09/05/80
42.000	5.81E-01 h24,22/12/80	6.54E-01 h24,22/12/80	8.36E-01 h24,22/12/80	8.00E-01 h24,09/05/80
41.750	3.89E-01 h24,10/05/80	5.87E-01 h24,10/05/80	9.59E-01 h24,14/07/80	7.14E-01 h24,10/05/80
41.500	4.04E-01 h24,09/01/81	6.27E-01 h24,09/01/81	9.91E-01 h24,26/03/80	1.41E+00 h24,26/03/80
41.250	5.31E-01 h24,09/01/81	5.93E-01 h24,09/01/81	4.77E-01 h24,18/01/81	5.76E-01 h24,09/12/80
41.000	2.99E-01 h24,09/12/80	3.22E-01 h24,23/03/81	5.01E-01 h24,09/12/80	8.17E-01 h24,09/12/80
40.750	2.87E-01 h24,09/12/80	3.00E-01 h24,13/03/81	4.27E-01 h24,17/11/80	4.74E-01 h24,13/03/81
40.500	2.57E-01 h24,22/10/80	4.36E-01 h24,13/03/81	6.10E-01 h24,06/04/80	9.40E-01 h24,06/04/80
40.250	5.63E-01 h24,06/04/80	4.76E-01 h24,06/04/80	4.17E-01 h24,06/04/80	3.48E-01 h24,06/04/80
40.000	6.20E-01 h24,06/04/80	3.53E-01 h24,06/04/80	3.50E-01 h24,06/04/80	4.61E-01 h24,09/12/80
39.750	3.84E-01 h24,06/04/80	3.22E-01 h24,09/12/80	4.89E-01 h24,09/12/80	4.29E-01 h24,16/01/81
39.500	2.83E-01 h24,09/12/80	3.14E-01 h24,09/12/80	4.72E-01 h24,21/11/80	3.22E-01 h24,18/04/81
39.250	2.26E-01 h24,22/10/80	2.63E-01 h24,16/01/81	2.92E-01 h24,18/04/81	3.22E-01 h24,05/11/80
39.000	2.23E-01 h24,16/01/81	2.80E-01 h24,21/11/80	3.32E-01 h24,05/11/80	4.45E-01 h24,18/04/81

X (km):	88.000	88.250	88.500	88.750
Y (km)				
44.000	3.79E-01 h24,23/11/80	3.93E-01 h24,05/12/80	4.59E-01 h24,05/12/80	3.37E-01 h24,30/12/80
43.750	4.23E-01 h24,23/11/80	4.59E-01 h24,23/11/80	5.39E-01 h24,05/12/80	4.84E-01 h24,07/02/81
43.500	4.27E-01 h24,07/02/81	5.07E-01 h24,23/11/80	5.53E-01 h24,05/12/80	6.47E-01 h24,05/12/80
43.250	4.46E-01 h24,07/12/80	5.38E-01 h24,23/11/80	7.12E-01 h24,23/11/80	7.75E-01 h24,05/12/80
43.000	5.71E-01 h24,05/05/80	4.86E-01 h24,07/12/80	8.17E-01 h24,07/02/81	6.24E-01 h24,23/11/80
42.750	2.95E-01 h24,16/10/80	4.27E-01 h24,23/11/80	4.92E-01 h24,07/02/81	6.58E-01 h24,23/11/80
42.500	6.48E-01 h24,06/12/80	3.99E-01 h24,09/05/80	5.48E-01 h24,07/12/80	6.02E-01 h24,07/02/81
42.250	7.56E-01 h24,06/05/80	5.75E-01 h24,16/11/80	3.88E-01 h24,16/10/80	4.89E-01 h24,16/10/80
42.000	5.06E-01 h24,22/12/80	5.34E-01 h24,16/11/80	6.19E-01 h24,16/11/80	6.45E-01 h24,16/11/80
41.750	5.39E-01 h24,10/05/80	5.69E-01 h24,25/12/80	6.94E-01 h24,25/12/80	8.63E-01 h24,25/12/80
41.500	1.35E+00 h24,09/01/81	1.99E+00 h24,09/01/81	1.34E+00 h24,09/01/81	1.08E+00 h24,06/12/80
41.250	1.52E+00 h24,17/11/80	1.15E+00 h24,09/12/80	7.43E-01 h24,09/12/80	6.17E-01 h24,23/03/81
41.000	1.52E+00 h24,13/03/81	1.03E+00 h24,13/03/81	1.52E+00 h24,06/04/80	4.11E-01 h24,23/03/81
40.750	1.56E+00 h24,06/04/80	2.70E+00 h24,06/04/80	6.31E-01 h24,09/12/80	3.68E-01 h24,21/11/80
40.500	1.58E+00 h24,06/04/80	8.16E-01 h24,09/12/80	7.84E-01 h24,17/07/80	5.36E-01 h24,20/04/81
40.250	3.61E-01 h24,09/12/80	7.38E-01 h24,16/01/81	7.39E-01 h24,05/11/80	6.27E-01 h24,05/11/80
40.000	3.76E-01 h24,16/01/81	3.08E-01 h24,05/11/80	4.48E-01 h24,05/11/80	2.80E-01 h24,05/11/80
39.750	3.51E-01 h24,10/05/80	3.07E-01 h24,20/04/81	2.90E-01 h24,05/11/80	1.66E-01 h24,08/12/80
39.500	2.63E-01 h24,05/11/80	2.23E-01 h24,05/11/80	1.83E-01 h24,05/11/80	1.12E-01 h24,17/02/81
39.250	2.78E-01 h24,05/11/80	1.98E-01 h24,18/11/80	1.24E-01 h24,08/12/80	1.07E-01 h24,17/02/81
39.000	2.28E-01 h24,18/11/80	1.56E-01 h24,08/12/80	1.51E-01 h24,08/12/80	1.45E-01 h24,03/12/80

X (km):	89.000	89.250	89.500	89.750
Y (km)				
44.000	3.74E-01 h24,30/12/80	3.70E-01 h24,30/12/80	3.69E-01 h24,11/02/81	2.89E-01 h24,30/12/80
43.750	4.32E-01 h24,30/12/80	4.45E-01 h24,30/12/80	3.58E-01 h24,30/12/80	2.80E-01 h24,30/12/80
43.500	5.35E-01 h24,30/12/80	5.10E-01 h24,11/02/81	4.16E-01 h24,30/12/80	2.80E-01 h24,30/12/80
43.250	6.06E-01 h24,07/02/81	3.84E-01 h24,24/10/80	4.21E-01 h24,24/10/80	2.73E-01 h24,24/10/80
43.000	7.81E-01 h24,05/12/80	5.19E-01 h24,05/12/80	5.40E-01 h24,24/10/80	3.25E-01 h24,30/12/80
42.750	7.77E-01 h24,05/12/80	8.01E-01 h24,05/12/80	7.14E-01 h24,24/10/80	3.17E-01 h24,30/12/80
42.500	6.40E-01 h24,23/11/80	6.84E-01 h24,07/02/81	5.41E-01 h24,24/10/80	3.30E-01 h24,20/06/80
42.250	6.34E-01 h24,01/02/81	5.25E-01 h24,31/01/81	3.75E-01 h24,24/10/80	2.98E-01 h24,20/06/80
42.000	6.32E-01 h24,22/11/80	9.88E-01 h24,23/11/80	3.38E-01 h24,07/01/81	3.04E-01 h24,06/06/80
41.750	9.28E-01 h24,25/12/80	8.24E-01 h24,02/02/81	1.85E+00 h24,01/02/81	6.98E-01 h24,20/11/80

41.500	8.66E-01 h24,23/03/81	5.13E-01 h24,03/02/81	9.97E-01 h24,09/01/81	1.50E+00 h24,29/06/80
41.250	5.82E-01 h24,23/03/81	3.63E-01 h24,09/12/80	3.95E-01 h24,17/02/81	6.07E-01 h24,24/04/80
41.000	2.45E-01 h24,21/01/81	3.40E-01 h24,21/01/81	3.28E-01 h24,02/12/80	5.95E-01 h24,19/11/80
40.750	2.79E-01 h24,10/05/80	3.30E-01 h24,17/02/81	5.53E-01 h24,03/12/80	5.01E-01 h24,24/04/80
40.500	7.50E-01 h24,02/12/80	5.97E-01 h24,03/12/80	2.29E-01 h24,17/02/81	3.03E-01 h24,24/04/80
40.250	3.39E-01 h24,05/11/80	3.07E-01 h24,03/12/80	2.12E-01 h24,02/12/80	2.82E-01 h24,11/05/80
40.000	2.13E-01 h24,03/12/80	1.86E-01 h24,03/12/80	1.76E-01 h24,11/05/80	3.01E-01 h24,19/11/80
39.750	1.81E-01 h24,03/12/80	1.59E-01 h24,03/12/80	1.60E-01 h24,11/05/80	2.01E-01 h24,19/11/80
39.500	1.39E-01 h24,03/12/80	1.28E-01 h24,03/12/80	1.43E-01 h24,11/05/80	1.46E-01 h24,19/11/80
39.250	1.19E-01 h24,03/12/80	1.05E-01 h24,03/12/80	1.27E-01 h24,11/05/80	1.36E-01 h24,11/07/80
39.000	1.26E-01 h24,03/12/80	1.23E-01 h24,15/09/80	1.86E-01 h24,11/05/80	2.15E-01 h24,11/07/80

X (km): / Y (km)	90.000	90.250	90.500	90.750
44.000	2.57E-01 h24,30/01/81	2.86E-01 h24,14/06/80	2.54E-01 h24,14/06/80	2.07E-01 h24,14/06/80
43.750	2.63E-01 h24,20/06/80	2.62E-01 h24,14/06/80	2.52E-01 h24,14/06/80	1.95E-01 h24,12/02/81
43.500	2.67E-01 h24,20/06/80	2.29E-01 h24,14/06/80	2.14E-01 h24,19/06/80	2.28E-01 h24,20/02/81
43.250	2.56E-01 h24,20/06/80	2.38E-01 h24,19/06/80	2.36E-01 h24,30/01/81	2.75E-01 h24,20/02/81
43.000	2.77E-01 h24,20/06/80	2.24E-01 h24,12/02/81	2.37E-01 h24,20/02/81	2.90E-01 h24,20/02/81
42.750	2.75E-01 h24,20/06/80	2.57E-01 h24,30/01/81	2.57E-01 h24,20/02/81	2.30E-01 h24,20/02/81
42.500	3.01E-01 h24,20/06/80	2.47E-01 h24,06/06/80	2.81E-01 h24,22/06/80	3.01E-01 h24,22/06/80
42.250	3.02E-01 h24,12/02/81	3.28E-01 h24,22/06/80	4.17E-01 h24,30/03/80	3.52E-01 h24,11/09/80
42.000	3.91E-01 h24,04/11/80	5.80E-01 h24,11/09/80	5.12E-01 h24,11/09/80	3.72E-01 h24,05/07/80
41.750	6.32E-01 h24,11/09/80	5.11E-01 h24,30/10/80	6.17E-01 h24,05/07/80	4.49E-01 h24,30/10/80
41.500	7.47E-01 h24,13/10/80	7.22E-01 h24,19/09/80	5.51E-01 h24,19/09/80	4.70E-01 h24,19/09/80
41.250	7.51E-01 h24,30/06/80	7.25E-01 h24,29/06/80	5.05E-01 h24,10/09/80	3.60E-01 h24,19/09/80
41.000	4.26E-01 h24,19/11/80	5.67E-01 h24,30/06/80	6.29E-01 h24,29/06/80	4.98E-01 h24,29/06/80
40.750	4.41E-01 h24,24/04/80	3.68E-01 h24,29/06/80	6.46E-01 h24,30/06/80	5.67E-01 h24,29/06/80
40.500	4.06E-01 h24,18/09/80	3.65E-01 h24,08/09/80	4.14E-01 h24,29/06/80	4.13E-01 h24,30/06/80
40.250	3.51E-01 h24,18/09/80	2.98E-01 h24,24/04/80	2.85E-01 h24,03/12/80	2.63E-01 h24,11/08/80
40.000	3.29E-01 h24,24/04/80	3.29E-01 h24,24/04/80	2.75E-01 h24,26/05/80	2.20E-01 h24,03/12/80
39.750	2.44E-01 h24,19/11/80	2.69E-01 h24,24/04/80	2.14E-01 h24,24/04/80	1.61E-01 h24,03/12/80
39.500	2.05E-01 h24,19/11/80	2.12E-01 h24,28/06/80	2.14E-01 h24,24/04/80	1.58E-01 h24,26/05/80
39.250	1.89E-01 h24,19/11/80	2.05E-01 h24,24/04/80	1.95E-01 h24,24/04/80	1.97E-01 h24,26/05/80
39.000	2.16E-01 h24,19/11/80	1.90E-01 h24,04/04/80	1.88E-01 h24,24/04/80	2.17E-01 h24,26/05/80

X (km): / Y (km)	91.000	91.250	91.500	91.750
44.000	1.99E-01 h24,15/06/80	2.15E-01 h24,12/02/81	2.10E-01 h24,12/02/81	1.96E-01 h24,12/02/81
43.750	2.37E-01 h24,12/02/81	2.26E-01 h24,12/02/81	2.13E-01 h24,12/02/81	1.83E-01 h24,12/02/81
43.500	2.56E-01 h24,12/02/81	2.45E-01 h24,12/02/81	2.13E-01 h24,12/02/81	1.91E-01 h24,20/02/81
43.250	2.67E-01 h24,12/02/81	2.26E-01 h24,12/02/81	1.94E-01 h24,30/03/80	2.03E-01 h24,30/03/80
43.000	2.51E-01 h24,20/02/81	2.37E-01 h24,30/03/80	2.16E-01 h24,30/03/80	1.87E-01 h24,28/10/80
42.750	2.52E-01 h24,30/03/80	2.80E-01 h24,30/03/80	2.37E-01 h24,12/06/80	1.93E-01 h24,12/06/80
42.500	3.13E-01 h24,30/03/80	2.87E-01 h24,12/06/80	2.15E-01 h24,11/09/80	1.83E-01 h24,11/09/80
42.250	2.95E-01 h24,11/09/80	2.47E-01 h24,11/09/80	2.25E-01 h24,05/07/80	2.05E-01 h24,05/07/80
42.000	3.32E-01 h24,28/10/80	2.55E-01 h24,30/10/80	2.35E-01 h24,30/10/80	2.05E-01 h24,30/10/80
41.750	4.47E-01 h24,05/07/80	2.78E-01 h24,15/08/80	2.34E-01 h24,15/08/80	2.07E-01 h24,15/08/80
41.500	3.64E-01 h24,19/09/80	2.62E-01 h24,19/09/80	2.13E-01 h24,19/09/80	1.93E-01 h24,19/09/80
41.250	3.31E-01 h24,19/09/80	3.33E-01 h24,19/09/80	2.85E-01 h24,19/09/80	2.43E-01 h24,19/09/80
41.000	3.71E-01 h24,07/11/80	3.16E-01 h24,10/09/80	2.67E-01 h24,07/11/80	2.40E-01 h24,19/09/80
40.750	4.41E-01 h24,29/06/80	3.49E-01 h24,07/11/80	3.36E-01 h24,07/11/80	2.39E-01 h24,19/09/80
40.500	4.20E-01 h24,29/06/80	2.94E-01 h24,29/06/80	2.41E-01 h24,29/06/80	2.43E-01 h24,07/11/80
40.250	3.25E-01 h24,30/06/80	3.54E-01 h24,29/06/80	2.68E-01 h24,29/06/80	2.19E-01 h24,29/06/80
40.000	2.27E-01 h24,11/08/80	2.37E-01 h24,30/06/80	2.49E-01 h24,29/06/80	2.34E-01 h24,01/07/80
39.750	1.60E-01 h24,02/09/80	1.94E-01 h24,29/06/80	2.19E-01 h24,29/06/80	2.18E-01 h24,29/06/80
39.500	1.51E-01 h24,08/09/80	1.53E-01 h24,29/08/80	2.27E-01 h24,11/08/80	2.51E-01 h24,10/06/80
39.250	1.82E-01 h24,30/05/80	1.54E-01 h24,30/05/80	2.59E-01 h24,07/07/80	1.98E-01 h24,11/08/80
39.000	1.76E-01 h24,18/09/80	1.59E-01 h24,30/05/80	2.02E-01 h24,07/07/80	1.73E-01 h24,10/06/80

X (km): / Y (km)	92.000
44.000	1.75E-01 h24,13/04/81
43.750	1.58E-01 h24,13/04/81
43.500	1.57E-01 h24,22/06/80
43.250	1.62E-01 h24,22/06/80
43.000	1.78E-01 h24,12/06/80
42.750	1.58E-01 h24,12/06/80

42.500	1.46E-01 h24,11/09/80
42.250	1.65E-01 h24,28/10/80
42.000	1.96E-01 h24,30/10/80
41.750	1.73E-01 h24,15/08/80
41.500	1.62E-01 h24,19/09/80
41.250	2.08E-01 h24,19/09/80
41.000	2.14E-01 h24,19/09/80
40.750	1.96E-01 h24,10/09/80
40.500	2.22E-01 h24,07/11/80
40.250	2.15E-01 h24,07/11/80
40.000	2.01E-01 h24,01/07/80
39.750	2.04E-01 h24,01/07/80
39.500	1.85E-01 h24,29/06/80
39.250	1.85E-01 h24,10/06/80
39.000	1.73E-01 h24,11/08/80

1

SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR (in micrograms/cubic metre)
AVERAGING TIME = 7 DAYS

X (km):	87.000	87.250	87.500	87.750
Y (km)				
44.000	1.37E-01 h24,11/05/80	1.24E-01 h24,28/01/81	1.29E-01 h24,28/01/81	1.25E-01 h24,11/02/81
43.750	1.31E-01 h24,11/05/80	1.19E-01 h24,28/01/81	1.23E-01 h24,28/01/81	1.27E-01 h24,28/01/81
43.500	1.51E-01 h24,11/05/80	1.39E-01 h24,11/05/80	1.07E-01 h24,28/01/81	1.33E-01 h24,28/01/81
43.250	1.48E-01 h24,10/12/80	1.47E-01 h24,10/12/80	1.31E-01 h24,10/12/80	1.53E-01 h24,28/01/81
43.000	1.46E-01 h24,10/12/80	1.58E-01 h24,10/12/80	1.43E-01 h24,10/12/80	1.83E-01 h24,10/12/80
42.750	1.20E-01 h24,28/01/81	1.60E-01 h24,10/12/80	1.64E-01 h24,10/12/80	1.80E-01 h24,11/05/80
42.500	1.37E-01 h24,28/01/81	1.58E-01 h24,28/01/81	1.88E-01 h24,28/01/81	2.09E-01 h24,10/12/80
42.250	1.56E-01 h24,28/01/81	1.96E-01 h24,28/01/81	2.06E-01 h24,28/01/81	2.40E-01 h24,28/01/81
42.000	2.01E-01 h24,24/12/80	2.23E-01 h24,24/12/80	2.76E-01 h24,24/12/80	2.74E-01 h24,28/01/81
41.750	1.58E-01 h24,14/01/81	2.24E-01 h24,14/01/81	3.21E-01 h24,14/01/81	2.91E-01 h24,14/01/81
41.500	1.34E-01 h24,29/03/80	2.21E-01 h24,15/07/80	3.49E-01 h24,14/01/81	4.77E-01 h24,14/01/81
41.250	1.64E-01 h24,21/01/81	2.04E-01 h24,21/01/81	1.98E-01 h24,14/01/81	2.26E-01 h24,14/01/81
41.000	1.04E-01 h24,10/12/80	1.05E-01 h24,10/12/80	1.53E-01 h24,19/11/80	2.61E-01 h24,19/11/80
40.750	8.56E-02 h24,19/11/80	8.98E-02 h24,19/11/80	1.17E-01 h24,28/10/80	1.07E-01 h24,29/03/80
40.500	6.69E-02 h24,21/01/81	8.75E-02 h24,29/03/80	9.86E-02 h24,06/04/80	1.54E-01 h24,06/04/80
40.250	9.06E-02 h24,06/04/80	7.67E-02 h24,06/04/80	7.22E-02 h24,06/04/80	7.85E-02 h24,29/03/80
40.000	1.02E-01 h24,06/04/80	6.45E-02 h24,06/04/80	8.86E-02 h24,29/03/80	9.17E-02 h24,28/10/80
39.750	7.46E-02 h24,06/04/80	7.83E-02 h24,29/03/80	9.08E-02 h24,21/10/80	8.66E-02 h24,24/08/80
39.500	6.26E-02 h24,21/10/80	5.94E-02 h24,21/10/80	8.28E-02 h24,24/08/80	9.57E-02 h24,21/01/81
39.250	4.62E-02 h24,24/08/80	5.54E-02 h24,24/08/80	9.17E-02 h24,21/01/81	7.81E-02 h24,19/11/80
39.000	4.71E-02 h24,24/08/80	8.32E-02 h24,21/04/81	8.92E-02 h24,21/01/81	1.43E-01 h24,19/11/80

X (km):	88.000	88.250	88.500	88.750
Y (km)				
44.000	1.49E-01 h24,28/01/81	1.51E-01 h24,28/01/81	1.36E-01 h24,28/01/81	1.09E-01 h24,28/01/81
43.750	1.54E-01 h24,28/01/81	1.92E-01 h24,28/01/81	1.83E-01 h24,28/01/81	1.57E-01 h24,28/01/81
43.500	1.53E-01 h24,28/01/81	1.85E-01 h24,28/01/81	2.27E-01 h24,28/01/81	1.89E-01 h24,28/01/81
43.250	1.78E-01 h24,28/01/81	1.87E-01 h24,28/01/81	2.81E-01 h24,28/01/81	2.66E-01 h24,28/01/81
43.000	2.10E-01 h24,10/12/80	1.97E-01 h24,28/01/81	2.87E-01 h24,26/11/80	2.39E-01 h24,28/01/81
42.750	1.39E-01 h24,10/12/80	1.64E-01 h24,28/01/81	1.81E-01 h24,28/01/81	2.27E-01 h24,26/11/80
42.500	2.88E-01 h24,10/12/80	1.99E-01 h24,10/12/80	2.06E-01 h24,10/12/80	1.90E-01 h24,28/01/81
42.250	2.34E-01 h24,28/01/81	2.02E-01 h24,28/01/81	1.66E-01 h24,11/05/80	1.62E-01 h24,10/12/80
42.000	2.21E-01 h24,28/01/81	2.14E-01 h24,28/01/81	2.26E-01 h24,28/01/81	2.34E-01 h24,28/01/81
41.750	2.58E-01 h24,14/01/81	2.54E-01 h24,14/01/81	2.95E-01 h24,24/12/80	3.66E-01 h24,24/12/80
41.500	4.68E-01 h24,15/07/80	6.84E-01 h24,15/07/80	4.65E-01 h24,10/12/80	4.84E-01 h24,21/01/81
41.250	4.75E-01 h24,14/01/81	3.56E-01 h24,19/11/80	2.18E-01 h24,10/12/80	1.79E-01 h24,21/01/81
41.000	4.12E-01 h24,28/10/80	2.20E-01 h24,21/01/81	2.51E-01 h24,06/04/80	1.24E-01 h24,21/01/81
40.750	2.51E-01 h24,06/04/80	4.66E-01 h24,06/04/80	1.58E-01 h24,21/01/81	1.23E-01 h24,24/08/80
40.500	2.98E-01 h24,06/04/80	1.86E-01 h24,21/01/81	1.79E-01 h24,24/08/80	1.39E-01 h24,19/11/80
40.250	8.13E-02 h24,28/10/80	1.49E-01 h24,21/04/81	1.79E-01 h24,19/11/80	1.61E-01 h24,21/04/81
40.000	9.04E-02 h24,24/08/80	7.70E-02 h24,21/01/81	1.17E-01 h24,19/11/80	6.57E-02 h24,16/06/80
39.750	9.90E-02 h24,21/01/81	7.65E-02 h24,19/11/80	7.17E-02 h24,21/04/81	4.61E-02 h24,21/01/81
39.500	5.86E-02 h24,19/11/80	5.79E-02 h24,19/11/80	4.59E-02 h24,16/06/80	4.02E-02 h24,21/01/81
39.250	7.67E-02 h24,19/11/80	4.79E-02 h24,21/04/81	3.13E-02 h24,16/06/80	3.61E-02 h24,21/01/81
39.000	6.25E-02 h24,21/04/81	3.87E-02 h24,16/06/80	4.16E-02 h24,21/01/81	4.42E-02 h24,21/01/81

X (km):	89.000	89.250	89.500	89.750

Y (km)				
44.000	9.64E-02 h24,31/12/80	1.05E-01 h24,31/12/80	1.00E-01 h24,31/12/80	8.50E-02 h24,04/02/81
43.750	1.13E-01 h24,31/12/80	1.27E-01 h24,31/12/80	1.05E-01 h24,31/12/80	8.03E-02 h24,04/02/81
43.500	1.75E-01 h24,28/01/81	1.46E-01 h24,31/12/80	1.20E-01 h24,31/12/80	8.15E-02 h24,04/02/81
43.250	2.04E-01 h24,28/01/81	1.32E-01 h24,31/12/80	9.99E-02 h24,11/02/81	8.23E-02 h24,31/12/80
43.000	2.08E-01 h24,28/01/81	1.61E-01 h24,31/12/80	1.36E-01 h24,11/02/81	1.00E-01 h24,31/12/80
42.750	2.41E-01 h24,28/01/81	2.16E-01 h24,31/12/80	1.93E-01 h24,11/02/81	1.01E-01 h24,31/12/80
42.500	2.29E-01 h24,26/11/80	1.87E-01 h24,04/02/81	1.46E-01 h24,25/02/81	9.74E-02 h24,25/02/81
42.250	1.83E-01 h24,14/01/81	1.95E-01 h24,04/02/81	1.31E-01 h24,25/02/81	9.53E-02 h24,25/02/81
42.000	2.43E-01 h24,05/03/81	2.84E-01 h24,04/02/81	1.28E-01 h24,04/02/81	1.00E-01 h24,23/06/80
41.750	3.97E-01 h24,24/12/80	3.41E-01 h24,24/12/80	6.33E-01 h24,11/02/81	1.94E-01 h24,08/07/80
41.500	3.97E-01 h24,21/01/81	2.27E-01 h24,21/01/81	3.01E-01 h24,14/01/81	3.70E-01 h24,02/09/80
41.250	1.76E-01 h24,28/10/80	1.07E-01 h24,14/10/80	1.30E-01 h24,17/12/80	1.72E-01 h24,19/11/80
41.000	8.74E-02 h24,24/08/80	8.57E-02 h24,03/12/80	1.10E-01 h24,21/01/81	1.48E-01 h24,02/09/80
40.750	7.29E-02 h24,24/08/80	1.20E-01 h24,21/01/81	1.71E-01 h24,28/10/80	1.38E-01 h24,19/11/80
40.500	1.74E-01 h24,04/02/81	1.45E-01 h24,21/01/81	7.51E-02 h24,28/10/80	9.06E-02 h24,19/11/80
40.250	1.00E-01 h24,21/01/81	6.65E-02 h24,21/01/81	6.64E-02 h24,28/10/80	7.25E-02 h24,19/11/80
40.000	7.12E-02 h24,21/01/81	4.51E-02 h24,28/10/80	5.39E-02 h24,28/10/80	7.50E-02 h24,11/05/80
39.750	5.15E-02 h24,21/01/81	4.22E-02 h24,28/10/80	4.48E-02 h24,28/10/80	5.18E-02 h24,11/05/80
39.500	3.57E-02 h24,21/01/81	3.70E-02 h24,28/10/80	3.76E-02 h24,28/10/80	3.88E-02 h24,11/05/80
39.250	2.76E-02 h24,21/01/81	3.24E-02 h24,28/10/80	3.19E-02 h24,28/10/80	3.89E-02 h24,11/05/80
39.000	2.71E-02 h24,28/10/80	3.52E-02 h24,28/10/80	3.79E-02 h24,28/10/80	5.06E-02 h24,02/09/80

X (km):	90.000	90.250	90.500	90.750
Y (km)				
44.000	7.25E-02 h24,31/12/80	8.63E-02 h24,23/06/80	8.30E-02 h24,23/06/80	7.54E-02 h24,25/02/81
43.750	7.17E-02 h24,23/06/80	8.54E-02 h24,23/06/80	8.95E-02 h24,04/02/81	7.68E-02 h24,25/02/81
43.500	7.77E-02 h24,23/06/80	8.38E-02 h24,23/06/80	8.33E-02 h24,23/06/80	8.80E-02 h24,25/02/81
43.250	8.11E-02 h24,23/06/80	8.71E-02 h24,04/02/81	8.73E-02 h24,25/02/81	9.67E-02 h24,16/06/80
43.000	9.58E-02 h24,23/06/80	8.39E-02 h24,25/02/81	9.04E-02 h24,23/06/80	1.02E-01 h24,09/06/80
42.750	9.18E-02 h24,04/02/81	1.01E-01 h24,25/02/81	1.08E-01 h24,09/06/80	1.20E-01 h24,25/02/81
42.500	1.08E-01 h24,25/02/81	1.25E-01 h24,23/06/80	1.43E-01 h24,23/06/80	1.48E-01 h24,09/06/80
42.250	1.22E-01 h24,25/02/81	1.62E-01 h24,23/06/80	1.75E-01 h24,09/06/80	1.59E-01 h24,23/06/80
42.000	1.42E-01 h24,23/06/80	1.91E-01 h24,23/06/80	1.71E-01 h24,23/06/80	1.23E-01 h24,05/11/80
41.750	2.15E-01 h24,05/11/80	2.00E-01 h24,05/11/80	2.31E-01 h24,05/11/80	1.71E-01 h24,05/11/80
41.500	3.05E-01 h24,16/09/80	3.03E-01 h24,16/09/80	2.34E-01 h24,16/09/80	1.92E-01 h24,16/09/80
41.250	2.39E-01 h24,02/09/80	2.40E-01 h24,02/09/80	2.00E-01 h24,23/09/80	1.58E-01 h24,23/09/80
41.000	1.84E-01 h24,01/07/80	1.96E-01 h24,02/09/80	1.93E-01 h24,02/09/80	1.83E-01 h24,02/09/80
40.750	1.30E-01 h24,09/09/80	1.81E-01 h24,02/09/80	2.40E-01 h24,02/09/80	1.80E-01 h24,02/09/80
40.500	1.05E-01 h24,09/09/80	1.58E-01 h24,01/07/80	2.08E-01 h24,02/09/80	1.50E-01 h24,02/09/80
40.250	9.17E-02 h24,01/07/80	9.52E-02 h24,01/07/80	1.36E-01 h24,02/09/80	1.24E-01 h24,02/09/80
40.000	8.37E-02 h24,01/07/80	9.28E-02 h24,01/07/80	1.07E-01 h24,02/09/80	1.12E-01 h24,02/09/80
39.750	6.23E-02 h24,19/11/80	7.08E-02 h24,01/07/80	7.43E-02 h24,01/07/80	7.85E-02 h24,02/09/80
39.500	5.10E-02 h24,19/11/80	5.85E-02 h24,01/07/80	6.52E-02 h24,01/07/80	6.83E-02 h24,02/09/80
39.250	4.54E-02 h24,19/11/80	5.47E-02 h24,01/07/80	5.49E-02 h24,01/07/80	6.59E-02 h24,02/09/80
39.000	5.10E-02 h24,11/05/80	4.99E-02 h24,01/07/80	5.22E-02 h24,01/07/80	6.77E-02 h24,02/09/80

X (km):	91.000	91.250	91.500	91.750
Y (km)				
44.000	7.62E-02 h24,25/02/81	7.98E-02 h24,25/02/81	7.53E-02 h24,16/06/80	7.10E-02 h24,16/06/80
43.750	8.73E-02 h24,25/02/81	7.74E-02 h24,16/06/80	7.37E-02 h24,16/06/80	7.93E-02 h24,09/06/80
43.500	8.68E-02 h24,16/06/80	8.29E-02 h24,16/06/80	9.43E-02 h24,09/06/80	9.71E-02 h24,23/06/80
43.250	8.63E-02 h24,09/06/80	9.74E-02 h24,09/06/80	1.05E-01 h24,23/06/80	1.05E-01 h24,09/06/80
43.000	1.14E-01 h24,25/02/81	1.26E-01 h24,23/06/80	1.10E-01 h24,09/06/80	9.10E-02 h24,09/06/80
42.750	1.31E-01 h24,23/06/80	1.35E-01 h24,09/06/80	1.10E-01 h24,08/07/80	9.62E-02 h24,08/07/80
42.500	1.49E-01 h24,08/07/80	1.57E-01 h24,08/07/80	1.16E-01 h24,23/06/80	9.63E-02 h24,23/06/80
42.250	1.26E-01 h24,23/06/80	1.08E-01 h24,23/06/80	8.90E-02 h24,23/06/80	7.48E-02 h24,16/06/80
42.000	1.05E-01 h24,05/11/80	9.28E-02 h24,05/11/80	8.65E-02 h24,17/08/80	7.57E-02 h24,17/08/80
41.750	1.72E-01 h24,05/11/80	1.11E-01 h24,05/11/80	9.30E-02 h24,05/11/80	8.57E-02 h24,05/11/80
41.500	1.52E-01 h24,16/09/80	1.16E-01 h24,08/07/80	9.70E-02 h24,16/09/80	8.60E-02 h24,16/09/80
41.250	1.43E-01 h24,23/09/80	1.33E-01 h24,16/09/80	1.11E-01 h24,16/09/80	9.42E-02 h24,16/09/80
41.000	1.48E-01 h24,02/09/80	1.35E-01 h24,16/09/80	1.11E-01 h24,23/09/80	1.08E-01 h24,23/09/80
40.750	1.53E-01 h24,02/09/80	1.42E-01 h24,23/09/80	1.29E-01 h24,23/09/80	1.01E-01 h24,16/09/80
40.500	1.33E-01 h24,02/09/80	1.09E-01 h24,02/09/80	1.01E-01 h24,02/09/80	9.38E-02 h24,02/09/80
40.250	1.23E-01 h24,02/09/80	1.19E-01 h24,02/06/80	1.06E-01 h24,02/06/80	9.15E-02 h24,02/06/80
40.000	1.04E-01 h24,02/09/80	9.47E-02 h24,02/09/80	9.62E-02 h24,02/06/80	9.42E-02 h24,02/06/80
39.750	8.58E-02 h24,02/09/80	8.84E-02 h24,02/09/80	8.64E-02 h24,02/09/80	9.09E-02 h24,02/06/80
39.500	7.38E-02 h24,02/09/80	8.05E-02 h24,02/09/80	9.73E-02 h24,02/09/80	9.43E-02 h24,02/06/80
39.250	7.16E-02 h24,01/07/80	7.57E-02 h24,02/09/80	1.01E-01 h24,01/07/80	8.33E-02 h24,02/09/80
39.000	5.99E-02 h24,02/09/80	6.46E-02 h24,02/09/80	7.94E-02 h24,01/07/80	7.82E-02 h24,02/09/80

X (km): 92.000

Y (km)	92.000
44.000	7.46E-02 h24,09/06/80
43.750	7.63E-02 h24,25/02/81
43.500	8.35E-02 h24,23/06/80
43.250	8.27E-02 h24,09/06/80
43.000	7.91E-02 h24,25/02/81
42.750	8.62E-02 h24,23/06/80
42.500	7.17E-02 h24,23/06/80
42.250	6.40E-02 h24,16/06/80
42.000	7.30E-02 h24,17/08/80
41.750	6.80E-02 h24,05/11/80
41.500	7.36E-02 h24,16/09/80
41.250	8.06E-02 h24,16/09/80
41.000	9.01E-02 h24,02/06/80
40.750	8.74E-02 h24,02/06/80
40.500	8.34E-02 h24,02/06/80
40.250	8.86E-02 h24,21/04/81
40.000	8.23E-02 h24,02/06/80
39.750	8.35E-02 h24,02/06/80
39.500	7.91E-02 h24,02/06/80
39.250	7.53E-02 h24,02/06/80
39.000	7.20E-02 h24,02/09/80

1

SECOND-HIGHEST RECORDINGS FOR EACH RECEPTOR (in micrograms/cubic metre)
3-MONTH RUNNING AVERAGES

Y (km) \ X (km):	87.000	87.250	87.500	87.750
44.000	7.15E-02 h24,30/11/80	5.90E-02 h24,30/03/80	5.56E-02 h24,30/03/80	5.32E-02 h24,30/03/80
43.750	6.98E-02 h24,30/02/80	6.44E-02 h24,30/11/80	5.85E-02 h24,30/03/80	5.54E-02 h24,30/03/80
43.500	7.74E-02 h24,30/02/80	7.62E-02 h24,30/02/80	5.73E-02 h24,30/11/80	6.37E-02 h24,30/03/80
43.250	7.29E-02 h24,30/02/80	7.75E-02 h24,30/02/80	7.61E-02 h24,30/02/80	8.54E-02 h24,30/11/80
43.000	7.44E-02 h24,30/02/80	7.95E-02 h24,30/02/80	7.74E-02 h24,30/02/80	1.01E-01 h24,30/02/80
42.750	6.87E-02 h24,30/02/80	8.90E-02 h24,30/02/80	8.72E-02 h24,30/02/80	9.44E-02 h24,30/02/80
42.500	7.54E-02 h24,30/02/80	8.97E-02 h24,30/02/80	1.08E-01 h24,30/02/80	1.19E-01 h24,30/02/80
42.250	7.51E-02 h24,30/02/80	9.78E-02 h24,30/10/80	1.08E-01 h24,30/10/80	1.33E-01 h24,30/02/80
42.000	9.32E-02 h24,30/02/80	1.04E-01 h24,30/02/80	1.26E-01 h24,30/02/80	1.31E-01 h24,30/02/80
41.750	7.83E-02 h24,30/02/80	1.07E-01 h24,30/02/80	1.50E-01 h24,30/02/80	1.46E-01 h24,30/02/80
41.500	7.48E-02 h24,30/02/80	1.04E-01 h24,30/02/80	1.48E-01 h24,30/02/80	1.99E-01 h24,30/02/80
41.250	8.93E-02 h24,30/11/80	1.04E-01 h24,30/11/80	1.01E-01 h24,30/11/80	1.17E-01 h24,30/11/80
41.000	5.64E-02 h24,30/11/80	5.74E-02 h24,30/11/80	7.95E-02 h24,30/11/80	1.23E-01 h24,30/02/80
40.750	4.64E-02 h24,30/11/80	4.93E-02 h24,30/02/80	5.74E-02 h24,30/02/80	5.39E-02 h24,30/02/80
40.500	3.48E-02 h24,30/02/80	4.43E-02 h24,30/02/80	4.24E-02 h24,30/02/80	5.32E-02 h24,30/03/80
40.250	3.66E-02 h24,30/02/80	2.97E-02 h24,30/03/80	2.97E-02 h24,30/03/80	3.46E-02 h24,30/03/80
40.000	3.36E-02 h24,30/03/80	2.66E-02 h24,30/03/80	3.74E-02 h24,30/03/80	4.04E-02 h24,30/10/80
39.750	2.93E-02 h24,30/03/80	3.39E-02 h24,30/09/80	4.06E-02 h24,30/10/80	3.64E-02 h24,30/10/80
39.500	2.78E-02 h24,30/09/80	2.68E-02 h24,30/10/80	3.68E-02 h24,30/10/80	3.04E-02 h24,30/10/80
39.250	2.00E-02 h24,30/10/80	2.22E-02 h24,30/10/80	2.79E-02 h24,30/10/80	2.95E-02 h24,30/10/80
39.000	1.87E-02 h24,30/10/80	2.57E-02 h24,30/10/80	3.26E-02 h24,30/10/80	4.23E-02 h24,30/10/80

Y (km) \ X (km):	88.000	88.250	88.500	88.750
44.000	6.21E-02 h24,30/03/80	6.81E-02 h24,30/03/80	6.45E-02 h24,30/03/80	5.45E-02 h24,30/03/80
43.750	6.36E-02 h24,30/03/80	8.29E-02 h24,30/03/80	8.57E-02 h24,30/03/80	7.66E-02 h24,30/03/80
43.500	6.64E-02 h24,30/03/80	7.77E-02 h24,30/03/80	1.02E-01 h24,30/03/80	9.08E-02 h24,30/03/80
43.250	8.53E-02 h24,30/03/80	8.11E-02 h24,30/03/80	1.19E-01 h24,30/03/80	1.26E-01 h24,30/03/80
43.000	1.19E-01 h24,30/11/80	9.54E-02 h24,30/03/80	1.24E-01 h24,30/03/80	1.10E-01 h24,30/03/80
42.750	8.46E-02 h24,30/02/80	9.52E-02 h24,30/11/80	9.10E-02 h24,30/03/80	9.52E-02 h24,30/03/80
42.500	1.45E-01 h24,30/02/80	1.16E-01 h24,30/02/80	1.23E-01 h24,30/11/80	1.02E-01 h24,30/03/80
42.250	1.34E-01 h24,30/02/80	1.21E-01 h24,30/02/80	1.01E-01 h24,30/11/80	1.00E-01 h24,30/11/80
42.000	1.14E-01 h24,30/02/80	1.18E-01 h24,30/02/80	1.34E-01 h24,30/02/80	1.53E-01 h24,30/02/80
41.750	1.41E-01 h24,30/02/80	1.50E-01 h24,30/02/80	1.77E-01 h24,30/02/80	2.15E-01 h24,30/02/80
41.500	2.10E-01 h24,30/02/80	3.01E-01 h24,30/02/80	2.60E-01 h24,30/02/80	2.67E-01 h24,30/11/80
41.250	2.32E-01 h24,30/11/80	1.83E-01 h24,30/11/80	1.26E-01 h24,30/11/80	1.01E-01 h24,30/11/80
41.000	1.78E-01 h24,30/02/80	1.10E-01 h24,30/02/80	1.02E-01 h24,30/02/80	6.42E-02 h24,30/02/80

Y (km)				
40.750	8.81E-02 h24,30/02/80	1.44E-01 h24,30/03/80	6.98E-02 h24,30/09/80	4.62E-02 h24,30/02/80
40.500	1.01E-01 h24,30/03/80	7.61E-02 h24,30/10/80	7.62E-02 h24,30/10/80	5.58E-02 h24,30/10/80
40.250	3.61E-02 h24,30/09/80	6.51E-02 h24,30/10/80	6.97E-02 h24,30/10/80	5.77E-02 h24,30/10/80
40.000	3.57E-02 h24,30/10/80	2.91E-02 h24,30/10/80	4.06E-02 h24,30/10/80	2.87E-02 h24,30/10/80
39.750	3.34E-02 h24,30/10/80	2.85E-02 h24,30/10/80	2.83E-02 h24,30/10/80	2.04E-02 h24,30/09/80
39.500	2.31E-02 h24,30/10/80	2.14E-02 h24,30/10/80	1.94E-02 h24,30/10/80	1.67E-02 h24,30/09/80
39.250	2.53E-02 h24,30/10/80	1.93E-02 h24,30/10/80	1.40E-02 h24,30/09/80	1.49E-02 h24,30/09/80
39.000	2.12E-02 h24,30/10/80	1.53E-02 h24,30/10/80	1.61E-02 h24,30/09/80	1.68E-02 h24,30/09/80

X (km):	89.000	89.250	89.500	89.750
Y (km)				
44.000	4.86E-02 h24,30/03/80	4.93E-02 h24,30/03/80	4.43E-02 h24,30/03/80	3.92E-02 h24,30/03/80
43.750	5.89E-02 h24,30/03/80	6.17E-02 h24,30/03/80	4.35E-02 h24,30/03/80	3.26E-02 h24,30/03/80
43.500	9.11E-02 h24,30/03/80	7.13E-02 h24,30/03/80	4.90E-02 h24,30/03/80	3.07E-02 h24,30/03/80
43.250	1.03E-01 h24,30/03/80	5.52E-02 h24,30/03/80	4.13E-02 h24,30/03/80	2.97E-02 h24,30/03/80
43.000	1.05E-01 h24,30/03/80	6.87E-02 h24,30/03/80	5.50E-02 h24,30/03/80	3.77E-02 h24,30/03/80
42.750	1.22E-01 h24,30/03/80	1.01E-01 h24,30/03/80	7.69E-02 h24,30/03/80	4.10E-02 h24,30/03/80
42.500	1.01E-01 h24,30/03/80	8.77E-02 h24,30/03/80	5.83E-02 h24,30/03/80	4.48E-02 h24,30/03/80
42.250	9.69E-02 h24,30/03/80	8.69E-02 h24,30/03/80	5.01E-02 h24,30/03/80	4.27E-02 h24,30/03/80
42.000	1.48E-01 h24,30/11/80	1.31E-01 h24,30/03/80	5.01E-02 h24,30/03/80	4.02E-02 h24,30/02/80
41.750	2.32E-01 h24,30/02/80	1.99E-01 h24,30/02/80	2.55E-01 h24,30/03/80	8.96E-02 h24,30/07/80
41.500	2.21E-01 h24,30/02/80	1.30E-01 h24,30/02/80	1.56E-01 h24,30/02/80	1.79E-01 h24,30/09/80
41.250	9.79E-02 h24,30/11/80	6.95E-02 h24,30/02/80	6.75E-02 h24,30/10/80	1.07E-01 h24,30/09/80
41.000	4.22E-02 h24,30/11/80	4.87E-02 h24,30/02/80	6.03E-02 h24,30/10/80	9.23E-02 h24,30/10/80
40.750	3.63E-02 h24,30/02/80	4.68E-02 h24,30/09/80	8.22E-02 h24,30/09/80	7.81E-02 h24,30/08/80
40.500	6.96E-02 h24,30/10/80	5.91E-02 h24,30/09/80	4.20E-02 h24,30/11/80	5.34E-02 h24,30/08/80
40.250	3.88E-02 h24,30/09/80	3.52E-02 h24,30/09/80	3.54E-02 h24,30/11/80	4.35E-02 h24,30/08/80
40.000	2.78E-02 h24,30/09/80	2.59E-02 h24,30/09/80	2.86E-02 h24,30/11/80	4.30E-02 h24,30/08/80
39.750	2.20E-02 h24,30/09/80	2.31E-02 h24,30/09/80	2.38E-02 h24,30/11/80	3.13E-02 h24,30/08/80
39.500	1.75E-02 h24,30/09/80	1.98E-02 h24,30/09/80	2.00E-02 h24,30/11/80	2.43E-02 h24,30/08/80
39.250	1.51E-02 h24,30/09/80	1.72E-02 h24,30/09/80	1.71E-02 h24,30/11/80	2.17E-02 h24,30/08/80
39.000	1.52E-02 h24,30/09/80	1.73E-02 h24,30/09/80	1.83E-02 h24,30/11/80	2.30E-02 h24,30/08/80

X (km):	90.000	90.250	90.500	90.750
Y (km)				
44.000	3.21E-02 h24,30/03/80	3.87E-02 h24,30/03/80	3.87E-02 h24,30/05/80	3.74E-02 h24,30/03/80
43.750	3.17E-02 h24,30/03/80	3.60E-02 h24,30/03/80	4.15E-02 h24,30/03/80	3.68E-02 h24,30/03/80
43.500	3.24E-02 h24,30/03/80	3.40E-02 h24,30/03/80	3.98E-02 h24,30/03/80	4.15E-02 h24,30/03/80
43.250	3.24E-02 h24,30/03/80	3.95E-02 h24,30/03/80	4.16E-02 h24,30/03/80	4.81E-02 h24,30/03/80
43.000	3.78E-02 h24,30/03/80	4.03E-02 h24,30/05/80	4.86E-02 h24,30/03/80	5.59E-02 h24,30/03/80
42.750	4.23E-02 h24,30/03/80	4.70E-02 h24,30/05/80	5.65E-02 h24,30/05/80	6.30E-02 h24,30/05/80
42.500	5.12E-02 h24,30/02/80	6.17E-02 h24,30/05/80	7.54E-02 h24,30/05/80	8.08E-02 h24,30/07/80
42.250	5.65E-02 h24,30/07/80	8.39E-02 h24,30/07/80	1.04E-01 h24,30/07/80	9.31E-02 h24,30/07/80
42.000	7.13E-02 h24,30/06/80	1.12E-01 h24,30/06/80	1.14E-01 h24,30/06/80	9.34E-02 h24,30/08/80
41.750	8.27E-02 h24,30/09/80	8.83E-02 h24,30/07/80	1.36E-01 h24,30/07/80	1.07E-01 h24,30/07/80
41.500	1.40E-01 h24,30/09/80	1.41E-01 h24,30/09/80	1.14E-01 h24,30/09/80	9.95E-02 h24,30/09/80
41.250	1.25E-01 h24,30/09/80	1.26E-01 h24,30/09/80	1.16E-01 h24,30/09/80	8.95E-02 h24,30/09/80
41.000	1.13E-01 h24,30/09/80	1.10E-01 h24,30/09/80	1.10E-01 h24,30/09/80	1.10E-01 h24,30/09/80
40.750	8.67E-02 h24,30/09/80	1.00E-01 h24,30/09/80	1.35E-01 h24,30/09/80	1.15E-01 h24,30/07/80
40.500	6.94E-02 h24,30/08/80	9.61E-02 h24,30/09/80	1.07E-01 h24,30/09/80	8.79E-02 h24,30/09/80
40.250	6.00E-02 h24,30/08/80	6.02E-02 h24,30/09/80	7.52E-02 h24,30/09/80	6.77E-02 h24,30/09/80
40.000	5.38E-02 h24,30/08/80	5.84E-02 h24,30/09/80	6.26E-02 h24,30/09/80	5.98E-02 h24,30/09/80
39.750	3.92E-02 h24,30/08/80	4.38E-02 h24,30/09/80	4.46E-02 h24,30/09/80	4.37E-02 h24,30/09/80
39.500	3.14E-02 h24,30/08/80	3.55E-02 h24,30/09/80	3.91E-02 h24,30/09/80	3.86E-02 h24,30/09/80
39.250	2.74E-02 h24,30/08/80	3.31E-02 h24,30/09/80	3.26E-02 h24,30/09/80	3.68E-02 h24,30/09/80
39.000	2.79E-02 h24,30/09/80	3.05E-02 h24,30/09/80	3.09E-02 h24,30/09/80	3.56E-02 h24,30/09/80

X (km):	91.000	91.250	91.500	91.750
Y (km)				
44.000	3.69E-02 h24,30/06/80	3.73E-02 h24,30/06/80	3.76E-02 h24,30/03/80	4.02E-02 h24,30/03/80
43.750	4.16E-02 h24,30/06/80	3.87E-02 h24,30/03/80	4.18E-02 h24,30/03/80	4.47E-02 h24,30/06/80
43.500	4.32E-02 h24,30/03/80	4.74E-02 h24,30/03/80	5.31E-02 h24,30/06/80	5.80E-02 h24,30/05/80
43.250	4.94E-02 h24,30/03/80	5.32E-02 h24,30/05/80	6.02E-02 h24,30/05/80	5.89E-02 h24,30/05/80
43.000	6.14E-02 h24,30/05/80	7.02E-02 h24,30/05/80	6.22E-02 h24,30/07/80	5.66E-02 h24,30/07/80
42.750	6.92E-02 h24,30/07/80	8.25E-02 h24,30/07/80	7.00E-02 h24,30/07/80	5.85E-02 h24,30/07/80
42.500	9.38E-02 h24,30/07/80	9.40E-02 h24,30/07/80	7.12E-02 h24,30/07/80	6.34E-02 h24,30/06/80
42.250	7.98E-02 h24,30/06/80	7.49E-02 h24,30/06/80	6.83E-02 h24,30/06/80	5.82E-02 h24,30/06/80
42.000	7.98E-02 h24,30/08/80	7.17E-02 h24,30/08/80	6.58E-02 h24,30/08/80	5.76E-02 h24,30/08/80

41.750	1.22E-01 h24,30/07/80	7.55E-02 h24,30/07/80	6.59E-02 h24,30/07/80	6.36E-02 h24,30/07/80
41.500	8.09E-02 h24,30/09/80	6.24E-02 h24,30/09/80	5.48E-02 h24,30/07/80	5.24E-02 h24,30/07/80
41.250	7.85E-02 h24,30/09/80	7.55E-02 h24,30/09/80	6.39E-02 h24,30/09/80	5.43E-02 h24,30/09/80
41.000	9.25E-02 h24,30/09/80	8.59E-02 h24,30/07/80	6.65E-02 h24,30/09/80	6.15E-02 h24,30/09/80
40.750	1.02E-01 h24,30/07/80	9.87E-02 h24,30/07/80	9.49E-02 h24,30/07/80	7.11E-02 h24,30/07/80
40.500	8.46E-02 h24,30/07/80	7.05E-02 h24,30/07/80	6.78E-02 h24,30/07/80	6.50E-02 h24,30/07/80
40.250	7.27E-02 h24,30/09/80	7.64E-02 h24,30/07/80	7.02E-02 h24,30/07/80	6.34E-02 h24,30/07/80
40.000	5.70E-02 h24,30/09/80	5.60E-02 h24,30/09/80	5.80E-02 h24,30/07/80	5.94E-02 h24,30/07/80
39.750	4.57E-02 h24,30/09/80	4.86E-02 h24,30/09/80	5.15E-02 h24,30/09/80	5.37E-02 h24,30/09/80
39.500	4.01E-02 h24,30/09/80	4.23E-02 h24,30/09/80	5.33E-02 h24,30/09/80	5.73E-02 h24,30/09/80
39.250	4.10E-02 h24,30/09/80	4.00E-02 h24,30/09/80	5.49E-02 h24,30/09/80	4.60E-02 h24,30/09/80
39.000	3.47E-02 h24,30/09/80	3.60E-02 h24,30/09/80	4.41E-02 h24,30/09/80	4.04E-02 h24,30/09/80

X (km): 92.000

Y (km)	
44.000	4.25E-02 h24,30/06/80
43.750	4.56E-02 h24,30/05/80
43.500	4.68E-02 h24,30/05/80
43.250	4.88E-02 h24,30/07/80
43.000	5.10E-02 h24,30/07/80
42.750	5.16E-02 h24,30/07/80
42.500	5.06E-02 h24,30/06/80
42.250	4.95E-02 h24,30/06/80
42.000	5.57E-02 h24,30/08/80
41.750	5.05E-02 h24,30/07/80
41.500	4.63E-02 h24,30/07/80
41.250	4.63E-02 h24,30/09/80
41.000	5.32E-02 h24,30/09/80
40.750	5.55E-02 h24,30/07/80
40.500	5.70E-02 h24,30/07/80
40.250	6.17E-02 h24,30/07/80
40.000	5.46E-02 h24,30/07/80
39.750	5.07E-02 h24,30/07/80
39.500	4.60E-02 h24,30/09/80
39.250	4.49E-02 h24,30/09/80
39.000	4.00E-02 h24,30/09/80

1

PEAK VALUES FOR THE 50 WORST CASES (in micrograms/cubic metre)
AVERAGING TIME = 24 HOURS

RANK	VALUE	TIME RECORDED hour date	COORDINATES (* denotes polar)	RANK	VALUE	TIME RECORDED hour date	COORDINATES (* denotes polar)
1	3.99E+00	24,22/10/80	(8.83E+04, 4.08E+04)	26	1.16E+00	24,23/03/81	(8.80E+04, 4.13E+04)
2	3.14E+00	24,14/07/80	(8.83E+04, 4.15E+04)	27	1.16E+00	24,07/04/80	(8.95E+04, 4.18E+04)
3	2.70E+00	24,06/04/80	(8.83E+04, 4.08E+04)	28	1.13E+00	24,28/12/80	(8.83E+04, 4.15E+04)
4	2.15E+00	24,07/02/81	(8.95E+04, 4.18E+04)	29	1.11E+00	24,11/10/80	(8.83E+04, 4.15E+04)
5	1.99E+00	24,09/01/81	(8.83E+04, 4.15E+04)	30	1.10E+00	24,24/11/80	(8.80E+04, 4.13E+04)
6	1.97E+00	24,26/03/80	(8.83E+04, 4.15E+04)	31	1.09E+00	24,07/01/81	(8.95E+04, 4.18E+04)
7	1.85E+00	24,01/02/81	(8.95E+04, 4.18E+04)	32	1.08E+00	24,25/11/80	(8.95E+04, 4.18E+04)
8	1.74E+00	24,23/11/80	(8.95E+04, 4.18E+04)	33	1.07E+00	24,04/01/81	(8.95E+04, 4.18E+04)
9	1.68E+00	24,17/11/80	(8.80E+04, 4.10E+04)	34	1.05E+00	24,09/11/80	(8.83E+04, 4.15E+04)
10	1.63E+00	24,30/06/80	(8.98E+04, 4.15E+04)	35	1.04E+00	24,02/01/81	(8.83E+04, 4.15E+04)
11	1.55E+00	24,31/01/81	(8.95E+04, 4.18E+04)	36	1.04E+00	24,25/03/80	(8.83E+04, 4.08E+04)
12	1.54E+00	24,18/01/81	(8.80E+04, 4.13E+04)	37	1.04E+00	24,19/08/80	(8.83E+04, 4.15E+04)
13	1.52E+00	24,13/03/81	(8.80E+04, 4.10E+04)	38	1.04E+00	24,14/01/81	(8.80E+04, 4.13E+04)
14	1.50E+00	24,29/06/80	(8.98E+04, 4.15E+04)	39	1.02E+00	24,03/10/80	(8.95E+04, 4.18E+04)
15	1.43E+00	24,14/09/80	(8.83E+04, 4.15E+04)	40	1.02E+00	24,11/01/81	(8.95E+04, 4.18E+04)
16	1.38E+00	24,09/05/80	(8.90E+04, 4.18E+04)	41	1.01E+00	24,12/07/80	(8.80E+04, 4.10E+04)
17	1.38E+00	24,09/12/80	(8.80E+04, 4.13E+04)	42	1.00E+00	24,09/10/80	(8.83E+04, 4.08E+04)
18	1.34E+00	24,30/12/80	(8.95E+04, 4.18E+04)	43	9.98E-01	24,10/09/80	(9.00E+04, 4.15E+04)
19	1.29E+00	24,10/05/80	(8.83E+04, 4.15E+04)	44	9.93E-01	24,08/04/80	(8.95E+04, 4.18E+04)
20	1.26E+00	24,21/01/81	(8.95E+04, 4.15E+04)	45	9.92E-01	24,04/11/80	(8.95E+04, 4.18E+04)
21	1.24E+00	24,06/02/81	(8.95E+04, 4.18E+04)	46	9.91E-01	24,17/06/80	(8.75E+04, 4.18E+04)
22	1.19E+00	24,06/12/80	(8.83E+04, 4.15E+04)	47	9.87E-01	24,16/05/80	(8.80E+04, 4.10E+04)
23	1.19E+00	24,12/01/81	(8.95E+04, 4.18E+04)	48	9.87E-01	24,13/01/81	(8.80E+04, 4.13E+04)
24	1.19E+00	24,08/01/81	(8.83E+04, 4.15E+04)	49	9.70E-01	24,02/12/80	(8.93E+04, 4.05E+04)
25	1.18E+00	24,17/03/81	(8.83E+04, 4.08E+04)	50	9.70E-01	24,28/10/80	(8.98E+04, 4.18E+04)

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PEAK VALUES FOR THE 50 WORST CASES (in micrograms/cubic metre)
AVERAGING TIME = 7 DAYS

RANK	VALUE	TIME RECORDED hour date	COORDINATES (* denotes polar)
1	7.20E-01	24,26/11/80	(8.95E+04, 4.18E+04)
2	6.94E-01	24,14/01/81	(8.83E+04, 4.15E+04)
3	6.84E-01	24,15/07/80	(8.83E+04, 4.15E+04)
4	6.33E-01	24,11/02/81	(8.95E+04, 4.18E+04)
5	6.17E-01	24,28/10/80	(8.83E+04, 4.08E+04)
6	6.06E-01	24,04/02/81	(8.95E+04, 4.18E+04)
7	5.92E-01	24,21/01/81	(8.80E+04, 4.13E+04)
8	5.47E-01	24,29/03/80	(8.83E+04, 4.15E+04)
9	5.45E-01	24,14/04/81	(8.95E+04, 4.18E+04)
10	5.45E-01	24,01/07/80	(8.98E+04, 4.15E+04)
11	5.17E-01	24,10/12/80	(8.83E+04, 4.15E+04)
12	5.09E-01	24,12/11/80	(8.83E+04, 4.15E+04)
13	4.66E-01	24,06/04/80	(8.83E+04, 4.08E+04)
14	4.56E-01	24,19/11/80	(8.80E+04, 4.13E+04)
15	4.27E-01	24,31/12/80	(8.83E+04, 4.15E+04)
16	4.07E-01	24,07/01/81	(8.83E+04, 4.15E+04)
17	3.97E-01	24,24/12/80	(8.90E+04, 4.18E+04)
18	3.83E-01	24,11/05/80	(8.78E+04, 4.23E+04)
19	3.70E-01	24,02/09/80	(8.98E+04, 4.15E+04)
20	3.60E-01	24,14/10/80	(8.83E+04, 4.15E+04)
21	3.43E-01	24,28/01/81	(8.90E+04, 4.18E+04)
22	3.41E-01	24,08/07/80	(9.05E+04, 4.18E+04)
23	3.40E-01	24,23/03/81	(8.80E+04, 4.13E+04)
24	3.35E-01	24,07/10/80	(8.90E+04, 4.18E+04)
25	3.34E-01	24,21/10/80	(8.83E+04, 4.15E+04)
26	3.33E-01	24,16/09/80	(8.83E+04, 4.15E+04)
27	3.27E-01	24,17/12/80	(8.98E+04, 4.15E+04)
28	3.06E-01	24,23/09/80	(9.00E+04, 4.15E+04)
29	3.04E-01	24,05/03/81	(8.93E+04, 4.18E+04)
30	2.94E-01	24,16/03/81	(8.83E+04, 4.15E+04)
31	2.91E-01	24,04/05/80	(8.95E+04, 4.18E+04)
32	2.90E-01	24,24/08/80	(8.83E+04, 4.15E+04)
33	2.65E-01	24,25/02/81	(8.95E+04, 4.18E+04)
34	2.62E-01	24,21/04/81	(8.85E+04, 4.03E+04)
35	2.62E-01	24,03/12/80	(8.93E+04, 4.05E+04)
36	2.50E-01	24,30/09/80	(8.83E+04, 4.15E+04)
37	2.43E-01	24,05/11/80	(8.98E+04, 4.18E+04)
38	2.28E-01	24,09/09/80	(8.98E+04, 4.15E+04)
39	2.26E-01	24,18/05/80	(8.80E+04, 4.25E+04)
40	2.22E-01	24,17/08/80	(8.98E+04, 4.15E+04)
41	2.00E-01	24,18/02/81	(8.95E+04, 4.18E+04)
42	1.91E-01	24,23/06/80	(9.03E+04, 4.20E+04)
43	1.76E-01	24,09/06/80	(8.83E+04, 4.15E+04)
44	1.76E-01	24,16/06/80	(8.90E+04, 4.05E+04)
45	1.70E-01	24,02/06/80	(9.05E+04, 4.08E+04)
46	1.51E-01	24,27/04/80	(8.80E+04, 4.30E+04)
47	1.46E-01	24,25/05/80	(8.98E+04, 4.15E+04)
48	1.34E-01	24,02/08/80	(9.05E+04, 4.18E+04)
49	1.30E-01	24,09/08/80	(9.05E+04, 4.18E+04)

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PEAK VALUES FOR THE 50 WORST CASES (in micrograms/cubic metre)
3-MONTH RUNNING AVERAGES

RANK	VALUE	TIME RECORDED hour date	COORDINATES (* denotes polar)
1	3.12E-01	24,30/11/80	(8.83E+04, 4.15E+04)
2	3.01E-01	24,30/02/80	(8.83E+04, 4.15E+04)
3	2.62E-01	24,30/10/80	(8.83E+04, 4.15E+04)
4	2.55E-01	24,30/03/80	(8.95E+04, 4.18E+04)
5	1.99E-01	24,30/09/80	(8.83E+04, 4.15E+04)
6	1.96E-01	24,30/04/80	(8.83E+04, 4.15E+04)
7	1.84E-01	24,30/08/80	(8.83E+04, 4.15E+04)
8	1.81E-01	24,30/06/80	(8.83E+04, 4.15E+04)
9	1.62E-01	24,30/07/80	(8.83E+04, 4.15E+04)
10	1.24E-01	24,30/05/80	(8.83E+04, 4.15E+04)

APPENDIX 4

NOISE IMPACT STATEMENT

Prepared By J.W. Cotterill
Boral Research

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Materials Laboratory

Boral Resources (NSW) Pty Ltd
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NOISE IMPACT STATEMENT FOR PROPOSED RE-DEVELOPMENT TO EXISTING BRICK MANUFACTURING FACILITY BRINGELLY N.S.W.

For: Boral Bricks (NSW) Pty. Ltd.
P.O. Box 21
Moorebank NSW 2170

Prepared by: J.W. Cotterill, B.E. M.A.A.S.
Noise Control Engineer
Boral Research

Report: 9015/NI

CONTENTS **PAGE**

1.0 INTRODUCTION

Boral Bricks (NSW) Pty. Limited, a subsidiary of Boral Limited, owns and operates a clay brick manufacturing facility at Bringelly, NSW.

It is the Company's intention to re-develop the existing facility and associated clay pit in order to increase the efficiency and production capability of the operation.

The existing operation is suffering from high production costs due to outdated manufacturing equipment, and is also under-utilising the reserves of clay and shale available at the site. For these reasons, and because of the expected increase in demand for clay products, especially pavers, the Company views this re-development as essential.

This Statement will form part of an Environmental Impact Statement to be submitted to the Camden Municipal Council, along with a Development Application for the site. The Statement will also be submitted to the State Pollution Control Commission, in order to obtain pollution control approval as the development constitutes a change to a scheduled premises.

The Noise Impact Statement 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 State Pollution Control Commission - Environmental Noise Control Manual and the Noise Control Act, 1975, N.S.W.

2.0 PROJECT DESCRIPTION

2.1 Current Clay/Shale Extraction

Clays and shales are selectively mined from the clay pit using 1 x 15 tonne self elevating scraper and 1 dozer. This material is stockpiled in various pre-determined blends.

Excavation and stockpiling are carried out by contractors and occur 3-4 times per year for a period of approximately 3 weeks at a time. The extraction rate is around 61,000 tonnes per annum from the existing pit.

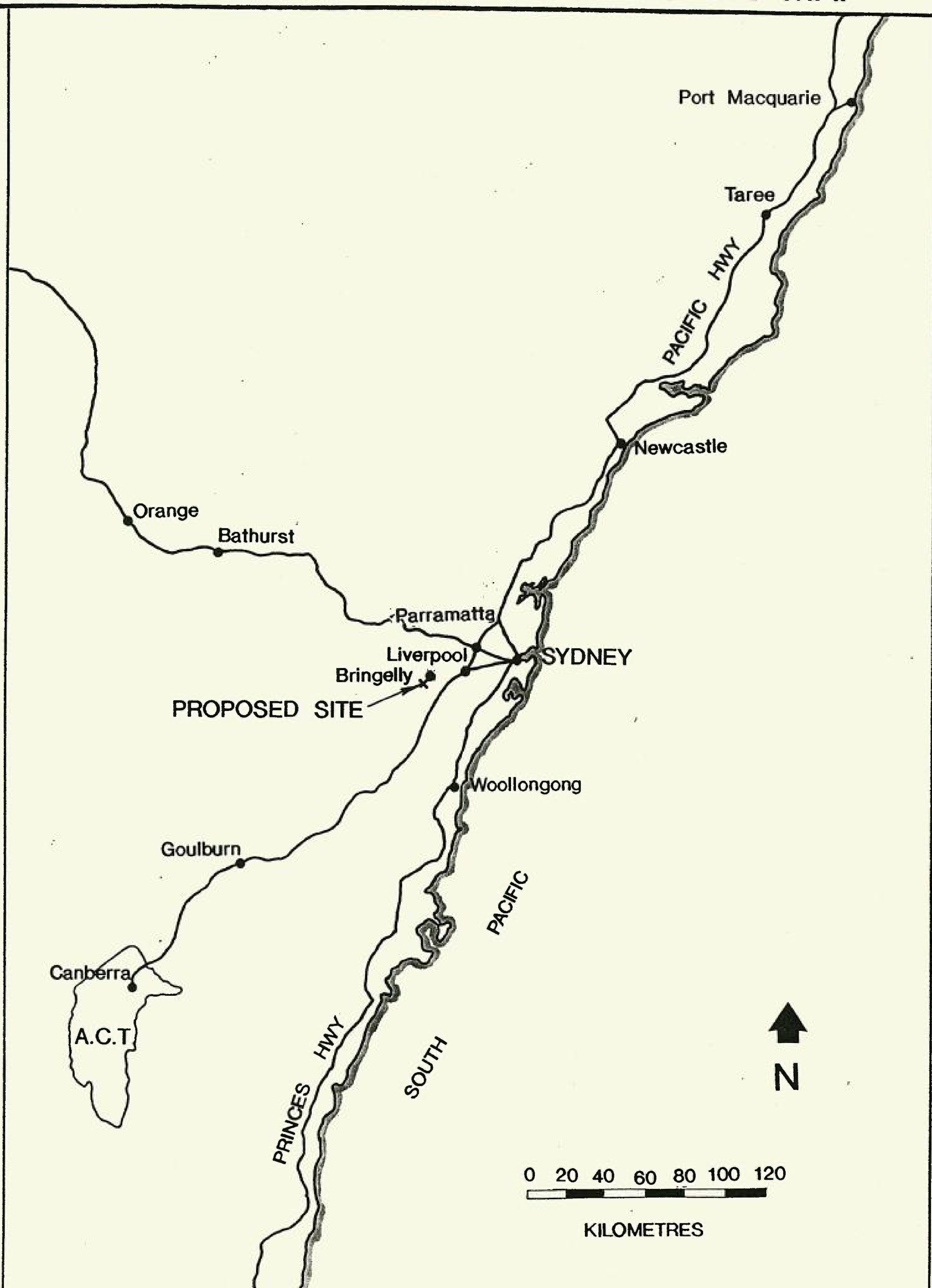
Clay and shale from two other sites, Erskine Park quarry and Boral Prospect quarry, are stockpiled at Bringelly and used in conjunction with the local material in normal production.

2.2 Current Manufacturing Process

Raw material is transported from the stockpiling area by front-end loader to the processing plant. Here the clay/shale blend is reduced by primary and secondary crushing and screened to produce a dry grind. This material is stockpiled under cover in partitioned bunkers, to keep the various blends separate.

The dry grind is subsequently loaded by front-end loader into a pugmixer where water is added. The mix is then conveyed through a vacuum chamber, extruded and cut to size.

REGIONAL MAP



The cut pieces, now brick or paver shaped, are conveyed to the kilns where they undergo a drying and firing process which is approximately 57 hours duration.

The existing plant was commissioned in 1968 and the equipment used is approaching the stage of being obsolete and uneconomic to repair.

2.3 Proposed Clay/Shale Extraction

The existing clay pit occupies an area of 3-5 hectares. It is proposed to extend the pit by approximately 12.5 hectares in a southerly and westerly direction, which will provide additional reserves of 4.8 million tonnes.

In order to supply the proposed manufacturing operation, the extraction rate from the pit will increase to approximately 200,000 tonnes per annum. This increase will require the use of 3 x 15 tonne self-elevating scrapers, 1 dozer and a grader in the extraction process.

Extraction will be conducted by contractors over a 3 month period, 2 times per year. Accordingly, larger stockpiles will be required for the operation.

2.4 Proposed Manufacturing Process

From pre-blended stockpiles the raw material (a mixture of clays and shales) is removed and transported by rubber tyred front-end loader to a primary crusher where the material is reduced to lump size of approx. 100mm diameter and conveyed by rubber belt conveyor directly to the grinding room.

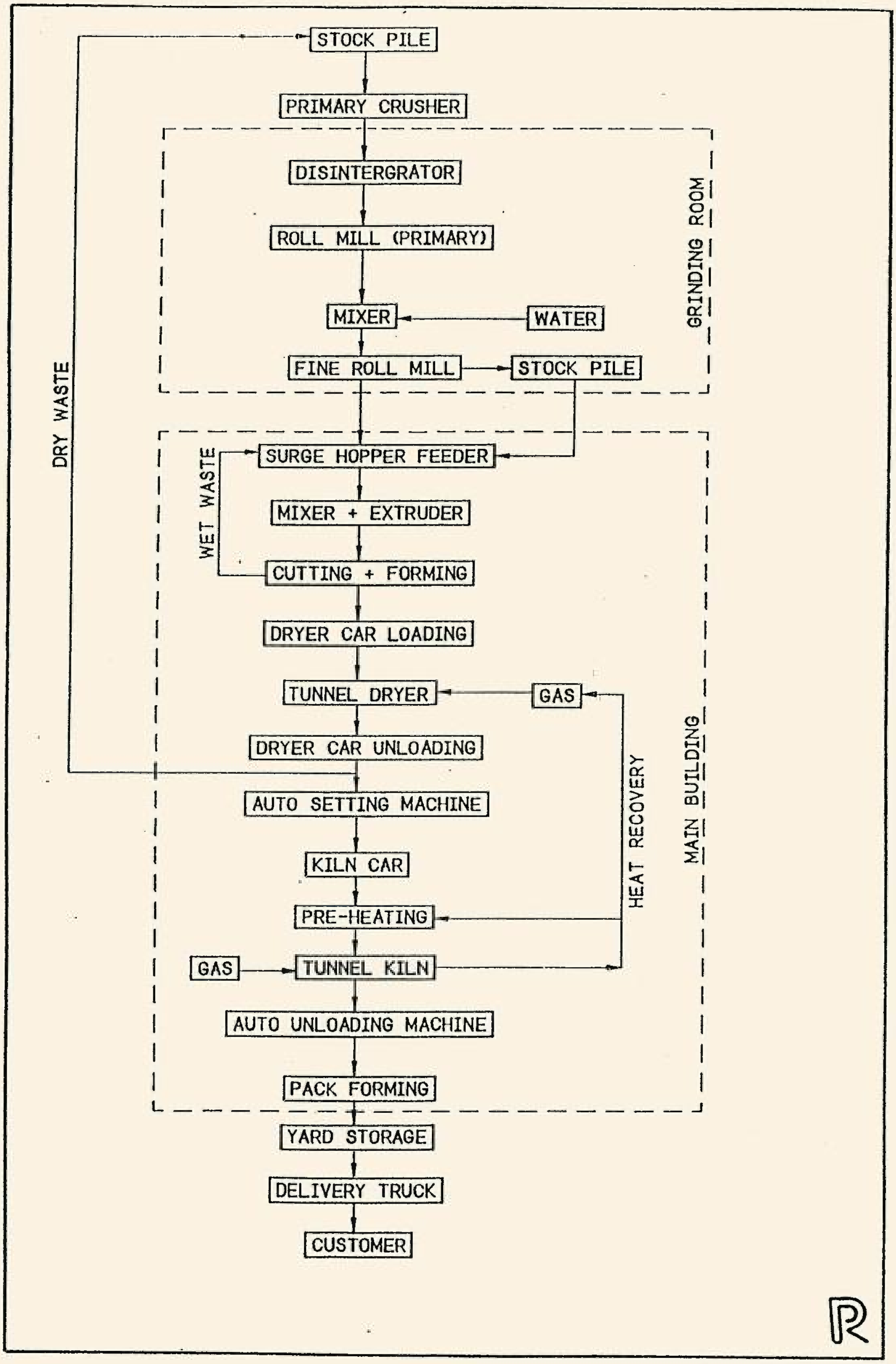
Within the grinding room the material is reduced to a very stiff fine grained paste by passing through roll mills and a mixer. At this point the material can be stored within the building or continue to a surge hopper/feeder in the main building. The material that is stored can be sent to the surge feeder at a later stage by loading it into a feeder with a front-end loader.

From the surge feeder the material is conveyed to a second mixer where the final water is added and then to the extruder cutter and press where the brick or paver is formed. The newly formed brick or paver is loaded into dryer cars and passed through one of two tunnel dryers. After the dryer, the dry product is removed from the dryer car and placed on to kiln cars automatically.

The kiln cars travel on rail tracks through a pre-heater to remove the final few percent of water and then pass through the tunnel kiln. While the process of "firing" takes place within the tunnel kiln on a continuous basis, the total time spent within the tunnel is 2 days, during which time the temperature of the product is increased to 1050-1100 degree Celsius and cooled to room temperature. Air required to cool the product is used to preheat the incoming product and is also ducted to the dryers. As the process of firing and drying is continuous (24hrs/day 7 days a week), the recuperation of heat results in a very efficient process. Products of combustion pass through a dry limestone absorption scrubber prior to the stack.

The fired product is transported on the kiln car to an unloading machine, where the finished product is automatically lifted from the kiln car and formed into packs suitable for delivery to the customer's site.

2.5 Flow Diagram



3.0 SITE DETAILS

The Boral Brick site is located off Greendale Road at Bringelly which is approximately 12 kilometres southwest of Liverpool. The land owned by Boral totals 385 hectares, of which only a small proportion is used for extraction and manufacturing processes associated with brick making. The remainder of the land is used mainly for grazing purposes.

The property details for the proposed clay pit extension and manufacturing plant relocation are :-

Lot 2 DP733115
Parish of Cook
County of Cumberland
Municipality of Camden
Zoning 1(A) General Rural

Surrounding the brick plant there are several residences. The setting is semi-rural with most of the land holdings being of hobby farm size. Approximately 700 metres to the east of the site is the township of Bringelly, which consists of a small shopping centre and school.

The surrounding residences are shown on the Location Map on page 13.

4.0 HOURS OF OPERATION

The existing and proposed hours of operation are as follows:-

4.1 Existing

Quarry: 0600 hrs to 1430 hrs Monday to Friday
Material Preparation: 1500 hrs to 2300 hrs Monday to Friday
(crushing)
Production: 0600 hrs to 1430 hrs Monday to Friday

4.2 Proposed

Quarry: 0600 hrs to 1800 hrs Monday to Saturday (during extraction only)
Material Preparation: 0600 hrs to 1800 hrs Monday to Sunday
Production: 0600 hrs to 1800 hrs Monday to Sunday

The firing operation in both the existing and proposed development is continuous, which means that the kilns run 24 hours per day.

It may be necessary in an emergency situation to extend the material preparation from 0600 hrs to 2400 hrs.

5.0 TRANSPORTATION

All vehicles access the site from Greendale Road. Finished product deliveries from the site use Greendale Road and either turn left onto the Northern Road (north towards Penrith), right onto Northern Road (south towards Narellan) or proceed over Northern Road onto Bringelly Road (east towards Liverpool). The figures indicate an equal split of delivery vehicles heading in each of the three directions.

Raw material leaves the Bringelly plant and is transported to Moorebank and Prospect brick plants.

Raw material enters the site from Erskine Park and Prospect quarry.

The current traffic generation, as well as that predicted after the re-development, is as follows:-

5.1 Existing Traffic Generation

Description	Average trips per day (Despatch and return)
Employees' cars	66
Visitors' cars	10
Product deliveries	20
Raw material departures	10
Raw material arrivals	10
	--
Total	116

5.2 Proposed Traffic Generation

Description	Average trips per day (Despatch and return)
Employees' cars	56
Visitors' cars	10
Product deliveries	66
Raw material departures	10
Raw material arrivals	12
	--
Total	154

5.3 Traffic Noise Impact

The effect of the noise due to increased traffic movement was considered along Greendale Road. Measurements were taken along Greendale Road and around the intersection with Northern Road of trucks accelerating, decelerating and under drive pass conditions. The worst case was deemed to occur at Bringelly Public School. The sound exposure level of several trucks and cars were taken and typical values are given below:-

Vehicle Type	Description	Sound Exposure Level dB(A)
Brick Truck	Drive past @ 6 metres	80
Brick Truck	Braking downhill, turning left into Greendale Rd from Northern Rd @ 60 metres	71
Brick Truck	Accelerating from stop sign at Greendale, Northern Rd intersection @ 40 metres	70
Car	Drive past @ 6 metres	74

* It must be noted that the brick trucks, under normal circumstances, do not use their exhaust brakes when entering or leaving Greendale Rd.

The worst affected part of the school is the southern most building located approximately 6 metres from the edge of the carriage-way on Greendale Road.

Calculations were made as to the current and predicted noise levels at the school from traffic on Greendale Road using Annual Average Daily Traffic (AADT) data obtained from the Roads and Traffic Authority. The current AADT level for Greendale of 1396 vehicles with 10% heavy vehicles was assumed.

As the traffic flow is relatively low, the equivalent continuous sound level (L_{AEQ}) was used as the descriptor. This descriptor is preferred by the State Pollution Control Commission in the Environmental Noise Control Manual - Section 157 for such situations.

Using the measured sound exposure level data, the L_{AEQ} was calculated for a period of 7 hours from 9.00am to 4.00pm. This was considered to be the time period within which the school room would be predominantly occupied. It was assumed that 70% of the AADT flow would occur between these hours. This flow is considered to be a maximum worst case and would not be encountered normally.

Assuming 80% of the proposed brick plant's heavy traffic generation occurs between 6.00am and 12.00 noon, the increase in heavy vehicle movements, between 9.00am and 4.00pm would be 29 movements.

The results of the survey are as follows:-

Road Traffic Noise - Greendale Road - School

	Traffic Flow (9.00am-4.00pm) 70% AADT	% Heavy Vehicles	L_{AEQ} Predicted dB(A)
Current situation	977	10%	61
After proposed re-development	1006	13%	61.5

The State Pollution Control Commission set a goal for existing situations of 60dB(A). At Bringelly School for the worst case scenario considered, the goal is exceeded in the current situation and will be marginally increased after the proposed re-development. The increase in the L_{AEQ} of 0.5dB(A) is quite small and would be difficult to measure in practice.

Noise levels from Northern Road would exceed the above figures significantly at various positions within the school, due to existing traffic conditions and would not be altered by the increase in flow from the upgrading at the brick plant.

Noise from trucks entering and leaving the existing brick plant site were measured at Residence B. Residence B is approximately 21 metres from Greendale Road. The results were as follows:-

Vehicle Type	Description	Sound Exposure Level [dB(A)]
Brick Truck	Entering site @ 21 metres	69
Brick Truck	Leaving site @ 21 metres	72
Car	Driving past @ 21 metres	64

Considering the worst case scenario for the upgraded plant, the calculated L_{EQ} for Residence B between 6.00am - 12.00am, the period of greatest traffic impact, was 53dB(A). This is well below the State Pollution Control Commission goal of 60dB(A) for existing situations.

6.0 NOISE CONTROL MEASURES

The equipment involved in materials preparation and brick manufacturing (except for the primary) is housed within 2 buildings which significantly attenuate the noise levels emitted. The buildings are steel frame and clad with Colourbond (or similar) steel sheet on the roof and walls. The typical transmission loss characteristics of a building facade are as follows:-

Octave	Hz	63	125	250	500	1K	2K	4K	8K
Transmission Loss (dB)		9	14	21	27	32	37	43	42

All mobile equipment external to the building shall be fitted with standard silencers appropriate for the equipment. The silencers shall be kept in good order to ensure minimal noise disturbance.

To attenuate noise from the primary crusher and mobile equipment used in both the manufacturing and quarrying operations, a bund wall will be constructed adjacent to the plant and stockpile areas. The bund will be an earth wall up to 6 metres in height. The wall will be seeded and treed where possible to act as both an acoustic and visual screen. The location and extent of the bund wall is shown on the Site Plan on page 12.

7.0 DISCUSSION OF NOISE SURVEY RESULTS

The instrumentation used, procedures followed and noise levels recorded are contained within Appendix A "Noise Monitoring Survey for Proposed Re-development of Brick Manufacturing Facility - Bringelly, NSW".

7.1 Background Noise Levels

Background noise levels were monitored between the 29th and 31st September 1990, at five separate locations. A summary of the results is given below:-

Location - Residence A - Lot 5 Loftus Rd - 415 metres east of proposed plant

Major Noise Sources - Traffic on Northern Road

- Existing brick plant operating [42dB(A)]
- Domestic animals

Background Noise Levels - L_{90} - 40 to 48dB(A) - Average 43.5dB(A)

Note - Traffic on Northern Road had a significant influence on the levels recorded at this location.

Location - Residence B - 23 Greendale Road - 450 metres north of Proposed Plant

Major Noise Sources - Traffic on Greendale Road

- Aircraft
- Birds
- Existing brick plant (barely audible)

Background Noise Levels - L_{90} - 39 to 42dB(A) - Average 40.4dB(A)

Location - Residence C - Company owned house - 398 metres southeast of Proposed Plant

Major Noise Sources - Existing brick plant
- Wind in trees
- Distant traffic

Background Noise Level - L_{90} - 43dB(A)

Location - Residence D - Newstead Farm (Company owned) - 1320 metres southwest of Proposed Plant Site

Major Noise Sources - Birds
- Wind in trees
- Distant traffic
- Existing brick plant (just audible at times)

Background Noise Level - L_{90} - 33dB(A)

Location - Opposite gate to Kenamoor (residence) - 2250 metres northwest of Proposed Plant

Major Noise Sources - Traffic on Greendale Road
- Birds
- Some domestic noise
- Aircraft

Background Noise Level - L_{90} - 39dB(A)

For all background noise monitoring locations, refer to the location map on page 13.

7.2 Discussion of Noise Survey Results

Similar equipment to that to be used in the re-development was measured at Boral Bricks - Badgerys Creek plant and Bringelly plant on the 29th and 31st August 1990. The sound power levels of the major noise sources are given below:-

Equipment	Sound Power Level dB(A)
Kiln and Dryer	
Hot air preheat fan	97
Rapid cooling fan	106
Wet air fan	97
Combustion air fan	110
Side injection fan (x 2)	105 (total)
Recirculation fan (x 2)	93 (total)
Main stack fan	100
Exhaust fan (x 2)	93 (total)
Recirculation fan (x 40)	100 (total)
Material preparation and manufacturing	
Primary crusher	100 (external)
Disintegrator	100
Primary high speed rolls	106
Secondary high speed rolls	107
Extruder and cutters	111
Rack handling system	104
Front-end loader (CAT.980 or similar)	107 (external)
Front-end loader (CAT.980 or similar)	107 (internal)
Forklift - gas powered (x 3)	105 (each)
Trucks	102 (each)
Clay/Shale Extraction	
Scraper - 15 tonne self-elevating (x 3)	114 (each)
Dozer - CAT. D8K (or similar)	111
Grader - CAT.120G (or similar)	105

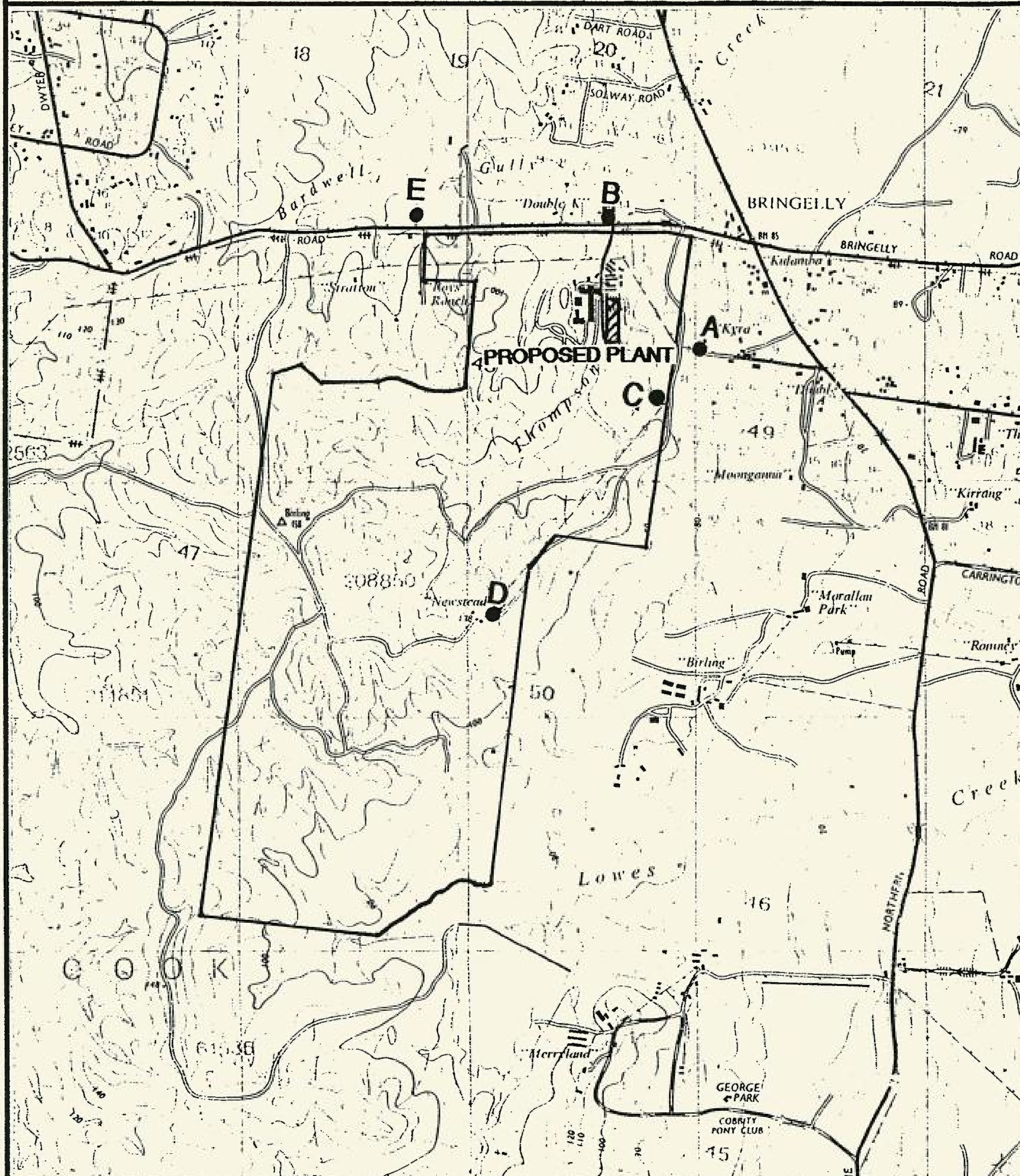
8.0 ASSESSMENT OF NOISE IMPACT

8.1 Noise Modelling

A computer model was used to predict noise levels surrounding the proposed brick manufacturing operation. The Environmental Noise Model (E.N.M.) used was produced in conjunction with the State Pollution Control Commission and makes allowances for ground type, barriers and atmospheric conditions. The effects of temperature inversion and wind strength and direction, can be introduced into the model.

For the Bringelly project, a ground contour map was digitised into the computer. This map included all topographic information as well as ground type and the location of buildings and other man-made structures (ie. bund walls, dams, roads). A plot of the digitised map is given on page 20.

LOCATION MAP



N ↑

NOISE SURVEY LOCATIONS A – E
SCALE 1: 25,000

8.2 Noise Source Locations

As part of the modelling process, each major noise source was located on the digitised map. The special locations are as follows:-

Noise Source	Location
Kiln and dryers (combination of all fans)	- Manufacturing building (No. 1)
Manufacturing equipment	- Manufacturing building (No. 1)
Material preparation equipment (excluding primary crusher)	- Material preparation building (No. 2)
Primary Crusher	- Southeast of material preparation building adjacent to raw material stockpiles
Front-end Loader No. 1	- Adjacent primary crusher
Front-end Loader No. 2	- Material preparation building (No. 2)
Scraper No. 1	- Unloading on stockpile
Scraper No. 2	- On haul road
Scraper No. 3	- Loading on pit floor
Dozer	- Ripping in pit
Grader	- Levelling stockpiles
Forklifts (3 operating at once)	- Fired ware storage area

8.3 Noise Prediction Method

With all noise sources located and topographical features defined, E.N.M. calculates the contribution of each source at specified points. Individual calculations were carried out for the closest residence to the east (excluding the Company residence) denoted Residence A and the closest to the north denoted Residence B. These residences were chosen as they would be the most noise effected.

A summary of the results, given below, show the noise contribution of each source ranked in descending order. For the equipment contained within buildings, the building itself becomes the noise source as sound is radiated through its walls, roof and openings. Therefore, the results show contributions from the building partitions and not the individual equipment.

The results have been split into the noise produced from the normal manufacturing process and to that from clay/shale extraction as the extraction process is not continuous throughout the year.

PREDICTED NOISE LEVELS – RESIDENCE A – BRICK MANUFACTURING
PROGRAM ENM SOURCE RANKING
SINGLE POINT CALCULATION

SOURCE TITLE	dB(A)
16 BORAL BRICK - BRINGELLY - FRONT END LOADER - 980	33.8
17 BORAL BRICK - BRINGELLY - FORKLIFT NO.2	29.7
21 BORAL BRICK - BRINGELLY - FORKLIFT NO.3	29.7
8 BORAL BRICK - BRINGELLY - FORKLIFT NO.1	29.7
9 BORAL BRICK - BRINGELLY - PRIMARY CRUSHER	27.5
205 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING ROOF	24.3
110 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST ROOF2	21.9
109 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST ROOF1	20.8
201 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING EAST WALL	20.1
111 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING WEST ROOF	18.4
202 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING SOUTH WALL	17.8
204 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING NORTH WALL	16.9
101 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL1	14.4
103 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL2	14.3
104 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING SOUTH WALL	11.9
107 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL3	5.5
203 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING WEST WALL	4.7
105 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING WEST WALL	3.9
102 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL1	-1.2
106 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL2	-3.9
108 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL3	-4.4
TOTAL	38.2

PREDICTED NOISE LEVELS – RESIDENCE A – CLAY / SHALE EXTRACTION
PROGRAM ENM SOURCE RANKING
SINGLE POINT CALCULATION

SOURCE TITLE	dB(A)
1 BORAL BRICK - BRINGELLY - SCRAPER NO.1	39.0
5 BORAL BRICK - BRINGELLY - GRADER	29.2
3 BORAL BRICK - BRINGELLY - SCRAPER NO.3	27.8
2 BORAL BRICK - BRINGELLY - SCRAPER NO.2	24.4
4 BORAL BRICK - BRINGELLY - DOZER	23.6
TOTAL	40.0

TOTAL COMBINED NOISE LEVEL – MANUFACTURING + EXTRACTION – 42.2 dB(A)

PREDICTED NOISE LEVELS – RESIDENCE B – BRICK MANUFACTURING
PROGRAM ENM SOURCE RANKING
SINGLE POINT CALCULATION

SOURCE	TITLE	dB(A)
8	BORAL BRICK - BRINGELLY - FORKLIFT NO.1	31.0
17	BORAL BRICK - BRINGELLY - FORKLIFT NO.2	31.0
21	BORAL BRICK - BRINGELLY - FORKLIFT NO.3	31.0
16	BORAL BRICK - BRINGELLY - FRONT END LOADER - 980	23.7
111	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING WEST ROOF	21.0
109	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST ROOF1	18.9
110	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST ROOF2	17.5
205	BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING ROOF	17.1
9	BORAL BRICK - BRINGELLY - PRIMARY CRUSHER	16.3
101	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL1	14.1
106	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL2	11.1
105	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING WEST WALL	10.6
203	BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING WEST WALL	8.9
201	BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING EAST WALL	8.9
107	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL3	8.4
108	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL3	7.8
102	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL1	6.2
103	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL2	5.9
204	BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING NORTH WALL	5.8
202	BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING SOUTH WALL	-1.4
104	BORAL BRICK - BRINGELLY - MANUFACT. BUILDING SOUTH WALL	-2.1
TOTAL		**36.5**

PREDICTED NOISE LEVELS – RESIDENCE B – CLAY / SHALE EXTRACTION
PROGRAM ENM SOURCE RANKING
SINGLE POINT CALCULATION

SOURCE	TITLE	dB(A)
1	BORAL BRICK - BRINGELLY - SCRAPER NO.1	32.9
3	BORAL BRICK - BRINGELLY - SCRAPER NO.3	31.1
2	BORAL BRICK - BRINGELLY - SCRAPER NO.2	30.4
4	BORAL BRICK - BRINGELLY - DOZER	30.0
5	BORAL BRICK - BRINGELLY - GRADER	24.2
TOTAL		**37.5**

TOTAL COMBINED NOISE LEVEL – MANUFACTURING + EXTRACTION – 40.0 dB(A)

8.4 Noise Impact Assessment

The impact the noise from the development will have on the surrounding residences can be assessed with reference to the State Pollution Control Commission - Noise Control Manual - Sections 20 and 21. These sections enable the determination of Recommended Planning Levels and Outdoor Background Noise Levels for the area. Extracts from these sections are 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 10dB(A) or more below acceptable level • at least, set maximum planning level 10dB(A) below existing background level
B. Background is at acceptable level	• set maximum planning level 10dB(A) below acceptable level
C. Background is below acceptable level by - 1dB(A) - 2dB(A) - 3dB(A) - 4dB(A) - 5dB(A) - 6dB(A) or more	• set maximum planning level - 9dB(A) below acceptable level 5dB(A) below acceptable level 3dB(A) below acceptable level 2dB(A) below acceptable level 2dB(A) below acceptable level 5dB(A) above background level

RECOMMENDED OUTDOOR BACKGROUND NOISE LEVEL
(For use with chapters 19 and 20)

ROW	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 (R1-AS1055)	Residential, church, hospital, school	Day Night	45 35	50 40

In order to determine the recommended planning limit at Residence A, the situation is not as straight forward as usual because the current background includes a contribution from the existing brickmaking facility. This contribution was measured at 42dB(A) during one of the background surveys. The purpose of the planning limit is to avoid the situation of background creep, where the background is raised by each successive development.

In this situation the noise contribution made by the existing plant will be removed and the new plant introduced. To avoid background creep, the planning limit should be calculated as follows:-
At Residence A

43.5dB(A) (current average background)	- 42dB(A) (existing brick plant)	= 41.3dB(A) (background without brick plant contribution)

Using the background without the existing brick plant contribution with table 20-1 gives:-

Recommended Planning Limit - 43dB(A)

It should be noted that the predicted noise level for the total operation of the proposed re-development is 42.2dB(A), which is consistent with the existing noise level of 42dB(A).

To determine the planning limit at night, the minimum background of 30dB(A) was assumed for the area. The State Pollution Control Commission recommends this minimum and suggests that where background levels fall below 30dB(A), that 30dB(A) be assumed to be the existing background level. The night time planning limit therefore becomes 35dB(A) which is 5 dB(A) above the background.

The table below gives the recommended planning limits and predicted noise levels for Residences A and B.

Residence	Average Background L_{90}-dB(A)	Acceptable Background L_{90}-dB(A) Day	Acceptable Background L_{90}-dB(A) Night	Recommended Planning Limit L_{10}-dB(A) Day	Recommended Planning Limit L_{10}-dB(A) Night	Predicted Noise Level Proposed Re-development L_{10}-dB(A)
A	43.5	45	35	43 (see above)	35	42 - Total operation 38 - manufacturing and kilns 25 - kilns only 35 - manufacturing and kilns without primary crusher and loader

Residence	Average Background L_{90}-dB(A)	Acceptable Background L_{90}-dB(A) Day	Night	Recommended Planning Limit L_{10}-dB(A) Day	Night	Predicted Noise Level Proposed Re-development L_{10}-dB(A)
B	40.4	45	35	43	35	40 - Total operation 37 - Manufacturing and kilns 25 - kilns only 35 - manufacturing and kilns without primary crusher and loader

It can be seen from the table that the operation will meet the Planning Limit at both residences A and B. The kilns will be suitable for operation on a continuous basis, and it is also a possibility that the manufacturing process (including materials preparation) can be worked at night (if the primary crusher and front-end loader are not used) without disturbance to any neighbours.

The noise level at the school from the re-development will be 35dB(A).

The need may arise to strip some upper sections of the pit area at about RL86m. This will be done on a short term basis with the dozer and using the existing hill for screening where possible. This procedure will raise the contribution of the dozer to 38dB(A) at Residence B and 33dB(A) at Residence A. The total noise from the operation will still fall below the relevant planning limit at each residence.

To enable the noise level to be determined at a number of residences surrounding the quarry, a Noise Contour Map has been produced and is given on page 20. The noise contour map represents the worst case scenario with all equipment operating.

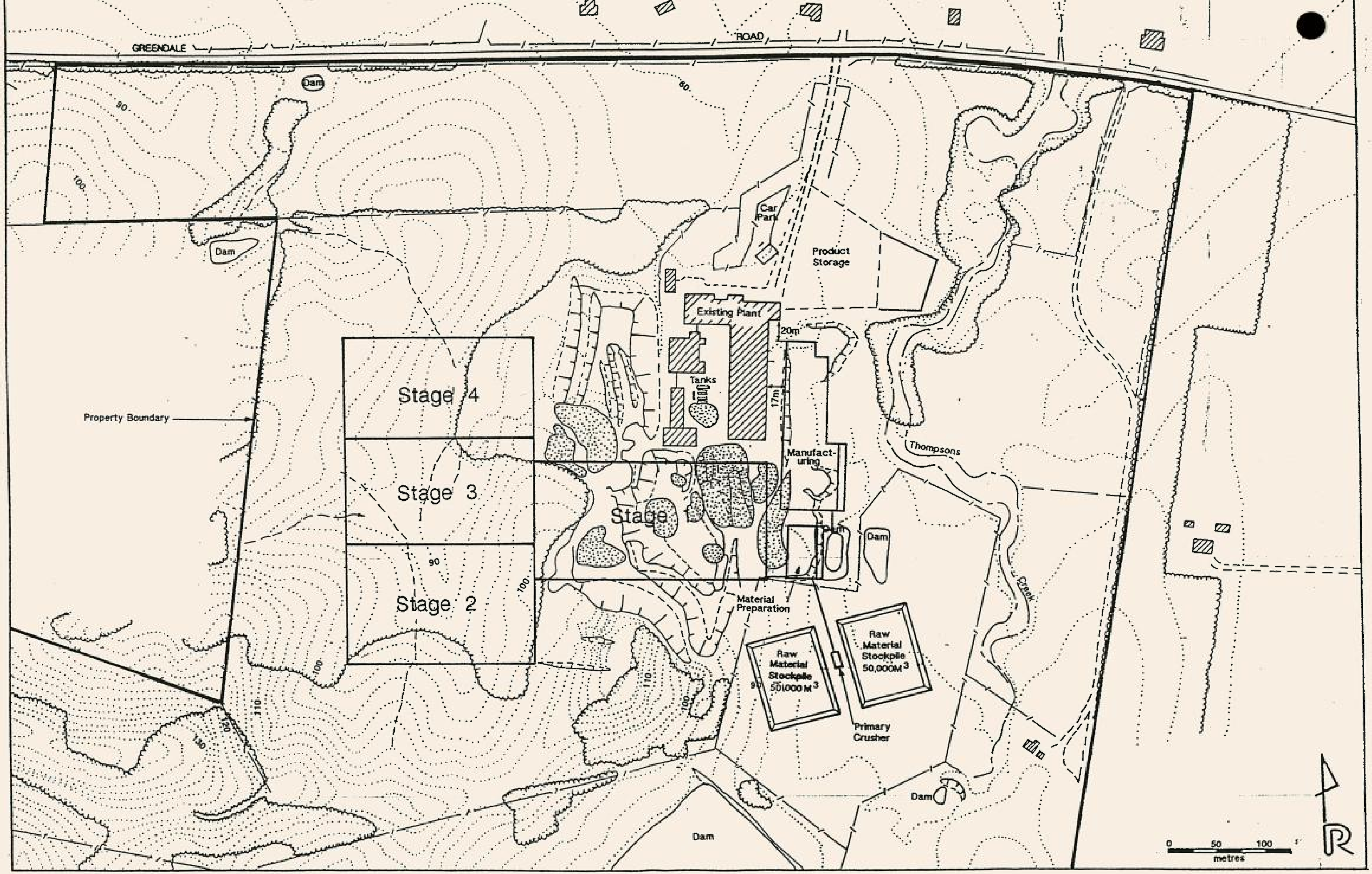
9.0 CONCLUSION

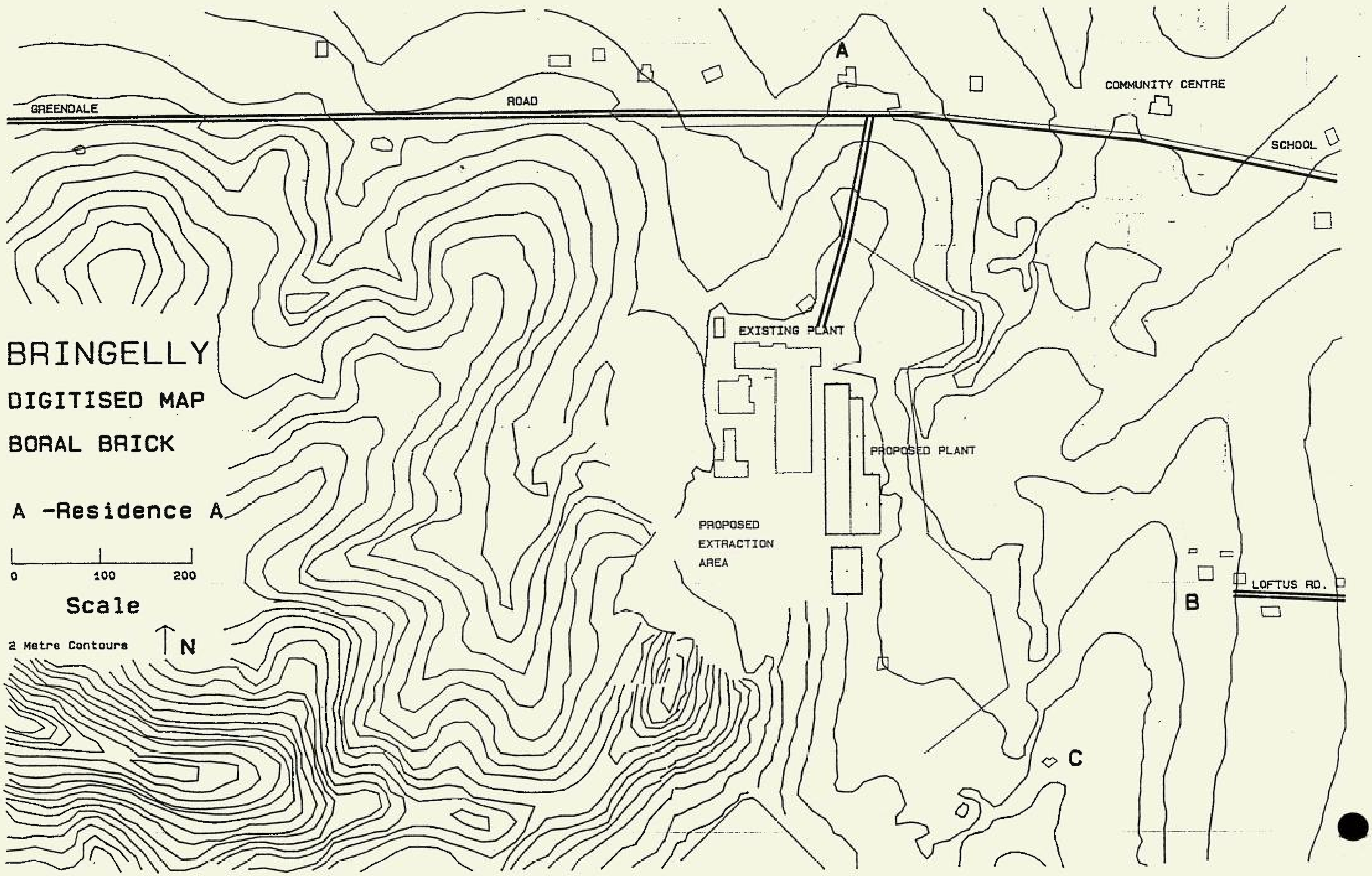
The re-development of the Bringelly Brick Manufacturing Facility by the installation of more modern and efficient plant and equipment will not alter the noise levels experienced by the surrounding neighbours. The predicted noise levels from the operation will meet the State Pollution Control Commission planning limits for such an operation.

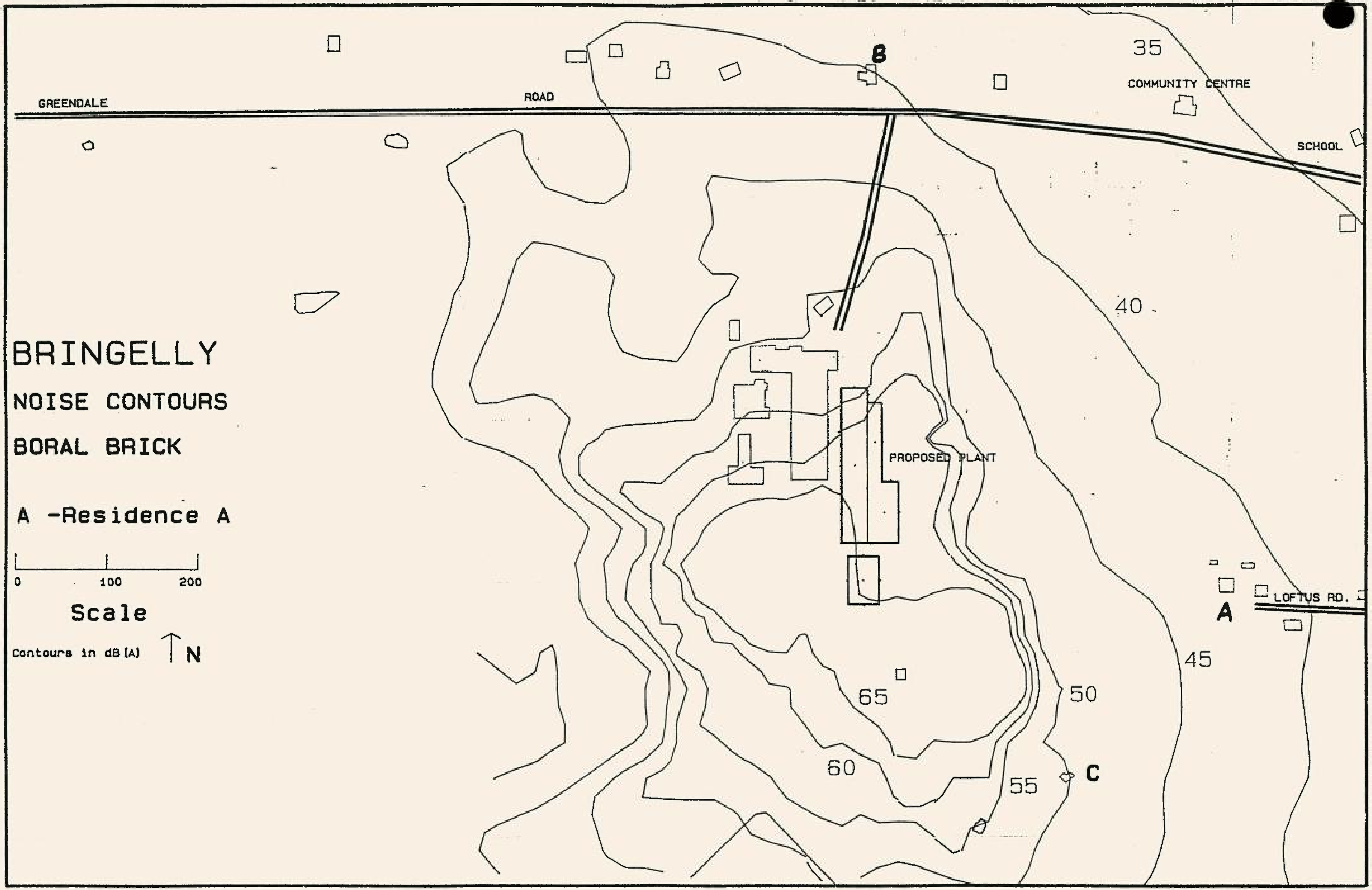
The noise produced by transportation will increase marginally due to the upgraded operation.

JOHN COTTERILL
NOISE CONTROL ENGINEER
29 November 1990
Ref. JWC.008

SITE PLAN


GREENDALE
ROAD
80
90
100
110
120
130
Dam
Property Boundary
Car Park
Product Storage
Existing Plant
20m
17m
Tanks
Manufact-uring
Stage 4
Stage 3
Stage 2
Stage 1
Thompsons
Creek
Material Preparation
Raw Material Stockpile 50,000 M 3
Raw Material Stockpile 50,000M 3
Primary Crusher
0
50
100
metres


BRINGELLY
DIGITISED MAP
BORAL BRICK
A -Residence A
0
100
200
Scale
2 Metre Contours
N
GREENDALE
ROAD
A
COMMUNITY CENTRE
SCHOOL
EXISTING PLANT
PROPOSED PLANT
PROPOSED
EXTRACTION
AREA
LOFTUS RD.
B
C


BRINGELLY
NOISE CONTOURS
BORAL BRICK
A -Residence A
0
100
200
Scale
Contours in dB (A)
N
GREENDALE
ROAD
B
35
COMMUNITY CENTRE
SCHOOL
40
PROPOSED PLANT
LOFTUS RD.
A
45
50
65
60
55
C

APPENDIX A

PROJECT: NOISE MONITORING SURVEY FOR PROPOSED BRICK MANUFACTURING FACILITY, BRINGELLY, NSW

CLIENT: Boral Bricks NSW Pty. Ltd.

PROJECT: 9015/NI

1. INSTRUMENTATION

Instrument	Model	Serial No.
Bruel & Kjaer Modular Precision Sound Level Meter	2231	1277056
Bruel & Kjaer Statistical Analysis Module	BZ7101	
Bruel & Kjaer Microphone	4165	1287896
Bruel & Kjaer Filter Set	1625	1284540
Bruel & Kjaer Calibrator	4230	1275360
Bruel & 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 State Pollution Control Commission - Environmental Noise Control Manual and the Noise Control Act, 1975.

3. BACKGROUND NOISE LEVEL

Background noise levels were monitored on the 29th, 30th and 31st August 1990, at five locations around the Bringelly site.

Recordings were made using the sound level meter and statistical analysis module with the microphone height at 1.4 metres above the ground.

The results of the background surveys are as follows:-

BACKGROUND NOISE SURVEY

Survey No./Date	Statistical Analyser Time ON OFF	Weather Conditions	Noise Sources	Background Noise Levels dB(A)
Location - Residence A, Lot 5 Loftus Street				
Survey 1 29.8.90	13.20hrs 13.40hrs	Temperature- 15°C Dry - 11°C wet Relative Humidity -61% Atmospheric Pressure 1016mbar Cloud - 100% high Wind - Still	* Traffic on Northern Rd * Dogs barking * Brick plant operating but barely audible * Aircraft	L_{90} - 42 (L_{10} - 48)
Survey 2 29.8.90	13.55hrs 14.15hrs	As above	As above * Trail bike	L_{90} - 43 (L_{10} - 51)
Survey 3 29.8.90	14.20hrs 14.40hrs	As above	As above	L_{90} - 42 (L_{10} - 49)
Survey 4 29.8.90	14.45hrs 15.05hrs	As above	As above	L_{90} - 41 (L_{10} - 53)
Survey 5 30.8.90	06.20hrs 06.40hrs	Temperature- 10°C Dry - 9°C Wet Relative Humidity - 88% Atmospheric Pressure 1020mbar Cloud - 70% high-medium Wind - Still	* Birds * Traffic on Northern Rd (increasing during survey) * Brick plant operating	L_{90} - 48 (L_{10} - 56)
Survey 6 30.8.90	06.50hrs 07.10hrs	As above	As above * Traffic increasing further	L_{90} - 48 (L_{10} - 55)
Survey 7 30.8.90	07.15hrs 07.35hrs	As above	As above * Traffic decreasing	L_{90} - 44 (L_{10} - 54)
Survey 8 30.8.90	15.38hrs 15.58hrs	Temperature - 22°C Dry - 15°C Wet Relative Humidity - 47% Atmospheric Pressure 1013mbar Cloud - 70% medium Wind - 2-4 knots NW	* Traffic on Northern Rd * Brick plant operating	L_{90} - 40 (L_{10} - 52)

Survey No. Date	Statistical Analyser Time ON (hrs)	OFF (hrs)	Weather Conditions	Noise Sources	Background Noise Levels dB(A)
Location - Residence B - 23 Greendale Rd					
Survey 9 30.8.90	09.30	09.50	Temperature - 14°C Dry - 12°C Wet Relative Humidity 79% Atmos. Pressure 1018mbar Cloud - 40% high Wind - still	* Aircraft * Traffic on Greendale Rd * Brick plant operating just audible	L_{90} - 40 (L_{10} - 55)
Survey 10 30.8.90	10.10	10.30	As above	As above * Bobcat working behind property	L_{90} - 42 (L_{10} - 50)
Survey 11 30.8.90	13.20	13.40	Temperature - 24°C Dry - 16°C Wet Relative Humidity 43% Atmos. Pressure 1013mbar Cloud - 40% high Wind - 0-2 knots NW	*Traffic on Greendale Rd *Brick plant operating	L_{90} - 39 (L_{10} - 54)
Survey 12 30.8.90	13.45	14.05	As above	As above	L_{90} - 40 (L_{10} - 52)
Survey 13 30.8.90	14.10	14.30	As above Cloud increasing 60% medium Wind increasing 0-6 knots NW	As above	L_{90} - 40 (L_{10} - 52)
Survey 14 30.8.90	16.05	16.25	Temperature - 22°C Dry - 16°C Wet Relative Humidity - 54% Atmos. Pressure 1013mbar Cloud - 80% Low Wind - 0-2 knots NW	* Traffic * Birds * Plant operating	L_{90} - 41 (L_{10} - 56)
Survey 15 30.8.90	16.30	16.50	As above	As above * Traffic increasing	L_{90} - 41 (L_{10} - 58)

Survey No. Date	Statistical Analyser Time ON (hrs)	OFF (hrs)	Weather Conditions	Noise Sources	Background Noise Levels dB(A)
<u>Location - Residence C - Company House</u>					
Survey 16 30.8.90	14.40	15.00	Temperature - 22°C Dry - 15°C Wet Relative Humidity - 47% Atmos. Pressure 1013mbar Cloud - 70% medium Wind - 2-4 knots NW	* Brick plant * Wind in trees * Birds * Distant traffic	L_{90} - 43 (L_{10} - 48)
<u>Location - Residence D - Newstead Farm</u>					
Survey 17 30.8.90	15.10	15.30	As above	* Birds * Plant audible (just at times) * Wind in trees * Some distant traffic	L_{90} - 33 (L_{10} - 41)
<u>Location - Opposite gate to Kenamoor - 30m off Greendale Rd</u>					
Survey 18 31.8.90	07.15	07.35	Temperature - 9°C Dry - 8°C Wet Relative Humidity - 88% Atmos. Pressure 1013mbar Cloud - 70% medium Wind - still	* Traffic * Birds * Some domestic noise * 1 aircraft	L_{90} - 39 (L_{10} - 57)

4. EQUIPMENT NOISE LEVELS

The sound power levels of the major sources of noise for the proposed manufacturing plant are given below in octave bands:-

Source #:1	Title:BORAL BRICK - BRINGELLY - HOT AIR PRE-HEAT FAN

DESCRIPTION	HOT AIR PRE-HEAT FAN MEASURED @ 3 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	99.5	102.5	97.5	98.5	94.5	92.5	88.5	83.5	72.5	67.5	106.5 97.4

Source #:2	Title:BORAL BRICK - BRINGELLY - RAPID COOLING

DESCRIPTION	RAPID COOLING RECOVERY FAN MEASURED @ 4 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	103.0	103.0	108.0	105.0	103.0	101.0	99.0	94.0	90.0	83.0	112.5 106.3

Source #:3	Title:BORAL BRICK - BRINGELLY - WET AIR FAN

DESCRIPTION	WET AIR FAN MEASURED @ 3 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	105.5	100.5	97.5	92.5	93.5	92.5	88.5	87.5	75.5	61.5	107.7 96.9

Source #:4	Title:BORAL BRICK - BRINGELLY - COMBUSTION AIR FAN

DESCRIPTION	COMBUSTION AIR FAN MEASURED @ 5 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	101.0	105.0	104.0	107.0	110.0	105.0	98.0	94.0	89.0	82.0	114.2 110.0

Source #:5	Title:BORAL BRICK - BRINGELLY - SIDE INJECTION FAN - 2OFF

DESCRIPTION	SIDE INJECTION FAN MEASURED @ 2 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	102.0	103.0	104.0	102.0	100.0	102.0	98.0	92.0	89.0	81.0	110.5 105.4

Source #:6	Title:BORAL BRICK - BRINGELLY - RECIRCULATION FAN - 2OFF

DESCRIPTION	RECIRCULATION FAN MEASURED @ 1 METRE B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	96.0	97.0	94.0	90.0	91.0	88.0	84.0	77.0	74.0	67.0	101.7 92.7

Source #:7	Title:BORAL BRICK - BRINGELLY - MAIN STACK FAN

DESCRIPTION	MAIN STACK FAN MEASURED @ 3 METRE B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	105.5	101.5	101.5	96.5	97.5	95.5	90.5	85.5	77.5	66.5	109.0 99.6

Source #:8	Title:BORAL BRICK - BRINGELLY - FORKLIFT NO.1

DESCRIPTION	FORKLIFT HYSTER (GAS) LOADING PALLETS @ 7 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	1011.8	500.33	84	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	100.0	109.0	104.0	99.0	104.0	101.0	96.0	91.0	91.0	81.0	112.2 105.4

Source #:9	Title:BORAL BRICK - BRINGELLY - PRIMARY CRUSHER
DESCRIPTION	PRIMARY CRUSHER @ 7 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	976.76	225.83	84	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	104.0	103.0	103.0	102.0	99.0	94.0	91.0	84.0	77.0	68.0	109.7 100.4

Source #:10	Title:BORAL BRICK - BRINGELLY - DISINTERGRATOR
DESCRIPTION	DISINTEGRATOR @ 7 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		2	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	103.0	102.0	102.0	101.0	97.0	93.0	90.0	83.0	77.0	68.0	108.6 99.1

Source #:11	Title:BORAL BRICK - BRINGELLY - HIGH SPEED ROLLS COARSE 2 O

DESCRIPTION	HIGH SPEED ROLLS CRUSHER (2OFF) @ 5METRES FROM C. LINE B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		2	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	104.0	108.0	108.0	106.0	103.0	99.0	98.0	92.0	86.0	77.0	113.6 105.5

Source #:12	Title:BORAL BRICK - BRINGELLY - HIGH SPEED ROLLS FINE 2 OFF

DESCRIPTION	HIGH SPEED ROLLS CRUSHER (2OFF) @ 5METRES FROM C. LINE (FINE) B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		2	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	105.0	110.0	109.0	108.0	104.0	101.0	98.0	93.0	86.0	80.0	115.1 106.7

Source #:13	Title:BORAL BRICK - BRINGELLY - EXTRUDER & CUTTER

DESCRIPTION	EXTRUDER & CUTTER MEASURED @ 3 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		2	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	97.5	101.5	102.5	102.5	102.5	102.5	101.5	103.5	105.5	105.5	113.0 110.5

Source #:14	Title:BORAL BRICK - BRINGELLY - POWER PACK & RACK HANDLING

DESCRIPTION	HYDRAULIC POWER PACK & RACK HANDLING SYSTEM MEASURED @ 3 METRE B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		2	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	97.5	100.5	99.5	100.5	95.5	98.5	98.5	94.5	84.5	74.5	107.6 103.7

Source #:15	Title:BORAL BRICK - BRINGELLY - EXHAUST FAN - 2OFF

DESCRIPTION	EXHAUST FAN MEASURED @ 1 METRE B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	96.0	97.0	94.0	90.0	91.0	88.0	84.0	77.0	74.0	67.0	101.7 92.7

Source #:16	Title:BORAL BRICK - BRINGELLY - FRONT END LOADER NO.1 - 980

DESCRIPTION	CAT 980 LOADER STOCKPILING @ 7METRES

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	976.76	225.83	84	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	104.0	112.0	107.0	102.0	103.0	104.0	97.0	92.0	88.0	79.0	114.8 106.8

Source #:17	Title:BORAL BRICK - BRINGELLY - FORKLIFT NO.2

DESCRIPTION	FORKLIFT HYSTER (GAS) LOADING PALLETS @ 7 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	1011.8	500.33	84	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	100.0	109.0	104.0	99.0	104.0	101.0	96.0	91.0	91.0	81.0	112.2 105.4

Source #:18	Title:BORAL BRICK - BRINGELLY - HOT AIR FAN - 2OFF

DESCRIPTION	HOT AIR FAN MEASURED @ 3 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	102.5	105.5	100.5	101.5	97.5	95.5	91.5	86.5	75.5	70.5	109.5 100.4

Source #:19	Title:BORAL BRICK - BRINGELLY - RECIRCULATION FAN - 40 OFF

DESCRIPTION	RECIRCULATION FAN MEASURED @ 1 METRE B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		1	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	103.0	104.0	101.0	97.0	98.0	95.0	91.0	84.0	81.0	74.0	108.7 99.7

Source #:20	Title:BORAL BRICK - BRINGELLY - FRONT END LOADER NO.2 - 980

DESCRIPTION	CAT 980 LOADER STOCKPILING @ 7METRES INSIDE BUILDING

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
				POINT		2	

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	104.0	112.0	107.0	102.0	103.0	104.0	97.0	92.0	88.0	79.0	114.8 106.8

Source #:21	Title:BORAL BRICK - BRINGELLY - FORKLIFT NO.3

DESCRIPTION	FORKLIFT HYSTER (GAS) LOADING PALLETS @ 7 METRES B&K 2231 S.L.M.

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	1011.8	500.33	84	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	100.0	109.0	104.0	99.0	104.0	101.0	96.0	91.0	91.0	81.0	112.2 105.4

Source #:001	Title:BORAL BRICK - BRINGELLY - SCRAPER NO.1

DESCRIPTION	SCRAPER MEASURED @ 14 METRES STOCKPILE AREA B&K 2231 SLM

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	1058	244	84	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	109.9	110.9	111.9	109.9	108.9	107.9	107.9	105.9	100.9	94.9	118.6 114.1

Source #:002	Title:BORAL BRICK - BRINGELLY - SCRAPER NO.2

DESCRIPTION	SCRAPER MEASURED @ 14 METRES HAUL ROAD B&K 2231 SLM

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	836.38	345.51	71	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	109.9	110.9	111.9	109.9	108.9	107.9	107.9	105.9	100.9	94.9	118.6 114.1

Source #:003	Title:BORAL BRICK - BRINGELLY - SCRAPER NO.3

DESCRIPTION	SCRAPER MEASURED @ 14 METRES ON PIT FLOOR B&K 2231 SLM

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	909.62	314.29	84	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	109.9	110.9	111.9	109.9	108.9	107.9	107.9	105.9	100.9	94.9	118.6 114.1

Source #:004	Title:BORAL BRICK - BRINGELLY - DOZER

DESCRIPTION	DOZER MEASURED @ 7 METRES ON PIT FLOOR CAT D8K B&K 2231 SLM

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	836.38	345.51	71	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	102.0	113.0	113.0	108.0	110.0	106.0	101.0	95.0	91.0	85.0	118.0 110.9

Source #:005	Title:BORAL BRICK - BRINGELLY - GRADER

DESCRIPTION	GRADER CAT 120G @ 7 METRES STOCKPILING AREA

DATA	X-COORD.	Y-COORD.	Z-COORD.	TYPE	SIZE	ENCL	SECTION
	1058	244	83	POINT			

Octave Hz	31.5	63	125	250	500	1K	2K	4K	8K	16K	Lin/Awt
PWL	98.0	107.0	108.0	99.0	99.0	101.0	99.0	94.0	85.0	75.0	112.0 105.2

5. E.N.M. Sample Calculations – Residence A

BORAL BRICK - BRINGELLY - FORKLIFT NO.1

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		100.0	109.0	104.0	99.0	104.0	101.0	96.0	91.0	91.0	81.0
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
BARRIER		6.3	7.4	9.1	11.4	12.9	16.0	19.0	22.0	25.0	25.0
AIR ABSORPTION		.0	.0	.1	.4	1.0	2.0	3.6	8.2	22.5	68.4
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-3.5	4.7	-3.1	-1.0	-2.5	-2.9	-2.5	-2.7
TOTAL AWT	29.7	37.3	45.2	35.9	20.0	30.8	21.6	13.5	1.2	-16.4	-72.2

SOURCE : 17

BORAL BRICK - BRINGELLY - FORKLIFT NO.2

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		100.0	109.0	104.0	99.0	104.0	101.0	96.0	91.0	91.0	81.0
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
BARRIER		6.3	7.4	9.1	11.4	12.9	16.0	19.0	22.0	25.0	25.0
AIR ABSORPTION		.0	.0	.1	.4	1.0	2.0	3.6	8.2	22.5	68.4
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-3.5	4.7	-3.1	-1.0	-2.5	-2.9	-2.5	-2.7
TOTAL AWT	29.7	37.3	45.2	35.9	20.0	30.8	21.6	13.5	1.2	-16.4	-72.2

SOURCE : 21

BORAL BRICK - BRINGELLY - FORKLIFT NO.3

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		100.0	109.0	104.0	99.0	104.0	101.0	96.0	91.0	91.0	81.0
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
BARRIER		6.3	7.4	9.1	11.4	12.9	16.0	19.0	22.0	25.0	25.0
AIR ABSORPTION		.0	.0	.1	.4	1.0	2.0	3.6	8.2	22.5	68.4
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-3.5	4.7	-3.1	-1.0	-2.5	-2.9	-2.5	-2.7
TOTAL AWT	29.7	37.3	45.2	35.9	20.0	30.8	21.6	13.5	1.2	-16.4	-72.2

SOURCE : 9

BORAL BRICK - BRINGELLY - PRIMARY CRUSHER

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		104.0	103.0	103.0	102.0	99.0	94.0	91.0	84.0	77.0	68.0
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7
BARRIER		5.5	5.9	6.8	8.2	10.4	12.4	14.6	17.6	20.6	23.6
AIR ABSORPTION		.0	.0	.1	.4	1.1	2.0	3.7	8.5	23.2	70.7
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-5.4	6.0	-.6	-3.9	-1.6	-1.6	-2.9	-1.5
TOTAL AWT	27.5	41.8	40.3	38.8	24.6	25.4	20.7	11.5	-3.3	-26.6	-87.6

SOURCE : 16

BORAL BRICK - BRINGELLY - FRONT END LOADER - 980

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		104.0	112.0	107.0	102.0	103.0	104.0	97.0	92.0	88.0	79.0
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7
BARRIER		5.5	5.9	6.8	8.2	10.4	12.4	14.6	17.6	20.6	23.6
AIR ABSORPTION		.0	.0	.1	.4	1.1	2.0	3.7	8.5	23.2	70.7
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-5.4	6.0	-.6	-3.9	-1.6	-1.6	-2.9	-1.5
TOTAL AWT	33.8	41.8	49.3	42.8	24.6	29.4	30.7	17.5	4.7	-15.6	-76.6

SURFACE : 101 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL1

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		98.5	98.7	91.6	83.6	78.3	70.2	59.4	48.6	44.9	37.6
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3
BARRIER		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.9
AIR ABSORPTION		.0	.0	.1	.4	1.2	2.2	3.9	9.0	24.5	75.3
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-.5	.6	-2.3	-1.2	-1.8	-2.2	.1	-1.7
TOTAL AWT	14.4	36.2	36.3	23.6	14.2	11.1	.9	-11.0	-26.6	-48.0	-100.0

SURFACE : 102 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL1

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		91.6	91.9	84.8	76.7	71.4	63.3	52.6	41.7	38.0	30.7
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		62.8	62.8	62.8	62.8	62.8	62.8	62.8	62.8	62.8	62.8
BARRIER		8.0	10.1	12.2	14.2	17.2	20.2	23.3	25.0	25.0	25.0
AIR ABSORPTION		.0	.0	.1	.4	1.1	2.1	3.7	8.6	23.4	71.5
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-1.3	3.0	-3.6	-.6	-2.7	-2.3	-2.4	-1.1	-2.7
TOTAL AWT	-1.2	26.7	20.2	6.7	2.8	-9.2	-19.1	-34.9	-52.3	-72.2	-100.0

SURFACE : 103 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL2

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		97.3	97.6	90.5	82.5	77.2	69.0	58.3	47.4	43.7	36.4
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
BARRIER		5.0	5.0	5.0	5.0	5.0	5.0	5.0	4.9	4.8	4.6
AIR ABSORPTION		.0	.0	.1	.4	1.0	2.0	3.5	8.2	22.4	68.3
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-.7	.8	-2.4	-1.2	-1.8	-2.1	.4	-1.4
TOTAL AWT	14.3	35.9	36.1	23.7	13.9	11.1	.8	-10.8	-26.0	-46.4	-97.5

SURFACE : 104 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING SOUTH WALL

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		96.9	97.1	90.0	82.0	76.7	68.6	57.8	47.0	43.3	36.0
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0	63.0
BARRIER		5.1	5.3	5.5	6.0	6.8	8.3	10.5	12.5	14.7	17.7
AIR ABSORPTION		.0	.0	.1	.4	1.1	2.1	3.8	8.7	23.7	72.7
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	1.4	.0	-1.3	-1.5	-2.0	-2.1	1.3	-.9
TOTAL AWT	11.9	34.8	34.8	20.0	12.7	7.0	-3.3	-17.5	-35.1	-59.5	-100.0

SURFACE : 105 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING WEST WALL

		FREQUENCY Hz								
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		101.4	101.7	94.6	86.6	81.3	73.1	62.4	51.5	47.9	40.6
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0
BARRIER		11.0	12.7	15.4	18.4	21.4	24.5	25.0	25.0	25.0	25.0
AIR ABSORPTION		.0	.0	.1	.5	1.2	2.4	4.3	9.8	26.3	81.3
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-1.6	5.0	-2.7	-3.4	-2.2	-2.4	-2.3	-3.1	-1.9
TOTAL AWT	3.9	32.3	26.5	10.0	6.3	-2.0	-15.5	-28.5	-45.0	-64.3	-100.0

SURFACE : 106 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL2

		FREQUENCY Hz								
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		93.8	94.0	86.9	78.9	73.6	65.5	54.8	43.9	40.2	32.9
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4	64.4
BARRIER		10.5	12.5	14.8	17.8	20.8	23.8	25.0	25.0	25.0	25.0
AIR ABSORPTION		.0	.0	.1	.5	1.3	2.5	4.4	10.1	27.3	84.6
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	1.9	.7	-3.9	-.8	-1.7	-2.2	-2.3	-1.9	-2.0
TOTAL AWT	-3.9	24.8	15.2	6.8	.1	-12.1	-23.5	-36.8	-53.3	-74.6	-100.0

SURFACE : 107 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL3

		FREQUENCY Hz								
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		91.2	91.5	84.4	76.4	71.1	62.9	52.2	41.3	37.7	30.4
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0
BARRIER		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
AIR ABSORPTION		.0	.0	.1	.5	1.3	2.4	4.3	9.8	26.4	81.4
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-4.7	4.3	-2.2	-.6	-.7	-2.1	-.5	-.1	-2.8
TOTAL AWT	5.5	28.1	27.1	10.9	9.0	1.4	-7.8	-19.0	-37.0	-57.6	-100.0

SURFACE : 108 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL3

FREQUENCY Hz

		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		90.8	91.1	84.0	75.9	70.6	62.5	51.8	40.9	37.2	29.9
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		63.9	63.9	63.9	63.9	63.9	63.9	63.9	63.9	63.9	63.9
BARRIER		9.0	11.3	12.8	15.7	18.8	21.8	24.8	25.0	25.0	25.0
AIR ABSORPTION		.0	.0	.1	.5	1.2	2.3	4.2	9.6	25.9	79.8
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	.5	1.5	-3.9	-.3	-2.7	-2.4	-2.0	-1.0	-2.7
TOTAL AWT	-4.4	23.9	15.4	5.7	-.3	-13.0	-22.7	-38.6	-55.6	-76.5	-100.0

SURFACE : 109 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST ROOF1

FREQUENCY Hz

		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		102.8	103.1	96.0	88.0	82.7	74.5	63.8	52.9	49.2	41.9
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5
BARRIER		5.7	6.0	6.1	.0	.0	.0	.0	.0	.0	.0
AIR ABSORPTION		.0	.0	.1	.4	1.2	2.2	4.0	9.2	24.9	76.6
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-5.2	3.7	-1.7	-.4	-1.5	-1.5	-1.4	-1.7	-3.3
TOTAL AWT	20.8	39.6	38.8	22.6	25.8	18.4	10.4	-2.1	-18.4	-37.5	-94.9

SURFACE : 110 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST ROOF2

FREQUENCY Hz

		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		103.2	103.5	96.4	88.4	83.1	74.9	64.2	53.3	49.6	42.3
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		62.8	62.8	62.8	62.8	62.8	62.8	62.8	62.8	62.8	62.8
BARRIER		5.8	6.0	6.1	.0	.0	.0	.0	.0	.0	.0
AIR ABSORPTION		.0	.0	.1	.4	1.1	2.0	3.7	8.5	23.3	71.1
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-5.3	3.2	-1.4	-.4	-1.9	-1.7	-2.1	-1.9	-.7
TOTAL AWT	21.9	40.6	39.9	24.2	26.6	19.6	12.0	-.6	-15.9	-34.5	-90.9

SURFACE : 111 ENCLOSURE : 1

BORAL BRICK - BRINGELLY - MANUFACT. BUILDING WEST ROOF

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		105.6	105.9	98.8	90.8	85.5	77.3	66.6	55.7	52.1	44.8
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		63.7	63.7	63.7	63.7	63.7	63.7	63.7	63.7	63.7	63.7
BARRIER		5.3	5.5	5.9	6.8	8.2	10.3	12.4	14.6	17.6	20.6
AIR ABSORPTION		.0	.0	.1	.5	1.2	2.3	4.1	9.5	25.6	78.7
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-2.4	6.8	-1.5	-4.5	-1.1	-2.0	-2.5	-2.4	-1.5
TOTAL AWT	18.4	42.6	39.0	22.2	21.4	16.9	2.1	-11.7	-29.5	-52.4	-100.0

SURFACE : 201 ENCLOSURE : 2

BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING EAST WALL

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		98.8	102.5	95.4	87.3	78.2	71.4	64.0	57.2	59.2	59.1
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7
BARRIER		5.1	5.2	5.4	5.7	6.4	7.6	9.5	11.8	13.5	16.5
AIR ABSORPTION		.0	.0	.1	.4	1.1	2.0	3.7	8.5	23.1	70.3
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-4.0	4.4	-3.1	-.1	-2.6	-2.0	-1.5	-2.4
TOTAL AWT	18.5	37.0	40.6	31.2	14.1	11.1	-.9	-9.3	-23.7	-38.6	-88.1

SURFACE : 202 ENCLOSURE : 2

BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING SOUTH WALL

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		96.8	100.5	93.4	85.3	76.3	69.5	62.0	55.2	57.2	57.1
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1
BARRIER		5.1	5.2	5.4	5.8	6.5	7.8	9.8	12.0	13.8	16.8
AIR ABSORPTION		.0	.0	.1	.4	1.1	2.1	3.8	8.9	24.1	73.7
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-4.3	4.8	-2.9	-.1	-2.7	-1.6	-3.0	-1.4
TOTAL AWT	16.1	34.6	38.1	29.0	11.2	8.5	-3.4	-12.0	-27.2	-40.8	-95.1

SURFACE : 203 ENCLOSURE : 2

BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING WEST WALL

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		98.8	102.5	95.4	87.3	78.2	71.4	64.0	57.2	59.2	59.1
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5	63.5
BARRIER		11.2	12.8	15.7	18.7	21.7	24.7	25.0	25.0	25.0	25.0
AIR ABSORPTION		.0	.0	.1	.4	1.2	2.2	4.0	9.2	24.9	76.6
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-3.1	8.5	-.2	-4.7	-.2	-3.3	-2.0	-2.6	-2.4
TOTAL AWT	4.7	30.1	29.3	7.6	4.9	-3.5	-18.8	-25.2	-38.5	-51.6	-100.0

SURFACE : 204 ENCLOSURE : 2

BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING NORTH WALL

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		96.8	100.5	93.4	85.3	76.3	69.5	62.0	55.2	57.2	57.1
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1
BARRIER		5.1	5.2	5.4	5.7	6.3	7.5	9.3	11.6	13.2	16.2
AIR ABSORPTION		.0	.0	.1	.4	1.1	2.1	3.9	8.9	24.1	73.8
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-.9	1.2	-2.3	-1.1	-1.7	-2.2	-1.0	-2.7
TOTAL AWT	15.2	34.6	38.1	25.7	14.9	8.0	-2.2	-12.6	-26.2	-42.2	-93.4

SURFACE : 205 ENCLOSURE : 2

BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING ROOF

		FREQUENCY Hz									
		31.5	63	125	250	500	1k	2k	4k	8k	16k
POWER LEVEL		105.2	108.8	101.8	93.7	84.6	77.8	70.3	63.6	65.6	65.5
DIRECTIVITY		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
DISTANCE		63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1	63.1
BARRIER		5.0	5.0	4.9	4.7	5.7	5.8	6.0	6.0	.0	.0
AIR ABSORPTION		.0	.0	.1	.4	1.1	2.1	3.8	8.8	24.0	73.6
TEMP & WIND		.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND		-6.0	-6.0	-2.0	1.9	-2.7	-1.2	-1.7	-2.1	-.3	-1.5
TOTAL AWT	24.3	43.1	46.7	35.7	23.5	17.4	8.0	-1.0	-12.2	-21.3	-69.7

PROGRAM ENM SOURCE RANKING

SINGLE POINT CALCULATION

X= 1347.1 Y= 336.2 Z= 84.8

SOURCE TITLE	dB(A)
16 BORAL BRICK - BRINGELLY - FRONT END LOADER - 980	33.8
17 BORAL BRICK - BRINGELLY - FORKLIFT NO.2	29.7
21 BORAL BRICK - BRINGELLY - FORKLIFT NO.3	29.7
8 BORAL BRICK - BRINGELLY - FORKLIFT NO.1	29.7
9 BORAL BRICK - BRINGELLY - PRIMARY CRUSHER	27.5
205 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING ROOF	24.3
110 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST ROOF2	21.9
109 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST ROOF1	20.8
201 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING EAST WALL	18.5
111 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING WEST ROOF	18.4
202 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING SOUTH WALL	16.1
204 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING NORTH WALL	15.2
101 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL1	14.4
103 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL2	14.3
104 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING SOUTH WALL	11.9
107 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING EAST WALL3	5.5
203 BORAL BRICK - BRINGELLY - MAT.PREP.BUILDING WEST WALL	4.7
105 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING WEST WALL	3.9
102 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL1	-1.2
106 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL2	-3.9
108 BORAL BRICK - BRINGELLY - MANUFACT. BUILDING NTH WALL3	-4.4
TOTAL	38.2

APPENDIX 5

ARCHAEOLOGICAL SURVEY

Prepared By Pam Dean Jones (Archaeologist)
Resource Planning Pty Limited

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 LOCATION AND SCOPE OF SURVEY

This report documents the results of an archaeological survey of land to be affected by a proposed expansion of clay/shale extraction, and extensions to the Boral clay products plant, south of Greendale Road at Bringelly. The property is known as Lot 2, DP 733115, Parish of Cook, County of Cumberland and the 1:25,000 Topographic Grid Reference for the plant is Warragamba 289662418. The location of the Boral property and of the portion covered by this archaeological survey is illustrated in **Figure 1**.

This archaeological survey has been carried out to determine the presence and significance of any aboriginal sites in the area affected by the proposed development. The survey does not cover the entire Boral property.

A clay shale quarry currently exists on the site, and the present plant has been in operation since 1968. The proposal involves a threefold increase in clay/shale extraction, and the construction of a new plant adjacent to the existing plant.

The field component of the survey was carried out by Pam Dean-Jones and Alan Anderson. Mr Anderson is the sites officer of the Tharawal Local Aboriginal Land Council.

1.2 REPORT CONTENT

The report includes a description of the geomorphic context of the property, to establish the general land use type, landscape, specific terrain, and substrate types within the study area, forms of ground surface present, and the nature of active surface processes. The study area lies within undulating terrain underlain by Wianamatta Shales, close to the southwestern margin of the Cumberland Plain. Much of the area has been cleared and grazed or cultivated over a long period.

A review of the known archaeological record of the Bringelly district, including the catchments of Thompsons Creek, Badgerys Creek, Bringelly Creek, Duncans Creek, and Lowes Creek, lying within a radius of 5km of the plant is provided to establish the types of archaeological evidence likely to occur in the area, and the state of preservation of known sites.

The report describes the field survey process, and records four isolated artefacts located during the survey.

1.3 SUMMARY OF RECOMMENDATIONS

Four isolated artefacts were located during the field survey. All four were lying on the surface of eroded tracks, and had no stratigraphic context. Although Aboriginal occupation of the area may have been more extensive than is indicated by this very limited evidence, the four isolated finds are considered to be representative of the degree of preservation of archaeological evidence within the study area. The land has been extensively cleared, grazed, cultivated and quarried over many years, i.e., the isolated flakes do not under-represent the existing archaeological status of the study area. The isolated flakes are not considered scientifically or culturally significant.

2.0 ENVIRONMENTAL CONTEXT

2.1 GEOMORPHIC CONTEXT

The study area is situated within the South Creek catchment area in the southwest of the Cumberland Plain. The Nepean Fault, marking the eastern margin of the Triassic Narrabeen Sandstones of the Blue Mountains is located approximately 7km to the west of the site. The Bringelly area is underlain by the Triassic Wianamatta Group. The Bringelly Shale comprising shale with some sandstone beds is the dominant underlying rock material.

The plant and quarry are located close to the boundary between two distinct landscape units. The land to the southwest comprises moderately to steeply undulating terrain, with short valley side slopes, side slope gradients of 10–20%, and a heavily dissected drainage pattern of low order, intermittent streams with little floodplain development.

To the northeast of the brickworks site, the land is gently undulating, with low local relief and open pattern of 3rd–4th order drainage lines. Thompsons Creek is the major local stream to the east of the study area, and has a well developed alluvial deposit, 60–80m wide, on either side of the channel.

The study area itself comprises part of an east–northeast oriented spur from Birling Trig (159m) which is the highest point in the district, and part of the floodplain of the upper reaches of Thompsons Creek. **Figure 4** is a schematic toposequence which illustrates the landform units and associated soil types represented in the study area.

The local geomorphic character has a number of implications for the preservation of archaeological evidence.

1. Erodibility of hillslope soil profiles. The topsoil on hillslopes in the study area is light to medium textured, weakly to moderately structured, sets hard when dry and is brittle. It is moderately to strongly susceptible to sheet and rill erosion, depending on position on the slope. Footslopes and intermittent drainage lines are also susceptible to the gullying. Evidence of active erosion is largely confined to tracks and drainage lines. There are large areas of sheet eroded topsoil exposed by tracks crossing the footslopes. There is a low probability of preservation of small scatters of stone artefacts under such conditions. The hillslopes are approximately 500m from the nearest permanent water.

2. Flooding of Thompsons Creek. Hydrological studies of Thompsons Creek indicate that with the present channel configuration, the alluvial flats

adjacent to the creek would not be overtopped by a 1 in 100 year flood. On this basis, any Aboriginal sites along the creek bank would not be disrupted by flood discharges, or buried by flood sediments. However the antiquity of the present broad, flat channel cross section is not known. Soil profile development on the alluvium, which includes a bleached A_2 horizon, indicates that the deposits are of considerable age (i.e., early Holocene?).

2.2 NATURAL VEGETATION

The natural vegetation of this area is mapped by Foster et al (1977) as **Eucalyptus moluccana** (Grey Box), **Eucalyptus tereticornis** (Forest Red Gum) woodland. Other eucalypt species represented include the ironbarks, **Eucalyptus crebra**, **Eucalyptus sideroxylon**, **Eucalyptus paniculata**, **Angophora floribunda**, **Casuarina cunninghamiana**, **Exocarpus sp.** The most common constituent of the understorey is **Bursaria spinosa**. Other species include **Acacia decurrens** and **parramattensis**, and **Melaleuca decora**, **Melaleuca linearifolia**, **Melaleuca stypheloides** in poorly drained areas.

Much of the study area has been extensively cleared.

2.3 LAND USE HISTORY

The undulating hills of the Bringelly area have been cleared and grazed for at least 150 years. The plant and quarry site, and the upper part of Thompsons Creek, were formerly a sheep grazing property.

Alluvial flats associated with Thompsons Creek have been cultivated for the production of fodder crops.

The canopy of the woodland to the west of the quarry remains relatively intact. There has been considerable understorey disturbance however; there is widespread erosion along tracks, and significant weed invasion, particularly by African Olive.

The quarry and plant have operated on the site since 1968. Ground surface disturbance associated with these industries, in addition to the actual plant and quarry area, includes construction of small settling dams and overburden and brick waste dumping to both the east and west of the plant. Flat alluvial floors to both the small creek west of the plant, and Thompsons Creek, indicate considerable recent sedimentation. In the case of the small western creek, this is clearly related to old overburden dumps.

3.0 ARCHAEOLOGICAL CONTEXT

There are few Aboriginal archaeological sites recorded in the southwest of the Cumberland Plain and only one site has previously been recorded within 5 km of the Boral property at Bringelly. This site (NPWS site 45-5-0496) is located on a tributary of Badgerys Creek, approximately 4km north of the present study area.

A search of the NPWS Aboriginal site records indicated a further four sites within 10 km of the study area (45-5-0213, 45-5-0214, 45-5-0234, 45-5-0517), and 12 sites 10-20 km from the study area. This must be regarded as a very low site density, and is much less than would be predicted from the potential of the area for occupation. The distribution of known sites is strongly correlated with the undulating, low local relief terrain with 3rd-4th order drainage lines, which are east of Bringelly. Sites have been recorded along Badgerys Creek, Kemps Creek and South Creek. No sites have been previously recorded in the hilly, strongly dissected area between Bringelly and the Nepean River.

The types of sites which have been previously recorded in the general area include open campsites, grinding grooves, rock engravings, and a carved tree. Open campsites account for 76% of the existing site records.

The most likely form of archaeological evidence in the present study area is open campsites. Such sites would be expected close to major drainage lines. The geology of the area suggests that rock shelters, rock engravings and grinding grooves are unlikely to occur in the study area.

4.0 FIELD SURVEY

A field inspection of the area to be affected by the proposed development was carried out on 29th November, by the consultant, and Alan Anderson who is the cultural resources officer for the Tharawal Local Aboriginal Land Council. The survey was carried out on foot. This inspection concentrated on:

(a) Tracks through remnant bushland to the west of the existing quarry and plant, including clearings and tracks along the intermittent drainage line through the eucalypt woodland.

(b) The banks of Thompsons Creek, to the east of the existing quarry and plant.

In addition, observations were made throughout the remainder of the area, e.g., along the ridge line across the alluvial flats adjacent to Thompsons Creek, and the footslopes adjacent to Greendale Road, during other fieldwork on the property.

Groundcover in the area of remnant bushland was close to 100%, comprising native grasses, shrubs and 2-5cm of leaf litter. There was total ground surface exposure along tracks in this area, but active sheet and rill erosion have greatly modified the natural surface. Groundcover around the margins of the existing quarry and plant is low, but the ground surface is heavily disturbed. The surface of the alluvial flats has been cultivated in the past. Groundcover is 70-90%, comprising mixed native and introduced grasses. There is limited ground surface exposure along the margins of Thompsons Creek.

The form of both the intermittent drainage line west of the existing quarry and plant, and of Thompsons Creek has been altered by dam construction, high levels of sedimentation from disturbance with the existing quarry and plant, and by dumping of brick rubble and sandstone overburden not required for brick or paver manufacture.

5.0 SURVEY RESULTS

Four isolated artefacts were identified during this survey. The locations of the archaeological material are shown on **Figure 2.** The material comprises:

* Red silcrete flake 15mm x 16mm x 4mm, previous flake scars, not rotated, no cortex. The flake was located on an exposure 10m x 5m adjacent to an intermittent drainage line, substrate brown clay loam, 100% surface visibility.

* Pink indurated siltstone flake 20mm x 17mm x 10mm, previous flake scars, not rotated, no cortex. The flake was located on an exposure created by a track across the footslope, with an area of 4m x 70m, approximately.

* Red silcrete flaked piece, maximum dimension <10mm, no cortex. The flaked piece was located on an exposure created by a track, midslope position, area approximately 3m x 70m.

* Red silcrete core, single platform, 5 flakes removed 25mm x 14mm x 15mm. The artefact was located on a track across the footslope to the southwest of the intermittent drainage line west of the existing plant.

All four finds were located in, or on the margin of, the area of remnant bushland to the west of the existing quarry and plant. No archaeological material was located along the banks of Thompsons Creek, which, on environmental grounds would be attributed a higher archaeological sensitivity. This area has however, been disturbed by agriculture and ground surface visibility is generally poor.

6.0 DISCUSSION

Although approximately 1000 Aboriginal sites have been recorded in the Macarthur region, very few archaeological sites have been recorded in the area around Bringelly which is close to the southern margin of the Cumberland Plain. The very low density of previously recorded sites is not in accordance with the potential of the area for occupation. A greater density of occupation evidence might also be expected from the antiquity of dated sites on the eastern margin of the Blue Mountains (Shaw's Creek) and from the Nepean terraces, north of Penrith.

The lack of regional evidence is therefore attributed to:

1. The small number of surveys carried out and the restricted area covered by these surveys.

the Boral property at Bringelly. This site (NPWS site 45-5-0496) is located on a tributary of Badgerys Creek, approximately 4km north of the present study area.

A search of the NPWS Aboriginal site records indicated a further four sites within 10 km of the study area (45-5-0213, 45-5-0214, 45-5-0234, 45-5-0517), and 12 sites 10-20 km from the study area. This must be regarded as a very low site density, and is much less than would be predicted from the potential of the area for occupation. The distribution of known sites is strongly correlated with the undulating, low local relief terrain with 3rd-4th order drainage lines, which are east of Bringelly. Sites have been recorded along Badgerys Creek, Kemps Creek and South Creek. No sites have been previously recorded in the hilly, strongly dissected area between Bringelly and the Nepean River.

The types of sites which have been previously recorded in the general area include open campsites, grinding grooves, rock engravings, and a carved tree. Open campsites account for 76% of the existing site records.

The most likely form of archaeological evidence in the present study area is open campsites. Such sites would be expected close to major drainage lines. The geology of the area suggests that rock shelters, rock engravings and grinding grooves are unlikely to occur in the study area.

4.0 FIELD SURVEY

A field inspection of the area to be affected by the proposed development was carried out on 29th November, by the consultant, and Alan Anderson who is the cultural resources officer for the Tharawal Local Aboriginal Land Council. The survey was carried out on foot. This inspection concentrated on:

(a) Tracks through remnant bushland to the west of the existing quarry and plant, including clearings and tracks along the intermittent drainage line through the eucalypt woodland.

(b) The banks of Thompsons Creek, to the east of the existing quarry and plant.

In addition, observations were made throughout the remainder of the area, e.g., along the ridge line across the alluvial flats adjacent to Thompsons Creek, and the footslopes adjacent to Greendale Road, during other fieldwork on the property.

Groundcover in the area of remnant bushland was close to 100%, comprising native grasses, shrubs and 2-5cm of leaf litter. There was total ground surface exposure along tracks in this area, but active sheet and rill erosion have greatly modified the natural surface. Groundcover around the margins of the existing quarry and plant is low, but the ground surface is heavily disturbed. The surface of the alluvial flats has been cultivated in the past. Groundcover is 70-90%, comprising mixed native and introduced grasses. There is limited ground surface exposure along the margins of Thompsons Creek.

The form of both the intermittent drainage line west of the existing quarry and plant, and of Thompsons Creek has been altered by dam construction, high levels of sedimentation from disturbance with the existing quarry and plant, and by dumping of brick rubble and sandstone overburden not required for brick or paver manufacture.

5.0 SURVEY RESULTS

Four isolated artefacts were identified during this survey. The locations of the archaeological material are shown on **Figure 2.** The material comprises:

* Red silcrete flake 15mm x 16mm x 4mm, previous flake scars, not rotated, no cortex. The flake was located on an exposure 10m x 5m adjacent to an intermittent drainage line, substrate brown clay loam, 100% surface visibility.

* Pink indurated siltstone flake 20mm x 17mm x 10mm, previous flake scars, not rotated, no cortex. The flake was located on an exposure created by a track across the footslope, with an area of 4m x 70m, approximately.

* Red silcrete flaked piece, maximum dimension <10mm, no cortex. The flaked piece was located on an exposure created by a track, midslope position, area approximately 3m x 70m.

* Red silcrete core, single platform, 5 flakes removed 25mm x 14mm x 15mm. The artefact was located on a track across the footslope to the southwest of the intermittent drainage line west of the existing plant.

All four finds were located in, or on the margin of, the area of remnant bushland to the west of the existing quarry and plant. No archaeological material was located along the banks of Thompsons Creek, which, on environmental grounds would be attributed a higher archaeological sensitivity. This area has however, been disturbed by agriculture and ground surface visibility is generally poor.

6.0 DISCUSSION

Although approximately 1000 Aboriginal sites have been recorded in the Macarthur region, very few archaeological sites have been recorded in the area around Bringelly which is close to the southern margin of the Cumberland Plain. The very low density of previously recorded sites is not in accordance with the potential of the area for occupation. A greater density of occupation evidence might also be expected from the antiquity of dated sites on the eastern margin of the Blue Mountains (Shaw's Creek) and from the Nepean terraces, north of Penrith.

The lack of regional evidence is therefore attributed to:

1. The small number of surveys carried out and the restricted area covered by these surveys.

2. The degree of past land surface disturbance in an area which has been cleared, grazed, and cultivated for approximately 150 years.

Four isolated flakes were located during the present survey. The survey area is underlain by Wianamatta Shales, and although few Aboriginal sites have been recorded in the southern Cumberland Plain, numerous sites are located on the Wianamatta Group in the northern part of the Cumberland Plain. These sites include dense scatters of large numbers of artefacts. The four isolated finds on the Boral property confirm that greater evidence of occupation of the southern part of the Cumberland Plain may be available, but do not otherwise provide useful information about Aboriginal land management practices or occupation strategies.

It is perhaps significant that three of the four isolated finds utilised red silcrete, and that all were small stone fragments with no cortex remaining.

An important issue with respect to the significance of the isolated finds is the potential for further material, not visible under present land use, ground cover or erosion status. The locations of the isolated artefacts in this instance do not suggest the presence of further archaeological material. All four were located on moderately extensive ground surface exposures, with moderate sheet erosion.

As discussed in Section 2.2 of this report, there is also a possibility of open campsites being located along the banks of Thompsons Creek. Ground surface visibility in this area is low, and some sections of the bank have previously been extensively disturbed by the dumping of fill.

Figure 16 shows the proposed layout of stockpiles, dams and flood protection banks along Thompsons Creek. The bund wall is located within 10m of the creek bank along the reach east of the existing brickworks. This section of bank has been considerably disturbed by dumping of fill in the past, and preservation of Aboriginal open campsites is unlikely. Further upstream. the bund is approximately 20m from the creek bank, increasing to 75m at its upstream extremity. No development will occur between the bund and the creek bank. Any sites which may be located immediately adjacent to the creek in this area, but are currently unknown, will not be affected by the proposed development.

7.0 RECOMMENDATIONS

1. Four isolated artefacts were located during this survey. The artefacts are not regarded as scientifically or culturally significant.

2. The artefacts were all located on the footslopes of the catchment of an intermittent stream west of the existing quarry and plant. The degree of ground surface disturbance in this area indicates that the finds are fully representative of the archaeological potential of this area. No further archaeological investigation of the west of the existing quarry and plant is required.

3. All four archaeological finds lie within the area which will be quarried during expansion of the operations. It is recommended that Boral Bricks

(NSW) Pty Limited apply to the Director, National Parks and Wildlife Service for consent to destroy the evidence of Aboriginal occupation.

4. No evidence of Aboriginal occupation was found along the west bank of Thompsons Creek. This area is regarded as having relatively high potential for preservation of Aboriginal sites. Although archaeological material may be obscured by dense grass cover or dumped rubble, it is considered unlikely that any flaked stone would be buried by recent alluvium, given the discharge capacity of the present channel.

The sections of the banks of Thompsons Creek which are relatively undisturbed will not be affected by the proposed development. The nearest encroachment will be approximately 25m, where a bund wall to the raw material stockpiles will be constructed. The remainder of the alluvial flat has been cultivated over a long period, and the preservation of archaeological material with any stratigraphic context is highly unlikely. It is therefore recommended that no further investigation of the west bank of Thompsons Creek is required. If any development of the east bank is proposed in the future, that area should be investigated separately.

APPENDIX 6

EROSION AND SEDIMENT CONTROL

AND WATER MANAGEMENT

APPENDIX 6
EROSION AND SEDIMENT CONTROL AND WATER MANAGEMENT

See also **Section 7.0** and **Figure 16**

1.0 DESIGN STANDARDS

Erosion and sediment control can water management structures have ben designed (preliminary) in accordance with the Soil Conservation Service of NSW publications "Design Manual for Soil Conservation Works", and "Urban Erosion and Sediment Control". Generally, the following design standards will apply to the various structures:

(a) Diversion Banks: will divert upslope runoff to safe disposal areas or gully storages and will also act as primary outlets from these structures. A design Average Recurrence Interval (ARI) of 20 years and a maximum velocity of 1.2 m/s (grassed condition) will be applied to the design.

(b) Gully Storages: will serve as additional clean water storages and to direct water to diversion banks. The primary outlets, usually a diversion bank will be designed to a 1:20 year ARI standard whilst emergency bywashes will accommodate the excess flows up to the 1:100 year ARI. Gully storages will not be prescribable structures under the Dams Safety Act, 1978. Freeboard of 1.2m will be applied to these structures.

(c) Primary Sediment Basins: will be designed to trap the 0.020mm and larger fraction in a settling volume of 0.60m minimum depth. The total volume of the basins will be made up of settling volume (0.60m minimum depth), in which the flow through rate will not exceed 0.20 m/s; and a sediment storage volume of at least 50% of settling volume beneath. Dewatering of the settling volume will be achieved over at least a 24 hour period.

* Volume of basins settling volume = 12mm runoff over contaminated catchment.

(d) Secondary Sediment Basins: these will serve as water management structures and as wet basins for the trapping of finer particles downstream of the primary sediment basins. Generally a minimum depth of 2.0m will be applied with the volume selected on the basis of the maximum runoff volume to be expected from a 1 in 1 year storm event. (SPCC, 1989, Pollution Control Manual for Urban Stormwater).

(e) Constructed Waterway: will convey runoff from the Stage 4 diversion along the ridge line and down to Bardwell Gully. Design ARI for this waterway will be 20 years with a minimum freeboard of 300mm to be applied to the bank height.

(f) Catch Drain: will convey surface runoff from the area of the new plant back to the lower of the primary storages. A design ARI of 20 years will be applied to this channel with a maximum velocity of 1.2 m/s (grassed condition).

(g) **Flood Protection Levee/Visual Screening Bund:** will provide freeboard protection of at least 1.0 metre above the adjacent 1:100 year flood level in Thompsons Creek. As such it will also serve a screening function for the raw material strockpiles and area of the new plant.

2.0 PRELIMINARY DESIGN DETAILS

The following sections give preliminary design details for the various water management components:

(a) Diversion Banks

TABLE 1
DIVERSION BANKS

Bank	Catchment (ha)	Time of Conc. (mins)	Q_{20} m^3/s	n	S_0 (m/m)	Q_{20} V_{max} (m/s)	Manning Depth (m)	Bed (m)
Stage 1	5.6	15	0.76	0.03	0.05	1.2	0.06	10.6
Stage 2	3.1	12	0.47	–	0.005	–	0.36	1.1
Stage 3	7.5	17	0.97	–	0.04	–	0.08	10.6
Stage 4	8.3	18	1.04	0.03	0.005	1.2	0.36	2.4

A minimum freeboard allowance of 0.30m will be applied to the diversion bank walls.

(b) Gully Storages

TABLE 2
GULLY STORAGES

Storage	Catchment (ha)	TWL RL	Volume (m^3)	Crest Width (m)	Batters (h:v)
Stage 2 Dam	3.1	98.5	1200	2.0	3:1
Stage 3 Dam	7.5	98.5	2100	2.0	3:1

A minimum freeboard allowance (after settlement) of 1.20m will be applied.

(c) Primary Sediment Basins

TABLE 3
PRIMARY SEDIMENT BASINS

Basin	Catchment (ha)	TWL RL	Volume (m^3)	Batters (h:v)	Average Depth (m)
Pit 1	~5.8	Var	700	3:1	1.5
Pit 2	~5.0	Var	600	3:1	1.5
* Basin 1	2.2	86.0	700	3:1	1.5
* Basin 2	~5.8 max	84.3	900	3:1	1.5
* Basin 3	~5.8 max	82.0	1200	3:1	1.5

A minimum freeboard allowance (after settlement) of 0.75m will be applied to the above ground basins.(*)

(d) Secondary Sediment Basins

TABLE 4
SECONDARY SEDIMENT BASINS

Basin	Catchment (ha)	TWL RL	Volume (m^3)	Batters (h:v)	Average Depth (m)
2° Basin 1 (on–line)	16 (max)	80.8	4000	4:1	2.0
2° Basin 2 (off–line)	15 (max)	83.0	6300	4:1	2.0

(e) Constructed Waterway

Catchment Area = 7.5 ha.

Q_{20} = $0.97 m^3/s$
V_{max} = 1.2m/s
S_0 = 0.04m/m
n = 0.03

Manning: Depth, y = 0.08m
Bed width, B = 11.0m

Adopt: Bank Height = 0.40m(min)
Bed width = 11.0m

(f) Catch Drain

Catchment Area = 2.6 ha.

Q_{20} = $0.59 m^3/s$
V_{max} = 1.2m/s
S_0 = 0.005m/m
n = 0.03

Manning	Depth,	y	=	0.67m
	Bed width,	B	=	0.74m
Adopt:	Bank height		=	1.0m(min)
	Bed width		=	1.0m

(g) Flood Protection Levee/Visual screening Bund

Minimum Height 2.0m above matural surface at upstream end. Maximum Height 5–6.0m above natural surface at lowest point. Side slopes approximately 2:1. Crest width approximately 2m prior to establishment of vegetative cover. Tempory erosion control will be installed in the form of a small catch drain at the down slope toe of the bund. This will discharge through a section of silt fence constructed on a 20m level weir outlet (1:1 year ARI).

3.0 THOMPSONS CREEK (HYDROLOGICAL CALCULATIONS)

Peak Discharge on Thompson Creek at downstream end of site has been calculated using the Rational Method (Australian Rainfall and Runoff 1987). Calculations ignore the flood attenuating capacity of a dam of approximately 5ML capacity on Thompsons Creek, 1250m upstream of Greendale Road (Downstream end of site).

a) Catchment Area A = $1.58 Km^2$

b) Time of Concentration
$= 0.76 \times A^{0.38}$
$= 0.76 \times 1.58^{0.38}$
$=$ 54.3 minutes

c) Rainfall intensity $I_{54.3}$ = 71.91 mm/hr

d) Coefficient of Runoff C $= C_{10} \times FF_{100}$

$FF_{100} = 2.57 - \left(\frac{0.588 \times 13}{6.4}\right)$
$= 1.376$

$C_{10} =$ 0.40 (Figure 5.1 AR & R Volume II)

Therefore $C = 0.40 \times 1.376$
$= 0.55$

e) Peak Discharge $Q = 0.278 \times C \times I \times A$
$= 0.278 \times 0.55 \times 71.91 \times 1.58$
$= 17.4 m^3$

f) Check Hydraulic capacity of existing culvert. Culvert configuration is comprised of three 600 x 1800mm box culverts.

Bed slope on culvert, S_0 = 0.008m/m

Hyraulic Radius (each cell), $R = \frac{Area}{Perimeter} = \frac{1.8 \times 0.6}{3.0}$

$= \quad 0.36\ \text{m}$

Manning 'n', $\quad n = 0.011$

Therefore capacity of culvert running full but not under head is given by Manning equation i.e.

$$Q = \frac{A \times R^{2/3} \times S_0^{1/2}}{n}$$

$$= \frac{3x(0.6x1.8) \times (0.36)^{2/3} \times 0.008^{1/2}}{0.011}$$

$$= 13.3\text{m}^3/\text{s}$$

g) Assuming this is the peak capacity of the culvert, (conservative as capacity would increase with additional head of water) maximum volume of water overtopping Greendale Road.

$$15.5\text{m}^3/\text{s} \quad - \quad 13.3\text{m}^3/\text{s} \quad = \quad 2.2\text{m}^3/\text{s}$$

Flow over Greendale Road would simulate flow across a broad-crested weir.

Discharge $\quad Q = 1.5xLxH^{3/2}$
Length $\quad =$ Assume 20m (Conservative w.r.t. height)

therefore depth of flow

$$H = \left(\frac{Q}{1.5xL}\right)^{2/3}$$

$$= \left(\frac{2.2}{1.5x150}\right)^{2/3}$$

$$= 0.056\text{m say } 100\text{mm}$$

h) Maximum flood depth for 1% Annual Exceedance Probability event can be inferred as being height of road plus depth of flow overtop i.e.

$76.4 + 0.1 = 76.5$mAHD say, 77mAHD