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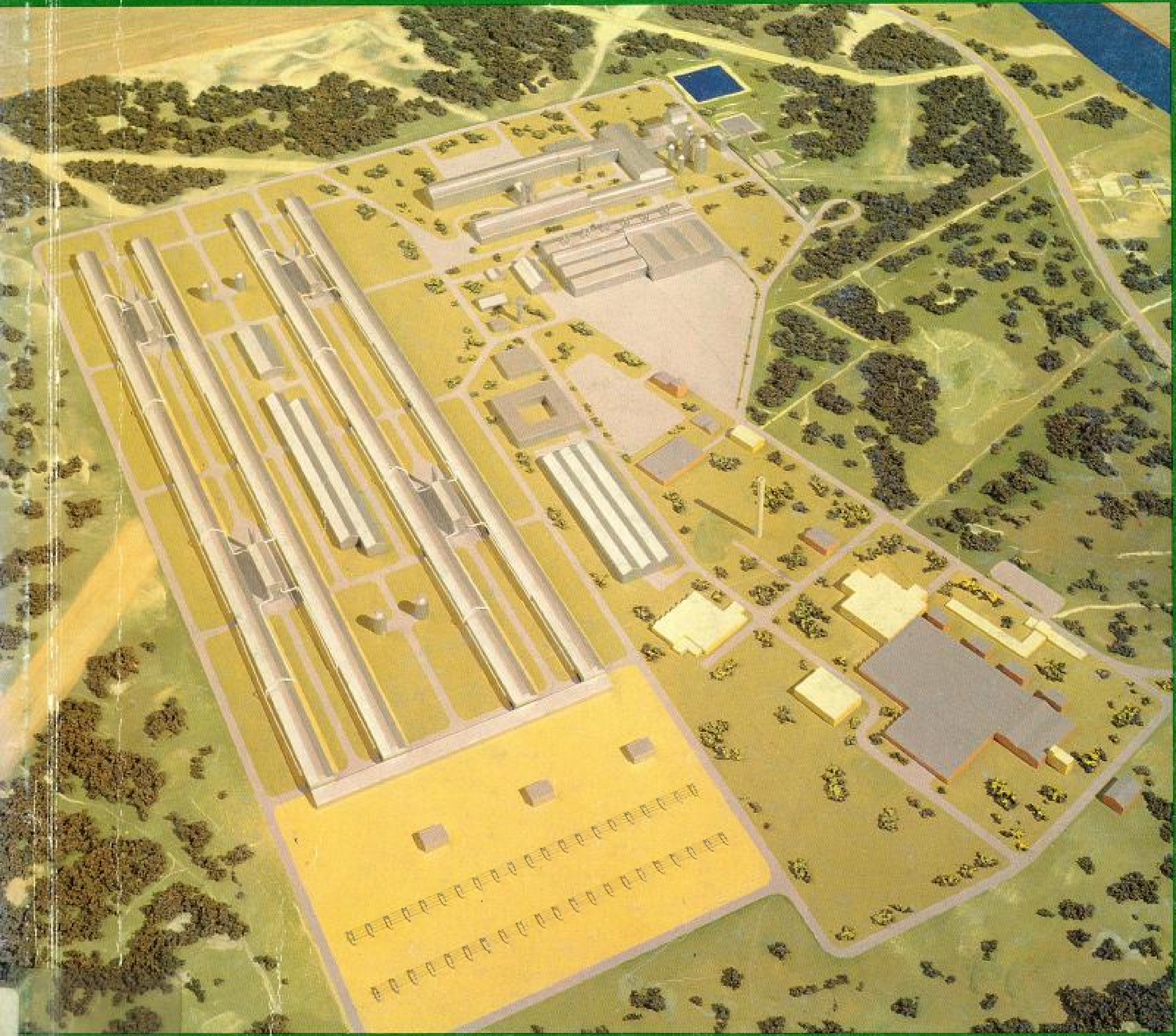
Environmental impact statement for an aluminium smelter at

Tomago, N.S.W.

TOMAGO ALUMINIUM
Company Pty Limited

Environmental Impact Statement for an Aluminium Smelter at Tomago, NSW

Volume 1



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TOMAGO
Aluminium Company Pty. Limited

Environmental Impact Statement for an Aluminium Smelter at Tomago, N.S.W.

Volume 1

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Summary and Overview

SUMMARY AND OVERVIEW

THE PROPOSAL

Tomago Aluminium Company Pty. Limited has prepared this Environmental Impact Statement for the proposal to establish an aluminium smelter on the site of the former Courtaulds (Australia) Limited's textilesfactory at Tomago in the Shire of Port Stephens, New South Wales.

The proposed site shown in *Figure 1.1* is in an area zoned for industrial development and is separated to the south from the City of Newcastle's heavy industry complex by the Hunter River.

The Company's technical and financial feasibility studies showed that a viable smelter could be operated at this location. The important tasks to be completed before the project could proceed were the winning of a guaranteed power supply, approvals of various authorities and the recognition of the residents of the Lower Hunter Valley of the value of the smelter to the region. The support of governments at the National and State levels has been received.

The first requirement was met when an agreement for the supply of power was negotiated with the Electricity Commission, N.S.W. This Statement presents details of the environmental implications of the project for assessment by interested citizens, Commonwealth Authorities, the Planning and Environment Commission N.S.W. and Port Stephens Shire Council. The requirements of the State Pollution Control Commission, N.S.W. have also to be complied with and additional technical information to supplement the Statement will be provided to support applications under the Clean Waters, Clean Air and Noise Control Acts.

Two other important aspects of the proposal are covered by separate Environmental Impact Statements. These are the construction of port and storage facilities for raw materials at the Rotten Row Basin on Kooragang Island in the estuary of the Hunter River and the extension of transmission lines to the Tomago site.

The environmental investigations for the proposal have been conducted by James B. Croft and Associates over a period of nearly one year. The procedure from the start was to identify and minimise potential impacts and this Statement presents the effects of the fully safeguarded smelter incorporating the most up to date technology for pollution control.

It will be recognised that every project irrespective of its size or cost has an unavoidable impact on the environment. This proposal is no exception, but it is believed that the impact will be minimal and represent a satisfactory resolution of the options open to the Company for the selection of a site, technology and supporting infrastructure for the venture, the community for employment and economic benefits at low additional levels of inconvenience and pollution, and the State and the Nation in public costs and benefits and the use of finite resources.

This Statement has reached an appreciable size and the results of many investigations have been presented only briefly to conserve space. Persons seeking amplification of any aspect are invited to approach the Company.

Details of the proposal and the environmental implications are given in the nine sections of the Statement. The salient features and important findings are summarised in the following overview.

THE COMPANY

Tomago Aluminium Company Pty. Limited is the operating company acting for the consortium of Aluminium Pechiney Australia Pty. Limited, Gove Aluminium Finance Pty. Limited, the Australian Mutual Provident Society, through its wholly owned subsidiary TOA Pty. Limited, Vereinigte Aluminium Werke Australia Pty. Limited and Hunter Douglas Limited. The major shareholder in Gove Aluminium Finance Pty. Limited is CSR Limited.

SCOPE AND OBJECTIVES

The proposal is to develop an aluminium smelter to produce up to 220,000 t/y of finished product for export. Development will be over a period of some seven years.

The proposed smelter will incorporate a proven technology developed by Aluminium Pechiney for the conversion of alumina to aluminium metal. The Company successfully participates in twenty aluminium smelters complying with the requirements for the protection of the environment in seven countries throughout the world. The smelter at Tomago will be built and operated to modern standards.

The important reasons for selecting Australia for the project were ease of access to sources of raw materials, convenience to expanding markets in Asia, long-term availability of power based on coal resources and a stable political situation. The choice among the possible locations in the Hunter Valley was based on criteria including proximity to electrical supply points, accessibility to port facilities and transportation infrastructure and the availability of a site with sufficient area for the smelter, a surrounding buffer zone and the absence of factors inhibiting the operation of the smelter in an environmentally acceptable manner. The site of the former Courtauld's textiles factory at Tomago met all of the requirements admirably.

The raw materials for aluminium production, alumina and petroleum coke, are to be shipped to the Port of Newcastle, unloaded at a new berth to be constructed on Kooragang Island and taken by road to the smelter at Tomago. 430,000 and 90,000 t/y of alumina and petroleum coke respectively will be transported in 77 return trips per day between 7.00 am and 6.00 pm, six days per week. The aluminium metal will be cast into various shapes and trucked in an average of 32 return trips per day to the port for transport by ship to market destinations. The road route to be followed from Kooragang Island will be Cormorant Road, Industrial Drive, Pacific Highway and Tomago Road.

Electrical power will be supplied from the State grid at 380 MW by the New South Wales Electricity Commission. Water and telecommunications are already connected to the site.

The workforce on the site will reach a peak of up to 1500 during construction in 1982. The operating plant will employ approximately 800 persons. The Company's policy will be to give preference to the employment of local people including women and young people. On the job training will upgrade the skills of semi-skilled and unskilled employees. A government-backed scheme to train 60 apprentices per year will be introduced at the beginning of 1981.

Tomago Aluminium Company Pty. Limited will be a new modern industrial enterprise in the Hunter Valley and in operating on the former site of Courtaulds (Australia) Limited will help to restore the advantages lost to Port Stephens Shire in the closure of that plant.

The Company intends to maximise the use of local knowledge, labour and suppliers and, with its own contribution of experience and resources will operate to supply a growing demand for aluminium throughout the world.

OPERATION OF THE SMELTER

Primary aluminium will be produced by electrolytic reduction of alumina using the Hall-Heroult process. Alumina, an oxide of aluminium, is dissolved in a bath of molten cryolite and fluorspar at approximately 950°C and electrolysed in a pot (cell) by direct current. The liquid aluminium is deposited at the cathode in the bottom of the pot and oxygen combines with the carbon anode. The pots consist of a carbon cathode insulated by alumina or refractory bricks inside a steel shell and are connected electrically in series. The current passes from the carbon anode through the bath to the cathode and thence by aluminium busbar to the neighbouring pot. Alumina is added to the molten bath and dissolves as electrolysis proceeds. The solidified crust of the bath is broken regularly to allow additional alumina to enter the cell.

Two potlines of 240 cells each will be required to meet the target production capacity of the plant of 220,000 tonnes of aluminium each year.

The fumes emitted from the process containing gaseous carbon oxides, sulphur dioxide, hydrogen fluoride and particulate carbon, alumina and fluorides are collected by a hood over the pot and extracted through a ducting system.

Molten aluminium is periodically withdrawn from the pot by vacuum suction. Alumina and fluoride compounds are added to the bath as required to replenish material removed or consumed in normal operation. Carbon anodes are replaced as they are consumed by the reaction with oxygen.

The Company proposes to use a centre worked prebaked (CWPB) cell developed by Aluminium Pechiney. The cell hooding gives a fume collection efficiency of 97.5 per cent, compared with 80 per cent normally associated with side-worked pots. This modern development results in low emission levels from the potline buildings.

The proposed layout of the plant provides for buildings to house facilities for the production of prebaked anodes, metal casting, workshops and laboratory, a substation for reduction of the power supply from 330 kV to 11kV, various structures and units of plant and a road network. The existing Courtaulds (Australia) Limited's office block is still in good condition and is to be retained as the administration offices.

SAFEGUARDS AND CONTROLS

The manufacture of aluminium results unavoidably in the production of gaseous, liquid and solid wastes. The technology for the control and disposal of the waste products is well understood and practised. Pechiney is a world leader in the field.

All potential sources of pollution at the proposed smelter will be minimised by the incorporation of safeguards at the design stage and by strict supervision of controls during operation. A monitoring programme is to be implemented as a measure of the efficiency of the plant safeguards and as a control to ensure that the levels of impact on surrounding areas do not exceed the limits predicted in the Environmental Impact Statement and required by pollution control authorities.

The Company's basic philosophy for the proposal is to combat sources of air, water and noise pollution at the source. Aluminium Pechiney's overseas experience indicates that the safeguards proposed will operate effectively and that contingency situations leading to large releases of pollution and resulting impacts will not occur.

From time to time various atypical conditions may modify the normal operating situations and the effects of these have been considered.

Air pollution control is to be achieved by a fume collection and extraction system on the pots and treatment to remove gaseous and particulate fluorides and other particulate matter. The fumes from each pot are contained by hooding which fully encloses the pot. Since the pots are centre worked, it is only during the anode changing operation that a portion of the hooding is normally removed. The overall fume collection efficiency of 97.5 per cent is high and the dry scrubbing system removes virtually all fluoride from the fumes. Fluoride will also be removed from the fumes of the anode baking furnace by dry scrubbing prior to discharge. This is an important innovation for Australia.

Emissions of sulphur dioxide will be controlled so that the resultant ground level concentrations are well below threshold values dangerous for human health and levels demanded for pollution control. All transfer points in the handling system for the alumina and petroleum coke will be enclosed to prevent dust loss. Dust extraction and collection systems will be incorporated. All emissions from the plant will meet the requirements of the New South Wales Clean Air Act.

Solid wastes will be disposed of off the site in a controlled landfill operation. The location of the disposal site is presently under investigation and will be the subject of a separate Environmental Impact Statement.

Pollution of the Tomago Sandbeds and the Hunter River will be prevented by the controls on all atmospheric emissions and by collection, testing and treatment of all potentially contaminated water. Site runoff from the roofs and roads will be directed to a storage dam for quality checking and treatment prior to release when necessary. Domestic waste water will be handled in a package treatment plant. Any process water will be treated prior to discharge and all discharges will meet the standards of the New South Wales Clean Waters Act.

Noise control during construction and operation of the smelter will be achieved by the specification and selection of equipment, attention to noise attenuation in plant design and by maintenance of mufflers. The smelter will meet the requirements of the New South Wales Noise Control Act.

Visual impact will be minimised by architectural design of buildings and the chosen layout of the smelter which retains a dense vegetation barrier. Additional planting and landscaping will provide screening from the remaining viewing points and improve the aesthetics of the plant.

A programme of discussions with surrounding landholders interested in selling their properties has been initiated with the objective of extending Company-owned land over a period of time to provide an effective buffer zone.

A monitoring programme for air and water quality, vegetation, wildlife, stock, forages, fruit trees, garden plants and vegetables has been developed to provide data on background pollution levels prior to the start up of the smelter and as a control procedure after the operations have commenced. Company policy will be to undertake development work to improve emission controls and, where practical, to implement improvements resulting from Aluminium Pechiney research and development activities around the world.

All aspects of environmental control and management will be co-ordinated by an Environmental Officer responsible to the Manager of the plant.

CONTROLS DURING CONSTRUCTION

The construction contractor will be required in the documents of contract to comply with all safeguards detailed in the Environmental Impact Statement and with conditions of approvals. Specified hours of operation will be complied with and any changes will first be approved by the relevant authorities.

Safeguards for the control of runoff will be built prior to construction to contain the activities. Discharges of water from the site will comply with the Clean Waters Act. A water tanker or hoses will be available to combat dust during site preparation, foundation construction and the handling of bulk materials. Waste water handling and disposal will comply with the requirements of the Hunter District Water Board and the State Pollution Control Commission.

Strict attention will be given to the control of construction noise. All noise generating plant and equipment will be properly silenced. Mufflers will be maintained in good condition.

Floodlighting will be shielded and directed away from residences.

The flow of building materials to the site will be regulated where possible and restricted to hours between 7.00 am and 6.00 pm on six days per week, excluding Sundays and public holidays.

ALTERNATIVES CONSIDERED BY THE COMPANY

TECHNOLOGY

Aluminium Pechiney is the largest seller of aluminium smelting technology in the world and is a leader in research and development of systems of pollution control in Europe and the United States. The Company has been in the forefront of development of the CWPB pot which eliminates the need to remove the hooding panels to add alumina and minimises fluoride losses from the potrooms.

The dry process for scrubbing primary potline and baking furnace emissions is highly efficient and best suited to the constraints and conditions applying to the Tomago site. The wet scrubbing process has not been favoured since it produces fluoride-rich liquid effluents which require subsequent treatment and disposal.

Modern plants operated by Aluminium Pechiney have demonstrated that the level of safeguards proposed for Tomago will result in the smelter having a low overall impact. The most effective proven control technology has been incorporated in all stages of the smelting and materials handling processes. Other alternatives which are available are regarded as less efficient.

LOCATION IN AUSTRALIA

World-wide economic criteria including a growth in demand for aluminium of 5 per cent per annum, declines in the ready availability of fuels, particularly oil, and resultant escalating costs of production in Europe and the USA have led to increased interest in investment in smelters in Australia. Other contributing factors are Australia's large bauxite reserves, reliable supplies of energy at competitive rates, established infrastructure including harbour facilities, a skilled workforce and government initiatives in attracting industries.

Restrictive environmental requirements overseas have not been a factor in the selection of Australia as the optimum location as local controls are equally stringent.

Australia is the largest producer of bauxite (31 per cent of world production) and the second largest manufacturer of alumina (22 per cent). Approximately 25 per cent of the bauxite and over 90 per cent of the alumina production are exported. Currently Australia produces only 2 per cent of the western world's aluminium. The Company's proposal will help to redress these imbalances and is in agreement with Australian Government policy to maximise the benefits to Australia by processing raw materials locally.

These factors are the basis of the Company's decision to establish a smelter in Australia. A decision not to proceed with the project would result in increased expansion of existing or planned smelters elsewhere in Australia and would be invalid in the light of the low level of impact predicted from the results of the environmental investigations.

LOCATION IN THE HUNTER REGION

Seventeen sites were examined throughout the Hunter Valley. Three sites at Kooragang Island in the estuary of the Hunter River, and Williamtown and Tomago to the north of the river were shown to be the most suitable for a smelter on technical, economic and environmental grounds. Detailed environmental assessments resulted in Tomago being selected as the best location.

Important attributes of the favoured site were its ease of access, good foundation conditions, availability of services, sufficient space, industrial zoning, the existing buildings of Courtauld's textiles factory suitable for offices and other uses and the low potential for air, water and noise pollution problems. None of the alternative sites was found to be as suitable in all respects.

SITE LAYOUTS

Plant layouts for the Tomago site involving east-west and north-south orientations for the potlines were evaluated on engineering, economic and environmental grounds. The former layout was adopted because of the fewer number of residences that might be affected by operational and construction noises and atmospheric emissions, and the smaller area of vegetation and wildlife habitat to be cleared.

TRANSPORT MODES

A number of transport options were evaluated for the movement of raw materials and products between the Port of Newcastle and the smelter.

i. Barging via the north arm of the Hunter River was not favoured because of the likely navigational and safety problems in negotiating the estuary of the river which is subject to shipping movements, tidal and floodwater flows, siltation and changes in water depth. Other factors were the absence of a permanent dredge, the need for mangrove clearance at unloading points and cost considerations.

ii. A railway linkage was discounted because of the need to construct a bridge over the Hunter River.

iii. Road and belt conveyor linkages across the western half of Kooragang Island were not selected because of the potential conflicts with nature reserve proposals and the problems of transferring materials across the north arm of the Hunter River.

iv. A road route via Stockton Bridge may be used occasionally for large items of plant during construction but is not favoured because of the longer travel distance to the plant and the number of residences to be passed along the route on the northern side of the river.

v. A road route via the Industrial Drive, Pacific Highway and Tomago Road is the favoured mode.

The use of the favoured route will result in a one hundred per cent increase in the heavy vehicle traffic on Tomago Road between the site and the Pacific Highway on six days per week between 7.00 am and 6.00 pm. Lower heavy vehicle traffic volumes (10 per cent or less) are expected on other roads during operation of the smelter. Similar increases will occur at peak times for workforce vehicles seven days per week.

The impact on Tomago Road was high when the Courtauld's factory was in operation and was foreseen when the Tomago area was zoned industrial. Possible congestion and delays along the route due to the additional traffic at peak periods are recognised as unavoidable effects of the project.

POTENTIAL IMPACT

INVESTIGATIONS

Detailed field and laboratory studies, surveys and analyses of the available literature and the overseas experience of Pechiney were used to identify the potential sources of impact of the smelter proposal. Special investigations included:

i. Computer modelling techniques to predict the dispersion patterns of gaseous and particulate fluorides and sulphur dioxide emitted to the atmosphere from the plant.

   The patterns show isopleths or lines of equal ground level concentration of the pollutants which are correlated with the results of monitoring programmes from operating plants to predict the effect of the emissions on native vegetation, forage and stock, crops, fruit trees etc.

ii. Field and laboratory studies of the background levels of fluorides in vegetation and animals.

iii. Laboratory studies of the movements of fluorides between vegetation, soils and soil moisture and the behaviour of fluoride-affected vegetation in bushfires and during decay.

iv. Laboratory studies of the movement of fluorides through the soil into groundwater aquifers and hence the potential for the impact of the smelter on water quality in the Tomago Sandbeds.

Impacts on the areas surrounding the smelter were based upon the assumption that the smelter will emit 1 kg of fluoride per tonne of aluminium and maximum safe levels for fluoride take up by vegetation and grazing stock specified by the State Pollution Control Commission. These levels are detailed in the Statement.

AREA OF INFLUENCE

Fluoride producing sources closest to the Tomago site are brick-works at East Maitland, chemical plants on Kooragang Island, the Broken Hill Proprietary Company steelworks at Mayfield and other fuel burning sources in the Newcastle area. Power stations around Lake Macquarie and the Alcan aluminium smelter at Kurri Kurri are more remote sources. Other fluoride producing industries proposed are thermal power stations at Eraring and Bayswater, expansion of the Alcan Smelter and Steelworks, and the Alumax aluminium smelter near Lochinvar.

The isopleths in *Figure 1.2* show that an overlap among sources is likely to result in concentrations of about 0.1 μg.Fg/m^3* between Tomago and Kooragang Island. Only plant species most sensitive to fluorides may be affected in this locality. There will be no overlaps producing meaningful concentrations between a smelter sited at Tomago and smelters at Kurri Kurri and Lochinvar. Emissions from the Tomago proposal will not affect commercial vineyards in the Lower Hunter Valley.

The most important zone around the Tomago smelter will be determined by the position of the 0.3 μg.Ft/m^3** isopleth. It will be the Company's policy to expand the buffer zone progressively around the plant to include this area. There will be constraints on growing sensitive fruit, forage and garden plants on the land between the 0.3 and 0.1 μg.Ft/m^3 isopleths.

The reliability of the positions of the isopleths will be established by the monitoring programme proposed by the Company. At this stage they are considered to be reasonable and conservative estimates as they are based upon an emission level which the Company feels can be improved in practice.

In the broader sense the proposal will have influences on the socio-economic structure of the region and the economies of the State and Nation. These impacts will be favourable and significant.

* 0.1 micrograms of gaseous fluoride per cubic metre of air at the ground level.

**0.3 micrograms of total fluoride per cubic metre of air at the ground level.

POLLUTION LEVELS

The design and operational safeguards proposed for the project will minimise the generation of air, water and noise pollution. Some impacts will be unavoidable.

Eleven residences east of the site will receive an increase in dust levels of about 0.06 g/m^2.mth during operation of the smelter. This will be a 3 per cent increase on existing dust levels and will not represent a significant impact.

Steam from cooling towers will condense adjacent to the plant and will not inconvenience residents.

Sulphur dioxide levels are expected to increase by up to 1.0 $\mu g/m^3$. This is a 4 per cent increase on existing levels and any impact will not be significant.

The small fresh water lagoon on the Company's property will receive emissions estimated to result in fluoride concentrations in the water of greater than 1 mg/l. Tidal flushing, fresh water inflows and the volume of estuarine water will dilute fluoride concentrations discharged to and deposited in the Hunter River. The increase in fluoride concentrations estimated to be 0.02 ppm is well below the acceptable level for Controlled Waters specified in the New South Wales Clean Waters Act. There will be no significant impact on other water bodies.

Two houses to the east of the site on Tomago Road will receive peak noise levels of 56 dB(A) in daylight hours during construction. The Company has options to purchase these houses. Sources of operating noises will be reduced to background at the boundary of the property. Heavy vehicles hauling raw materials and products between the smelter and the port at Newcastle will be a source of disturbance to residents living on Tomago Road between the site and the Pacific Highway.

Visual impacts as a result of the project will be minimal due to the densely vegetated zone surrounding the site. The green anode shop, dry scrubber stacks, water tower and coke storage silos will be visible from distant viewing points and these structures will be painted to blend with the skyline and minimise the impact.

HUMAN HEALTH

The Company proposes to minimise gaseous emission in the potroom by the maintenance of high hooding efficiency. The average contaminant levels over an 8 h shift will be well below the Australian

National Health and Medical Research Council Hygienic Standards for Atmospheric Contaminants (1979) of 2 mg/m^3 hydrogen fluoride, 2.5 mg/m^3 fluoride as fluorine, 55 mg/m^3 carbon monoxide, 12 mg/m^3 sulphur dioxide and 10 mg/m^3 nuisance particulates.

Possible health hazards such as exposure to heat, noise, dust, sulphur dioxide, carbon monoxide, carbon dioxide and benzene soluble organics will be controlled by operating procedures. Education and training programmes will advise employees on all aspects relating to health and use of protective equipment. Workplaces will be regularly monitored by qualified personnel to check emissions and exposures and to ensure that all legislative and Company standards are maintained. A medical centre will be established and a part-time Medical Officer will visit the plant on several days per week. The centre will be attended Monday to Friday by qualified first-aid personnel. All supervisors and selected personnel on each shift will be trained in first-aid.

Residents living within proximity of the site will not be exposed to harmful levels of pollution. Average atmospheric fluoride levels at the site boundary will be about 2000 times less concentrated than the limits set by the Australian National Health and Medical Research Council for atmospheric fluoride in the workplace. The consumption of meat and milk from cattle grazed in the vicinity of the site, or eating soups and stews prepared from these cattle bones will not affect human health. Although the fluoride content of leafy vegetables grown near the site will increase, the practice of discarding the outer and older leaves and washing the vegetables prior to cooking will result in the increased daily intake being insignificant.

FARMING

Sensitive crop and forage species occurring in pasturelands within the annual average 0.3 μg.Ft/m^3 isopleth will be at risk. This area includes a dairy, horse and cattle grazing properties east of the site on Tomago Road and part of a mixed grazing property west of the site. Barley and sorghum crops within the 0.1 μg.Ft/m^3 isopleth may also be affected.

There will be no impact on commercial stone fruit orchards and vineyards since the nearest properties are well outside the 0.1 μg.Ft/m^3 zone. A commercial vegetable farm may experience fluoride levels up to 0.5 μg.Fg/m^3 on occasions and sensitive species may be at risk. Sensitive garden species, fruit and vegetables grown in household gardens may be at risk within the 0.3 μg.Fg/m^3 zone.

Grazing stock at the dairy, beef, mixed beef and horse breeding properties near the site will be at risk if grazed permanently within the 0.3 μg.Fg/m^3 isopleth. No risk to pets or aquatic fauna is expected. Honey Bees are sensitive to fluoride and impacts on bee populations will be monitored.

LAND USE

The site is in an industrial zone and no rezoning will be required. Minor restrictions on certain land uses in adjoining areas may be necessary.

The dairy, horse and cattle breeding properties close to the smelter may require changes to the established agricultural land use patterns. The need for change is expected to be mainly within the 0.3 $\mu g. Ft/m^3$ isopleth but may extend to specific uses within the 0.1 $\mu g. Ft/m^3$ isopleth.

The smelter will not alter the use of residential land other than restrict horticultural species which may be cultivated in household gardens.

The smelter will not adversely affect existing industrial and commercial land uses. Benefits will accrue to some firms through subcontracting during the construction and operation of the smelter. Increased demand for industrial blocks close to the site is likely.

The smelter will have no adverse effects on existing recreational facilities near the site, or recreational use of the Hunter River. The site is too distant from major tourist attractions of Lake Macquarie, Port Stephens, vineyards at Pokolbin, and beaches to have any impact.

Tomago Road is not important for tourist traffic. There will be a benefit to the tourist industry through the provision of educational tours through the plant.

Some conflicts could arise during the construction phase when there is competition for occupancy of caravan parks and other temporary accommodation.

There will be no significant impact on Tomago School, Uniting Church, Progress Association Hall, Detention Centre or Tomago Sandbeds Water Supply Catchment area.

FLORA AND FAUNA

Sulphur dioxide will have no significant impact on native vegetation.

Fluoride emissions may result in long-term changes in dominance, structure and composition of the Tomago Sandbed's vegetation within the 0.5 μg.Ft/m^3 isopleth. This area is mainly on the smelter site and on land zoned industrial. Mangrove-Salt Marsh and Swampland communities adjoining the Hunter River will not be affected.

Increased fluoride levels are expected in native fauna within the 0.3 μg.Ft/m^3 zone. At higher concentrations, death or reduced fecundity within individuals may occur. It is likely that tolerant species will increase in number while sensitive species decline. Reduced productivity and simplification of vegetation communities may result in changes to habitat, species number and diversity. The impact on wildlife may be significant.

THE TOMAGO SANDBEDS

The Company proposes to protect the quality of water in the Tomago Sandbeds by preventing or minimising the movement of potential pollutants into the aquifer.

The dry scrubbing of 97.5 per cent of pot emissions will minimise fluoride emission from the plant. No solid wastes will be stored or buried on the site or in the catchment area and all contaminated site runoff will be collected in an impervious storage dam and treated before discharge to the Hunter River.

More than 85 per cent of fluoride emissions washed by rainwater into the soil will be absorbed by the soil and not passed into the groundwater. An average fluoride concentration of 0.18 mg/l could be expected which is well below the recommended level of 1 ppm fluoride in drinking water for dental health benefits. There will be negligible impact on groundwater of the Tomago Sandbeds during construction and operation of the smelter.

SOCIAL IMPACT

The growth in population stimulated by the proposal will rise to 8300 in the construction period during 1983 and decline to approximately 6000 thereafter.

The estimated demand for additional temporary accommodation during the construction phase will be approximately 1000 units between 1981 and 1983 reducing to 250 in 1985. Temporary accommodation facilities may be strained in the short term.

Between 750 and 1500 additional houses will be required to accommodate the permanent population generated by the proposal. There should be sufficient houses and residential land to meet demands.

The project will have no significant impact upon educational, health, recreational and community facilities. There will be no impact on areas of historical significance.

ECONOMIC IMPACT

The project will provide a direct stimulus to the economy of the Hunter Region and the Nation through the initial investment of approximately $600 million. An estimated 83 per cent of the investment will be spent in Australia. Main expenditures during the operation of the smelter will be salaries and wages, rates and taxes to Local, State and Commonwealth Governments, maintenance, power, raw materials and transport costs. Salaries and wages will amount to an estimated $15 million per year.

The smelter will provide up to 1500 jobs on site during construction and indirectly 420 to 600 jobs in related industries. From 1985 onwards when the smelter is in operation there will be 800 permanent jobs on site. Total new employment in the Hunter Valley resulting from the project will stabilise between 1400 to 2200 jobs. Permanent jobs will be provided for approximately 560 unskilled and semi-skilled persons who will be trained by the Company, and 200 tradesmen.

It is estimated that up to 5400 permanent jobs will be created in Australia as a result of the project. Fifty per cent will be located in New South Wales. The Hunter Region will receive about 80 per cent of the new jobs in the State.

During construction an estimated $52 million is expected to be generated throughout Australia due to income multiplier effects. About $26 million should pass to people in the Hunter Region. When operational, the payroll income of $15 million will generate an additional income of between $21 million and $36 million throughout Australia due to indirect effects. Of this amount, between $7 million and $17 million will pass to the Hunter Region.

Benefits which the State Government will receive as a result of the smelter include harbour and berthing charges, payroll, consumption and income taxes, land tax and fuel tax. Costs include the wharf facilities, upgrading of Tomago Road and road maintenance costs. The State Government and authorities will receive an estimated net benefit of $60 million during the 52 year life of the smelter.

The project will result in over $300 million in export earnings for the Nation. This is 2.3 times the combined export value of the Australian raw materials input and is in accordance with the Commonwealth Government's policy that mineral products be upgraded before export. The export of aluminium will bring 30 times the value of the equivalent amount of export bauxite and upgrading of the raw material requires 25 times as many people as the equivalent mining operation. The smelting of aluminium provides 2.7 times as many jobs as production of the equivalent amount of alumina. It is expected that all raw materials, except for petroleum coke, aluminium fluoride and cryolite, will be purchased in Australia.

REGIONAL DEVELOPMENT AND PLANNING

The project will assist in the achievement of the Hunter Regional Plan's economic goals by substantial direct investment and job creation within the economy. The smelter's location is in accordance with the recommended strategy of the Plan as it maximises the use of existing zoning and infrastructure and minimises disruption to existing and planned settlement patterns.

Regional developments which are related to the smelter include two power stations supplying power and supporting mines, the transmission lines from the power station to the smelter, the unloading and loading facilities for raw materials at Kooragang Island and to a lesser extent the transport routes which connect these developments.

ENERGY RESOURCES

An Energy Statement is provided for the proposal. It is estimated that 3.9 million kilowatt hours of electricity, 10.8 million litres of diesel fuel and 1.1 million litres of petrol will be used during construction of the smelter. An energy consumption of this magnitude is not unusual for major projects.

The proposed smelter will utilise about one seventh of the capacity of Eraring Power Station and 3 per cent of the New South Wales electrical generation capacity planned for 1985, and about 7 per cent of the projected total electrical energy consumption in 1987. This level of consumption will not result in significant depletion of the State's or Nation's energy resources.

About 1.4 mt of coal will be required each year to provide electrical energy to the smelter. This is less than 6.7 per cent of projected exports from the northern New South Wales coalfields in 1985. Over a 50 year life the smelter will consume only 0.4 per cent of the resources of black coal in northern New South Wales coalfields.

These reserves will be used to produce an export commodity of greater value to Australia than the export of the raw materials.

The project will prevent the extraction of 30 mt of coking coal underlying the site in the life of the smelter. This resource represents about 0.2 per cent of measured and indicated reserves of coal in northern New South Wales coalfields. The ultimate removal of the coal will not be inhibited.

ATYPICAL CONDITIONS

The technology proposed by the Company has been developed to protect both the external environment and the working place. The safeguards developed will ensure that maximum levels of chemical substances and physical agents in the working environment are less than standards and recommendations accepted by international authorities.

The safeguards included in the design and proposed operating methods of the smelter incorporate the most advanced technology available and the potential for accidents is very low. Microprocessors are used throughout the plant to regulate production processes and are designed to identify any irregularities should they occur. Systems have been incorporated in every stage of the smelting process to provide backup should atypical operating conditions arise.

The majority of power supply and distribution networks are duplicated to prevent total power loss. In the event of this unlikely occurrence, fume generation in pots will cease and fume within the hooding system will gradually escape and be discharged from the roof vents. Plant emergency power provided from onsite generators will supply lighting and other needs associated with a safe and orderly plant shutdown. An interruption to plant water supply is similarly unlikely due to a duplication of supply sources.

An analysis of the conditions at startup indicates that emission levels are unlikely to exceed the 1 kg.F/t of aluminium used for impact assessment purposes. No impacts greater than those which have been stated are likely in the early production stages.

LONG-TERM IMPLICATIONS

The long-term effects of the proposed development on the physical environment of the site have been predicted from the best available knowledge on aluminium smelters operating in Australia and overseas. The proposed monitoring programmes have been designed to provide additional quantitative data on the effects of the development. As experience grows on the site more information will be available to combat any presently unforeseen problems.

Pechiney's experience suggests that the levels of impact predicted in the Impact Statement are conservative and that the effects in the long term will be minimal and restricted mainly to the buffer zone which the Company wishes to develop.

It is believed that the Statement predicts the long-term economic and social effects accurately. The demand for industrial land in the region is not being met adequately by the supply. Land use around the site will become increasingly industrially orientated rather than the mix of rural-grazing/industrial land uses that exist at the present time. The areas to the north of the Hunter River are likely to develop as an industrial complex.

The increase in population as a result of the additional jobs combined with the continuing expenditure from the smelter will add to the region's economic base.

The project will result in major increases in export earnings for the Nation which will flow directly to employees, material suppliers, government revenues and shareholders of the participating companies and indirectly to other sectors.

EFFECT OF CHANGES TO THE PROJECT ON THE LEVEL OF IMPACT

The design and operational safeguards proposed for the project substantially eliminate or minimise the potential impacts of the proposal. The emission and air quality controls to be incorporated employ the most advanced technology proven at the present time. The Company believes that its safeguards will be adequate for the life of the smelter and does not envisage a need to upgrade the levels of control.

CONCLUSION

This Environmental Impact Statement has been prepared for Tomago Aluminium Company Pty. Limited to support the proposal by a consortium of Australian and prominent overseas companies to build and operate an aluminium smelter at Tomago, in the Hunter Valley, New South Wales, Australia.

The Company's objectives for the proposal have been detailed and relate to the development of the smelter to produce 220,000 t/y of aluminium metal for export.

The environmental investigations have identified the potential impacts and safeguards proposed to enable the operation to be conducted to meet requirements specified by authorities.

The findings have shown that impacts will be primarily confined to the immediate vicinity of the smelter. These effects will be related to an increase in fluoride levels in vegetation which in turn will cause a change in structure and composition of native flora and fauna assemblages. Certain ornamental plants, fruit trees and vegetables grown within close proximity to the plant may be affected by increased fluoride levels and the grazing of animals in this zone will be restricted. The Company is negotiating with concerned residents and landholders to purchase properties.

A series of investigations and monitoring programmes have been developed to establish details of ambient conditions to control the operation of the plant and to identify precisely any unforeseen problems as they arise.

Studies of the broader implications of the proposal have indicated that there will be no adverse impact on human health. The smelter will have no effects on existing recreational facilities near the site or recreational use of the Hunter River. The site is remote from the major attractions, Lake Macquarie, Port Stephens, vineyards at Pokolbin and beaches and will have no adverse impact on tourism. An upgrading of accommodation facilities as a result of the project is likely to be a benefit.

There will be significant net benefits to the economy of the region and Nation. Of the initial investment of $600 million, more than 80 per cent will be spent in Australia. During both construction and operation, there will be a reduction in regional unemployment levels in skilled, semi-skilled and unskilled sectors. Employment will be available on the site and generated in associated industries and service organisations located in the region and elsewhere. The Company will directly provide over 800 new job opportunities.

Export earnings will be substantially increased compared with the income derived from the sale of unprocessed bauxite. These will flow directly to employees, equipment suppliers, government revenues and shareholders of the participating companies and indirectly to other sectors.

The project will assist in the achievement of the economic goals of the Hunter Regional Plan. The use of existing zoning and infrastructure is to be maximised. There will be a reduction in the regional trend of out-migration and a stabilising of existing and planned settlement patterns.

The less attractive features of the proposal relate to the need to haul raw materials and products on roads between the smelter and the port and in particular to the impact of the traffic and construction noise on residents on Tomago Road between the site and the Pacific Highway.

The Company is confident that a viable smelting operation can be conducted on the Tomago site. The environment will be adequately protected to ensure a minimal level of impact. The region will benefit from the proposal.

Key to the Environmental Impact Statement

SECTION 1

KEY TO THE ENVIRONMENTAL IMPACT STATEMENT

SUMMARY

This section is provided to assist interested persons to understand the arrangement of information in the Statement and the method of investigation used to gather the information, and arrive at the conclusion on the effects of the smelter.

1.1 HOW TO READ THIS IMPACT STATEMENT

Tomago Aluminium Company Pty. Limited believes that it is important that persons interested in reading the Environmental Impact Statement for its smelter proposal at Tomago should first understand the way in which the results of the investigations leading to the conclusions in the *Summary and Overview* are presented.

There are three volumes to the Statement.

VOLUME 1 contains the text of the Impact Statement.

VOLUME 2 contains the appendices supplying the details of many of the investigations reported briefly in the first volume.
It is not necessary to read Volume 2 to appreciate Volume 1.

VOLUME 3 presents the figures and diagrams used to illustrate Volumes 1 and 2. A separate volume of figures has been provided so that a figure and the text referring to it can be viewed together.

Referring to Volume 1. Excluding this key to the Impact Statement *(Section 1)* there are eight sections.

Section 2 introduces the proposal, views it in its setting in the Hunter Valley, indicates the Government Departments involved in discussions with the Company and the pollution control requirements of the State Pollution Control Commission.

Section 3 details the corporate structure behind Tomago Aluminium Company Pty. Limited and presents information about the manufacture and marketing of aluminium throughout the world; basic to the Company's decision to come to Australia and the Hunter Valley.

Section 4 looks at the alternative sites and transportation options examined before the Tomago site was selected as the favoured site. *Sections 3* and *4* are background information to the Company's proposal.

Section 5 describes the Company's proposals for constructing and operating the smelter on the site.

Section 6 is fundamental to the whole environmental study as it identifies the constraints imposed by the environment on the construction and operation of the smelter.

Section 7 describes a series of special investigations which were undertaken to better understand the properties of the existing environment and the ways in which the smelter will react with it.

Section 8 details the design and operational safeguards which were developed to meet the constraints identified.

Section 9 presents the final analysis of the impact of the safeguarded proposal and leads to the conclusions presented in the *Summary and Overview* at the beginning of the Statement.

The way in which the information is spread through Volume 1 is simply expressed in *Table 1.1*.

1.2 THE WAY IN WHICH THE ENVIRONMENTAL INVESTIGATIONS WERE CONDUCTED

There are many ways in which the environmental investigations for the smelter proposal could have been conducted. The method adopted here was to identify the problems and solve as many of them as practical so that this document presents the Company's best project and its effects for persons and authorities to assess.

Table 1.2 shows the method used to analyse the impact of the Tomago smelter proposal. The stages shown in the table are:-

1. Examination of the Company's first proposals for the smelter.

2. Detailed study of the components of the existing environment of the Tomago site and other aspects and matters likely to be affected by the proposal. This important study led to the isolation of the potential constraints imposed by the environment on the smelter.

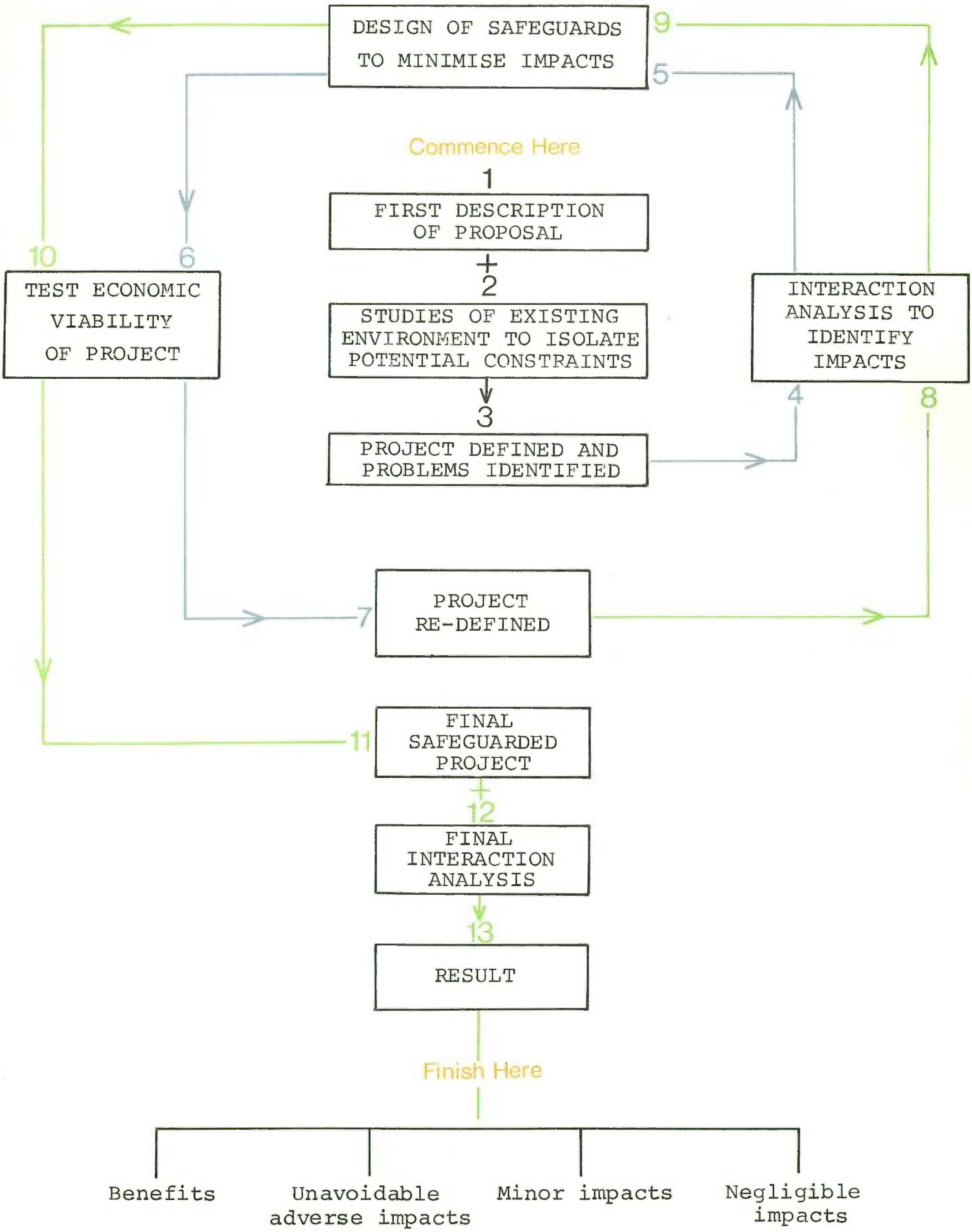
TABLE 1-1

FINDING A WAY THROUGH THE IMPACT STATEMENT (VOLUME 1)

SECTION	
1	How to follow the Impact Statement.
2	Introduces the proposal and indicates the requirements to be met by the Company.
3&4	Provide background information on the Company, the aluminium industry, reasons for coming to the Hunter Valley and for selecting the Tomago site.
5	Presents the Company's proposal. The objectives for the project and the processes and buildings to be located at Tomago are described.
6	Looks at the environment and the social and economic structure of the area before the proposed smelter comes. The constraints imposed on the proposal are identified.
7	Reports on some special studies and research to improve the understanding of the environment and the effects of the smelter.
8	Describes how the Company's best project was arrived at by designing safety precautions to minimise pollution and impact.
9	All the impacts of the fully safeguarded smelter on water supplies, people, amenities, crops, grapes, pollution levels, etc. are assessed.
Summary and Overview	This section at the beginning of the Statement summarises the findings and conclusions.

TABLE 1-2

THE METHOD OF ENVIRONMENTAL IMPACT ANALYSIS



3. The proposal was then defined and viewed in its true perspective showing all the problems, e.g., those causing pollution.

4. The first interaction analysis was undertaken to identify the seriousness of the problems, the need for safeguards, and hence the potential impacts.

5. Design and operational safeguards (e.g., atmospheric emission controls) were incorporated in the project to minimise the impacts identified.

6. The cost of the safeguards was then considered to ensure that the proposal remained viable after they were added.

7. The proposal was redefined to include all the viable safeguards and the impact assessment process started again.

8,9,&10. The process of impact identification, minimisation of impacts with safeguards, and tests of viability was repeated until the maximum practical safeguarding was achieved.

11. The final safeguarded proposal was arrived at.

12. The final interaction analysis was conducted.

13. The results of the impact analysis identifying the benefits, unavoidable, minor and negligible impacts was reached.

The approach for the preparation of the Impact Statement follows the general procedures outlined in Environmental Standard EI-4 (amended) of the Planning and Environment Commission, New South Wales, and also complies with the provisions of the Environmental Protection (Impact of Proposals) Act as required by the Commonwealth Government.

Introduction

SECTION 2

INTRODUCTION

SUMMARY

The proposal of Tomago Aluminium Company Pty. Limited to construct an aluminium smelter at Tomago in the Hunter Valley is introduced.

The Hunter Region is undergoing a period of growth due to industrial development and the smelter proposal is reviewed within the present regional setting. The role that the Company sees for its new smelter in the region and the Shire of Port Stephens is outlined.

A summary is presented of the status of the Company's negotiations with governmental authorities and of the requirements to be met for the control of pollution.

Attention is drawn to the Impact Statements for port facilities and transmission lines to be read in conjunction with this Statement.

2.1 THE COMPANY'S PROPOSAL

This Environmental Impact Statement has been prepared by James B. Croft and Associates at the request of Tomago Aluminium Company Pty. Limited to support applications to Port Stephens Shire Council for Development Consent and to the Commonwealth and State Government Authorities for approvals to establish an aluminium smelter on properties held by the Company at the location at Tomago in the Shire of Port Stephens shown in *Figure 1.1*.

Tomago Aluminium Company Pty. Limited is the operating company acting for the consortium of Aluminium Pechiney Australia Pty. Limited, Gove Aluminium Finance Pty. Limited, the Australian Mutual Provident Society, through its wholly owned subsidiary TOA Pty. Limited, Vereinigte Aluminium Werke Australia Pty. Limited and Hunter Douglas Limited. The major shareholder in Gove Aluminium Finance Pty. Limited is CSR Limited.

The proposal is to develop an aluminium smelter to produce up to 220,000 t/y of finished product for export. At this stage there are no plans to expand production. Development will be over a period of some seven years.

The proposed smelter will incorporate a proven technology developed by Aluminium Pechiney for the conversion of alumina to aluminium metal. The Company successfully participates in twenty aluminium smelters complying with the requirements for the protection of the environment in seven countries throughout the world. The smelter at Tomago will be built and operated to modern standards and will incorporate the most up to date technology for the efficient production of aluminium and to minimise pollution.

The overall reasons for selecting Australia for the smelter were ready accessibility to sources of raw materials, proximity to expanding markets in Asia, long-term availability of economical power based on coal resources, and a stable political situation. The choice among the potential sites in the Hunter Valley was based on factors including proximity to electrical supply points, accessibility to port facilities and industrial infrastructure, the availability of a site with sufficient area for the smelter with a surrounding buffer zone, and the ability to construct and operate a smelter in an environmentally acceptable manner. It was on this basis that the site of the former Courtauld's textiles factory at Tomago was selected.

The basic raw materials for aluminium production, alumina and petroleum coke, are to be shipped to the Port of Newcastle, unloaded at a new berth to be constructed on Kooragang Island and taken by road to the smelter at Tomago. Electrical power to the site will be supplied from the State grid by the New South Wales Electricity Commission. The aluminium metal will be cast into various shapes and trucked to the Port of Newcastle for transport by ship to various market destinations.

Tomago Aluminium Company Pty. Limited will be a new modern industrial enterprise in the Hunter Valley and in operating on the former site of Courtaulds (Australia) Limited will help to restore the advantages lost to Port Stephens Shire in the closure of that plant. The project is expected to become a new focus for the stimulation of industrial growth in the Hunter Region.

The Company intends to maximise the use of local knowledge, labour and suppliers and, with its own contribution of experience and resources, will operate to supply a growing demand for aluminium throughout the world.

2.2 OBJECTIVES OF THE IMPACT STATEMENT

Programmes of negotiations with governments, environmental and engineering investigations, land procurement, planning and marketing and financial feasibility studies have shown that the construction and operation of the smelter proposed by the Company will be a viable venture on the site chosen at Tomago. This document has been prepared to detail the procedures proposed to safeguard the environment and as an objective assessment of their effectiveness.

Every attempt has been made to consider all potential environmental effects, present data on all relevant aspects of the smelter design and operation and report the results of all investigations. The Company and its Consultants believe that the implications of the proposal have been carefully assessed in terms of the current state of knowledge of the impact of aluminium smelting and that the predictions stated are fair and accurate.

The Statement is submitted as a basis for discussion and not as a 'fait accompli' for the proposal. The Company is prepared to rectify omissions and reconsider any aspect which may appear to be insufficiently accounted for. Personal communications from organisations, groups and individuals are welcomed.

2.3 SETTING IN THE HUNTER VALLEY

2.3.1 Regional Growth

The Hunter Valley is now widely recognised as a mature regional entity. Its established record of growth and development reflect a long standing successful working partnership between residents, industry and governments. The fact that opportunities for increased productivity and major new ventures are now greater than ever is a tribute to the region's economic vitality and attractiveness for investment.

The region contains fifteen local government areas and, with a population in excess of 430,000, ranks sixth in importance in Australia. The economy is broadly based with the primary industries, agricultural, pastoral, horticultural, viticultural, forestry and fishing all represented, long established mining and heavy manufacturing industries and strong wholesale, retail and servicing sectors. There are established urban centres and a transportation infrastructure centred on the port of Newcastle.

The recent depression of the National economy has resulted in substantial unemployment in the Hunter Valley. A period of industrial growth, which has traditionally underlain the region's prosperity, is needed to improve this situation with all of its severe economic and social implications. The indications are that such a period is imminent, as the region has entered a period of growth unprecedented since the early establishment of the coal and steel industries.

As in the past, the growth is based upon the extraction of the Valley's coal resources in response to world wide demands for coals as fuels and raw materials for metal producing, manufacturing and chemical industries. *Figure 2.1* shows the areas of mining development and the locations proposed for new industrial projects.

A demand for large tonnages of coal for export markets emerged in the early 1970's and led to renewed interest in the Singleton Coal Measures of the Upper Hunter Valley with opencut mining potential. The New South Wales Government responded and allocated many of the areas shown in the figure for exploration. By the end of the decade a number of important new mines with target production levels of up to 5 mtpy were in the early production, development and final planning stages.

All growth predictions for coal point to accelerating demands for steaming and coking types. Many new mines are expected to come into production in the 1980's and 1990's and provide job opportunities for thousands of new mine workers. The population of the Singleton-Muswellbrook area alone is likely to double to 50,000 before the end of the century.

In addition to being a source of coal for export, the Hunter Region's coal resources will continue to attract electric power generating stations to meet the State's normal growth in demand for electricity and additional demands of new power consuming industries. New power stations are currently being constructed at Eraring on Lake Macquarie and close to Liddell in the Upper Hunter to supplement the existing stations in the region at Liddell, Wangi, Vales Point and Lake Munmorah. It is conceivable that further stations will be built in the Hunter Region in the future.

It can also be expected that the region will continue to interest a range of major industries directly and indirectly dependent on coal. The established infrastructure, mature economy and workforce potential are also important determining factors. Already the viability of coal conversion and metallurgical coke production are being evaluated. Ultimately, when these industries are established, opportunities will follow for chemical and related industries to process and manufacture by-products.

The Tomago aluminium smelter proposal, a similar project by Hunter Valley Aluminium Pty. Limited for a smelter near Lochinvar to the west of Maitland and the expansion of the Kurri Kurri smelter of Alcan Australia Limited are all examples of the growing attractiveness of the Hunter Valley to industry.

The expansion in mining and heavy industries is creating work for the construction and servicing sectors. In addition to the projects themselves, new installations for the storage and handling of raw materials and products, rail connections and loading facilities, roads, port works, reliable water supplies and sources of sand, gravel and crushed rock for building are all required and many works are in progress and being planned. The region is already seeing a rapid growth in the business of smaller firms and agencies selling, hiring and maintaining plant, vehicles and equipment, and supplying design, construction and fabrication services, goods and materials.

Development is not restricted to major industries as building booms are currently being experienced by many local government areas in the region. There are widespread demands for housing and the erection of new commercial buildings and complexes are evident in all centres, particularly Newcastle.

The proposal of Tomago Aluminium Company Pty. Limited is one of a large number of new projects coming forward to strengthen the industrial complex of the Hunter Valley. The region has prospered historically from development of its heavy industrial base and will do so again as the benefits of the major investments are redistributed.

2.3.2 Challenges for the Future

Amid a lot of activity in the Hunter Valley, there are residents genuinely concerned that the benefits of industrial expansion may not be shared, that some may be personally or financially disadvantaged and the living environment may be irreversibly changed for the worse. These fears are not without grounds as industrial development has traditionally brought social and environmental problems as well as affluence. This need not be the case in the Hunter Valley as many of the potential problems are recognisable at this stage. Examples of the types of broad planning, environmental, social and economic issues that are sources of concern are:-

i. There is growing competition for land among mining, farming, manufacturing, urban, natural and undisturbed uses. Sterilisation of coal, boundary conflicts, transport and service corridors, intrusions onto floodplains and land buying and resumptions for various purposes are all questions for consideration.

ii. The Hunter Valley, beyond the coastal plain, is a relatively narrow valley with a confined air space. Many sources contribute to reduced air quality and more information is needed on the meteorology to form accurate assessments and bases for the design of safeguards.

iii. The Hunter River is a small river to be given a large task of supplying agricultural, industrial and urban water needs and maintain its quality and ecological integrity.

iv. There are many sociological and socio-economic questions which are related to aspects like i, ii and iii, as well as to pressures from growing permanent and transitory populations, needs for amenities, facilities and services, differences in incomes and opportunities and communication problems.

v. Economic questions are related to the allocation of the costs of development between the public and private sectors, priorities in the expenditure of public funds, cost pressures on local councils and communities providing facilities and services, compensation for losses and discomfort and redistribution of benefits.

Many of these questions relate to the collective effects of projects and to industrial development in general, and are more in the province of governments than individual project proponents. Nonetheless, this Statement addresses those issues relevant to the Tomago proposal. In particular, the social and economic aspects were considered important. The partner companies to the project recognised the growing pressures on the Upper Hunter in selecting the Tomago site for a smelter and the low levels of impact identified in the environmental investigations confirmed the decision.

2.3.3 Shire of Port Stephens

The proposed Tomago site is in the Shire of Port Stephens which covers an area of 978 km^2 from the north of the Hunter River to Port Stephens. The administrative centre for the Shire is at Raymond Terrace.

The Shire is the major growth centre in the Hunter Region. The 1976 population of 20,935 represents an increase of 18.1 per cent since 1971. The main centres are Nelson Bay and Raymond Terrace with populations of 4966 and 6989 respectively.

Building is the growth industry. In 1978, Council received 1138 building applications with a total value of $19 million. In 1979, the number rose to 1384 with a value of $29 million. Most applications were for single dwellings, flats and commercial buildings.

Tourism is an important industry for the Shire and Council is actively promoting the many attractions of Port Stephens beaches and waterways.

The land use is predominantly rural. In 1977/78, the Shire had 201 rural holdings with an average size of 112 ha. Dairying has been dominant until a recent decline, due to economic factors, resulted in changes to grazing and subdivision of the land into hobby farms. Oyster farming is important in Port Stephens and market gardens and poultry farms are scattered throughout the Shire.

Light industry is gaining in importance as manufacturers and workshops are attracted to the industrial zone at Tomago.

Two major water supply works for the Lower Hunter Valley are located in the Shire. The Tomago Sandbeds water supply works are located northeast of Tomago. Groundwaters are extracted over an area of 91 km^2 from 20 pumping stations with a yield of 625 $kl/d.km^2$. The Grahamstown water supply works are located east of Raymond Terrace.

The proposed new smelter at Tomago will occupy the site of the former Courtaulds (Australia) Limited's textiles plant and will help restore the 1200 jobs lost when the factory closed in 1976.

2.3.4 The Company's Role

The advantages of the Hunter Valley with its strong industrial tradition were considered in the decision to establish in the region. In proposing the new smelter, the Company sees its contribution to regional development to be:-

i. To plan and design a smelter which is technically practical and economically viable to construct and operate and meet the requirements for the approval of the project by the Department of Environment and Planning of New South Wales and the Australian Department of Science and Environment. Data are provided in this Impact Statement to enable the project to be assessed in conjunction with other new projects by the relevant authorities.

ii. To co-operate with local residents, Port Stephens Shire Council and the State Pollution Control Commission to ensure that the levels of pollution and the impacts of the project do not exceed those predicted in the Statement and specified by the Commission.

iii. To participate with residents of the area, employees and the Council to develop and operate an important new enterprise which will be of benefit to the Shire.

2.4 SUPPORTING DOCUMENTS

The proposal of Tomago Aluminium Company Pty. Limited to construct the aluminium smelter is supported by this Environmental Impact Statement and the following two impact statements concerned with port facilities on Kooragang Island and the construction of transmission lines.

"Environmental Impact Statement for Port and Storage Facilities at Kooragang Island, N.S.W."

prepared by James B. Croft and Associates on behalf of the Company.

"Transmission Line Requirements for Aluminium Smelter at Tomago"

prepared by the Electricity Commission of New South Wales.

2.5 DISCUSSIONS WITH AUTHORITIES

Discussions and negotiations on aspects of the project have been commenced with government authorities and will be continued.

Australian Department of Science and Environment: The Department's requirements for the preparation of the Impact Statement have been met. Discussions are continuing with other Australian government authorities as required.

N.S.W. Department of Environment and Planning: Liaison was maintained with the Department during preparation of the Statement.

The Company was provided with a document entitled:-

"Proposed Aluminium Smelter in Newcastle/Hunter Region, Environmental Impact Statement, Suggested Contents Brief".

The brief was taken into account in the preparation of this Statement.

State Pollution Control Commission, N.S.W.: The Company's involvement with the Commission will be on a continuing basis. The safeguards for pollution control at the proposed smelter have been discussed and the project description, dispersion modelling and monitoring programmes presented in this Statement incorporate many of the aspects considered. The Commission's general requirements for the smelter are summarised in the following Section 2.6.

With the approval of the proposal in principle and the receipt of Development Consent from Port Stephens Shire Council, the Company will confer with the Commission for approvals to construct and licences to operate under the Clean Waters, Clean Air and Noise Control Acts. Additional information including details of engineering designs and operational procedures will be supplied to support the relevant applications.

Premier's Department - Industrial Development Unit: The Company has worked closely with the Unit in the selection of the favoured site and the development of the proposal. The discussions are continuing.

Maritime Services Board: The Company is collaborating with the Board in the planning and design of the port and storage facilities on Kooragang Island.

N.S.W. Public Works Department: The Company has been involved with the Department in the proposals for the port and storage facilities.

Electricity Commission of N.S.W.: Discussions with the Commission relate to electric power negotiations and the provision of transmission lines to the Tomago site.

N.S.W. Department of Main Roads: The Company is discussing with the Department the requirements for the use of main roads between the port facilities on Kooragang Island and the proposed smelter at Tomago.

Hunter District Water Board: The Board administers the supply of water to Newcastle and has requested the Company to investigate the potential contamination of the Tomago Sandbeds from the smelter operations. The results of the studies conducted to date are presented in the sections of the Statement concerned with the impact of the proposal on groundwater.

Port Stephens Shire Council: The Company has discussed the requirements for the project with Council which will be responsible for granting Development Consent. Arrangements are also being made with Council and the Planning and Environment Commission for a display of material associated with the project in Raymond Terrace.

Newcastle City Council: The Company is discussing with Council its requirements for Kooragang Island and the road haulage of raw materials from the port facilities to Hexham.

Other Authorities: Discussions and information have been received from the Australian Bureau of Meteorology, Energy Authority, N.S.W., Department of Mineral Resources, The National Parks and Wildlife Service, N.S.W. and other authorities.

A full list of authorities consulted is provided in *Appendix 1* with the project team for environmental investigation.

2.6 REQUIREMENTS FOR POLLUTION CONTROL

The assessment of impact of the proposed smelter at Tomago has been based upon an emission rate for fluorides of 1 kg/t of aluminium. This standard is used by the U.S. Environmental Protection Agency as the limiting factor for fluoride emission control action at sources and has been adopted by the State Pollution Control Commission for assessment purposes.

The Commission's intended approach to pollution control of aluminium smelters is presented in the recent publication:-

"Pollution Control in the Hunter Valley with Particular Reference to Aluminium Smelters".

Tomago Aluminium Company Pty. Limited's planning is in accord with this publication.

The requirements as outlined in the document can be summarised as follows:-

Smelter Design

Air-Pollution Controls: Effective controls are to be applied to all stages of the electrolytic reduction of alumina to aluminium metal and to the associated activities including anode baking, metal casting and dust generating sources such as shot blasting, crushing, grinding and screening.

Water-Pollution Controls: The controls are to be included for cooling waters, site runoff, leachates from solid wastes and sewage wastes.

Noise-Pollution Controls: All potential sources are to be controlled.

Post-Development Controls

Control of pollution from the smelter operations is to be based upon a detailed monitoring programme to cover the following aspects:-

i. Smelter emissions.

ii. Ambient air quality.

iii. Damage to and foliar fluoride levels in native vegetation.

iv. Damage to and foliar fluoride levels in cultivated (non-forage) vegetation.

v. Foliar fluoride levels in forage.

vi. Effects on farm animals.

vii. Effects on native and other wild animals.

Impact of Operations

The Commission has recommended that a buffer zone be developed around the smelter to avoid unnecessary damage to vegetation and animals. Zones of decreasing potential impact around the smelter are to be predicted initially by mathematical modelling techniques and by the results of the monitoring programme when the smelter comes into operation.

Guidelines as to atmospheric fluoride levels leading to damage and appropriate land uses are given as:-

i. Effects on Native Vegetation: Sensitive Australian vegetation is at risk when the 3-month average of gaseous fluorides exceeds 0.5 $\mu g/m^3$.

ii. Effects on Grapes: 0.1 $\mu g/m^3$ average for the growing season is the maximum concentration tolerable for the growing of grapes.

iii. Effects on orchards growing stone fruits and gardens for Gladioli and other sensitive species: These activities are best conducted outside of zones around the smelter with concentrations greater than 0.1 $\mu g/m^3$.

iv. Plants such as Barley, Citrus Species, Sorghum, Sunflower and Clover: These should be grown beyond the zones with more than 0.5 $\mu g/m^3$.

v. Farm Animals: Guidelines for the protection of cattle require that the fluoride content of forage, expressed as mass of fluoride on a dry unwashed basis, should not exceed

- 80 mg/kg more than once in any two consecutive months,
- 60 mg/kg each month for more than two consecutive months, or
- 35 mg/kg on an annual average, using monthly samples.

vi. Native Animals: Limits have not been set but when the criteria applied to cattle are used, sensitive animals would be at risk in zones with concentrations greater than 0.3 $\mu g/m^3$.

Corporate Structure, Economics and Marketing

SECTION 3

CORPORATE STRUCTURE, ECONOMICS AND MARKETING

SUMMARY

This section presents the background to the decision of the Consortium of Aluminium Pechiney Australia Pty. Limited, Gove Aluminium Finance Pty. Limited, Australian Mutual Provident Society, VAW Australia Pty. Limited and Hunter Douglas Limited to establish an aluminium smelter at Tomago in New South Wales.

The companies' discussions with governments,and financial and marketing studies conducted since 1978 have shown that a viable smelter can be operated from this location.

The major shareholders, Aluminium Pechiney Australia Pty. Limited (35 per cent) and Gove Aluminium Finance Pty. Limited (35 per cent), acting as Tomago Aluminium Company Pty. Limited will be responsible to the Consortium for the management of the construction and operation of the smelter. The remaining shareholders are active in the production of aluminium and aluminium products throughout the world, or are providers of funds and will contribute to the Consortium according to their expertise.

Overall Australian equity in the proposal is 51 per cent.

World-wide economic criteria including a growth in demand for aluminium of 5 per cent per annum, declines in the ready availability of fuels, particularly oil, and resultant escalating cost of production in Europe and the USA have led to increased interest in investment in smelters in Australia.

Other factors contributing to Australia's attractiveness are large bauxite reserves, reliable supplies of energy at competitive rates, established infrastructure including harbour facilities, a skilled workforce, political stability and government initiatives in welcoming industries.

Restrictive environmental requirements overseas have not been a factor in the selection of Australia as the optimum location.

Australia is the largest producer of bauxite (31 per cent) and the second largest producer of alumina (22 per cent) but only produces 2 per cent of the western world's aluminium. Due to inadequate refining and smelting capacities, approximately 25 per cent of Australia's bauxite and over 90 per cent of alumina production are exported. The Company's proposal to help to

3.1 TOMAGO ALUMINIUM COMPANY PTY. LIMITED

3.1.1 History of the Proposal

Encouraged by its awareness of the potential of New South Wales for large investment and after preliminary discussions with the Government, Aluminium Pechiney Australia Pty. Limited commenced feasibility studies for an aluminium smelter in the State in 1978.

The Hunter Valley area was chosen as the optimum location because of the availability of electrical power at competitive rates with overseas sources, proximity to shipping and bulk unloading facilities, a reliable workforce, ample land for development and ready access to Australian and overseas markets.

Power agreements were negotiated with the Electricity Commission of New South Wales for the supply of the first block of power of 190 MW not earlier than January 1st, 1983, and not later than August 31st, 1983, with a second block available on June 1st, 1985, and not later than December 31st, 1985.

A preliminary assessment of potential sites in the Hunter Valley, New South Wales was carried out by *James B. Croft and Associates (1979)* and the former Courtaulds textiles factory site at Tomago was selected as the preferred site on environmental, economic and technical grounds. Details of the sites examined are considered in *Section 4*.

Following decisions to proceed with the project, a consortium was formed in December 1979 consisting of Aluminium Pechiney Australia Pty. Limited, Gove Alumina Limited, which held an option on the Courtaulds site, and the Australian Mutual Provident Society to establish the proposed smelter. In January 1980, Vereinigte Aluminium Werke (VAW) and Hunter Douglas NV were introduced as further partners. The interest in the project held by each of the joint venturers is:-

Company	Percentage
Aluminium Pechiney Australia Pty. Limited	35
Gove Aluminium Finance Pty. Limited	35
Australian Mutual Provident Society	15
VAW Australia Pty. Limited	12
Hunter Douglas Limited	3

An operating company to act as agent for the joint venturers was incorporated in March 1980 under the name of Tomago Aluminium Company Pty. Limited. Overall structure of the Tomago smelter project is shown in *Figure 3.1.*

3.1.2 The Consortium

The companies participating in the project are:-

Aluminium Pechiney Australia Pty. Limited

The Company is a subsidiary of the French Pechiney Ugine Kuhlmann Group which produces about 8 per cent of western world aluminium and is the largest manufacturer of aluminium in Europe, producing 1 mt/y.

The Group ownsor has interests in twenty smelters located in France, Cameroun, United States of America, Spain, Greece, Holland and South Korea and manufactures a full range of semi-fabricated products from aluminium metal.

Pechiney Ugine Kuhlmann is the world's largest seller of smelter technology. Independent producers in Scotland, Yugoslavia, Russia, Brazil and Japan utilise Pechiney processes.

The Group also produces specialty steels including stainless and bearing steels, structural and tool steels, titanium and zirconium, and a new series of high-strength, boron steels for the machine tool and automotive industries. Copper wire and cables are manufactured for electrical use, bar, tubes, sheet and strip for other industries. Insulated conductors for electrical power distribution, telecommunications and other applications are also marketed.

The Group manufactures carbon products including all types of electrodes and cathode blocks used in electro-metallurgical processes.

The Company mines fluorospar for the reduction of aluminium, for production of fluoride derivatives and for fluorination of uranium.

In 1977, Pechiney Ugine Kuhlmann mined 4.5 mt of bauxite from deposits located in France, Greece and Guinea for processing in refineries operated by the Company in these countries. It also participates in the exploration and mining of uranium, ore concentration and fluorination and fuel element manufacture and assembly.

The manufacture of chemicals accounts for approximately 20 per cent of sales. The range of products manufactured includes pesticides, fungicides and pharmaceutical products, halogen compounds such as fluorine derivatives, hydrogen peroxide, adhesives, plastics, dyes and pigments. In 1977, 52,000 t of aluminium fluoride and 14,600 t of cryolite were produced for aluminium smelting.

Materials for use in the manufacture of prosthetic and orthopaedic appliances and hospital equipment are also produced.

In Australia at the present time, the Pechiney Ugine Kuhlmann Group is active in two main areas. Aluminium Pechiney Holdings Pty. Limited holds a 20 per cent interest in the Aurukun bauxite deposits on Cape York Peninsula, Queensland. Other participants in this venture are Billiton of Australia with 40 per cent and Tipperary, a Texan Company with 40 per cent.

Aluminium Pechiney Australia Pty. Limited has 20 per cent equity in Queensland Alumina Limited which operates the world's largest alumina plant at Gladstone. The Company's share of alumina produced at this plant, which amounts to 480,000 t/y, is currently shipped to the USA for processing.

Gove Aluminium Finance Pty. Limited

This Company is the vehicle through which Australian shareholders in Gove Alumina Limited will participate in the proposed smelter project. The shareholding is:-

Company	Percentage
CSR Limited (through a wholly owned subsidiary)	50.00
Peko Wallsend Limited	12.90
Australian Mutual Provident Society	12.34
Mutual Life and Citizens Assurance Company Limited	9.28
Bank of New South Wales	5.16
Commercial Banking Company of Sydney Limited (through a wholly owned subsidiary)	5.16
Elder Smith Goldsbrough Mort Limited	5.16

All are Australian companies and among the leaders of the financial, mining, manufacturing and rural industries in Australia.

Gove Alumina Limited has a 30 per cent interest in the Gove bauxite mine and alumina refinery. The remaining 70 per cent interest is held by Swiss Aluminium Australia Limited. Proved reserves of bauxite at Gove total 226 mt. Alumina shipments by the joint venturers in the year ended March 1979 totalled 1.13 mt, whilst Gove Alumina Limited exported 1.77 mt of bauxite.

Australian Mutual Provident Society (AMP Society)

The Company is the largest mutual life insurance company in Australia with total assets of $6,049 million at December 31st, 1979. It is wholly owned by its policy holders. The AMP Society is a major provider of funds for national resource development and in 1979 investments totalled $749 million.

The AMP Society participates in the Australian alumina industry through a 12.1 per cent interest in Gove Alumina Limited and its equity in the proposed Tomago Aluminium smelter is above 20 per cent when account is taken of this and its shareholdings in CSR Limited and Hunter Douglas Limited. The Company is participating in the Tomago project through a wholly owned subsidiary, TOA Pty. Limited.

VAW Australia Pty. Limited

The Company is a subsidiary of Vereinigte Aluminium Werke (VAW), the largest producer of primary aluminium metal in West Germany. It operates five aluminium smelters in West Germany and has a share in a sixth. Producing 369,000 t of aluminium in 1979 it was the eighth largest producer in the world.

Comalco Limited is a major supplier of bauxite to VAW's two alumina refineries in West Germany. VAW has a 50 per cent interest in a third alumina refinery in West Germany, a 10 per cent entitlement to bauxite from the Bokē project, and 5 per cent entitlement to alumina output from the Friguia project, both in Guinea.

VAW is 99.99 per cent owned by Vereinigte Industries - Unternehmungen, a wholly State owned corporation.

Hunter Douglas Limited

The Company is a leading Australian manufacturer of aluminium, architectural, building and consumer products. The majority shareholder is Hunter Douglas NV. Thirty per cent is held by institutions and the general public in Australia.

Hunter Douglas NV is headquartered in the Netherlands, and as well as the activities indicated above, the Company develops, manufactures and distributes precision machinery and machine tools and engages in metal trading. It has production facilities in fourteen countries including Australia, and a 15 per cent interest in the Pechiney aluminium smelter at Vlissingen in the Netherlands.

Australian equity in the Tomago smelting project varies depending upon the definitions that are applied. However, effectively the breakdown is:-

Company	Australian Equity (percentage)
Gove Aluminium Finance Pty. Limited	35
TOA Pty. Limited	15
Aluminium Pechiney Australia Pty. Limited	-
VAW Australia Pty. Limited	-
Hunter Douglas Limited	1
	51

3.1.3 Tomago Aluminium Company Pty. Limited

This company is jointly and equally owned by Aluminium Pechiney Australia Pty. Limited and Gove Alumina Limited and was formed to manage the construction and later the operation of the smelter. Technical and management services to Tomago Aluminium Company Pty. Limited will be provided by Aluminium Pechiney, Aluminium Pechiney Australia Pty. Limited and CSR Limited.

3.1.4 Roles of the Participants

Each of the participants will provide its share of the expenditure to construct the project and bring it into operation. Each will then provide alumina according to its interest, pay its share of operating costs and take its share of product aluminium metal. The advantages of this arrangement are that the partners can arrange the financing to best suit their interests, and also handle any taxation benefits, such as investment allowances to best suit their own situations. Each participant is represented on the policy committee and has an opportunity to influence major policy matters, construction budgets and operating budgets.

Aluminium Pechiney and Gove Alumina also have special responsibilities needed to further the venture. Aluminium Pechiney will supply technology for the smelter, including training of personnel and provision of key technical and senior management staff. Gove Alumina and its 51 per cent parent CSR, will provide management expertise in the areas of industrial relations and commercial accounting. Appropriate fees will be paid to the respective companies for the provision of these services.

3.1.5 Preparatory Activities

The consortium has continued the environmental investigations which form the basis for this Impact Statement. Environmental aspects have been considered in every stage of the investigation and design work for the smelter. Discussions have been held with government authorities and private bodies with interests and expertise in environmental matters, and their comments have been incorporated as part of the design process. The result of this approach has been a high level of safeguards and therefore a low potential for adverse environmental effects.

It is expected that construction of the plant will be carried out by an international firm experienced in Australian operations. It is estimated that over 80 per cent of the capital investment will be spent in Australia. Only specific pieces of equipment which are not manufactured in Australia or cannot be supplied at the time required will be imported.

It is expected that the first potline of 110,000 t/y capacity will commence production in March 1983, and the second, also of 110,000 t/y capacity, in 1985. At full capacity, approximately 430,000 t of alumina will be used each year in the smelting process, and it is expected that all the alumina used will be derived from Australian sources.

3.2 WORLD ALUMINIUM INDUSTRY

3.2.1 Growth

The world aluminium industry has experienced substantial growth over the last decade. Between 1960 and 1974, aluminium consumption grew at a rate of about 9 per cent, almost twice the growth rates of aluminium's two main competitors, steel and copper.

Since 1974, growth has stabilised at approximately 5 per cent per annum. Nevertheless, the demand is steadily increasing and is expected to accelerate because of the potential for the metal to be used as an energy saving material in the packaging, transport, building and electrical industries.

Tomago Aluminium Company Pty. Limited believes that extra capacity will be needed by the 1980's to meet forecast world demand, shortages caused by a lack of investment in the smelting industry since 1974, and production cutbacks in Japan. The Company forecasts a continuing international long-term growth in primary metal demand of approximately 5 per cent in the western world and over 7 per cent in developing Asian countries.

The *Commonwealth Department of Industry and Commerce (1979)* has estimated that, from 1977 to 1982, western world aluminium production capacity will increase by 3.1 per cent per annum from 13.1 mt to 14.8 mt. From 1982 to 1985, installed capacities will increase by 5.3 per cent per annum rising from 14.8 mt to 18.2 mt at the end of 1985. New plants in Africa, Latin America, Asia and Australia are expected to account for 66 per cent of the total increase in smelting capacity.

3.2.2 Structure

Aluminium smelting is a highly specialised process requiring high capital investment and, consequently, large corporations, in consortium or singularly, have tended to dominate all stages of production.

Although there are over 70 producers in the western world, six corporate groups account for approximately 60 per cent of alumina capacity and about 55 per cent of primary aluminium capacity. These groups are Pechiney Ugine Kuhlmann (French), Swiss Aluminium Limited (Swiss), Alcan Aluminium Limited (Canadian), Aluminum Company of America (USA), Kaiser Aluminum and Chemical Corporation (USA), and Reynolds Metals Company (USA).

3.2.3 Production

The location of major bauxite, alumina and aluminium producing countries is shown in *Figure 3.2.* World bauxite, alumina and aluminium production are shown in *Table 3.1.*

TABLE 3.1

WORLD PRODUCTION OF BAUXITE, ALUMINA, AND ALUMINIUM

Country	Bauxite * (percentage)	Alumina** (percentage)	Aluminium** (percentage)
Australia (Oceania)	30.8	22.4	2.9
America	28.6	37.4	40.7
Europe	8.4	13.8	23.3
South and East Asia	4.7	7.8	10.5
Africa	14.0	2.0	2.3
Other	13.8	16.6	20.3
Total Production (mt)	(85)	(30)	(14.3)

*1977, **1979
Source: *Commonwealth Department of Industry and Commerce (1979)*

3.3 FACTORS AFFECTING THE LOCATION OF SMELTERS

The most relevant factors which contribute to the siting of new aluminium smelters are a reliable source of electricity at relative low cost, close proximity to raw material sources and potential markets and a stable economic and political climate conducive to investment.

Prior to 1973, aluminium producers located smelters near major markets in North America and Europe where they relied on hydro-electric power and oil-burning power stations for the supply of electricity. Economies arising from a developed infrastructure and tariff structures which favoured the import of the raw materials bauxite and alumina, rather than aluminium also contributed to the attractiveness of these countries. Subsequently, the decline in fuel availability, particularly oil, and the associated increase in the price of crude oil on international markets, significantly raised production costs in Europe and the USA, and the international aluminium industry saw the need to investigate alternative locations for investment in smelter capacity.

Australia became a focus of attention because of its reliable supplies of primary energy, especially coal and natural gas, large bauxite reserves, fewer infrastructure problems than many other countries, a skilled labour force and political stability. Other countries including South America and South East Asia meet many of these requirements but are less attractive in the overall view at this time.

Although important, environmental controls are not seen as a determining factor in smelter location in Australia as the requirements in this country are equally as stringent as in many overseas countries.

A positive benefit for companies seeking to develop the Australian aluminium industry is the investment climate resulting from the policies of the Australian and State Governments. A major thrust of the Australian Government's policies has been control of the level of inflation which, combined with inherent political stability, ensures confidence in the longer term investment potential. Flexible guidelines for foreign investment in mining and processing industries have been established and an investment allowance is provided to encourage capital expenditure. All State Governments have specific policies to facilitate the development of major projects such as alumina refineries and aluminium smelters, and the New South Wales Government has been active in promoting the advantages of the State for these industries.

All of these factors have resulted in Australia developing a leading competitive position as a world aluminium producer. This is being reflected in the increased interest shown by producing companies in establishing or expanding their smelting operations in Australia, and in the confidence of the Tomago Aluminium Company Pty. Limited in proposing the Tomago project.

3.4 AUSTRALIAN ALUMINIUM INDUSTRY

3.4.1 Structure

In Australia, five out of the six major international companies are active in alumina and aluminium production. The *Commonwealth Department of Industry and Commerce (1979)* estimates that, on the basis of plant capacity, about two-thirds of refining and smelting operations are owned by overseas interests. Historically this degree of foreign ownership has been related to the international integration of aluminium producers, and the need for experience, technology and overseas equity to assist in the planning and capital outlay required for these large projects. *Table 3.2* lists areas of interest of the major international companies.

TABLE 3.2

AREAS OF INTEREST OF MAJOR INTERNATIONAL COMPANIES

Company	Area of Interest
Kaiser Aluminum and Chemical Corporation	Bauxite mining Alumina refining Aluminium smelting
Aluminum Company of America (Alcoa)	Bauxite mining Alumina refining Aluminium smelting
Alcan Australia Limited	Alumina refining Aluminium smelting
Swiss Aluminium Limited (Alusuisse)	Bauxite mining Alumina refining
Pechiney Ugine Kuhlmann	Bauxite mining Alumina refining

3.4.2 Bauxite

Australia's abundant and accessible bauxite reserves have led to the development of the largest bauxite mining industry in the world. In 1978, 24.3 mt or 31 per cent of the total world production was mined in this country. Approximately 19 mt was processed to alumina in domestic refineries and the balance exported, primarily to Europe and Japan.

The *Commonwealth Department of Industry and Commerce (1979)* predicts that Australia's bauxite production will increase to 31 mt in 1985 to cater for additional domestic processing requirements.

Mining operations are located in the Darling Ranges of Western Australia, Cape York Peninsula, Queensland and Gove, Northern Territory. The companies operating the mines, the mine locations and capacities are shown on *Table 3.3.* and the locations on *Figure 3.3.*

TABLE 3.3

AUSTRALIAN BAUXITE MINES

Mine Operator	Location	Capacity (end 1978) (mt/y)
Alcoa of Australia Limited	Darling Ranges W.A. (Jarrahdale, Del Park Huntly)	13.50
Comalco Limited	Cape York Peninsula, Qld. (Weipa)	11.25
Swiss Aluminium Australia Pty. Limited/Gove Alumina Limited	Gove, N.T.	5.00

Source: *Commonwealth Department of Industry and Commerce (1979)*

In addition to the bauxite deposits currently being mined, two new mines have been proposed for the Darling Ranges by Alcoa of Australia Limited and Worsley Alumina Pty Ltd. The locations are shown on *Figure 3.3.* Other known commercial deposits being evaluated for mining are in the Mitchell Plateau (W.A.) and the Aurukun and Wenlock River areas on Cape York Peninsula (Qld.).

Australia's bauxite resources total approximately 6200 mt, of which 4400 mt have been classified as measured or indicated (18 per cent of total world reserves) and 1700 mt inferred. The distribution of these resources is shown on *Figure 3.3* and detailed in *Table 3.4*.

TABLE 3.4

AUSTRALIAN BAUXITE RESOURCES
(mt)

Location	Measured	Indicated	Inferred	Total
Cape York Peninsula (Qld.)	1044	931	1740	3715
Darling Ranges (W.A.)	234	750	n.a.	984
Kimberley Area (W.A.)	235	995	n.a.	1230
Gove (N.T.)	226	n.a.	n.a.	226
Totals	1739	2676	1740	6155

Source: *Bureau of Mineral Resources, Geology and Geophysics, Australia*

3.4.3 Alumina

Australia accounts for approximately one quarter of the world's alumina production. Since 1970, production has increased from 2.2 to 6.6 mt/y and Australia now ranks with the USA as the largest alumina producing countries in the world.

Three-quarters of the bauxite produced in Australia is processed in four domestic refineries at Gladstone in Queensland, Pinjarra and Kwinana in Western Australia, and Gove in the Northern Territory. The locations of these plants are shown on *Figure 3.3* and ownership and design capacity are given in *Table 3.5*.

The construction of two new 1 mt/y refineries at Wagerup and Worsley and the expansion of the Gove and Gladstone refineries is expected to increase Australia's production capacity to 10 mt/y by 1985.

TABLE 3.5

AUSTRALIAN ALUMINA PLANTS

Refinery Ownership	Location	Annual Capacity (mt)	Bauxite Sources
QUEENSLAND ALUMINA LIMITED (Comalco 30.3% Kaiser 28.3% Alcan 21.4% Pechiney 20.0%)	Gladstone (Qld.)	2.4	Weipa (Qld.)
GOVE JOINT VENTURE (Swiss Aluminium Australia Pty.Limited 70%, Gove Alumina Limited 30%)	Gove (N.T.)	1.1	Gove (N.T.)
ALCOA OF AUSTRALIA LIMITED (Alcoa U.S. 51% Western Mining 20% BH South 16% North Broken Hill 12% Other 1%)	Kwinana (W.A.)	1.4	Jarrahdale (W.A.)
ALCOA OF AUSTRALIA LIMITED	Pinjarra (W.A.)	2.0	Huntly, Del Park (W.A.)
		6.9	

In the longer term there is the prospect that refineries may be built in the Mitchell Plateau (W.A.) and Cape York (Qld.).

Australia's alumina production is expected to expand with the world production of aluminium. In 1978, Australian smelters used approximately 500,000 t of alumina. By the end of 1985 domestic consumption is expected to approach a rate of 3 mt/y. Production increases are being planned to meet the projected domestic consumption and export markets. The Tomago project will be brought into production to receive alumina refined at Gladstone and Gove.

3.4.4 Aluminium

While Australia occupies a major position in the supply of bauxite and alumina to the world aluminium industry, its smelting capacity is small by world standards. Only 10 per cent of the alumina produced locally is processed in smelters in Australia.

Currently, the three smelters in Australia have a combined capacity of 257,000 t/y, which is approximately 2 per cent of world primary aluminium capacity. The location of these smelters is shown in *Figure 3.3* and ownership and production detailed in *Table 3.6*.

TABLE 3.6

AUSTRALIAN ALUMINIUM SMELTERS

Owner	Location	1978 Production Capacity (t/y)
Alcan (Australia) Limited	Kurri Kurri, N.S.W.	45,400
Alcoa of Australia Limited	Point Henry, Vic.	100,000
Comalco Limited	Bell Bay, Tas.	112,000
		257,400

Five new smelters are planned for New South Wales, Queensland and Victoria, and extensions to existing smelters in Victoria and New South Wales. The location, ownership, proposed capacity and start-up dates are shown in *Table 3.7*.

These proposals will increase Australia's smelting capacity to 1.4 mt/y by 1985, that is, about 10 per cent of current world capacity, with the potential to rise to approximately 2 mt/y or 14 per cent.

TABLE 3.7

AUSTRALIAN FUTURE ALUMINIUM SMELTING CAPACITY

Company	Location	Capacity at End of 1985	Proposed Maximum Capacity	Proposed Initial Production Date
Comalco Limited	Gladstone, Qld.	206,000	400,000	1982
Comalco Limited	Bell Bay, Tas.	112,000	112,000	Existing
Alcan Australia Limited	Gladstone, Qld.	100,000	250,000	n.a.
Alcan Australia Limited	Kurri Kurri, N.S.W.	135,000	135,000	Extensions to existing
Alcoa of Australia Limited	Portland, Vic.	264,000	528,000	1983
Aluminium Pechiney Australia Pty. Limited	Tomago, N.S.W.	220,000	220,000	1983
Alumax Inc.	Lochinvar, N.S.W.	236,000	236,000	1984
Alcoa of Australia Limited	Point Henry, Vic.	165,000	165,000	Extensions to existing
		1,438,000	2,046,000	

3.4.5 Fabrication of Aluminium

Primary aluminium metal produced in Australia is utilised in a range of domestic markets as detailed in *Table 3.8*. Domestic consumption is expected to increase at about 5 per cent annually to 1985. At the present time, there are twelve specialist aluminium plants in Australia, manufacturing fabricated aluminium mill products.

TABLE 3.8

AUSTRALIAN ALUMINIUM DOMESTIC MARKETS

Industry	1968 (per cent)	1977 (per cent)
Building and Construction	39	37
Electrical	18	12
Consumer Durables	11	7
Transport	15	10
Containers and Packaging	8	26
Machinery and Equipment	9	8
	100	100

Source: *Aluminium Development Council of Australia, The Australian Aluminium Industry, 1978.*

3.5 POTENTIAL MARKETS

3.5.1 Domestic Market

The Australian aluminium industry is currently expanding after a period of fluctuation between 1970 and 1975. Overall, there has been an upward trend in domestic consumption as shown in *Table 3.9*.

TABLE 3.9

AUSTRALIAN CONSUMPTION OF PRIMARY ALUMINIUM METAL
('000 t/y)

1970	1971	1972	1973	1974	1975	1976	1977	1978
124	139	112	151	176	138	168	170	184

Source: *Commonwealth Department of Industry and Commerce,(1979)* It is expected that there will be an increase in local aluminium consumption of about 5 per cent per annum to 1985 when approximately 259,000 t/y will be consumed by Australian industries. Expansion of existing smelter capacity from 257,000 t/y at the end of 1978 to 412,000t/y by 1982 will adequately cater for the increased domestic demand and the new capacity to be installed is planned for export.

Projected reserves of primary aluminium metal expected to be consumed on the domestic market and available for export are shown in *Table 3.10*.

TABLE 3.10

RESERVES OF PRIMARY ALUMINIUM FOR DOMESTIC CONSUMPTION AND OVERSEAS TRADE (t/y)

	1978	1985
Production	266,500	1,385,000
Domestic Consumption	184,000	259,000
Available for Export	82,500	1,126,000

Tomago Aluminium Company Pty. Limited expects that all aluminium produced at the Tomago plant will be exported initially.

3.5.2 Potential Export Markets

Between 1978 and 1985, primary aluminium demand in the western world is expected to rise at a rate of 5 per cent per annum, a growth rate almost 50 per cent less than that observed from 1950 to 1966. Growth of demand should be greater in developing countries (7 to 9 per cent per annum) than in industrialised countries such as the USA (4.1 per cent) and Western Europe (4.9 per cent).

Tomago Aluminium Company Pty. Limited believes that installed production capacities in the western world will increase by 4.2 per cent per annum over the period 1977 to 1985. This increase will be slower in industrialised countries (between 0.5 per cent and 3 per cent per annum) and, as a result, the proportion of installed capacities in the major producing countries should decrease from 88 per cent in 1977 to 76 per cent in 1985.

Over the past decade, South East Asia and, in particular, Japan have experienced considerable industrial growth. Aluminium Pechiney Australia Pty. Limited monitored this annual growth at 8.5 per cent (compared with 2.7 per cent in the USA or 3.4 per cent in Western Europe). These economic indicators, combined with the fact that the Japanese aluminium industry is presently restructuring after a decline in competitiveness resulting from escalating fuel costs, indicate strongly that the Asian region presents a significant and increasing market for primary aluminium.

To date, Aluminium Pechiney Australia Pty. Limited has sold 50,000 t/y of primary aluminium metal to South East Asian countries, including Japan and China and by 1983, expects to trade in the vicinity of 145,000 t of metal with these nations.

In 1978, Australia exported 80,000 t of primary aluminium to Japan and South East Asia. Major importers were Japan (72 per cent), Philippines (9 per cent), China (8 per cent) and Thailand (4 per cent).

It is expected that most of the metal produced at the Tomago plant will be exported to Japan, China, the Philippines and South Korea, and will replace metal that might normally have been shipped from plants in the USA and Europe. The proximity of Australia to the developing South East Asian countries provides significant savings in transport costs and places Australian producers in a strong competitive position. Aluminium Pechiney is currently examining the feasibility of a central storage and despatch facility in Asia, possibly in Singapore.

3.6 CONCLUSION

The Tomago Aluminium Company Pty. Limited and the partners to the venture have conducted exhaustive economic feasibility and world-wide marketing studies and concluded that the proposal to construct and operate a smelter at Tomago in the Hunter Valley, New South Wales, will be a viable enterprise.

The new smelter will supply a growing demand for aluminium in reliable markets, and meet the requirement of the Australian Government that local raw materials be processed in Australia rather than exported for treatment elsewhere in the world. Recognition of the attractiveness of New South Wales, and the Hunter Valley in particular, for major industrial investment, and the encouragement of the State Government have added to the Company's convictions as to the merits of its proposal.

Alternative Sites and Transport Options

SECTION 4

ALTERNATIVE SITES AND TRANSPORT OPTIONS

SUMMARY

This section examines the alternative sites investigated by the Company prior to the selection of the Tomago site and the transport options for moving raw materials and products from the smelter to the Port of Newcastle.

The criteria for selecting the Hunter Region and suitable sites for a smelter were close proximity to electric power stations, port facilities and transportation infrastructure, the availability of water and natural gas, sources of labour for construction and suitable permanent workforce, proximity to urban centres with services, facilities and amenities and the absence of serious environmental constraints.

Seventeen sites were examined throughout the Hunter Valley. Three sites at Kooragang Island in the estuary of the Hunter River, and Williamtown and Tomago to the north of the river were shown to be the most suitable for a smelter on technical, economic and environmental grounds. Detailed environmental assessments resulted in Tomago being selected as the best location.

Important attributes of the favoured site were its ease of access, good foundation conditions, availability of services, sufficient space, industrial zoning, the existing buildings of Courtauld's textiles factory suitable for offices and other uses and the low potential for air, water and noise pollution problems. None of the alternative sites was found to be as suitable in all respects.

A number of transport options were evaluated for the movement of raw materials and products between the Port of Newcastle and the smelter.

i. Barging via the north arm of the Hunter River was not favoured because of the likely navigational and safety problems in negotiating the estuary of the river which is subject to shipping movements, tidal and floodwater flows, siltation and changes in water depth. Other factors were the absence of a permanent dredge, the need for mangrove clearance at unloading points and cost considerations.

ii. A railway linkage was discounted because of the need to construct a bridge over the Hunter River.

iii. Road and belt conveyor linkages across the western half of Kooragang Island were not selected because of the potential conflicts with nature reserve proposals and the problems of transferring materials across the north arm of the Hunter River.

iv. A road route via Stockton Bridge may be used occasionally for large items of plant during construction but is not favoured because of the longer travel distance to the plant and the number of residences to be passed along the route on the northern side of the river.

v. A road route via the Industrial Drive, Pacific Highway and Tomago Road is the favoured mode.

The use of the favoured route will result in a one hundred per cent increase in the heavy vehicle traffic on Tomago Road between 7.00 am and 6.00 pm. Heavy vehicle traffic volumes will increase on other roads during the operation of the smelter by approximately 10 per cent or less. Similar increases will occur at peak times for workforce vehicles seven days per week.

The impact on Tomago Road was high when the Courtauld's factory was in operation and was foreseen when the Tomago area was zoned industrial. Possible congestion and delays along the route due to the additional traffic at peak periods are recognised as unavoidable effects of the project.

4.1 FACTORS AFFECTING SITE SELECTION

4.1.1 Criteria

In addition to the world economic view for aluminium, the factors investigated in the Company's decision to locate a smelter in the Hunter Valley were a continuous and reliable source of electric power at competitive rates, proximity to shipping and bulk unloading facilities, suitable transportation infrastructure, sources of construction labour, reliable workforce with a balance between skilled and unskilled workers, and sites meeting space and environmental requirements.

4.1.2 Advantages of the Hunter Valley

The various criteria are met in the Hunter Valley as follows:-

Electric Power: The New South Wales Electricity Commission negotiated an agreement with the Company to guarantee a supply of power to a site at reasonable distance from the power sources at Liddell in the Upper Hunter Valley and Eraring on Lake Macquarie. A timetable for the receipt of power has been agreed to.

Port Facilities: The Hunter Valley is serviced by the Port of Newcastle which is mainly equipped for handling commodities and raw materials in bulk for export and local heavy industries. Currently the port is being deepened and further ship loading facilities are to be provided for the planned large increases in coal exports.

When operating at full capacity, the proposed smelter at Tomago will consume 430,000 t of alumina, 90,000 t of coke and 24,000 t of pitch per year. The former two raw materials will be brought by sea and the latter is expected to come from a local supplier.

Discussions with the Maritime Services Board and the New South Wales Department of Public Works established that new port facilities could be provided on Kooragang Island in the estuary of the Hunter River and the Company in association with the other aluminium producers, Hunter Valley Aluminium Pty. Limited and Alcan Australia Limited, was requested to design unloading and storage facilities. Wharf facilities would be provided by the Maritime Services Board. A separate Environmental Impact Statement has been prepared for the port facilities.

Transportation: The Hunter Valley has a developed system of roads and railways. The Company's evaluation of transportation options for raw materials and products is presented later in this section.

Water Supply: Industries in the Newcastle area are supplied adequately from the reticulation network of the Hunter District Water Board which meets the demands from its dams, storage areas and groundwater sources. Supplies in the Upper Hunter are met from the Hunter River under the control of the Water Resources Commission of New South Wales. Aluminium smelting is a small consumer of potable water and the Valley's resources are adequate to supply all needs.

Gas: Proposals to supply Newcastle with natural gas have been approved and a pipeline from Sydney is under construction.

Sites for a Smelter: The proposed smelter requires an area of approximately 78 ha of relatively flat land to accommodate potlines and plant facilities. The overall dimensions of the site also determine plant orientation and access which, in turn may affect the pattern of emission dispersion. The sites selected for investigation are considered in the following section.

Construction Workforce: A number of projects including surface facilities for coal mines, power stations, ship loading facilities and large buildings are under construction or planned for Newcastle and the Hunter Valley. Current indications are that a large pool of construction workers is being created and that major contracting firms from outside and within the region will draw on this resource as the projects come forward. Commencement and completion times for projects are sure to be staged and it is unlikely that all construction will take place at the same time. As competition for the major projects is expected to be strong, delays in meeting schedules due to workforce deficiencies are not foreseen.

Employees for the Smelter: The proposed plant will require an operational workforce of 800 persons. The Company is confident that the Hunter Valley with a population in excess of 430,000, a strong industrial base and high levels of unemployment will be able to supply the majority of workers without the need for recruiting people from outside the region. Where practical, preference will be given to employees residing locally and there will be opportunities for women.

Amenities, Services and Facilities: The Hunter Valley contains many long established urban centres well provided with public facilities, council operated services and cultural and recreational amenities. A company establishing a smelter in the Hunter Valley has no task ahead of it to construct a township and create a new community.

Environmental Requirements: The environmental requirements for new projects are identical throughout New South Wales and no special provisions exist for the Hunter Valley.

4.2 EVALUATION OF ALTERNATIVE SITES

4.2.1 Background

Following its decision to locate in the Hunter Valley, Tomago Aluminium Company Pty. Limited examined a number of sites recommended in an Investment Brief prepared by the Industrial Development Unit of the Premiers Department of New South Wales. The sites were selected on the basis of an examination of aerial photographs and topographic maps and from information supplied by local authorities and real estate agents.

A total of seventeen sites were examined and five were selected for further investigation by *Crooks Michell Peacock Stewart Pty. Limited (1979)* Finally, three sites were identified as meeting all the requirements for the siting of the proposed smelter and these were subjected to a detailed environmental assessment by *James B. Croft and Associates (1979)*, to identify the favoured site. Descriptions of all the sites and details of the environmental evaluation of the three final sites are presented in *Appendix 2*.

4.2.2 Sites in or near the Hunter Valley

The seventeen sites examined are shown on *Figure 4.1* and compared in the matrix presented in *Table 4.1*.

The sites are:-

Site 1 - Wyong (A)
Site 2 - Wyong (B)
Site 3 - Muswellbrook
Site 4 - Belford
Site 5 - Branxton
Site 6 - Greta
Site 7 - Lochinvar (A)
Site 8 - Lochinvar (B)
Site 9 - Lochinvar (C)
Site 10 - Neath
Site 11 - Heddon Greta
Site 12 - Tomago (A)
Site 13 - Tomago (B)
Site 14 - Williamtown
Site 15 - Fullerton Cove
Site 16 - Cardiff
Site 17 - Kooragang Island

TABLE 4.1

COMPARISON OF THE ENVIRONMENTAL
ASSESSMENT OF ALTERNATIVE SITES

Potential Impacts	Sites 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Site Conditions	High	High	Low	High	Medium	High	Medium	Medium	Medium	High	Low	Medium	High	High	High	Low	Medium
Coal Resources	Medium	Medium	High	Low	High	Low	Low	Low	Low	High	High	Medium	Medium	Medium	Medium	Medium	Medium
Access and Utilities	Low	Low	High	High	High	High	Low	Low	Low	High	High	Low	Medium	Low	Medium	Low	Low
Flora and Fauna	Medium	Low	Low	Low	Medium	Medium	Low	Low	Low	Medium	Medium	High	Low	Low	Medium	Low	Low
Agricultural Land Use	Medium	Medium	High	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low
Urban Land Use	Medium	Medium	Low	Low	Low	Low	Medium	Medium	Medium	Medium	Low	Low	Low	Medium	Low	High	High
Air Pollution	Medium	Medium	Medium	Medium	Medium	Medium	High	High	High	High	Low	Medium	Medium	Low	High	High	High
Water Pollution	High	High	Low	Low	Low	Low	Medium	Medium	Medium	Low	Medium	Medium	Medium	Medium	High	High	Medium
Noise Pollution	High	High	Low	Low	Low	Low	Low	Low	Low	High	Low	Low	Medium	Medium	Medium	High	Medium
Visual Aspects	High	High	Medium	Medium	Medium	Low	High	High	High	Medium	Medium	Low	High	High	High	Medium	Medium
Social Environment	Medium	Medium	High	High	High	High	Medium	Medium	Medium	Low	Low	Low	Low	Medium	Low	Low	Low
Buffer Zone	o	*	*	–	–	o	*	*	*	–	–	*oΔ	*	*Δ	Δ*	*	*o

IMPACTS

High
Medium
Low

BUFFER ZONE

* Freehold
o Crown
Δ Natural Area

The criteria described above for location in the Hunter Valley and factors including exposure to flooding, earth and drainage works which might add to environmental impact, transport routes for raw materials and products, surrounding land use and environmental aspects were taken into account to identify three sites for final examination at Tomago, Williamtown and on Kooragang Island.

4.2.3 Kooragang Site

This site is shown in *Figure 4.2* and the results of the detailed evaluation are presented in *Appendix 2.2*.

The site is close to the Port of Newcastle and well serviced by roads and a railway, but upgrading of the water supply and power facilities, and the provision of a sewage treatment plant would be necessary.

Since the site is only partly filled by spoil dredged from the Hunter River, further filling would be required to raise it to a flood free level and additional foundation treatment would be needed.

High background dust, emissions and sound levels caused by the extensive industrial development, combined with the exposed nature of the site to winds from all directions, which would disperse emissions in the directions of Fern Bay and Stockton, were factors that mitigated against selection of the smelter on this site.

4.2.4 Williamtown Site

This site, shown on *Figure 4.3*, is located 10 km north of Newcastle. It is well serviced by roads, but amplification and extension of water supply and other facilities would be necessary.

The area has poor foundations and would require substantial filling to raise the site. This, in turn, would impede the natural flow of floods between Fullerton Cove and Tilligerry Creek.

The site is cleared, but extensive use is made of the land and surrounding pastures for the grazing of horses and cattle. It is close to Williamtown School and the RAAF base and problems related to the obstruction of air traffic, noise, increased traffic and visual amenity would have to be resolved.

The site is relatively exposed to winds from all directions and fogs are common. Rezoning to an industrial use would be required and the siting of the smelter would have significant sociological impact due to the contrast with the existing rural lifestyle of many residents in proximity.

4.2.5 Tomago Site

The initial environmental assessment identified this site, shown on *Figure 4.4,* as the optimum location for the proposed smelter. Its former use as a textiles factory and the industrial zoning of the area substantially reduced land-use conflicts. The site is one of the few areas zoned industrial close to Newcastle which is of sufficient size for a smelter. A low level of infrastructure development is required as the site is provided with access, a water supply and telecommunications. Engineering and other relevant support facilities are also available in the adjacent industrial areas.

The site has good foundation conditions and is protected from prevailing winds by surrounding vegetation. Agricultural land uses are confined to the south and west of Tomago Road and there are no large residential concentrations in proximity.

As the area is zoned industrial and steel fabrication and warehouses are operated on adjoining properties, the background sound levels are high and the site has low scenic interest. Proximity to the Tomago Sandbeds was not seen as a problem beyond resolution.

It was recognised that a smelter located on this site would act as a major source of employment for residents of Port Stephens Shire and Newcastle City.

4.2.6 Comparison of Alternative Sites and the Preferred Locality

The matrix in *Table 4.1* presents a comparative environmental assessment of all the sites. Impacts associated with the development of a smelter on the sites have been rated as high, medium and low. Where known, the type of buffer zone surrounding the sites is indicated.

The analysis shows that on the basis of environmental and economic criteria, Site 12, Tomago (A), is the most suitable site for the construction and operation of a smelter.

4.3 TRANSPORTATION OPTIONS

Following selection of Tomago as the favoured site, a number of alternative methods were examined for the transport of raw materials from the port facilities at Rotten Row on Kooragang Island and the products to a destination at the port. Those methods considered practical after preliminary evaluation are discussed below and illustrated in *Figure 4.5*.

4.3.1 Road Transport

Route 1a: This option is to truck raw materials and products between the port facilities and the smelter via the Industrial Drive, Pacific Highway and Tomago Road, a distance of 18.5 km.

On the basis of a 22.5 t payload and 6 day operation, approximately 85 return trips per day would be required for raw materials, and 32 return trips per day for products. (One return truck trip is two truck movements.) It is expected that the trucks would be of similar design to those at present used for alumina haulage to the Alcan Smelter at Kurri Kurri and that the haulage would be on a contract basis. The trucks would be enclosed tankers which would be loaded and unloaded by vacuum systems to minimise dust emissions and spillage. The safeguards incorporated in the design of the truck bodies ensure dust free handling of the raw material. Upgrading of Tomago Road would be required.

Readily available equipment such as forklift trucks and mobile cranes would be used for product handling.

Route 2a: This route was considered as an alternative to 1a. and involves road haulage via Stockton Bridge, Nelson Bay Road, Cabbage Tree Road and Tomago Road. The route is considerably longer, being about 24 km from the berth at Rotten Row to the site.

The same number of truck movements would be required as route 1a.

This route would be attractive if the future port development on Newcastle Bight should become a reality. This alternative route is also available if large items must be moved which would be difficult to negotiate through the intersection and bridge at Hexham, or during periods of long delays on the route of option 1a. Some upgrading would be necessary along Cabbage Tree Road and Tomago Road if the route was to be used consistently.

4.3.2 Conveyor and Road Across Kooragang Island

A possible route for a direct conveyor to transport materials from the Rotten Row berth to the Tomago site is shown in *Figure 4.5*. This route was selected to minimise conflicts with the proposed development of Kooragang Island and is approximately 9 km long.

The design of the system could be restricted by conditions of the New South Wales Department of Public Works on the location and elevation of structures to prevent inhibition of flood flows in the Hunter River. It is believed that the conveyor would have to be elevated over Kooragang Island to fulfill these requirements. The conveyor would also be required to be elevated across the Hunter River to allow the passage of vessels from Carrington Slipways and the coal loading facility at Hexham. Tomago Road would also be crossed by elevating the conveyor.

In selection of the conveyor route, consideration would be given to establishing it adjacent to the easement for the smelter power supply so that the area of disturbance was confined to a single belt rather than two separate areas.

Products will require transport to the port by some other means and due to the relatively small quantity to be moved, trucking via the Pacific Highway is considered the most practical method. This represents approximately 32 return trips per day, 6 days per week.

A road across Kooragang Island on the route of the conveyor shown on *Figure 4.5* would necessitate a barge connection or bridge for transporting materials across the Hunter River at Tomago. Interference with shipping movements, siltation problems, and the need to clear Mangrove communities on both sides of the river at Tomago were reasons for this route not being favoured.

4.3.3 Barging

This option is to transport materials and products by barge between Rotten Row and Tomago via the north arm of the Hunter River as shown in *Figure 4.5*.

The concept involves loading the barges with alumina and petroleum coke at a berth immediately north of the proposed unloading facility for the raw materials at Rotten Row. The loading facility would consist of breasting piles with a warping winch to move the barge beneath a fixed loader. The fixed belt conveyor loader would have a tubular spout and would be fed by belt conveyors from the alumina and coke silos.

The barge proposed for handling both materials would have a total capacity of 2300 dwt, consisting of 1900 t of alumina and 400 t of coke. Separate holds would be provided for the two materials and they would be fitted with hatch covers. A pusher tug would be used to move the barge.

A berth facility would be constructed at Tomago to load and unload the barges. Alumina would be unloaded by self unloading equipment consisting of air slides under the alumina bins fitted to an air lift at the end of the barge. The air lift would transfer the alumina into a silo on the shore. A compressor would be located on the shore to provide the air supply.

Coke would be unloaded by front end loaders. The end of the coke hold would be capable of being lowered to form a ramp for front end loaders to enter the barge. Coke would be transferred into a shore mounted hopper fitted with a belt conveyor to transfer it to a storage silo.

The materials would be moved to silos at the smelter by tanker trucks.

Aluminium products would be transported to the port using a flat decked barge. Provision would be made below the deck for a tank to carry alumina to allow flexibility for alumina transport. Ramps would be provided at the shore to allow loading using fork lift trucks. Unloading at the port would be either by fork lift trucks or mobile cranes for transfer to a storage area.

It is envisaged that both barges would be pushed together by a single tug in a cyclic operation.

A complete cycle of material loading at the port, unloading at Tomago, subsequent product loading at Tomago and unloading at the port could be completed during daylight hours. Plant demands could be met by 5 day operation of the barges.

The proposal to move both materials and products by barge would require the construction of a wharf at Tomago adequate to carry the high loads of aluminium products. Discussions with officers of the Department of Public Works indicate that consent for such a development may be refused because of the likely impedance to flood flows which would probably lead to damage elsewhere.

Another major constraint on the selection of barging is the vulnerability of this method to interruption compared to the other alternatives available. Supply may be interrupted by flooding in the Hunter River which could prevent barging activities for short periods, or if heavy siltation occurred in the channel for more prolonged periods.

As no permanent dredge is maintained in the harbour, substantial time would pass before siltation problems could be rectified.

Clearing of Mangrove communities on the Hunter River for berthing facilities would also be necessary.

Barging represents a unique operation in the harbour and if one of the barges were damaged or sunk, it could not be readily replaced. The concept was regarded as complex, inflexible and hazardous near the tidal mouth of the Hunter River.

4.3.4 Rail

This option involves connecting the site with the Great Northern Railway at Hexham and then branching into the Kooragang Island Railway south of Sandgate.

Specially designed sealed rail wagons would be required for material transport while standard flat cars would be used for product movement.

The construction of the line from Hexham to Tomago would require crossing both the Pacific Highway and Tomago Road, and bridging of the Hunter River.

This section would pass through undisturbed land.

It is envisaged that five trains per week would be required for materials and approximately three per week for products.

4.3.5 Comparison of Transport Options

An environmental assessment of all options is presented in *Table 4.2*. Noise levels, air quality, water quality, visual impact, flora and fauna, land use/zoning and costs are compared and impacts rated as high, medium and low. In summary,

i. Barging via the north arm of the Hunter River was not favoured because of the likely navigational and

TABLE 4.2

COMPARISON OF THE TRANSPORT OPTIONS FOR THE MOVEMENT OF MATERIALS AND PRODUCTS

OPTION	NOISE LEVELS	AIR QUALITY	WATER QUALITY	VISUAL IMPACT	FLORA AND FAUNA	LAND USE/ZONING	COSTS INCLUDING CAPITAL COST	GENERAL
1a ROAD HAULAGE VIA PACIFIC HIGHWAY	Noise will be detected at the farm houses along the route LOW	Sealed units will prevent dust. Additional vehicle emissions virtually undetectable above existing levels. LOW	Risk of spills leading to suspended solids increases is low LOW	No change since road traffic is already clearly visible LOW	No new roads, therefore no change LOW	Conforms with existing land use LOW	$1.60 to $2.00 per tonne No Capital Costs.	The option offers high utilisation of specialised equipment. There is no manual handling of materials thereby minimising safety risks. Maximum flexibility to change to alternative as no capital cost is involved.
1b ROAD HAULAGE VIA NELSON BAY ROAD	Same levels as 1a, but higher impact due to lower background levels MEDIUM	Greater traffic volume increase than 1a, therefore higher impact on areas traversed MEDIUM	As above LOW	As above LOW	As above LOW	As above LOW	$2.00 per tonne No Capital Costs	As above
2 CONVEYOR AND ROAD ACROSS KOORAGANG ISLAND	Low operating noise, maintenance and repair vehicles will produce highest levels. LOW	Conveyor will be sealed therefore no dust released to atmosphere. Regular cleaning of conveyor enclosure will be required. LOW	The conveyor will be sealed therefore there will be no risk of spillage. LOW	Visible along entire route. Most prominent at river crossing and Tomago Road. HIGH	Reduction in grazing land available. Possible interference in nature reserve proposals and impact on flora and fauna worthy of preservation. HIGH	Reduced grazing area. Limit development of area zoned industrial. Restricts nature reserve proposal. HIGH	Operating $5 to $6 per tonne Capital Cost $16 million	The constant maintenance required would be difficult during floods Single breakdown leads to system failure.
3 BARGING ALONG HUNTER RIVER	Unloading at Tomago will create maximum noise levels. Levels due to barging will be low LOW	Some dust generated by coke unloading and very low level by alumina air lift. MEDIUM	Dust and spillages at unloading point will need to be controlled MEDIUM	Wharf and storage facilities prominent in the area MEDIUM	Mangroves will be lost in the area required for the Tomago berth. HIGH	Wharf would impede flood flows. MEDIUM	$3 to $4 per tonne Capital Cost $10 million	This option has high vulnerability during flooding and risk of barge damage. Constant dredging would be required to ensure safe passage.
4 RAIL VIA GREAT NORTHERN LINE	High levels at loading and unloading points as well as in transit. Moving train produces 95dB(A) at 1 m. HIGH	Sealed units therefore little dust at transfer points. LOW	Sealed units therefore low risk of spills. LOW	Rail bridge over Hunter prominent. HIGH	The new line passes through cleared land of little significance. LOW	Route passes through floodway at Tomago and forms barrier to flood flows. MEDIUM	$4 to $5 per tonne Capital Cost $14 million	Low utilisation of specialised equipment as tankers would be single purpose and only one train per day would be used.

safety problems in negotiating the estuary of the river which is subject to shipping movements, tidal and floodwater flows, siltation and changes in water depth. Other factors were the absence of a permanent dredge, the need for mangrove clearance at unloading points and cost considerations.

ii. A railway linkage was discounted because of the need to construct a bridge over the Hunter River.

iii. Road and belt conveyor linkages across the western half of Kooragang Island were not selected because of the potential conflicts with nature reserve proposals and the problems of transferring materials across the north arm of the Hunter River.

iv. A road route via Stockton Bridge may be used occasionally for large items of plant during construction but is not favoured because of the longer travel distance to the plant and the number of residences to be passed along the route on the northern side of the river.

v. A road route via the Industrial Drive, Pacific Highway and Tomago Road is the favoured mode.

The physical, social and economic impacts of the preferred option, including costs of upgrading Tomago Road, congestion and road safety are discussed in *Section 9*.

Description of the Proposal

SECTION 5

DESCRIPTION OF THE PROPOSAL

SUMMARY

This section is presented as a description of Tomago Aluminium Company Pty. Limited's proposal for the construction and operation of the smelter on the Tomago site. It is included in the Statement to assist interested authorities, organisations and individuals to appreciate the basic reports of the environmental investigations and implications. The safeguards proposed by the Company to protect the environment are only given brief mention as this important aspect is the entire subject in *Section 8*.

The Company's objective to establish a viable smelter to meet market requirements and to function as a new modern operation employing local people is outlined. The scope of the proposal in which the components are introduced is summarised. The detailed description of the components then follows.

The design, construction and commissioning stages are scheduled to extend over seven years. The workforce on the site will reach a peak of up to 1500 during construction in 1982. The operating plant will employ approximately 800 persons. The Company's policy will be to give preference to the employment of local people including women and young people. On the job training will upgrade the skills of semi-skilled and unskilled employees. A government-backed scheme to train 60 apprentices per year will be introduced at the beginning of 1981.

Primary aluminium will be produced by electrolytic reduction of alumina using the Hall-Heroult process. Alumina, an oxide of aluminium, is dissolved in a bath of molten cryolite and fluorspar at approximately 950°C and electrolysed in a pot (cell) by direct current. The liquid aluminium is deposited at the cathode in the bottom of the pot and oxygen combines with the carbon anode. The pots consist of a carbon cathode insulated by alumina or refractory bricks inside a steel shell and are connected electrically in series. The current passes from the carbon anode through the bath to the cathode and thence by aluminium busbar to the neighbouring pot. Alumina is added to the molten bath and dissolves as electrolysis proceeds. The solidified crust of the bath is broken regularly to allow additional alumina to enter the cell.

Two potlines of 240 cells each will be required to meet the target production capacity of the plant of 220,000 t of aluminium each year. An east-west orientation for the potlines was favoured to a north-south orientation after evaluation of the environmental and materials handling requirements.

The fumes emitted from the process containing gaseous carbon oxides, sulphur dioxide, hydrogen fluoride and particulate carbon, alumina and fluorides are collected by a hood over the pot and extracted through a ducting system.

Molten aluminium is periodically withdrawn from the pot by vacuum suction. Alumina and fluoride compounds are added to the bath as required to replenish material removed or consumed in normal operation. Carbon anodes are replaced as they are consumed by the reaction with oxygen.

The Company proposes to use a centre worked prebaked (CWPB) cell developed by Aluminium Pechiney. The cell hooding gives a fume collection efficiency of 97.5 per cent, compared with approximately 80 per cent normally associated with side-worked pots. This modern development results in low emission levels from the potline buildings.

The proposed layout of the plant provides for buildings to house facilities for the production of prebaked anodes, metal casting, workshops and laboratory, a substation for reduction of the power supply from 330 kV to 11kV, various structures and units of plant and road network. The existing Courtaulds (Australia) Limited's office block is still in good condition and is to be retained as the administration offices.

The raw materials for aluminium production, alumina and petroleum coke, are to be shipped to the Port of Newcastle, unloaded at a new berth to be constructed on Kooragang Island and taken by road to the smelter at Tomago. 430,000 and 90,000 t/y of alumina and petroleum coke respectively will be transported in 77 return trips per day between 7.00 am and 6.00 pm, six days per week. The aluminium metal will be cast into various shapes and trucked in an average of 32 return trips per day to the port for transport by ship to market destinations. The road route to be followed from Kooragang Island will be Cormorant Road, Industrial Drive, Pacific Highway and Tomago Road.

Electrical power will be supplied from the State grid at 380 MW by the New South Wales Electricity Commission. Water and telecommunications are already connected to the site.

The smelter will be a new modern facility which will strengthen the industrial zone at Tomago. The Company is confident that the plant will and can be built and operated as an asset to the Shire of Port Stephens.

5.1 OUTLINE OF THE PROPOSAL

5.1.1 The Company's Objectives

The Tomago Aluminium Company Pty. Limited proposes to develop an aluminium smelter at Tomago in the Shire of Port Stephens, as shown in *Figure 1.1*.

The decision to build the smelter at the proposed location followed appraisals of the growing world demand for aluminium metal, and of the relative attributes favouring Australia, New South Wales and the Hunter Valley for a major investment in the aluminium industry at the present time. The background to this decision is considered in *Section 3*.

The selection of the favoured site involved the elimination of some sixteen alternatives according to criteria outlined in *Section 4* and the experience of Aluminium Pechiney in operating smelters successfully throughout the world. The Company believes that the Tomago site will meet all of its requirements and that a safe and successful venture can be conducted from it.

The plant has been designed to produce 220,000 t/y of aluminium metal by the electrolytic reduction of alumina. At this stage it is proposed that all of the metal will be exported. Subject to the acceptance of the proposal and approval of the project by the relevant authorities, the participants have negotiated contracts for the sale of much of the aluminium and are confident that markets will be secured for the balance when the product is available. The viability of the venture is based upon the operation of a smelter producing 220,000 t/y and an expansion is not planned.

The Company proposes to build a modern smelter incorporating the combined benefits of the experience of the consortium partners. The expertise being focused on the project covers all aspects of aluminium production and marketing throughout the world and a detailed knowledge of operations within Australia's industrial framework. Important objectives of the project are to establish an efficient project utilising an Australian workforce and meeting local requirements for the maintenance of good industrial relations.

The Company will work closely with the Council of Port Stephens Shire to ensure that the benefits to the area are maximised. It is hoped that the amicable working relationship between the existing aluminium smelter at Kurri Kurri, the local council and the adjoining communities can be reproduced at Tomago. The Company is confident that the prosperity similar to that attributable to the smelter near Kurri Kurri will form a focus for growth and development in Port Stephens Shire.

5.1.2 Scope

All of the aspects outlined below are discussed in further detail in the following pages of this section.

The layout of the buildings on the Tomago site and their relationship to the existing buildings of Courtaulds (Australia) Limited is shown in the perspective *Figure 5.1*.

The plant will comprise two potlines each of 240 pots. Facilities will be provided for the manufacture of carbon anodes and for the casting of the aluminium metal into the required forms. Various items of plant, structures, maintenance buildings, offices, laboratory and warehouses will be located on a landscaped site as shown in the figure.

Electrical power will be supplied to a substation on the site by the Electricity Commission of New South Wales under the terms of an agreement signed in August 1979.

Water is connected and natural gas will be piped to the site.

Access to the plant will be via the gate house on Tomago Road. The former car parking facilities of Courtaulds (Australia) Limited catered for a larger workforce than required for the smelter and will be adequate for all foreseeable situations including construction.

The raw materials consumed will be alumina, petroleum coke and pitch. Alumina from Australian sources and imported coke will be unloaded at a wharf to be constructed at Rotten Row in the south arm of the Hunter River and transported by road via the Industrial Drive, Pacific Highway and Tomago Road to the smelter. Pitch is expected to be produced in Newcastle and delivered by road tanker.

The aluminium metal will be delivered by road to the Port of Newcastle.

Plant construction is expected to extend over five years. The workforce on the site will reach a peak of 1200 to 1500 during 1982. The plant will be operated on a continuous basis, employing approximately 800 persons.

Appropriate safeguards to minimise pollution and sources of potential impact have been designed into processes and operational practice, and further details on these is provided in *Section 8*.

5.1.3 Development Schedule

It is expected that power will be applied to the first pots approximately 32 months from the time approval is received for the project. Start-up of the complete line will take about 8 months. The second potline will be commissioned two years after the initial 'power on' with an 8 month start-up period again assumed.

A final capacity of 220,000 t/y of salable aluminium metal is proposed. The forecast incremental increase in production is shown in *Table 5.1*.

TABLE 5.1

PROPOSED PRODUCTION RATE

Construction Phase	Annual Production (t)
Development consent - year 1	
Year 4	47,000
5	110,000
6	158,000
7	220,000

5.2 THE SMELTING PROCESS

5.2.1 Conversion of Alumina to Aluminium

Figure 5.2 is a flow sheet showing the aluminium production process.

Primary aluminium will be produced by electrolytic reduction of alumina using the Hall-Heroult process. Alumina, an oxide of aluminium, is dissolved in a molten cryolite bath at approximately 950^{o}C and electrolysed in a pot (cell) by direct current. The liquid aluminium is deposited at the cathode in the bottom of the pot and oxygen combines with the carbon anode.

The pots comprise a carbon cathode insulated by alumina or refractory bricks inside a steel shell and are connected electrically in series. A direct current passes from a carbon anode through the bath to the cathode and thence by aluminium busbar to the neighbouring pot.

Alumina is added to the molten bath and dissolves as electrolysis proceeds. The solidified crust of the bath is broken regularly to allow additional alumina to enter the cell.

The fumes emitted from the electrolytic process containing gaseous carbon dioxide, sulphur dioxide, hydrogen fluoride and particulate carbon, alumina and fluorides are collected by a hood over the pot and evacuated for treatment.

Molten aluminium is periodically withdrawn from the pot by vacuum suction. Alumina and fluoride compounds are added to the bath as required to replenish material removed or consumed in normal operation. Carbon anodes are replaced as they are consumed by the reaction with oxygen.

Plates 2 to 5 show potroom operations at the St. Jean de Maurienne smelter operated by Pechiney in France.

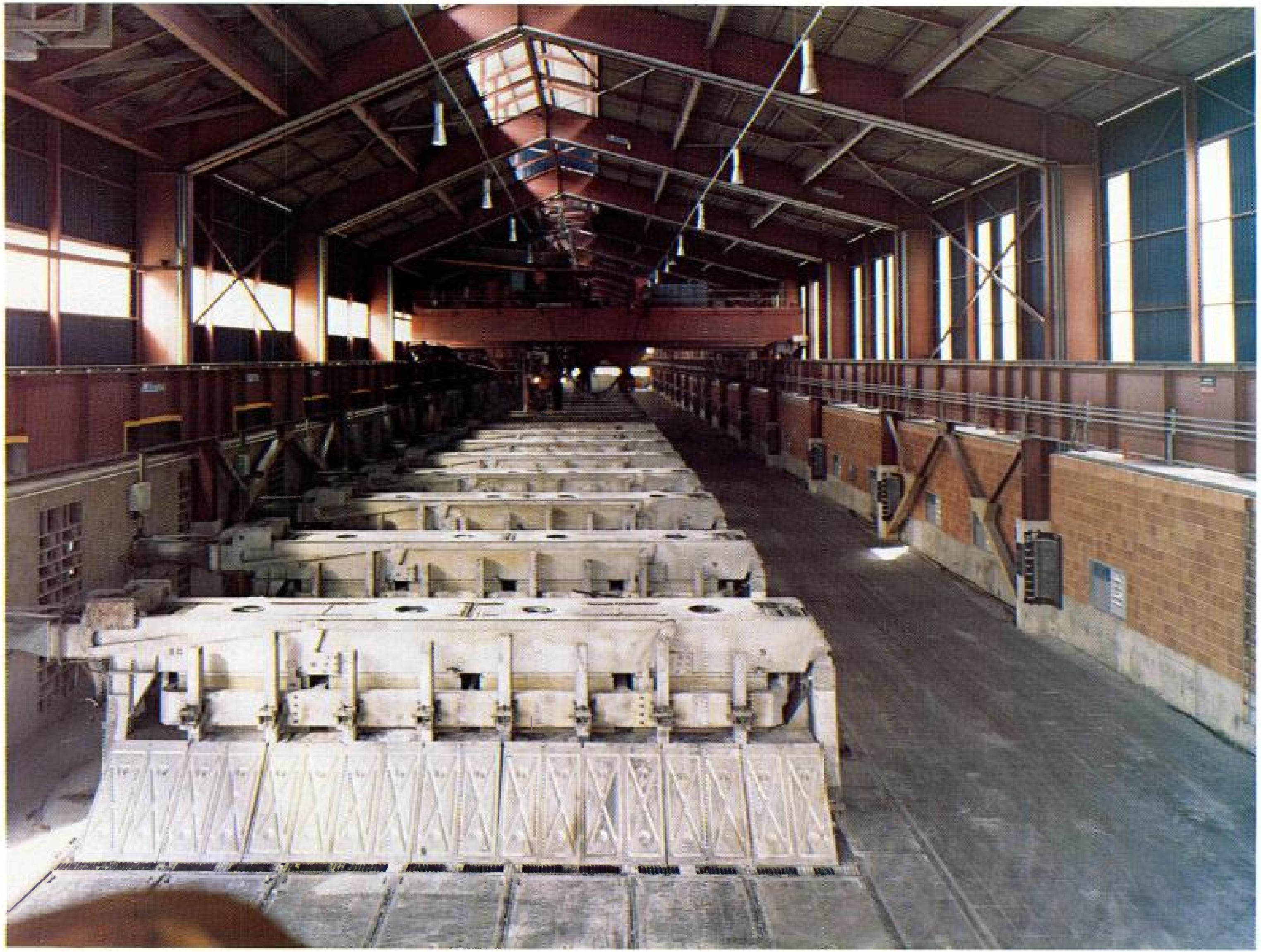


PLATE 2 TYPICAL VIEW ALONG POTROOM, ST JEAN de MAURIENNE SMELTER, FRANCE.

5.2.2 The Pechiney Cell

The Company proposes to use a centre worked prebaked (CWPB) cell of its own design as shown in *Figure 5.3*. Pots will be arranged side by side in four groups of thirty. Each potline comprises 240 pots housed in two separate buildings with each pot nominally producing 1282 kg of liquid metal per day. Pots will operate at 175 kA consuming 13,430 kW.h/t of liquid metal at a current efficiency of 91 per cent.

Figure 5.4 shows a diagrammatic representation of the raw materials required for the manufacture of 1.012 t of solid aluminium product.

As shown in *Figure 5.3*, the cathode is contained in an independent shell supported by electrically insulated concrete beams. The lining consists of carbon blocks resting on a layer of alumina. Heat losses are controlled with refractory and insulating bricks. The cell sides are similarly protected by carbon blocks. All joints are tamped with a carbon ramming paste.

A steel superstructure rests on the cathode shell via isolation joints and supports the anode system, the hood and the crust breaking and alumina feeding equipment.

Alumina additions are made to the bath from hoppers suspended from the superstructure between the two rows of anodes. Each pot is fitted with four centre crust breakers with associated alumina hoppers, metering systems and sixteen anode assemblies.

Pot emissions are confined by a combination of fixed hooding and removable side panels. A fixed roof and end pieces are integrated with the superstructure. Panels close the space framed by the hooding and the side of the pots.

Each pot is equipped with an electrical panel, a digital voltmeter, and a microprocessor. The microprocessor monitors and controls pot performance.

5.2.3 Operational and Environmental Safeguards

Full details of all operational and environmental safeguards for normal and atypical conditions are provided in *Section 8*.

The aluminium smelting process produces gaseous, liquid and solid wastes.

Gaseous emissions emanating mainly from the reduction cells and the anode baking furnace are the most significant wastes. The Company proposes to minimise losses to the atmosphere by reducing source emission levels, maximising the collection of fumes and scrubbing them to a high degree of cleanliness before discharge.

Both the potline fume and bake oven exhaust gases will be scrubbed with alumina. Scrubbing efficiency in the case of fluorides, the most significant emission, will be 99.9 per cent at the potlines and 92 per cent at the anode bake oven.

No polluted liquids will leave the site in an untreated form. Total plant water consumption will be low to reduce the volume requiring treatment. All contaminated site runoff will be intercepted, collected and treated prior to discharge.

Solid wastes will be a source of contamination only if leached by water. The Company proposes to minimise the amount of water which may be able to contact the solid wastes and collect and treat any leachate produced. No waste burial will be undertaken on site.

Close control over emissions coupled with specific engineering design features will ensure excellent safe working conditions for smelter employees. Continuing health monitoring and safety training will maintain high standards in both areas.

5.2.4 Raw Materials

Table 5.2 lists all major materials to be utilised on site, their form, packaging, consumption, transportation mode to site and storage details.

PLATE 3   ANODE CHANGING OPERATION AT THE ST JEAN de MAURIENNE SMELTER, FRANCE

TABLE 5.2

DETAILS OF RAW MATERIALS AND THE FINISHED PRODUCT

Material	Source	Form	Packaging	Consumption	Transport to site	Return Truck Trips	Site Storage
Alumina	Australia	Powder	Bulk	430,000 t/y	Road	64/d	4 Silos
Petroleum Coke	USA	Coarse Powder	Bulk	90,000 t/y	Road	13/d	2 Silos
Pitch	Local	Liquid	Bulk	24,000 t/y	Road	4/d	Heated Tank
	USA	Solid	Bulk				Silo
Aluminium Fluoride	USA, Japan	Powder	Palletised Bags	3,900 t/y	Road		Warehouse
Alloying Elements	Local	Ingot	Pallets, Containers	3,000 t/y	Road		Warehouse
Packing Coke			Containers	3,345 t/y	Road		Warehouse
Refractories	Local	Bricks	Pallets	4,800 t/y	Road		Warehouse
Cathode Blocks	Japan	Blocks	Pallets	1,920 t/y	Road		Warehouse
Cathode Bars	Local	Bars	Pallets	1,320 t/y	Road	Overall average of 4 trucks per day	Warehouse
Cast Iron	Local	Ingot	Pallets	850 t/y	Road		Warehouse
Cathode Paste	Japan	Paste	Bags	750 t/y	Road		Warehouse
Nitrogen	Local	Liquid	Bulk	38,000 Nm^3/y	Road		Cooled Tank
Argon	Local	Liquid	Bulk	68,000 Nm^3/y	Road		Cooled Tank
Chlorine	Local	Gas	Bottles	6.1 t/y	Road		Warehouse
Soluble Oil	Local	Liquid	Drums	75 t/y	Road		Warehouse
Lubricating Oils	Local	Liquid	Drums	100,000 l/y	Road		Warehouse
Lubricating Greases	Local	Grease	Drums	15 t/y	Road		Warehouse
Diesel	Local	Liquid	Bulk	300,000 l/y	Road		Tank
Finished Product		Wire, ingots slabs and billets	Pallets, Containers	220,000 t/y	Road transport to Port	32/d	

Note: Truck Trips assume 22.5 t payload, operating 6 d/wk.

Construction Materials -

Material	*Quantity*	*Use*
Sand	30,000 m^3	concrete
Cement	15,000 m^3	concrete
Aggregate	45,000 m^3	concrete
{ Road materials	30,000 m^3	roads
{ Gravel sub-base	10,000 m^3	roads
Steel structures	43,000 t	pot steel work and construction
Roof sheeting	300,000 m^2	roof surfacing

Typical analyses for alumina, coke and pitch are provided in *Appendix 3*.

5.3 PLANT LAYOUT AND BUILDINGS

5.3.1 Plant Layout

Two alternative plant layouts with potlines orientated east-west and north-south respectively were considered by the Company.

East-West Orientation

This orientation is shown in *Figure 5.5* and is the favoured layout due to lower potential environmental effects and less difficult materials handling (Discussed in detail in *Section 9)*.

In this preferred orientation the electrical substation is located at the western end of the potlines which extend to within 150 m of the eastern boundary of the site. A distance of 150 m from the Tomago Sandbeds Water Supply Catchment will be maintained.

The area between the potlines will be occupied by the crane maintenance shop, the pot rebuilding shop, the ladle cleaning shop and the fresh alumina silos. Other facilities will be located south of the potlines as shown in the figure. The existing Courtaulds (Australia) Limited office block will continue to be used for administration staff.

North-South Orientation

The alternative north-south orientation is shown in *Figure 5.6*. In this layout, the electrical substation is located in the southeast corner of the site approximately 200 m from Tomago Road. The pot-rooms extend northwards to within 100 m of the catchment boundary and to 150 m from the eastern boundary of the site.

The relative position of other facilities does not change.

5.3.2 Plant Description

The buildings, items of plant and structures for aluminium smelting on the Tomago site are considered in the following five major groups:-

i. potlines
ii. anode manufacture and storage
iii. casting facilities
iv. laboratories and offices
v. general warehouse and maintenance.

The functions of each are described below. The electrical substation is discussed in *Section 5.6.2*. It should be appreciated that minor changes may be necessary during the final design stages but the overall concepts will be as described.

Potlines

Potrooms: Four potrooms are proposed, each 800 m by 22 m. In each building, 120 pots are arranged side by side in four groups of 30 pots. Passageways between groups of pots and at both ends of the buildings are used for equipment and material handling. Five pot tending assemblies per building perform all pot tending operations.

The buildings will be of steel-framed construction. The working floor is to be constructed of concrete with open steel grilles to provide ventilation. The building is to be exhausted through a continuous roof vent. The vent is designed so that natural ventilation will provide an airflow of 20 m^3/s per pot.

Figure 5.7 shows a typical section and elevation through a potline.

Dry Scrubber Buildings: Fumes collected from the pots will be ducted to dry scrubber units. Each potline is served by two scrubber facilities located between the potline buildings.

Fresh Alumina Storage: Four silos, one close to each dry scrubber, will provide storage for fresh alumina delivered to the site.

Pot Rebuilding Shop: Approximately 120 pots annually will be rebuilt in a workshop located between the potlines.

Crane Maintenance: Pot tending machines will be serviced in a building adjacent to the pot rebuilding shop.

Ladle Cleaning: Bath crust and scrap metal will be removed from transfer and tapping ladles in a ladle cleaning shop constructed between the potlines. Ladles will also be relined in this area.

Anode Manufacture and Storage

Anode manufacture will be undertaken in three adjacent buildings, namely the green anode shop, a storage building for both green and baked anodes and an anode baking furnace. A process flow sheet for anode manufacture is shown in *Figure 5.8.*

Green Anode Production: The expected operating life of an anode is 21 to 24 days. At maximum production, approximately 140,000 t of anodes will be required annually.

Green anodes are produced using petroleum coke, liquid pitch and recycled anode butts. Proportioned quantities of crushed and classified coke and recycled butts are heated and mixed with liquid pitch. Anodes are formed in a vibrocompactor and spray cooled with water to facilitate handling. Cooled anodes are transported by overhead cranes either to storage or directly to the baking furnace.

Two 8000 t silos will be used as main storage for petroleum coke.

Liquid pitch will be kept in a heated tank.

The green anode shop is the tallest building on the site; *Figure 5.9* shows typical elevations.

Anode Baking: Anode baking is performed in two furnaces. Each consists of 40 sections constructed in two rows separated by a central aisle. Each section consists of six pits, each with a capacity of 12 anodes.

The pits are separated by flue walls in which the bases circulate. Heating is by means of automatically controlled burners. A system of movable burners and exhaust manifolds allows the establishment of a preheating, baking and cooling regime for all anodes.

Exhaust gases are collected for treatment in an alumina dry scrubber before discharge to the atmosphere. *Figure 5.10* illustrates the baking furnace and scrubber layout.

Anode Rodding: Anode rodding is performed in a separate building.

Used anodes are cleaned on vibrating tables, shot blasted and stripped from the steel pins in a press. Cast iron is removed from the anodes for recycling.

Stem bracket assemblies are repaired, if necessary, prior to graphite coating of the pins in preparation for rodding of a new anode. Cast iron for the rodding process is produced in one of two low frequency induction furnaces.

Anode rodding is highly mechanised, with anodes moving on individual trolleys between working stations.

A covered area is provided for storage of used and new anode assemblies.

PLATE 4 RECHARGING OF ALUMINA HOPPERS WITHIN POTROOM, ST JEAN de MAURIENNE SMELTER, FRANCE

Casting Facilities

Hot metal produced in the pots is vacuum tapped into tapping ladles and then transferred to transport ladles for removal to the cast house. A process flow sheet for cast house operations is provided in *Figure 5.11.*

Cast House: The cast house will be divided into four halls to facilitate material handling. The various areas are as follows:-

An elaborating hall containing holding furnaces for receival of hot metal.

A casting hall with continuous horizontal casting machines for ingots, semi-continuous vertical casting pits for T-ingots, slabs and billets, a continuous rotary casting machine for small ingots and two continuous casting and rolling lines for wire-rod.

A finishing hall for homogenising and sawing.

A storage hall.

Associated Plant: The following facilities will be adjacent to the cast house:-

Dross cooling: Cast house dross will be cooled prior to grinding and separation of salable aluminium granules.

Cast house water cooling: Process water will be cooled in an induced-draught cooling tower prior to recycling. Cooling is required in the substation, carbon plant and cast house.

Compressor house: Compressed air requirements for the plant will be met by a compressor house operating at 800 kPa. Installed capacity will be 300 Nm^3/min.

Water tower: Process water will be stored in a special tank to provide fire fighting reserves and a guaranteed cooling water supply to the casting plant.

Laboratory and Offices

This group is effectively divided into two separate areas.

Laboratory and Technical Offices: A laboratory will be housed within a complex adjacent to the potroom and will be equipped to carry out the standard analyses required in a smelter plant. These include checking of raw materials, production tests and environmental control.

Offices for engineers and general foremen and some clerical employees will also be located in this complex. Supervisory personnel will have offices on the job site.

Administration Offices: The plant management and administration departments will be accommodated in the offices formerly used by Courtaulds (Australia) Limited. These will be refurbished to a high standard.

General Warehouse and Maintenance

General Warehouse: Spare parts and operating supplies will be stored in this building. A fenced open space will be provided as an iron and steel storage yard.

Maintenance Shop and Warehouse: A maintenance shop complete with its own interconnected warehouse will be built for the various mechanical and electrical operations required.

Machines and tools necessary for this work will be provided.

General Services

Change Rooms and Showers: Two facilities, one adjacent to the potrooms and the other adjacent to the anode manufacturing plant, will be provided for production personnel. The capacity will be sufficient for peak usage at the change of shift.

Entrance Station: A single entrance station with lockable gates will be established at the site boundary for both personnel and vehicles. A weighbridge will be installed at the station and a waiting room will be provided. The location of this station is to be finally selected to optimise materials and personnel movement.

5.3.3 Materials Handling

A materials handling flow sheet is shown on *Figure 5.12*.

Alumina, coke and pitch delivered to the site by truck will be unloaded directly into enclosed storages.

Alumina will be transferred to the dry scrubber and then to the pot tending assemblies by fully enclosed conveyors and airslides. Feed to the pot hoppers will be by a closed coupling from the pot tending assembly.

Coke and pitch used in anode manufacture will be transferred from storage silos to the carbon plant by fully enclosed conveyors.

Green anodes will be cooled and placed on a powered roller conveyor. Specially equipped overhead stacking cranes, providing for the handling

PLATE 5 DRY SCRUBBER AT THE ST JEAN de MAURIENNE SMELTER, FRANCE

of several anodes at a time, will take the green anodes from the conveyor and send them either directly to the baking furnace or to the anode storage building.

If directed to the baking furnace, the stacking cranes will load the anodes onto platforms hauled by a cable hoist travelling in the centre aisle of the furnace. Three independent sets of six platforms are to be used for moving green anodes to the required pit and baked anodes back into storage.

Baking furnace tending assemblies will handle the anodes between the pits and the platforms. These assemblies will also pack the pits with coke or anthracite and are fitted for this purpose with a gulper, hopper, filling spout and dust collector. Packing material will be stored in an independent silo.

Movement of anode assemblies within the rodding shop will be by means of individual trolleys located on an overhead conveying system, allowing stops at each working station.

Used or new anode assemblies will be collected in groups of four onto special pallets. Transport between potlines and the anode plant will be by special hooded trailers.

Liquid aluminium will be tapped from the pots into a tapping ladle, from whence it will be transferred to a transport ladle. Transport ladles can accommodate the 32 hour production of three pots which is carried between potline and cast house on a special liquid metal truck.

Crushed bath material will be stored in a main 100 t silo located at the processing shop. This material will be transferred to individual 20 t silos for each potroom from the main silo using a 15 t truck.

Semi-finished and finished product movement within the cast house and from there to the storage area will be by means of a combination of powered rollers and forklift trucks.

All mobile equipment will be diesel powered.

5.3.4 Perimeter Zone

The extent of the Company-owned land is shown on *Figure 4.4*. It comprises an irregular area around the plant of approximately 508 ha which is to be retained by the Company and managed to provide a buffer zone around the site perimeter.

North of the Plant: The perimeter zone is 1.2 km deep and comprises mostly land within the Tomago Sandbeds area. The area is timbered apart from the disused airstrip and a small bare area resulting from mineral sand extraction.

South of the Plant: The perimeter zone varies in depth from 400 to 600 m, with the exception of the area adjacent to the Stauffer chemicals factory. Approximately 50 per cent of this part of the perimeter zone was cleared for the Courtaulds textiles factory. The Company also owns land between Tomago Road and the Hunter River on either side of the Tomago Detention Centre.

East of the Plant: The Company-owned land is irregularly shaped and varies in depth from a maximum of 900 m to a minimum of 150 m where it adjoins developed and undeveloped industrial land. Approximately half of this zone is timbered and the remainder varies from bare to shrub covered as a result of earlier mineral sand extraction.

West of the Plant: The perimeter zone is between 300 m and 500 m wide and is timbered. At the narrowest point it adjoins land occupied by the Newcastle International Motordrome.

While not within Company ownership, the heavily timbered catchment area of the Hunter District Water Board's Tomago Sandbeds serves as a buffer zone to the north and northeast of the site.

The Company intends to manage the perimeter zone on its property. This will include the maintenance of 100 m wide firebreaks immediately adjacent to the plant, the eradication of weeds and noxious plants and limited burning of undergrowth during winter months in the areas adjacent to the firebreaks. The area will be kept free of rubbish and anti-litter signs will be posted at appropriate places.

5.4 CONSTRUCTION ACTIVITIES

5.4.1 Timetable

The various activities associated with the plant development and the time allotted to each are shown in *Table 5.3*.

TABLE 5.3

CONTRUCTION TIMETABLE

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Development Consent*						
Detailed Engineering	12 Mths					
Site Preparation	3 Mths		2 Mths			
Civil Work		20 Mths		20 Mths		
Steel Buildings		20 Mths		18 Mths		
Equipment		24 Mths			20 Mths	
Start-up						
1st Line			8 Mths			
2nd Line						8 Mths

5.4.2 Foundation Conditions

The rock units of the Tomago Coal Measures are relatively competent and provide a suitable foundation for construction.

The sand units vary in density and will require compaction prior to construction. No unusual difficulties are expected for excavations up to several metres depth. The high water table indicates that de-watering will be necessary. Temporary or permanent retaining structures will be required for excavations.

5.4.3 Site Clearing and Earthworks

There will be two periods of site preparation. The first for the first potline and all associated facilities will be of three months duration in the second quarter of the first year of the construction schedule. the second will be during the second half of year three.

Site clearing will involve the removal of the small layer of topsoil and all vegetation. The vegetation will be stockpiled and burned at times permitted by the Fire Control Act. The topsoil will be used for landscaping works around the site.

5.4.4 Provision of Services

The services required for construction purposes are water, electricity, telephone and sanitation. With exception of sanitary facilities, all are already connected to the site. Chemical treatment units will be provided for sewage disposal; details will be discussed with the Port Stephens Shire Council.

5.4.5 Workforce

It is estimated that a construction workforce of between 1200 and 1500 persons will be required for the plant. The majority of these will be locally recruited but the actual numbers cannot be specified as it remains the responsibility of the construction contractors to provide an adequate workforce.

5.4.6 Supply of Materials

The majority of the materials and items of plant will be locally produced and delivered from the manufacturer to the site by road transport. It may be necessary to import some items which will be shipped to Newcastle and then trucked from the port to the site. The favoured route for materials transport is via the Pacific Highway and Hexham Bridge but some items may have to be moved via Stockton Bridge and the Nelson Bay Road.

Where possible, all materials and plant will be restricted in size to allow transport by vehicles within the legal limits. In certain cases where final assembly must be carried out away from the site, a permit will be sought from the New South Wales Police Department to allow such items to be transported by road.

5.5 TRANSPORTATION

5.5.1 Raw Materials Receival at Newcastle

The bulk facilities for receipt of alumina and petroleum coke are to be built on Kooragang Island adjacent to a new berth to be dredged in the basin known as Rotten Row. The new berth will be constructed to the north of the existing bulk berth which is used by Alcan Australia Limited for the unloading of alumina and petroleum coke and by other companies for phosphate and various bulk commodities. The proposed layout to cater for all potential uses is shown in *Figure 5.13*. *Plate 6* is an impression of the facilities viewed from North Stockton.

Construction of the berth and silos will require reclamation at the northern end of Rotten Row Basin. The material for reclamation will be steelworks slag and some material dredged from the new berth. The size of the vessels for the transport of alumina is expected to be in the range of 20,000 to 50,000 t.

Alumina and petroleum coke will be unloaded from vessels by two rail mounted pneumatic unloaders which will each have a nominal capacity in the range of 400 t/h for alumina and approximately 200 t/h for petroleum coke. The pneumatic unloaders maintain a continuous flow of material through a totally enclosed system. The mixture of air and alumina is discharged into a closed tank where the solids are separated. The air leaves the tank through an automatic bag filter unit and the accumulated solids pass through a sealed mechanism at the bottom.

Alumina will be discharged from the travelling unloaders onto an enclosed reversible belt conveyor which can direct the material either to the existing Alcan silos or the new storage silos to be constructed for the Tomago project and that of Alumax. Material from the wharf conveyor will pass to an elevating conveyor and then to distribution conveyors above the storage silos.

The proposed storage facilities will consist of five or six alumina silos, each of 35,000 t capacity and four petroleum coke silos of 16,000 t capacity. Those supplying the Tomago smelter will discharge to road transport vehicles using a totally enclosed transfer system. There will be provision for the discharge from other silos to rail vehicles.

Provision will be made in the bulk facilities for possible storage of pitch. At this time, it is unlikely that pitch will be stored as it is anticipated that local suppliers will be able to meet the needs of the aluminium smelters with direct supply to the plants. Space is to be provided as shown in *Figure 5.13* for the installation of an additional silo for alumina should this be necessary.

When the existing and proposed aluminium smelters reach full capacity operation, the total quantities of alumina and petroleum coke handled through Rotten Row will be:-

Alumina	1,170,000 t/y
Petroleum Coke	249,000 t/y.

Associated with the bulk facilities will be an office block, amenities, toilets and a small workshop and warehouse. Parking space will be provided for employees and visitors. A sewage disposal system will be installed to cater for the requirements of employees and ships at the berth.

Further details of this facility are provided in a separate Environmental Impact Statement.

5.5.2 Transport of Raw Materials

Transfer of raw materials from the port to the smelter will be by road. These operations will be carried out by contractors, using special road tankers for the alumina and enclosed highway trucks for petroleum coke.

The preferred route is along Industrial Drive, the Pacific Highway and Tomago Road. The distance to be travelled is approximately 18.5 km.

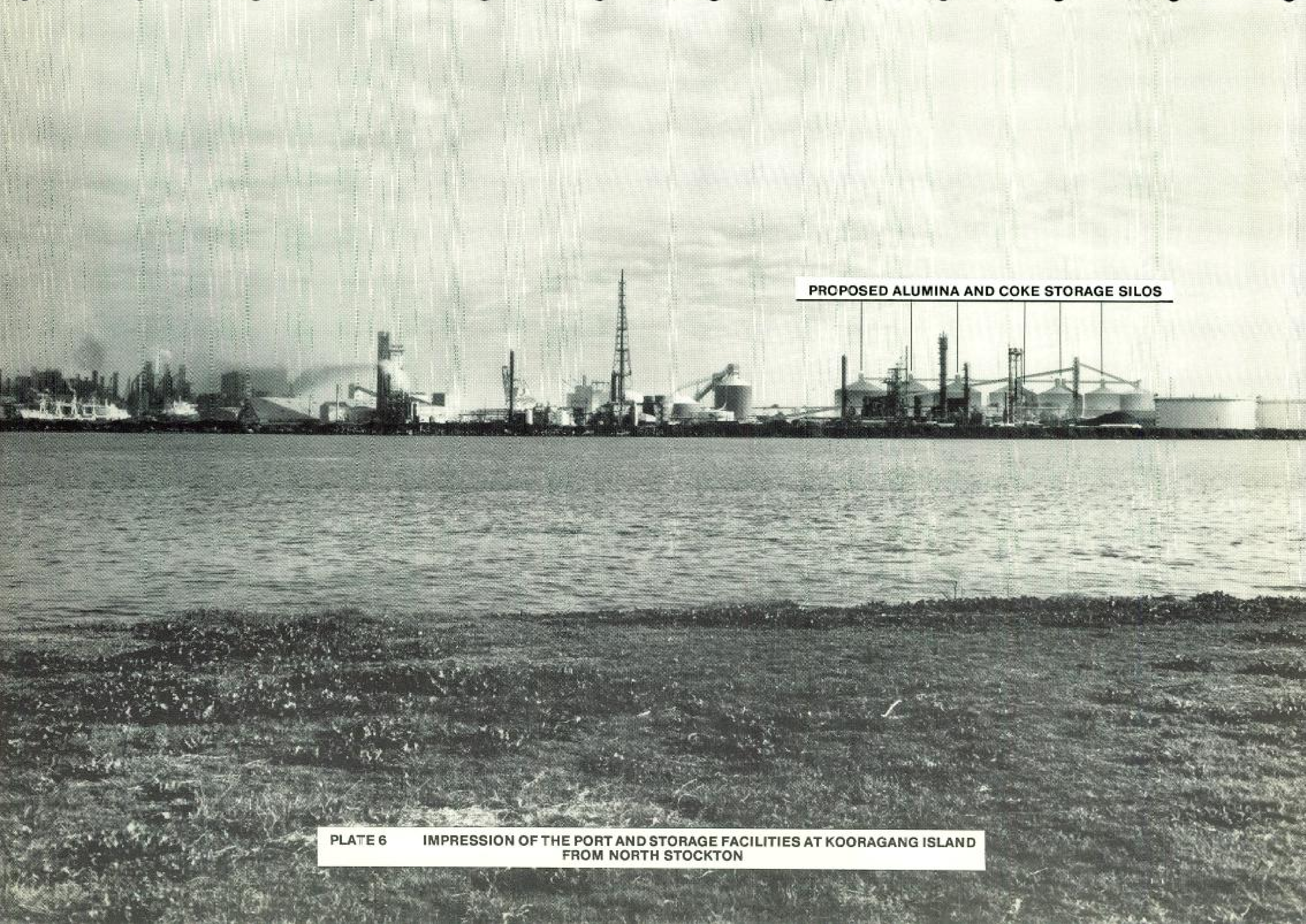


PLATE 6 IMPRESSION OF THE PORT AND STORAGE FACILITIES AT KOORAGANG ISLAND FROM NORTH STOCKTON

Pitch will be transferred in tankers from the manufacturer in Mayfield to the site along the route detailed above.

Aluminium fluoride and cathode blocks will also be road transported from the port to the smelter. Truck numbers are not significant in comparison with those indicated above.

All other raw materials will be obtained locally and total road deliveries for minor materials will average four trucks per week day.

Details of raw material movements are given in *Table 5.2*. *Section 4* of this Statement considers the transport options and the identification of the favoured option.

5.5.3 Transport of Finished Products

Finished products will be bundled, loaded onto pallets or packed in standard shipping containers before being transported by road to the Port of Newcastle. An average of 32 return trips per day will be required to move the product to port on the basis of 6 d/wk.

The route will be via the Pacific Highway and Industrial Drive to a loading facility which is still the subject of negotiations with the relevant government authorities. For efficient loading operations, the berth will need to be equipped with a general cargo crane, a container crane and a transit storage area.

At present, these facilities are only available at separate wharves at the Port of Newcastle. A 26 t capacity general cargo crane is located on Throsby Wharf and a container crane is at the Western Basin. For most cases of product shipment the use of these installations would require the movement of the vessel between the two wharves and the passage of haulage vehicles through Wickham and Carrington. To improve this situation, the Company is negotiating with the New South Wales Maritime Services Board for the development of a general cargo facility on Kooragang Island. Planning is in initial stages only and no decisions have been made on location or facilities to be provided.

5.6 SERVICES

5.6.1 Introduction

Table 5.4 summarises the utility services required by the plant.

TABLE 5.4

PLANT SERVICES

Stage	Service	Means of Supply	Quantity
Construction	Electricity	Existing Power lines, substation	12 x 10^6 kW.h
	Water	Existing pipelines	15-30 m^3/h
	Sewage	Onsite chemical units	Sufficient for 1500 persons
	Telecom-munications	Existing lines	
Operational 220,000 t/y	Electricity	2x330 kV lines	380 MW
	*Water	Existing service	102-237 m^3/h
	Sewage	Onsite treatment plant	10-25 m^3/h
	Natural Gas	Newcastle Gas Company Pipeline	900,000 GJ/y
	Telecom-munications	Existing Service	No change

* (Process water makeup - 92 m^3/h, Potable requirement - 10-25 m^3/h
(Firesystem makeup - 0-120 m^3/h

5.6.2 Electricity

The Shortland County Council will provide electric power for the construction phase using existing power lines and substation on the site.

The Electricity Commission of New South Wales will supply electric power to the site for aluminium smelting. Reliability of supply will be critical and will be ensured by the construction of two 330 kV transmission links. One will originate from the transmission line connecting Liddell Power Station to Newcastle Substation. The other will be from the Newcastle Substation and will draw power from the southern power stations. Each line will be capable of supplying the maximum demand of the plant.

The New South Wales Electricity Commission has prepared a separate environmental study on the proposed transmission lines. The route is shown in *Figure 5.14*.

The on-site substation will be provided with 330 kV duplicate busbars with bus-section switches in each bus and will include:-

i. Two incoming bays each complete with isolator with earthing switch, circuit breaker, bus-selection switches and metering, and protection current and potential transformers.

ii. Four rectifier unit bays for each potline, each bay complete with bus-selection switches, circuit breaker, step down regulating transformer, rectifier transformers, saturable reactors, rectifiers and D.C. isolating switches.

iii. Two plant service transformer bays each complete with bus - selection switches, circuit breaker and 330/11 kV step down transformer.

Auxiliary power distribution around the plant will be at 11,000 V provided by the two 30 MVA, 330/11 kV transformers located in the 330 kV substation. Further transformers will convert the supply to 1000 V for the potlines.

The switchgear in the 11 kV section of the substation will comprise two incoming units to control the secondary side of the above plant service transformers, bus-selection unit and outgoing feeder to supply the 11,000/415 V secondary substations located throughout the plant.

Total power to the plant will be measured by summation metering on the two incoming lines. To monitor and control plant operations both A.C. and D.C. power to each potline will be individually metered.

5.6.3 Water Supply

The site is served by two mains supplying treated water from the Tomago Sandbeds catchment area. One is a 25.4 cm mild steel cement lined main tapped from the 50.8 cm cast iron cement lined (C.I.C.L.) main to Newcastle. This 25.4 cm main is located in an easement along the eastern boundary of the Stauffer chemicals factory. The second supply is provided by a 76.2 cm C.I.C.L. main at the southwest corner of the site which serves as a connection between a 30.5 cm C.I.C.L. main and a 25.4 C.I.C.L. main which provides the Hexham-Tarro-Beresfield area with water from the Tomago Sandbeds. The 76.2 cm main is already metered. A system of valves on the main enables water to be pumped from the Chichester supply to the site, if the Tomago supply were to fail. The second supply is the preferred source of extraction because of the greater available capacity and assured supply during failure of the Tomago system, when compared to the 25.4 cm supply.

5.6.4 Sewerage

A package treatment plant able to handle all plant sewage will be constructed.

5.6.5 Natural Gas

Natural gas will be supplied by pipeline to the site by the Newcastle Gas Company. Details of supply have not been finalised at this time.

5.6.6 Communications Network

No augmentation is required of the existing telephone service to the site.

5.7 WORKFORCE

It is expected that 800 persons will be employed when production reaches maximum design capacity.

During the engineering construction and start-up periods, some expatriate staffing will be provided. The timing of local recruitment will vary according to the positions to be filled. Senior appointments will be made first, to start from the time basic engineering is completed.

The potlines, cast house and baking furnace will operate on three shifts per day, 7 d/wk. It is anticipated that the green anode plant will operate on three shifts per day 5 d/wk and the rodding shop two shifts per day, 5 d/wk. Routine maintenance will be performed on day shift, 5 d/wk. In addition, a skeleton staff of maintenance personnel will be assigned to each production shift.

Table 5.5 provides a permanent manning schedule for plant operation on a daily basis, without allowance for absences due to leave.

It will be the Company's policy to give preference to the employment of local people. There will also be opportunities for women and young people.

Tomago Aluminium Company Pty. Limited proposes to train 60 apprentices a year beginning January 1981, under a government-backed pilot scheme.

Building trade apprentices will be taken on first, followed by metal trade apprentices in 1982. Preference will be given to the youth of Port Stephens Shire. The existing unused buildings on the site will be used as classrooms. Two years of part-time technical training will be covered in twenty weeks. The third year of the four year apprenticeship will be spent working at the smelter site with attendance at technical college on a part-time basis.

The apprentices will be taught by technical college teachers. The skilled tradesmen will be indentured to either the Master Builders' Association or the Metal Trades Industry Association, many of whom will be needed to build and operate the smelter.

TABLE 5.5

WORKFORCE REQUIREMENTS

	General Managers	Superintendents or equivalent	Engineers or equivalent	General Foremen or equivalent	Assistant General Foreman or equivalent	Secretarial	Senior Employees	Employees	Day Workers	2 Shifts 5 days per week	2 Shifts 6 days per week	3 Shifts 5 days per week	3 Shifts 7 days per week
General	1					2 Executive 6 Secretaries		12					
Accounting		1	1				4 Accountants	12 Account Clerks					
Purchasing		1	1				4 Buyers	3 Assistants					
Data Processing				4 System Analysts	1 Scheduler		3 Operators	4 Data Preparers					
Personnel	1	1							2 Foremen				
Medical		1 Physician (part-time)					1 Nurse						
Public Relations		1							1 Foreman				
Warehouse				1			1 Co-ordinator		1 Foreman				
Traffic		1			1								
Security				1					4 Senior 4 Corpsmen				
Production	1	5	4	5	7		3	5	5 Foremen 49 Workers	4 Foremen 22 Workers	6	12	36 Foremen 232 Workers
Laboratory		1	1	1			6	4					4 Quantometer operators
Mechanical		2	1	4	1		3 Planners	5	6 Foremen 108 Tradesmen	24 Tradesmen			20 Tradesmen
Electrical	1	1	1	4			1 Planner	2	4 Foremen 38 Tradesmen	3 Tradesmen			12 Tradesmen
Mechanical Design				1	1		3 Draftsmen	1					
Electrical Design							1 Draftsman						
Total	4	15	10	21	11	8	30	48	222	53	6	12	304

Note:- Schedule does not include additional manning requirements due to absences for annual leave which would give a total workforce of approximately 800

The Existing Environment and Potential Constraints

SECTION 6

THE EXISTING ENVIRONMENT AND POTENTIAL CONSTRAINTS

SUMMARY

This section of the Statement presents the results of the geological, hydrological, botanical, ecological, meteorological, sociological, field and laboratory investigations of the existing conditions of the environment of the proposed smelter site and background socio-economic studies of the region and subregion which may experience changes resulting from the proposal.

The objectives were to identify particular features of importance requiring further detailed investigations and potential constraints which will need to receive special attention in the design of safeguards for the construction and operation of the smelter.

Special environmental studies which followed these investigations are described in Section 7. The safeguards developed to minimise or eliminate the effects of the smelter on the environment are detailed in Section 8.

The important features and potential constraints are:-

TOPOGRAPHY: The site is gently undulating with elevations ranging from 2.3 m AHD in low-lying areas on the sand flats to a maximum of 17.3 m AHD on rock outcrops on the western margin. Slopes are less than 3^{o}. Minimal earthworks will be required to provide a level site.

FOUNDATION CONDITIONS: The site is underlain in part, by deep sand units and, in part, by sandstone, shale and coal belonging to the Tomago Coal Measures. The rock units provide relatively competent foundation materials. The sand units vary in density and will require compaction to support structures or, alternatively, loads may need to be transmitted to bedrock. No particular problems are expected.

COAL MINING: Underground coal mining was carried out on the site between 1856 and 1863 and again between 1922 and 1924. The extent of the underground workings are unknown and parts of the proposed plant may be undermined. This is recognised as a potential constraint to construction and further investigations are to be undertaken.

FUTURE COAL POTENTIAL: There is potential for future underground coal mining on the site. Reserves of high fluidity, low ash, coking coal are estimated at 30 mt. The coal is regarded as a long-term resource by the New South Wales Department of Mineral Resources. Construction of a smelter on the site will be a constraint to future total coal extraction, but the large reserves available elsewhere in the Hunter Valley mean that this resource will not be required during the economic life of the smelter.

SOIL EROSION: Grey duplex soils occurring on the rock units are prone to erosion and gullying, while the uniform sandy soils, which are widely distributed on the sandbeds, are not prone to erosion. There will be no unusual problems in controlling erosion.

SOIL COMPOSITION: Clay soils are medium dense and poorly drained. Sandy soils are fine-grained, vary in density with depth and contain a percentage of finely dispersed silt and clay.

The sand consists primarily of quartz with smaller quantities of heavy minerals. The sandy soils are low in fertility and soluble salts and are acid (pH 4.6 to 5.7). They contain aluminium, phosphorus, potassium, sodium and magnesium which decrease with depth of profile. Total fluorides range from 14.1 to 45.5 ppm and water soluble fluorides also show a general decrease with depth. These analyses do not represent abnormal background conditions.

RUNOFF: Precipitation on the sandbeds infiltrates directly to the groundwater table and is seen as a potential constraint requiring consideration in the development of safeguards. Runoff from the rock units flows towards the sandbed areas and to the Hunter River.

FLOODING: The proposed plant site is higher than areas affected by the 1 in 100 year flood level. Minor parts of the Company's property are subject to low level flooding. No difficulties are foreseen for the project.

WATER QUALITY: Fresh water bodies occurring on the site are neutral, have low soluble salts and high suspended solids. Hardness, chloride, sulphate, alkalinity and fluoride levels are below maximum levels set by the New South Wales Clean Waters Act. Analyses reflected drought conditions.

Estuarine and salt water bodies in the subregion have normal levels of salts and low levels of fluoride. The fresh water bodies in the subregion are of large size (reservoirs) and have lower salts and fluoride levels than samples from the site.

GROUNDWATER: Groundwater of the Tomago Sandbeds is found within 1.5 m to 5 m of the surface. The aquifer has been developed as a major source of domestic water for Newcastle by the Hunter District Water Board and there are plans to expand the utilisation. Water stored in the sandbeds is derived entirely from rainfall and attention to the design of safeguards to protect the groundwater has been of prime concern in this Statement.

GROUNDWATER QUALITY: Groundwater occurring on the site is acidic and is low in soluble salts, fluoride, sulphate, chloride and alkalinity. Colour and turbidity are variable and iron content frequently high. Free hydrogen sulphide is present in nearly all samples. Water from the sandbeds is treated prior to distribution to service reservoirs. A high quality product is distributed.

FOGS AND INVERSIONS: Inversions occur frequently throughout the year and fogs in the cooler months. These aspects are seen as constraints because of the potential to trap emissions on the site and are taken into account in dispersion modelling studies. Both inversions and fogs are dispersed by morning convective currents.

WINDS: The site is exposed to all winds which blow predominantly from the northeast and south in summer and northwest and west in winter. Strongest winds are westerly and northwesterly and form the basis for the determination of the most suitable orientation of the plant. Meteorology receives detailed consideration in the modelling studies.

MICROCLIMATE: Wind funnels are created by areas cleared of vegetation, notably the airstrip and transmission line easements. These areas will require landscaping to reduce wind funnel effects. Turbulence occurs in the vicinity of the bedrock high.

AIR QUALITY: Dust fallout levels on the site are low at 1.95 ± 0.18 g/m^2.mth and are a measure of the dust generated by trail bike riding and clearing. Fluoride levels average 0.06 µg F/m^3 and range from zero to 0.12 µg F/m^3 as a result of the effect of other fluoride producing industries.

BACKGROUND SOUND LEVELS: Sound levels measured at 46 dB(A) in the day and 36 dB(A) at night reflected the ambient conditions in the existing industrial area. Higher levels were recorded in the vicinity of the Pacific Highway and Tomago Road and were attributed to traffic. The sounds are of low frequency.

VEGETATION: The surrounding native vegetation of the Tomago Sandbeds is diverse, dense and relatively undisturbed.

Woodland associations form the most dominant vegetation type interspersed with a variety of swamplands. Most vegetation types are adequately reserved in New South Wales, but numerous species occur in the area which are on the New South Wales Protected Plants List. Attention to safeguards to minimise the effects of the smelter on the surrounding vegetation will be required to protect species and, in turn, the Tomago Sandbeds.

FAUNA: The most common fauna in the sandbeds are passerine birds, fruit bats and macropods. The Koala and New Holland Mouse are two species occurring on the site which have indefinite and possibly endangered long-term survival prospects. The area is considered to be rich in wildlife and careful monitoring of species will have to form part of the environmental management plans for the smelter.

Further from the site the mangroves and marshes of the wetlands adjoining the Hunter River are of considerable importance as wildlife habitat.

ECOLOGICAL RELATIONSHIPS: Fresh water swamps within the sandbeds and estuarine wetlands on Kooragang Island, Fullerton Cove and Hexham Swamp are of high conservation significance. All occur within 5 km of the site and support a diverse range of waterfowl and waders. Subtle ecological controls are important in relationships between vegetation and habitat in the Tomago Sandbeds area.

LAND USE AND ZONING: The site is located on land zoned industrial and is surrounded by industrial firms, particularly metal fabrication and engineering plants. This aspect is not seen as a constraint on the location of the smelter on this site.

AGRICULTURAL LAND USES: A diverse range of agricultural land uses are carried out in the vicinity of the site, including dairying, beef cattle grazing, mixed grazing, horse breeding, poultry, vegetable growing and piggeries. Detailed attention to appropriate safeguards to lower effects on these land uses is rated highly.

TIMBER PRODUCTION: Hardboards Australia Limited manages approximately 500 ha of natural and planted pine and native forests 4 km northeast of the site. This important industry needs to be taken into account.

URBAN LAND USE: The nearest settlement concentration is at Hexham. There are 157 occupied residences to the south of the Hunter River and scattered along the Pacific Highway and Tomago Road within 4 km of the site. The location of each residence has to be considered.

RECREATIONAL AND SPECIAL LAND USES: Formal recreational facilities within proximity to the site include the International Motordrome, a sports oval, two tennis courts, a bowling green and a recreational club building.

Special land uses within close proximity of the site are the proclaimed Tomago Sandbeds Water Supply Catchment, Tomago Public School, Uniting Church, Tomago Progress Association Hall, and Tomago Detention Centre.

FISHING AND PRAWNING: Commercial fishing and prawning are carried out in the Hunter River between Hexham and Newcastle. The river is an important breeding area for fish and prawns and the fishing industry considers the Hunter River estuary a valuable fisheries resource.

RESIDENTS IN PROXIMITY: The 157 occupied residences within 4 km of the proposed smelter site house 460 persons. Some 260 live south of the Hunter River and 200 live to the north. Average length of residency of persons living north of the river is 15 years. Many older residents worked at Courtaulds textiles factory. Newer residents in the past ten years have been attracted by the undeveloped nature of the area. Lifestyle is distinctly rural. The population to the south of the river has a high proportion of retired and elderly people. Their lifestyle is urban orientated. The future of residents in close proximity to the proposal is of prime importance.

POPULATION: Approximately 20,000 persons live within 10 km of the site. Centres include Raymond Terrace, Beresfield and Jesmond.

Population in the Newcastle Statistical Subdivision in 1976 was 362,980.

POPULATION CHARACTERISTICS: The age structure of the Newcastle Statistical Subdivision differs from the National percentage due to outmigration of people to 39 years seeking employment. Residents in the 40 and over age group is higher than the National figures.

Trends are expected to continue and maintain growth at between 0.65 and 1.6 per cent per annum.

EMPLOYMENT: Major employing industries in the Hunter Valley are manufacturing, particularly metal products and machinery, and wholesale and retail trade. Currently 3.1 per cent of the workforce in the Hunter Region, consisting primarily of semi-skilled and unskilled workers, are unemployed.

ACCOMMODATION: The most popular areas for new homes in the Lower Hunter Region are Elermore Vale, Marylands and Wallsend. New South Wales Housing Commission homes and rental accommodation are not readily available in the Newcastle area. There are five caravan parks in Newcastle City and Raymond Terrace areas, and fifteen hotel-motels in the Maitland, Raymond Terrace and Nelson Bay areas.

SERVICES: There are significant numbers of pre-schools, primary and secondary schools in the Lower Hunter Region and 20 new schools planned. Special education schools, Technical Colleges and University facilities are available as well as a large range of hospital, ambulance and baby health centres.

ARCHAEOLOGICAL SITES: The only archaeological site of significance identified on the site is a tree trunk near the main entrance to the site, which bears an half-oval shaped cut believed to be made by aborigines.

HISTORICAL SETTLEMENTS: No structures or items of historical importance occur on the site. Tomago House and Chapel located 1.5 km east of the site are historical buildings in proximity.

VISUAL ASPECTS: The site is located in an area that is considered to have a variety of visual elements which vary from low to high scenic appeal. The stacks of the existing Courtaulds textiles and Stauffer chemicals factories are the only activities close to the site that can be seen from vantage points.

REGIONAL PLANNING: Major planning proposals in the Hunter Regional Plan forecast significant new growth in the East Maitland, Thornton, West Maitland and Kurri Kurri areas, and infill growth for the northern end of Lake Macquarie.

A harbour deepening programme will enable the entry of vessels up to 120,000 t deadweight and new berths at Rotten Row and Kooragang Island are planned.

Other major industrial developments planned include a new aluminium smelter near Lochinvar and expansion of the existing smelter at Kurri Kurri.

REGIONAL DEVELOPMENTS: The Hunter Valley will experience major industrial and resource development growth within the next decade. Opencut and underground mines, power stations, aluminium smelters, numerous industrial and transport developments and dams are planned. These developments together are expected to cost well in excess of $2500 million.

6.1 TOPOGRAPHY

The Tomago site is on the southwestern edge of an extensive low-lying area of sand dunes and flats extending along the coast from the Lower Hunter River estuary to the southern side of Port Stephens. The Pacific Ocean is approximately 11 km to the east of the site.

To the north and northeast, the area containing the site merges into low undulating slopes which form the eastern flank of the mountainous region between the Williams and Karuah Rivers. It adjoins the estuarine flats and alluvial floodplain of the Hunter River to the west and south.

The proposed site is flat to gently undulating with elevations ranging from 2.3 m AHD in swampy areas in the northeast corner to 17.3 m AHD on the western margin. Site contours are shown on *Figure 6.1*. All slopes are less than 3^o.

6.2 GEOLOGY AND GEOMORPHOLOGY

6.2.1 Regional Geology and Geomorphology

The proposed site is located partly on a large sand mass known as the Inner Barrier, which extends from Tomago in the southwest to Tanilba Bay in the northeast. The sand mass has an average width of 5 km and consists of stabilised sand sheets, dunes and beach ridges.

The Inner Barrier is separated from the coast by a more recent Outer Barrier, and by estuarine swamps and flats. *Figure 6.2* illustrates the relationship of these sand barriers and the interbarrier estuarine lowlands to the coastline and bedrock sequences of the Lower Hunter Valley.

6.2.2 Site Geology

Figure 6.1 shows the proposed site located partly on the stable, vegetated sand sheets and dunes of the Inner Barrier and partly on the sediments of the Tomago Coal Measures.

The rocks of the coal measures crop out on the western margin of the site and dip to the south beneath the Hunter River.

The rocks consist of fine to medium grained, massive grey sandstone and siltstone interbedded with grey shale and coal. Surface exposures are usually poor and very weathered. In areas covered by sand, the underlying bedrock surface consists of very stiff, sandy and silty clay derived from the in-situ weathering of the sediments.

Clay slopewash derived from the erosion of the bedrock units forms a thin layer (1 to 2 m thick) overlying sand adjacent to the contact with the Tomago Coal Measures.

The sand units form northeast-southwest trending, low amplitude windblown dunes and sheets of fine to medium grained, white to grey sand. The units are well vegetated and broad depressions and swamps separating the dunes are commonly damp and contain peat up to 1 m in thickness.

The sand thickness varies from 3.85 m on the western margin of the site to 15.9 m southeast of the disused airstrip.

The sand dunes and sheets have been disturbed by the construction of the now disused airstrip and Courtaulds textiles factory, past coal mining activities and heavy mineral sand mining. Gravel and coal washery refuse have been used as filling in the construction of the airstrip, parts of the Courtaulds textiles and Stauffer chemical factories and access roads and tracks.

6.2.3 Coal, Heavy Minerals and Industrial Sands

Coal

Figure 6.2 shows the locations of five diamond drill holes for coal. These bores were drilled between 1861 and 1889 by exploration companies and all intersected economic coal seams to depths of 427 m.

The seams belong to the Tomago Coal Measures and include the Donaldson Seam, the Big Ben Seam (formerly the Tomago Thick Seam), the Tomago Thin Seam, the Scotch Derry Seam and two uncorrelated seams of significant thickness. The seams appear to thin to the east and cindering has been recorded in the Hexham Island, Bibby and Cookes Windeyer Estate Bores.

Underground coal mining was carried out on the site between 1856 and 1863 and again between 1921 and 1924. The location of the access shaft to the workings is shown on *Figure 6.1*.

Tomago Colliery: The shaft for this colliery was sunk in 1856 to a depth of 106.4 m. Two seams, the Big Ben Seam at 97 m and the Tomago Thin Seam at 105.5 m were worked by the Tomago Coal Mining Company. The Big Ben Seam was 1.2 m thick and the better quality Tomago Thin Seam was 0.9 m thick. Between 100 t and 150 t of coal were mined daily. Mining had ceased by October 1864.

Big Ben Colliery: In 1922, the Big Ben Coal Mining Company Limited commenced mining on the site of the former Tomago Colliery. It is thought (*Cleland 1979*) that the new company planned to dewater the existing shaft and use it as an air inlet, while sinking a separate access elsewhere on the site. There are no records of any coal being mined and operations closed in 1924.

Quantity of coal mined: It is estimated that between July 1857 and July 1863, approximately 75,000 t of coal from the Big Ben Seam and 50,000 t from the Tomago Thin Seam were mined (*Cleland, 1979*). Because of the thickness of the Big Ben Seam (2.1 m), it is probable that mining was carried out by bord and pillar methods, while the Tomago Thin was mined long-wall. Assuming that extraction was down dip, an area of between 2 ha and 5 ha on the southern side of the shaft would be undermined, although no records of the exact extent of the underground workings are available.

Subsidence: An area of approximately 30 m^2 surrounding the shaft has subsided up to 2 m and the workings are full of water. No other evidence of subsidence associated with the coal mining operations has been found in the existing buildings and stacks of the Courtaulds textiles and Stauffer chemicals factories. Because of the depths of the seams in the area, strength of the roof strata and time that has elapsed, further subsidence is not expected.

Future coal potential: There is some potential for future underground coal mining on the proposed site. Difficult mining conditions may be encountered since all seams occur beneath a thick cover of unconsolidated sediments adjacent to the Hunter River and the Tomago Sandbeds groundwater aquifer.

Reserves of coal beneath the Tomago smelter site have been estimated at 30 mt to a depth of 335 m (assuming the Donaldson seam is 1.2 m thick, Big Ben 1.8 m, Tomago Thin 0.9 m, Scotch Derry 9.1 m and two uncorrelated seams 1.2 m thick each), (*Thomson, 1979*).

Drilling has established that the coal is a high fluidity, low ash coking coal suitable for blending with Upper Hunter Coals of low fluidity to produce an optimum grade of coking coal. Some seams south and east of the proposed site have been extensively cindered and further coal exploration would be required to determine the extent of high quality coal on the site.

There are no short-term plans to extract the coal but, because of its quality and potential to blend with Upper Hunter coals, it is regarded as a valuable long-term resource by the New South Wales Department of Mineral Resources.

Heavy Mineral Sands

Figure 6.1 shows the area mined between 1967 and 1971 by Rutile and Zircon Mines (Newcastle) Limited for heavy minerals.

Mineral sand grades averaged 2 to 3 per cent by weight, and were mined by dredging to a depth of approximately 8 m. All known economic grades were mined and the area rehabilitated.

No prospecting for heavy minerals has been carried out over the proposed site as most of this area is a Reserve within which mining titles will not be granted. The low grades of heavy mineral recovered during operations in adjacent areas indicate that on geological grounds, the grades occurring on the site would be uneconomic. Both the mineral sand industry (Rutile and Zircon Mines (Newcastle) Limited) and New South Wales Department of Mineral Resources (*Smith 1979*) consider that there is no potential for future mineral sand mining in this area.

Industrial Sand

The low dunes occurring in the northeast portion of the proposed site shown on *Figure 6.1* are capped with 1 to 2 m of a fine grained, white sand suitable for the manufacture of colourless glass products. Quantities of high quality glassmaking sand in the area are estimated at 100,000 t (*Smith, 1979*). The New South Wales Department of Mineral Resources regards these dunes as additional sources of glassmaking sand to supplement existing supplies and is concerned at total sterilisation of the sand deposits.

6.3 SOILS

6.3.1 Soil Types and Erosion Potential

Figure 6.1 indicates that the distribution of soil types is closely related to the underlying geology.

Grey Duplex Soils (Dd) are developed on the Tomago Coal Measures. These soils display strong textural and structural differences between the 'A' and 'B' horizons. The 'A' horizon consists of a silty clay loam of a predominant grey to grey-brown colour which varies in thickness from 0 to 20 cm and is underlain by a grey, light to medium clay forming the 'B' horizon. Typically, the soils of the 'A' horizon are permeable, friable, and of low plasticity while the clay of the 'B' horizon is moderately plastic and hard.

The duplex soils are prone to erosion and gullying occurs along formed tracks. They are moderately to poorly drained and have not been developed agriculturally.

Two soil types found on the sand units are uniform sandy soils (Uc), developed on the sand sheets and dunes and organic soils (O) associated with the low-lying peat swamps.

The organic soils (O) are confined to the low-lying peat swamps and consist of 30 cm of dark brown to black organic matter with clay less than 15 per cent. This horizon overlies a moist, leached, fine to medium-grained white sand. Underlying soil horizons are similar to the uniform sandy soils (Uc).

The uniform sandy soils are widely distributed on the site. They consist of a dark grey, fine to medium grained sand with variable amounts of organic matter. The thickness of the A_1 horizon averages 0.5 m. A leached A_2 horizon consisting of white, fine to medium grained sand up to 3 m in thickness commonly underlies this horizon. Dark brown to black, humate-impregnated sand underlies the surface white or grey sand. This humate (B_1) horizon is closer to the surface in the low-lying depressions than on the dunes and appears to be related to the groundwater table.

Both the uniform sandy and organic soils are well drained and not subject to erosion. Rainfall infiltrates directly through the soil to the groundwater table and flows down the hydraulic gradient towards the Hunter River, or drains to the low-lying peat swamps.

6.3.2 Soil Analyses

Full details of soil analyses are given in *Appendix 4* and *Tables A4.1 to A4.3* within the appendix. Soil sampling sites are shown on *Figure 6.3*.

The results of analyses were:-

i. The sand is medium to fine-grained and uniform in size and grading in surface distribution and depth. *Figure 6.4* shows that the density of undisturbed sand varies from loose near the surface to medium dense at 3.6 to 4.6 m and becoming very dense below 4.6 m.

ii. The sand consists of quartz (average 95 per cent), rutile, zircon, ilmenite, pyroxenes and minor feldspar with a higher content of silt and clay near the surface than at depths greater than 2 m. The variation in clay and silt content with depth is illustrated in the figure.

iii. Organic matter, water soluble phosphorus, potassium, sodium and magnesium contents are higher in the surface soil layers than at depth.

iv. Water soluble fluoride shows a decrease with depth.

v. The total aluminium content of the soil is variable, being higher in the range between 1 m and 2.5 m, than in the surface layer. Water soluble aluminium also shows a similar trend.

vi. The soils are low in fertility. Total phosphorus content ranges from 7 to 23 ppm and nitrogen 1 to 15 ppm.

Total Kjeldahl nitrogen is less than 0.04 per cent except in the surface 15 cm where it reaches 0.13 per cent.

vii. Total soluble salts are low (<0.01 per cent) and pH ranges from 4.6 to 5.7.

viii. The total fluoride content of the soil ranges from 14.1 to 45.5 ppm and is similar to the fluoride content of soils measured by *Larsen and Widdowson (1971)*, (1.8 to 38.0 ppm).

6.4 SURFACE WATER

6.4.1 Subregional Drainage Pattern

The site is adjacent to the Hunter River which has a catchment area in excess of 25,000 km^2 in the Hunter Valley. From Hexham to Newcastle, the river is split into two channels, the north arm and the south arm separated by Kooragang Island. A shallow estuarine bay known as Fullerton Cove, adjoins the north arm of the Hunter River while the Hexham Swamp occurs on the western side of the south arm.

Precipitation on the Inner and Outer Barriers infiltrates to the shallow groundwater table within the sand units. Swamps and lagoons are found throughout the barriers where the groundwater table rises to the surface.

The low-lying depression between the barriers is drained by two man-made channels, the Ten and Fifteen Foot Drains which flow west from Williamtown to Fullerton Cove. East of Williamtown, the interbarrier depression is drained by Tilligerry Creek into Port Stephens.

Grahamstown Reservoir is approximately 10 km northeast of the site. This large body of water with a surface area of 25.36 km^2 and average depth of 6 m was constructed by the Hunter District Water Board to serve as an additional source of domestic water for the Newcastle area.

6.4.2 Site Surface Drainage

There are no permanent flowing water channels on the site. Runoff from the rock units flows east in small intermittent streams towards the sandbeds, where it infiltrates to the groundwater table. Stream courses are not well-defined and, in many cases, gullies along existing tracks form the main channels.

Precipitation on the sand units infiltrates to the groundwater table which rises to the surface after sustained rainfall and increases the extent of the swampy areas. Minor runoff only occurs after sustained heavy downpours.

6.4.3 Flood Levels

Figure 6.3 shows the extent of flooding on the site and surrounding areas from a 1 in 100 year flood on the Hunter River. The New South Wales Department of Public Works has estimated that these levels closely approximate those of the February 1955 flood, the highest recorded flood in the Hunter Valley. Minor flooding to levels of 4.3 m and 3.5 m AHD will occur along the northern and southern boundaries respectively.

Flooding due to a 1 in 50 year flood will be limited to approximately 2.3 m AHD on the northern perimeter and 2.7 m AHD on the southern boundary and will not encroach on the site. A 1 in 20 year flood will only overtop the banks of the Hunter River in low-lying areas which are protected by recently constructed levee banks.

No flooding should occur in the areas proposed for the plant.

6.4.4 Water Quality

The details of water quality sampling procedures, methods of analysis and results are presented in *Appendix 5*.

A total of 25 sites within a 10 to 12 km radius of the site has been monitored or sampled on a monthly basis since November 1979. The sampling points shown in *Figure 6.5* include all the surface water areas on the site, as well as the estuarine and fresh water swamps, lakes and streams within the subregion possibly affected by the smelter.

Changes in water quality resulting from tidal influences in the Hunter River close to the site (W2) were studied in a 24 hour survey of pH, conductivity, temperature and fluoride levels.

The results are summarised for the following three types of water body:-

Group A: Fresh water bodies on the proposed site.

Group B: Estuarine water sites within the subregion.

Group C: Fresh water sites within the subregion.

i. *Group A*

* The waters are neutral (pH 6.8) with low soluble salt levels (1.8 mmhos/cm at 25^{o}C, 1086 mg/l salt).
* The suspended solid level is very high (1429 mg/l) and it is unlikely that these fresh water bodies would support significant populations of fish and benthic fauna. Research studies have shown that few fish are found in fresh water bodies containing more than 400 mg/l suspended solids.
* The total hardness of these waters is approximately 496 mg $CaCO_3$/l which is within acceptable limits. The World Health Organisation recommends a maximum total hardness of 500 mg $CaCO_3$/l.
* The chloride levels are low (166 mg/l) and the water would be suitable for irrigation. Research studies have shown that chloride concentrations of 175, 265, and 350 mg/l will limit production of stone fruits, citrus fruits and vines respectively. The chloride level is well below the acceptable level of 250 mg/l indicated in Schedule 2 of the New South Wales Clean Waters Act.
* The sulphate levels are low (187 mg/l) and are well below the acceptable levels of 250 mg/l indicated in Schedule 2 of the New South Wales Clean Waters Act.
* The alkalinity level of 487 mg$CaCO_3$/l is within the generally agreed acceptable range of 30 to 500 mg $CaCO_3$/l. High alkalinity levels have been shown to assist in promoting algal growth.
* The fluoride level of 0.30 mg/l is well below the acceptable level of 1.5 mg/l indicated in Schedule 2 of the New South Wales Clean Waters Act.
* Mercury and pH at site W1 exceed the maximum permissible discharge levels for an industrial site as specified in Schedule 2 of the New South Wales Clean Waters Act.

ii. *Group B*

* Soluble salts (27650 mg/l), chloride (12967 mg/l) and sulphate (2040 mg/l) levels are higher than Group A. Suspended solids (60 mg/l) and total alkalinity (153 mg/l) are lower. Fluoride (0.94 mg/l) results are lower than expected for ocean water (1.4 mg/l), reflecting the influence of fresh water influxes and the estuarine nature of many of the water sites.
* Barium and mercury at site W2 exceed the maximum permissible discharge levels for an industrial site as specified in Schedule 2 of the New South Wales Clean Waters Act.

iii. *Group C*

* The results for Group C are lower than for Group A as most of the sites are on larger bodies of water with more extensive catchment areas. The group includes Grahamstown Reservoir and the "Blue Lagoon" in the Hunter District Water Board proclaimed Tomago Sandbeds Water Supply Catchment.
* At site W22 pH exceeds the maximum permissible discharge levels for an industrial site as specified in Schedule 2 of the New South Wales Clean Waters Act.

Hunter River 24 hour Survey

The results of the 24 hour survey of the Hunter River at site W2 are shown in *Figure 6.6* and summarised as:-

* There was little change in pH over the twenty-four hour period. The range was 7.5 to 8.0
* The water temperature was considerably higher than the ambient air temperature. A longer monitoring period would be required to assess the influence of diurnal and tidal changes on water temperature.
* The conductivity, which is indicative of salinity, followed the normal pattern. At high tide the salinity was high and at low tide the salinity was low, due to fresh water influxes from the Hunter River.
* The approximate levels of fluoride in ocean water and fresh water are 1.4 and 0.1 mg/l respectively. The fluoride levels in the estuarine portion of the Hunter River follow the same trends as salinity as illustrated in *Figure 6.6*.

6.5 GROUNDWATER

The results of an extensive study of the groundwater of the Tomago Sandbeds are presented in *Section 7* and detailed in *Appendix 6*. Aspects of this study are discussed below.

6.5.1 Aquifer Definition and Extent

The Tomago Sandbeds extend to an average depth of 18 m below the surface and are relatively unconsolidated and continuous over the entire area. The fine grained sand forms a fairly uniform aquifer in which the water table varies from 1.5 m to 5 m below the surface.

The exact limits of the groundwater aquifer have not been precisely defined, but the proclaimed boundary of the Tomago Sandbeds Water Supply Catchment shown on *Figure 6.7* is considered the approximate limits of the aquifer suitable for water supply. This boundary encompasses an area of 106 km^2.

The water stored in the sandbeds is derived entirely from rainfall. Groundwater contours determined by the Hunter District Water Board are shown on the figure and indicate a natural hydraulic gradient towards the Hunter River, the Pacific Ocean and Port Stephens.

Groundwater flows on the proposed site have been investigated by *Australian Groundwater Consultants Pty. Limited (1980)*. The bores shown in *Figure 6.8* have been monitored continuously since August 1979 and the results show that the natural flow of the groundwater is to the south and southwest from the vicinity of GW3. The Hunter District Water Board has identified a groundwater high trending in a southwest direction from near pumping station 2 (*Figure 6.7*) and separating the flows to the south and north. The Consultants' results suggest that the high continues as shown in *Figure 6.8*. Although it is likely that the actual position of the high may vary slightly with seasonal conditions, the overall flow directions should remain relatively constant.

Further evidence of a northwesterly flow of groundwater north of the high is provided by surface flows from the natural lagoon east of GW4 which are to the northwest as indicated on *Figure 6.8*.

No definitive results have been obtained for groundwater flows from the bedrock high on the western portion of the site but it has been assumed that flows are away from the maximum elevation and probably not connected to the groundwater of the Tomago Sandbeds.

Details of factors affecting infiltration, recharge and flow are described in *Appendices 6.3 and 6.4*.

6.5.2 Groundwater Usage

The Hunter District Water Board has developed the sandbeds as a major source of domestic water for Newcastle. Twenty primary pumping stations (see *Figure 6.7*) supply water to a central plant at Tomago, where it is treated and pumped to reservoirs for distribution. About 91 km^2 of the proclaimed catchment area are utilised for water supply.

In 1977-78, a total of 13,577 Ml of water was delivered to the Newcastle area from the sandbeds, representing 16 per cent of the domestic water requirements of the Newcastle-Lake Macquarie area. Other sources of domestic water are Chichester Dam and Grahamstown Reservoir which jointly delivered 71,027 Ml of water in 1977-78.

The Tomago Sandbeds are not utilised as a year-round water source. Most stations are operated only during the summer months when the demand is greatest. The number of stations delivering water to the central treatment plant at any one time is dependent on demand, water quality and the storage situation with regard to other sources and supply.

Within 5 km of the proposed site there are three pumping stations (1, 2 and 20). Stations 1 and 2 are the original pumping stations first brought into service in 1939. Both use a shallow-well suction-lift system for drawing water from a depth of 12 m.

Station 20 uses deep bore pumps and draws water from a depth of 20 m. It consists of 8 bores installed 220 m apart in a straight line orientated north-south parallel to the water table contours and to intercept groundwater which flows naturally to the Hunter River.

Water is pumped from the sandbeds to the treatment plant at Tomago. It is first aerated in spray basins to remove hydrogen sulphide, lower carbon dioxide and increase oxygen content. Flocculation and sedimentation processes using lime, alum and chlorine are followed by filtration through sand filters. The purified water then passes to a 9.1 Ml capacity clean water reservoir for delivery to service reservoirs and pumping stations.

6.5.3 Groundwater Quality

Details of groundwater sampling procedures, techniques and results are presented in *Appendix 6.6.2*.

Groundwater has been sampled since December 1979 from four bores on the site (GW1 to GW4) and five bores at pumping stations 1, 2 and 20 (GW5 to GW9). *Figure 6.8* shows the locations of the bores.

The analytical results indicate that:-

i. The groundwater is acidic (≈pH6.0) except for GW4 which is neutral (pH 7.2).

ii. GW4 has higher soluble salts (1548 mg/l) and conductivity (2.20 mmhos/cm at 25°C) than the remaining sites which have salt contents of 135 mg/1 (average) and conductivity (0.18 mmhos/cm at 25°C).

iii. The fluoride (average 0.08 mg/l) and sulphate (average 44 mg/l) are low, except for GW4 which has a sulphate level of 135 mg/l. Results are all below the maximum levels in Schedule 2 of the New South Wales Clean Waters Act.

iv. The total hardness of water at all sites is well below the World Health Organisation's maximum total hardness of 500 $mgCaCO_3/l$.

v. The chloride levels at all sites except GW4 are below the maximum level indicated in Schedule 2 of the New South Wales Clean Waters Act.

vi. The total alkalinity of GW4 is higher (494 $mgCaCO_3/l$) than the remaining sites (average 18 $mgCaCO_3/l$), but all results are within the acceptable range of 30 to 500 mg

$CaCO_3/1$.

The results for GW4 are anomalous when compared with those from the remaining sites. It is probable that GW4 has been contaminated by an external source, or alternatively represents an isolated, more saline site within the groundwater aquifer. GW4 has not been included in the calculation of overall mean values.
Detailed laboratory studies have been conducted to examine the effects of gaseous and particulate emissions from the smelter on the quality of the groundwater. Results of this work are discussed in *Section 7*.

6.6 METEOROLOGY

6.6.1 Sources of Data

The climatic characteristics have been assessed from official meteorological records from stations at Williamtown and West Maitland approximately 13 km east and 18 km west of the site respectively.

6.6.2 Temperature and Humidity

Temperatures on the site occur within the range of average daily temperatures shown on *Figure 6.9*. The hottest month is January with an average daily maximum temperature of between 27°C and 29°C. Temperatures above 30°C occur from November to March, with 'heat wave' days (greater than 35°C) occurring on at least five days in both December and January. July is the coldest month with an average daily minimum temperature of between 3°C and 6°C.

The average daily relative humidity is shown on *Figure 6.9*. The yearly average is approximately 52 per cent, with the highest readings occurring in late summer and the lowest in Spring.

Dry temperate weather conditions may lead to bushfires, as evidenced by twelve fires attended by the Tomago Bush Fire Brigade in 1978.

6.6.3 Inversions and Fog

Data on inversions is presented in *Table 6.1*.

TABLE 6.1

PERCENTAGE OF INVERSIONS IN EACH SEASON
RELATED TO THE HEIGHT OF THE TOP OF THE INVERSION

				Inversion Heights (m)					All
Season	0-100	100-200	200-300	300-400	400-500	500-600	600-700	>700	Heights
Summer	10.7	21.4	4.7	3.8	3.2	5.0	0.9	2.4	52.4
Autumn	10.6	32.9	17.6	6.9	3.9	2.6	0.7	0.9	76.1
Winter	9.8	35.7	17.2	8.3	5.6	0.6	0.6	0	78.3
Spring	11.3	28.2	14.5	9.7	5.9	3.2	0.8	0.8	74.2

Inversions occur on approximately half the days in summer and three quarters of the days in other seasons. Seventy-seven per cent of the inversions are less than 300 m in height.

The weakest inversions occur in summer when the height of inversions is greater and the mean increase in temperature with height is less than in other seasons for which the mean heights and lapse rates are similar. In all seasons, approximately 40 per cent of the temperature difference between the surface and the top of the inversion is $2^{o}C$ or less. The inversions are usually dissipated by morning convective currents.

Radiation fog occurs frequently on the site in the cooler months. Its formation is assisted by the low-lying flats and surrounding estuarine plain. The fog is usually dissipated by morning convective currents after a duration of approximately 3 to 4 hours.

6.6.4 Rainfall

The average monthly rainfall recorded by the Hunter District Water Board at pumping station 1 is shown in *Table 6.2*.

TABLE 6.2

AVERAGE MONTHLY RAINFALL (mm)
(1969 to 1979)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Total (mm)	134.4	110.4	143.8	90.1	116.1	137.3	27.9	48.7	62.9	93.2	98.2	93.1	1156.1
Days	10.6	10.4	13.6	9.09	10.1	12.1	6	6.9	9.9	11.7	11.5	8.4	120

The average annual rainfall of 1156.12 mm falls on 120 d/y. Most of the rain (33 per cent) falls from January to March when thunderstorm activity is prevalent. A secondary peak occurs in May and June. March is the wettest month and receives 143.8 mm or 12.4 per cent of the annual total and has an average of 10.5 mm of rain falling per rain day.

The driest period is from late winter to early spring when dry westerly winds prevail. July, the driest month, receives 27.9 mm or 2.8 per cent of the annual total and has an average of 4.6 mm of rain falling per rain day.

6.6.5 Winds

Appendix 15 presents details of the meteorological data from Williamtown used to assess wind speed and direction for dispersion modelling.

The data from the Williamtown RAAF base includes wind speed and direction for several times a day and variation in temperature with height (measured by radiosonde balloons). This information has been analysed to give the percentage of readings in each combined wind speed, wind direction and stability category for each month.

The wind roses in *Figure 6.10* are derived from readings taken at 9am and 9pm and show wind speed and direction proportions for each month. These indicate a predominance of winds from the northeast and south sectors in the summer months, from the northwest and west sectors in the winter months and a more even distribution in autumn and spring.

The roses show direction of wind rather than wind source for comparison with the patterns of emission dispersion described in *Section 7*.

6.6.6 Microclimate

As the site is uniform in relief, slope and elevation, the only significant microclimatic influences are the wind funnels created by the clearing of vegetation, and the wind turbulence created by the bedrock high west of the former Courtaulds textiles factory.

Wind funnels are created by the northwest-southeast trending transmission line easement for southeastly winds and the disused airstrip for northwesterly winds.

The bedrock high to the west of the site provides a barrier for westerly winds, slowing them down and creating lee waves on the eastern slopes. Easterly winds become turbulent in the vicinity of the bedrock high as the winds are lifted to higher elevations.

6.6.7 Air Quality

Details of air quality monitoring procedures, methods of analysis and results are presented in *Appendix 7*.

Dust Levels

A total of eight dust deposition gauges was installed on the proposed site during November 1979 at the locations shown on *Figure 6.3*. The stations are serviced at monthly intervals and analysed for:-

Total dust (g/m^2.mth)
Residue after ashing at 450^{o}C (g/m^2.mth)
Water soluble fluoride (mg/1)
Total fluoride (μgF/g)

The results of analysis show that the average measured dust fallout level for the site for the November 1979 to June 1980 period was 1.95 ± 0.18 g/m^2.mth. which is considerably less than the level of 4.22 ± 0.27 g/m^2.mth. measured by the State Pollution Control Commission in Newcastle between October and November 1977. Water soluble fluoride levels were low (<0.25 mg/l) and the average total fluoride in the dust is 3.5μgF/g or 0.0003 per cent. Approximately 50 per cent of the total dust is organic matter.

Atmospheric Fluoride Levels

Twenty static ambient fluoride monitoring stations shown on *Figure 6.3* were installed during February 1980. Samples are collected monthly. The *Israel (1974)* equation was used to convert results expressed as $\mu gF/cm^2.d$ to $\mu gF/m^3$.

The results show that there is little variation in static ambient fluoride levels on and near the proposed site. The overall mean of results obtained to date (February to June 1980) is 0.0072±0.0017 $\mu gF/cm^2.d$ which is equivalent to approximately 0.06±0.03 $\mu gF/m^3$. An increase in the average fluoride level on the site from 0.06$\mu gF/m^3$ in May to 0.12$\mu gF/m^3$ in June 1980 has been attributed to seasonal variations influencing -

i. The emissions from industries in the Mayfield and Kooragang Island area which have been carried to the proposed site by occasional gentle southerly breezes.

ii. Trapping of emissions on the site by winter inversions.

Two stations, 11 and 12 have higher readings than the average fluoride level. This result could be due to the fact that station 11 receives salt spray from the Hunter River and fertiliser dust from a nearby garden and station 12 receives spray drift from a nearby coating factory.

6.7 AMBIENT SOUND LEVELS

Details of the sound level studies conducted on the site and in the surrounding area are described in *Appendix 8*.

Sound levels were monitored at a total of fourteen sites within the area shown on *Figure 6.11* during November 1979 and January 1980. In addition, two 24 hour surveys were conducted at measurement site N5 and the results shown in *Figure 6.12.*

The mean background (L_{95}) sound level was 46 dB(A) during the day and 36 dB(A) at night. The higher day time sound level is attributed to the higher traffic volumes on the main roads and the activities of the majority of industrial facilities which operate only during the day. Background (L_{95}) sound contours for day and night periods are shown on *Figure 6.11.*

The results of octave frequency analyses at sites N2 and N10 indicate that night time sound components at these sites are predominantly low frequency (<1000Hz) signals.

The two 24 hour studies show that background sound levels are dependent on time of day and vehicular movements. Background day time sound levels on a Sunday are similar to day time levels measured during the week. Normal noise reductions which would be expected on a Sunday as a result of local industries not operating are offset by increased vehicular movements at weekends. The International Motordrome near the site is a source of high sound levels when in operation. Infrequent meetings haveresulted in no study being conducted to date.

6.8 FLORA

6.8.1 Scope

Figure 6.13 shows the floral assemblages occurring on the site and in the surrounding areas. The Mangrove-Salt Marsh areas on Fullerton Cove and Kooragang Island to the south and east of the site and the diverse vegetation associated with the Tomago Sandbeds exist as relatively undisturbed areas. Exotic plants occur where the land has been cleared for agricultural purposes south and west of the proposed site. Vegetation near the proposed plant is largely regeneration as it is likely that much of the area was cleared when a coal mine operated on the site.

The relationships between the vegetation of the site and that of the subregion containing it is shown in *Figure 6.14*.

Details of the field observations and the characteristics of the native vegetation assemblages are presented in *Appendices 9.1 and 9.2*. Plant species, species distribution and abundance are listed in *Appendix 9.3*.

The following three broad categories of vegetation have been recognised:-

i. Estuarine areas subject to tidal influence.

ii. The Tomago Sandbeds where the vegetation is supported by sandy soils of low fertility.

iii. Cleared pastoral lands and associated swamp areas.

6.8.2 Native Flora

Estuarine Areas

i. Mangroves: Stands of the Grey Mangrove (*Avicennia marina*) border the Hunter River, Fullerton Cove and Kooragang Island. The River Mangrove (*Aegiceras corniculatum*) is also present but is a less common species favouring sheltered sites. The stands are classified as Closed Forest to Tall Shrubland according to Specht's Structural Classification (*Specht et al, 1974*).

ii. Salt Marsh: The areas under tidal influence on the landward side of the Mangrove stands are dominated by salt-tolerant plants or bare mud. Changes in micro-topography result in the dominant species varying between Sand Couch (*Sporobolus virginicus*), Samphire (*Salicornia quinqueflora*) and *Juncus maritimus*.

Tomago Sandbeds

i. Dry Sclerophyll Closed Forest to Woodland: Several associations belonging to the Dry Sclerophyll Closed Forest to Woodland classification occur within the Tomago Sandbeds. The two most common associations are the Rusty Gum (*Angophora costata*) - Red Bloodwood (*Eucalyptus gummifera*) Association and the Rusty Gum - Scribbly Gum (*Eucalyptus haemastoma*) - Red Bloodwood Association. Saw Banksia (*Banksia serrata*) and Woody Pear (*Xylomelum pyriforme*) are common understorey plants. The ground cover is generally dense and consists of a wide diversity of plants typical of heathland.

Figure 6.13 shows the distribution of plants within the two associations to be highly variable. The Spotted Gum *(Eucalyptus maculata)* - Ironbark Association is well developed on the bedrock units on the western part of the site while a Forest Red Gum *(E. tereticornis)* stand occurs to the northwest of the disused airstrip. A small clump of young Flooded Gum *(E. grandis)* has developed northeast of the disused airstrip. The Rusty Gum - Stringybark *(E. globoidea)* Association is poorly represented on the site.

ii. Swampland: Broad-leaved Paperbark *(Melaleuca quinquenervia)* Swamp Mahogany *(Eucalyptus robusta)* swamps, coastal bogs containing a variety of heath plants and Lepironia swamps occur throughout the area.

iii. Closed Scrub: Ball Honey-myrtle *(Melaleuca nodosa)* Closed Scrub occurs in two areas shown on *Figure 6.13*.

The eastern area consists of a dense layer of Ball Honey-myrtle with occasional Ironbarks, Stringybarks, Red Gums and Rusty Gums.

The Closed Scrub adjacent to the sand mined area displays a much wider diversity. The dense vegetation is dominated by Ball Honey-myrtle but also contains Rock Banksia *(Banksia aspleniifolia)*, Tantoon *(Leptospermum flavescens)*, Feather Honey-myrtle *(Melaleuca thymifolia)* and others.

The cleared and low-lying land, which is now used as pastures, contains remnants of the original vegetation marked by isolated Swamp Oaks. Stands of Swamp Oak and Red Gum occur at the Tomago Road - Pacific Highway intersection. Paperbarks grow in the largest stands.

The area of regeneration to the west of Old Punt Road consists predominantly of Paperbarks and Oaks with some Spotted Gum.

Low-Lying and Pastoral Land

The areas shown on *Figure 6.13* as Reed Swamp have a wide range of characteristics including features belonging to She-Oak Swamps. Patches of the Common Reed *(Phragmites australis)* occur on the Mangrove-lined perimeters of the low-lying areas. Scattered individuals of Swamp Oak also occur with an understorey of *Juncus* species. The intermediate areas are dominated by grasses and *Scirpus caldwelli*.

Semi-permanent swamps around Fullerton Cove consist of sparsely grassed land with clumps of *Juncus maritimus* and small remnants of other salt-tolerant species. In the numerous shallow channels, Arrowgrass *(Triglochin striata)* and Water Buttons *(Cotula coronopifolia)* occur. Some of the larger man-made channels contain Common Reed and Sand Couch and Samphire on their banks.

Semi-permanent swamps on Kooragang Island consist of Fresh Meadow dominated by Water Buttons, Seasonal Fresh Swamp dominated by Water Ribbons and some Salt Marsh near Mangroves.

6.8.3 Agricultural and Horticultural Flora

The pastures in the vicinity of the site consist mainly of Kikuyu *Pennisetum clandestinum)* and Couch *(Cynodon dactylon)* with White Clover *(Trifolium repens)* and Paspalum *(Paspalum dilatatum)* as common subordinates.

Weeds found in the cleared and pastoral land are listed in *Table 6.3*.

TABLE 6.3

WEED SPECIES OCCURRING IN PASTURELANDS

Scientific Name	Common Name
Rumex sp.	Dock
Xanthium chinense	Noogoora Burr*
Senecia lautus	Fireweed
Rubus vulgaris	Blackberry*
Alternanthera philoxeroides	Alligator Weed*

* indicates noxious weed.

South of Tomago Road, the pastureland is dissected by drains flowing into the north arm of the Hunter River. Water plants, e.g. Water Ribbons *(Triglochin procera)* and the noxious Alligator Weed *(Alternanthera philoxeroides)* grow profusely in the drains necessitating regular clearing.

There are no large cultivation areas near the site, but more than 90 per cent of residents have vegetable gardens and a wide variety of native and exotic flowering plants. (Refer to *Appendix 9.4* for Species List). House 26, shown on *Figure 6.18*, contains an orchid nursery with a diverse range of native and exotic orchids. Breeding and experimentation are also carried out.

The extent of Slash Pine *(Pinus elliottii)* and Radiata Pine *(Pinus radiata)* plantations owned by Hardboards Australia Limited are shown on *Figure 6.14*. Bunya Pine *(Araucaria bidwillii)*, Norfolk Island Pine *(Araucaria heterophylla)* and Radiata Pine are grown in the grounds of Tomago House. Radiata Pine is also grown in the grounds of Tomago Public School.

Bent Grass *(Eragrostis stolonifera)* is grown on the greens of the Courtaulds Bowling Club and couch on the nearby oval.

6.9 FAUNA

Details of field observations and trapping methods are given in *Appendices 10.1 and 10.2* and all species observed are listed in *Appendix 10.3*.

6.9.1 Native Mammals, Reptiles and Amphibians

At the time of study, the Grey-headed Fruit Bat *(Pteropus poliocephalus)* was very common at night, while in the early hours of the morning and late afternoon, a small number of Grey Kangaroos *(Macropus giganteus)* and Red-necked Scrub Wallaby *(Macropus rufogriseus)* were observed feeding in open areas.

Koalas *(Phascolarctos cinereus)* occur in the area bounded by Tomago Road and the Pacific Highway. Their relative abundance is difficult to assess because of their inactivity during the day and natural colour blending with the surrounding vegetation. Three Koalas were observed in Red Gums on the site and two dead Koalas were also found.

The New Holland Mouse *(Pseudomys novaehollandiae)*, Swamp Rat *(Rattus* *lutreolus)* and the Common Dunnart *(Sminthopsis murina)* were species of native small mammalsfound on the site. One Common Dunnart was trapped but two individuals of each of the other species were caught. A Black Rat *(Rattus rattus)* was also trapped at the most northern trap site with the New Holland Mouse. The House Mouse *(Mus musculus)*, although not trapped, would be expected to occur in the vicinity of the Courtaulds buildings and near residences on Tomago Road.

A number of Ringtail Possum *(Pseudocheirus peregrinus)* nests was found in the dense paperbark areas and one adult was observed carrying two young.

Introduced mammals established in the Tomago Sandbeds are listed in *Appendix 10.3*. The feral pig *(Sus scrofa)* damages native flora when searching for edible bulbs and larvae. Other exotic fauna species do not cause extensive physical damage, but feed on native flora and fauna.

Sightings of reptiles were confined to the Tomago Sandbeds. The Bearded Dragon *(Amphibolurus barbatus)* and Garden Skink *(Lamphropholis guichenoti)* were commonly observed; other reptiles were seldom seen. The Red-bellied Black Snake *(Pseudechis porphyriacus)* is probably widespread.

The number of wetland areas indicate that there would be a diversity of frog species but, because of the very dry conditions, only the Dwarf Tree Frog *(Litoria fallax)* was observed.

The vegetation communities present a wide habitat range which would be exploited by a diverse fauna population. Further study should reveal a greater number of species than those observed.

6.9.2 Avifauna

The few birds on and near the site at the time of the study was attributed to the low number of plant species flowering and the dry conditions.

Most common birds were the Raven *(Corvus coronoides)*, Magpie *(Gymnorhina tibicen)* and Starling *(Sturnis vulgaris)*. Of the birds associated with the forest areas, the Sacred King-fisher *(Halcyon sancta)* and Yellow-faced Honeyeater *(Meliphaga chrysops)* were the most common.

The seventy-four bird species observed during the study are shown in *Appendix 10.4* with a list of species expected to occur in the area.

6.9.3 Aquatic Fauna

The fresh water swamps of the Tomago Sandbeds normally contain surface water, but many were dry after a prolonged dry period. *Bayly and Williams (1977)* state that such ponds are characterised by an invertebrate fauna of Clam Shrimps *Conchrostracans)*, Fairy Shrimps *(Anostracans)* and Tadpole Shrimps *(Notostracans)*.

The invertebrate fauna make up the first link in the aquatic food chain and are, in turn, preyed upon by frogs and fish. Nearing the top of the food chain are birds such as the Little Pied Cormorant *(Phalacrocorax melanoleucos)* and reptiles such as the Eastern Water Skink *(Spenomorphis quoyii)*.

The Hunter River near Tomago supports an aquatic fauna adapted to high turbidity and varying salt and fresh water regimes. *Appendix 10.5* lists the fish and crustacea known to occur in the Hunter River (from *Ruello, 1976)*.

The tidal mud flats are inhabited by a number of invertebrates. These include worms, molluscs such as the Mud Slug *(Orchidium sp.)*, and crustaceans, e.g. the Mangrove Crab *(Sesarma erythrodactyla)*.

6.9.4 Commercial and Domestic Animals

The types and extent of agricultural land uses are shown on *Figure 6.17*.

The major domestic animals in the vicinity of the site are cattle, pigs, horses and chickens and, to a lesser extent, goats and greyhounds.

Some beekeepers place hives among the flowering plants of the Tomago Sandbeds but these are not considered to be of major importance in terms of honey production.

A variety of pets are owned by local residents.

6.10 ECOLOGICAL RELATIONSHIPS

6.10.1 Flora Distribution

Factors influencing the distribution of vegetation on the proposed site are soil type, water table and the extent of tidal flooding.

The Tomago Sandbeds are low in fertility and highly permeable and, as a result, plant communities possess xeromorphic features enabling them to survive water shortages. For example, Epacrids have a very small leaf size while the Saw Banksia possesses the stiff hard leaves common to heath plants which minimise damage caused during periods of water stress.

Because of the low fertility of the sandbeds, exotic weed species are virtually non-existent. Native trees such as the Rusty Gum and Scribbly Gum are best suited to such poor sandy soils (*Anderson, 1968*), and peas and wattles overcome problems of infertility with the aid of nitrogen-fixing bacteria in nodules attached to the roots.

The soils derived from the rocks to the west of the Courtaulds textiles factory are richer in nutrients. The sandstones and siltstones have broken down forming a substrate suitable for Spotted Gums, Ironbarks and associated flora. *Hall et al (1975)* state that Spotted Gums prefer soils that are moist, well drained and of moderate to heavy texture.

The presence of Flooded Gum indicates a richer soil. *Willis and Brown (1978)* state that Flooded Gum is generally found in soils that are deep, well drained and of volcanic or alluvial origin. Erosion of the adjacent rock outcrops, as well as deposition of alluvium from flooding of the Hunter River have enhanced soil fertility.

In topographic lows where the water table is at or near the surface, plants adapted to various degrees of waterlogging have become established. A wide range of tolerances are exhibited by individual species, such as the Water Lillies which favour permanent water, and Water Buttons which can survive prolonged dry periods.

A feature of the Mangrove and Salt Marsh communities is their distinct zonation. The Grey Mangrove is a hardy plant which can establish on most consolidated substrates regularly inundated by tidal waters, while the River Mangrove is generally found in sheltered areas protected by stands of the Grey Mangrove. The zonation from Samphire to Swamp Oak is a response to increased height above sea level and a lowering of tidal influence.

The pastureland vegetation has resulted from clearing and grazing. Grazing animals select the more palatable grass species, encouraging the development of such weeds as Fireweed. Fertilisers have encouraged the spread of introduced grass species, such as Kikuyu and Clover.

6.10.2 Fauna Distribution

The variety of vegetation assemblages provide diverse fauna habitats which can be divided into three groups: the Tomago Sandbeds, areas influenced by salt water, and cleared or pastural land.

Tomago Sandbeds

The vegetation of the Tomago Sandbeds comprises a tree cover of various species and ages, a mid-understorey, and a dense ground cover which provide a wide range of feeding, nesting and shelter sites.

The Koala is dependent on Eucalypts, particularly the Red Gum, and has been observed throughout the Tomago Sandbeds. A small group has been regularly seen to the northwest of the Courtaulds textiles factory.

The New Holland Mouse is generally associated with seral stages after fire and its distribution on the sandbeds area varies according to fire frequency. It was trapped in both the Rusty Gum-Red Bloodwood Association and the Rusty Gum-Scribbly Gum-Red Bloodwood Association.

The species and structural diversity of the sandbeds provides a variety of habitats for reptiles and birds, particularly passerines.

The numerous swamps in the sandbeds broaden the habitat diversity. The small natural pond to the east of the disused airstrip is a regular roosting site for Little Pied Cormorants *(Phalacrocorax melanoleucos)* and Sea Eagles *(Haliaeetus leucogaster)*, and Black Ducks *(Anas superciliosa)* utilise the open water. The Swamp Rat, which is very much dependent on such swamps, was trapped at the edge of this natural pond.

Salt Water

The Mangrove and Salt Marsh areas support a limited fauna. Native mammals and reptiles are virtually non-existent and only a few bird species commonly occur. The Mangrove Heron *(Butorides striatus)* is totally dependent on the Mangroves, while the mud banks along the Hunter River provide feeding grounds for a variety of birds including the White-faced Heron. At Fullerton Cove and on Kooragang Island, where large expanses of land are exposed at low tide, a diverse range of waders are found.

Cleared or Pastoral Land

Only a small number of native species have found the cleared and pastoral land suitable habitat, these include Magpies *(Gymnorhina tibicen)*, Kookaburras *(Dacelo novaeguinea)* and the Red-bellied Black Snake *(Pseudechis porphyriacus)*.

Both the Grey Kangaroo and Red-necked Scrub Wallaby graze on the grasses near the disused airstrip where there is suitable feed within easy reach of dense cover.

6.10.3 Man's Impact on the Environment

The most visually significant activity of man has been the clearing of land for agricultural, residential and industrial purposes and, associated with such clearing, the introduction of a number of exotic plants. Improved pasture species have been encouraged and plants, such as Blackberry, have spread with little assistance.

A number of introduced animals occur in the Tomago Sandbeds, including the Feral Pig *(Sus scrofa)*, Dog *(Canis familiaris)* and Cat *(Felis* *catus)* and these have placed extra predatory pressure on native fauna. The Hare *(Lepus europaeus)*, House Mouse *(Mus musculus)* and Black Rat *(Rattus rattus)* occupy habitats overlapping, and therefore competing with, native fauna.

Near the Courtaulds textiles factory, a number of trees, particularly Blackbutt and Swamp Mahogany, show signs of previous damage, possibly caused by airborne emissions. The building of roads and the airstrip have caused the death of some swamp-adapted trees and colonisation in other areas.

Management of the Courtaulds textiles factory site involved regular burning of the property, which has kept much of the ground cover in a very early seral state. Blady Grass and Bracken Fern are very common and appear to be favoured by the New Holland Mouse.

A variety of attractive flowering plants occur on the Tomago Sandbeds. The extent of the more popular Christmas Bell *(Blandifordia grandiflora)* is being reduced by picking.

The quality of water on land adjacent to Fullerton Cove has been altered by man from salt to fresh over the last 150 years. Last century, convicts built a levee bank on the perimeter of Fullerton Cove to exclude salt water and develop the area as fresh pastureland. The levee fell into disrepair and salt water re-invaded the pastureland, but recently, the New South Wales Department of Public Works completed another levee, again returning the Salt Marsh to fresh pastureland.

6.10.4 Status of Site and Individual Species

The Tomago Sandbeds, the Mangroves of Fullerton Cove and the Mangrove-Salt Marsh areas of Kooragang Island are three large units of native vegetation which are relatively intact, but have been disturbed by the construction of easements for services, and the introduction of exotic plants and animals.

Most associations found in the three areas belong to the classifications described by *Specht et al (1974)* as being in a reasonable to excellent state of preservation in New South Wales. The Ball Honey-myrtle Closed

Scrub is an exception and belongs to a Coastal Scrub classification which is poorly conserved in New South Wales. However, the Ball Honey-myrtle Closed Scrub comprises only a minor component of the sandbed vegetation, and its true conservation status is difficult to determine, since its characteristics differ from those described by *Specht et al (1974)*.

Specht et al (1974) states that no Mangrove or Salt Marsh groups, with the exception of Mangrove Open Scrub, is conserved in New South Wales. Mangrove Open Scrub itself is only moderately conserved, while tidal mudflats are very poorly preserved. The proposed nature reserves planned for Fullerton Cove and Kooragang Island will conserve large areas of these wetland assemblages.

All plants which occur on the site and included on the New South Wales Protected Plant List are listed in *Appendix A9.3*. Of these, the Christmas Bush, Flannel Flower and Woody Pear are common on the Tomago Sandbeds.

Of the mammals known to occur, all except the Koala and New Holland Mouse are common and widespread *(Bell, 1978)*. Both the Koala and New Holland Mouse are not endangered at present, but their future survival is uncertain. Of those mammals expected to occur on the site, the future survival of the Native Tiger Cat, Mountain Possum, Greater Glider and Sugar Glider is uncertain.

None of the reptiles known or expected to occur on the site, or birds listed in *Appendix A10.4* are endangered.

The Darter, Mangrove Heron, Glossy Ibis, Common Bronzewing, Pheasant Coucal, Pied Butcherbird and Spangled Drongo, were all observed on or in the vicinity of the site, and were found by *Morris (1975)* to be uncommon in the Newcastle area.

Goodrick (1970) ranked the value of a number of coastal wetlands as habitats for waterfowl. *Table 6.4* shows the relationships of each of the swamp types encountered on or near the site to Goodrick's ranking.

TABLE 6.4

RELATIVE VALUE OF SWAMPS ON SITE TO SUBREGIONAL WETLANDS

Swamp type shown on Figure 6.13	Goodrick's definition	Value High	Value Medium	Value Low
Mangroves	Mangroves		x	
Salt Marsh	Salt Meadow		x	
	Salt Flat		x	
Paperbark dominated	Tea Tree		x	
Coastal Bog	Coastal Bog			x
Coastal Lepironia Swamp	Coastal Lepironia Swamp			x
Reed Swamp	Reed Swamp		x	
Reed Swamp	She-oak Swamp			x
Semi-permanent)	Fresh Meadows	x		
Brackish to fresh)	Seasonal Fresh Swamp	x		
water)	Semi-permanent Fresh Swamp	x		
)	Salt Flat		x	
)	Salt Meadow		x	

6.10.5 Natural Areas and Nature Reserves

The relationship of the site vegetation to the flora of the subregion is shown on *Figure 6.14*. The site is surrounded by large areas of fresh and salt water wetlands interspersed with cleared pastoral land, some dry sclerophyll forest remnants to the west, and coastal dune forest to the east. The Tomago Sandbeds form a southwest-northeast trending sand mass separating Fullerton Cove and Stockton Bight from Grahamstown Reservoir.

The site is virtually surrounded by an array of habitats suiting many waterfowl and waders. *Figure 6.15* shows the location of proposed nature reserves in the vicinity of the site. All except one of the proposals are centred on wetlands, indicating their conservation significance in the region.

Hexham Swamp to the west of the site is a major wetland of over 2500 ha. The swamp contains eleven of the fourteen wetland types described by *Goodrick (1970)*. A large number of birds make use of the swamp including White Ibis *(Threskiornis molucca)*, Straw-necked Ibis *(Threskiornis spinicollis)* and Black Swans *(Cygnus atratus)*. In 1978, the New South Wales Planning and Environment Commission recommended the area be proclaimed a nature reserve *(New South Wales Planning and Environment Commission, 1978)*.

The proposed nature reserves on Kooragang Island and Fullerton Cove consist predominantly of tidal mudflats, Mangroves and Salt Marsh. Not only are these communities poorly conserved in New South Wales, but they support a great diversity and abundance of birdlife, particularly migratory waders. It has been estimated that 8000 to 10,000 waders visit the Hunter River estuary, largely concentrating on Kooragang Island and Fullerton Cove every year *(Kendall and Van Gessell, 1974)*. Over 190 bird species have been identified on Kooragang Island including a number of species rare in New South Wales, such as the Jabiru *(Xenorhynchus asiaticus)*, Ruff *(Philomachus pugnas)*, Broad-billed Sandpiper *(Limicola falcinellus)* and Pectoral Sandpiper *(Calidris melanotos)*.

An agreement signed by the Japanese and Australian Governments in 1974 for the protection of migratory and very rare birds in danger of extinction, and their environment, covers 38 species known to occur on Kooragang Island. The two governments proclaimed the agreement in an endeavour to preserve migratory bird species common to both countries and the diminishing amount of migratory wader habitat *(Dames and Moore, 1979)*.

Kooragang Island and Fullerton Cove are an integrated system dependent on the tidal and salinity regimes of the Hunter River. This system has been described as one of the most valuable areas of its kind in New South Wales *(Moss, 1977)*. Hexham Swamp forms part of this system, being connected to the Hunter River via Ironbark Creek. *Coffey (1973)* described these three areas and Hexham Island as "the most viable and diverse unit that could be preserved as a natural system".

Moffats Swamp, 18 km northeast of the site, is a proclaimed nature reserve. It consists of dense Gahnia, sedges and water plants surrounded by a ring of Broad-leaved Paperbarks. It possesses geomorphological, scenic and habitat value.

To the northeast of Moffatts Swamp and on the western shores of Port Stephens is the proposed Pipeclay Creek Nature Reserve. This proposal comprises most of the land below high water mark, dominated by Mangroves and Salt Marsh.

The proposed Newcastle Bight Dunes Nature Reserve is the only proposal not located on wetlands. Both it and Pipeclay Creek have been recommended for preservation by the *National Parks Association of New South Wales (1976)*. The area consists of sand dunes dominated by communities of Blackbutt, Rusty Gum and Saw Banksia. Wetlands comprise part of this proposal and cover low-lying areas dominated by Paperbark.

6.10.6 Potential Ecological Problems

At the present time, the flora and fauna assemblages on the site are in a state of ecological balance. The large number of feral species do present problems not only to the native fauna, but also potentially to domestic stock. The introduction of dangerous exotic diseases could be maintained and spread by feral populations. Some weed species, such as Blackberry, if not controlled could also spread.

6.11 LAND USE

6.11.1 Planning

Planning within Port Stephens Shire is undertaken according to Interim Development Order Number 23 which was gazetted in May 1974 and replaced the provisions of the Northumberland County District Planning Scheme and previous Interim Development Orders 1-22.

Figure 6.16 shows the zoning of the site and its environs. The area north of the Hunter River is administered by Port Stephens Shire Council, while the area south of the Hunter River, and including Kooragang Island, is within the Newcastle City Council local government area. A small area west of the area covered by *Figure 6.16* is within the Maitland City Council local government area.

North of the Hunter River

i. Non-Urban 'A' : Zone 1(a): This zoning restricts land use to agriculture and forestry. A minimum subdivision area of 40 ha is applicable.

ii. Non-Urban 'B' : Zone 1(b): This zoning is intended to prevent ribbon development along main roads. Restrictions are placed upon subdivisions less than 40 ha in area and having a frontage of less than 400 m to a main road. A range of developments, including commercial and industrial use are prohibited. Included in this category is land fronting Tomago Road to the east of the Tomago Industrial Estate and land on the Pacific Highway.

iii. Non-Urban 'C' : Zone 1(c): This zoning encompasses the flood-prone land of the Hunter River floodplain to the east and west of the site and south of Tomago Road. Only agricultural land use is permitted within this zone without the consent of Council. Developments which may be carried out only with the consent of the Council, include dwelling houses, extractive industries, forestry, parking areas, recreation and mineral sand mining. Proposed development is also subject to approval by the New South Wales Department of Public Works.

iv. Industrial (General): Zone 4(a): This zoning covers the extent of the Tomago Industrial Estate, in which the site is located. All proposed development within this zone is subject to Council's consent and such conditions imposed by the Council. As the site has frontage to a main road, the Council must receive the prior concurrence of the New South Wales Department of Main Roads before consent can be granted to developments within this zone.

v. Special Uses 'A' : Zone 5(a): This zoning applies to areas reserved for the Tomago Sandbeds Water Supply Catchment which adjoins the northern boundary of the site and continues to the east; the Tomago Detention Centre which is located immediately south of the site; and the Tomago Public School, which is located to the southeast.

South of the Hunter River

Development within the areas of Hexham and Kooragang Island, shown on *Figure 6.16*, is undertaken according to the Northumberland County District Planning Scheme.

Kooragang Island is zoned 4(b) Industrial 'B' (heavy) and since 1953 development on the island has been controlled by the New South Wales Department of Public Works. The area cleared and used for grazing is referred to as the Western Area of Kooragang Island and is proposed for industrial development in Stage 3. As Stage 1 of the island reclamation scheme is less than one-third complete, reclamation and development of Stage 3 is not expected to commence in the foreseeable future. The northern area of Kooragang Island, north of the industrial railway line, is presently in a natural state and has been proposed for preservation as a nature reserve, but no definite boundaries have been fixed.

The Hexham area shown on *Figure 6.16* is zoned industrial under the present planning scheme. A Draft Interim Development Order has been prepared for the Tarro, Hexham and Sandgate areas. This scheme retains the existing industrial zoning to the east of the Pacific Highway, but areas to the west are proposed as either Rural 1(g) (floodplain) or Rural 1(h) (floodway). Campbell Island and the estuarine area immediately to the north have been proposed for Rural Environmental Protection 7(b) (estuarine wetlands).

West of the Hunter River

This area occurs within the Newcastle City Council and the Maitland City Council local government areas and is zoned Non-Urban 'C' (floodplain).

6.11.2 Agricultural Land Uses

Land to the south of Tomago Road and the Hunter River, and west of Old Punt Road and the Pacific Highway, is predominantly used for agricultural purposes. *Figure 6.17* shows the extent and types of agricultural land uses within a 4.5 km radius of the proposed site. *Table 6.5* shows the comparative sizes and number of the different farm types and their important characteristics.

TABLE 6.5

AGRICULTURAL LAND USES

Farm Type	Number in area	Stock Numbers (approximate)	Size of Farm Units (ha)	Period of Operation (Years)
Dairy	2	60-1400	60-400	100-130
Beef Cattle Grazing	1	100	120	<1
Horse Breeding-Cattle Grazing	3	Cattle 12-250 Horses 20-50	50-230	4 - 40
Mixed Grazing		Variable		>10
Poultry	2	60,000	<2	≤22
Piggery	3	200-1000	<3	9-14
Hobby Farms	3		<1	
Commercial vegetable growing	1		<10	3

Dairying

There are two operating dairy farms within the area, one on Tomago Road, approximately 1 km southeast of the site, and a larger dairy located on the western side of the Hunter River approximately 4 km northwest of the site. The larger Greenway Dairy, covers over 400 ha and has been operated for 100 years. Fresian cattle make up the bulk of the dairy herd, which consists of 1400 head including 1000 milkers. Milk is supplied to Wyong Amalgamated Dairies and some fast-growing crops such as rye grass and oats are cultivated. This dairy will be moving operations from the area in the near future as a result of encroaching residential settlement and for economic reasons.

The land including the second dairy formed part of the original Windeyer Estate and has been used for dairying for over 100 years. The present farmers have operated the property on a share basis for two years. Sixty head of Fresian cattle are run on 61 ha, with 50 to 55 cows comprising the milking herd. The milk quota of 473 l/d is supplied to the Hunter Valley Co-operative Dairy Company Limited. A Fresian stud is operated in conjunction with the dairy.

A small dairy herd is run on Kooragang Island, approximately 3 km southwest of the site, but milk is only used for farm purposes and not sold commercially.

Beef Cattle Grazing

A property approximately 1.7 km east of the site has recently changed from dairy farming to beef cattle grazing. The farm supports 100 head of Fresian and Hereford cattle on approximately 120 ha. Until 1979, this farm was an operating dairy with grain-fed cattle and a milk quota of approximately 273 l/d. Cattle are now only grazed on the land and vealers are sold for beef through Maitland Saleyards. The farmers intend to gradually increase the Hereford content of the herd and continue with beef production.

Horse Breeding-Cattle Grazing

Horse breeding and cattle grazing activities tend to be intermixed in the area, usually with only one activity predominating. The largest farm of this type (approximately 230 ha), 3 km north of the site, runs 200 to 250 Herefords with some mixed stock. Cattle are usually sold as steers, but may also be sold as vealers. Approximately 20 thoroughbred mares and foals are also permanently grazed in the area.

Adjacent to this large farm, 1.5 km northwest of the site, is the property Kennington Park, which grazes approximately 30 thoroughbred horses and a small number of mixed beef cattle.

Approximately 50 Palamino and Australian Stock Horses are bred on a farm 2.5 km east of the site on Tomago Road with a small number of dairy cattle.

Mixed Grazing

This activity differs from horse breeding-cattle grazing in that land is usually leasehold and stock more mixed and variable in numbers. Horses are generally only grazed, rather than forming part of breeding herds. Most of the agricultural land on Kooragang Island is utilised for mixed grazing with both horses and cattle free to range widely. Some horses are kept for the pet food industry and the cattle are sold for beef.

Poultry Farming

Two poultry farms are operated adjacent to each other on Tomago Road approximately 1.7 km west of the site. Both of these farms breed chickens for Steggles Proprietary Limited. Chickens are supplied to the farms and raised for varying periods of time, then sent back to Steggles' processing plant at Beresfield. Feed is supplied regularly by Steggles, and the number of chickens held is approximately 60,000.

Pig Farming

There are three operating piggeries on Tomago Road and one small operation on Kooragang Island.

The largest piggery, located approximately 2 km east of the site, is associated with Ringal Valley Proprietary Limited, and is run on a leasehold basis in conjunction with a breeding farm at Bennetts Green. Pregnant sows are sent to Bennetts Green until their litter is produced. Young piglets are then sent to Tomago and the sow follows a few days later. Over 1000 pigs are kept at the piggery, including approximately 100 sows, 350 suckers, 650 growers and 50 bacon pigs, which are sold at varying ages from 6 to 30 weeks. Feed is supplied by the Ringal Valley Pty. Limited and consists mainly of milo and wheat.

Two other piggeries, approximately 1.5 km west of the site on Tomago Road, stock 150-200 pigs and 500 pigs, respectively, which are suitable for sale for pork and bacon at between 6 and 10 months. Neither piggery is run as a main source of income and the smaller is operated in conjunction with a butcher's shop. Both have been worked for approximately 14 years. All pigs are predominantly grain fed, with some mixing and crushing of grain carried out on site.

Turf Farming

A buffalo grass turf farm has operated on an intermittent basis adjacent to the western side of Tomago house.

Commercial Vegetable Growing

There is one commercial vegetable growing operation located approximately 4.5 km northeast of the smelter site. Although not fully dependent on the vegetable garden, the grower gains a substantial income from sale of the vegetables.

Most vegetables grown are vine crops and include watermelons, rockmelons, cucumbers, pumpkins and a variety of squash. Tomatoes are also grown. The total area under cultivation is approximately 2.8 ha and approximately 0.2 ha is used for each particular vegetable crop.

It is the intention of the grower to continue growing vegetables on a similar basis as at present. The area is considered to be very productive for vegetable growing.

Nurseries

Rutile and Zircon Mines (Newcastle) Limited, located on the Pacific Highway beyond the western boundary of the Tomago Industrial Estate, operates a plant nursery for rehabilitating mined areas. The nursery has an annual turnover of between 50,000 and 100,000 plants. Florapark Nurseries Pty. Limited is a similar sized nursery located outside of the Tomago Industrial Estate, 4 km north of the site at Motto Farm, and has a stock of approximately 100,000 plants.

Hobby Farming-Rural Residency

Hobby farming is a minor agricultural land use in the area. Typically, a farm consists of 1 ha of land used for a dwelling, growing vegetables, and keeping a number of domestic pets, such as goats and dogs. The largest area is held by Tomago House, which is essentially a rural residence, adjoined on three sides by an operating dairy farm. Other hobby farms on Kooragang Island were originally farming units which have ceased to operate, but the farmers have remained living on the land.

Management Practices

Management practices vary markedly in the area, the extremes being the intensive management of the poultry and pig industries and the fairly loose management of mixed grazing areas.

Employment of labour tends to be minimal, with most farms run as family or solitary concerns with casual labour employed when necessary. The largest horse breeding-cattle grazing property employs three people full time.

Fertilising and pasture improvement are common practices in pastureland areas. Superphosphate, nitrogen fertilisers and lime are generally applied once a year. The main pasture improvement species are kikuyu grass and clover. The area of land cultivation varies on each farm and many of the low-lying areas have been cultivated at some time, generally for fodder crops. The largest area under cultivation is on the smaller dairy farm and consists of 24 ha of clover and rye grass and 6 ha of lucerne. The larger dairy farm grows only a small amount of fodder, usually a fast growing crop such as oats or rye grass.

The vegetable garden covers 2.8 ha of cultivated ground. Fertilising is carried out regularly usually with cow and fowl manure. Up to 20 t of manure and 0.5 t of lime are applied each year.

Other crops grown on the horse breeding-cattle grazing properties include barley and sorghum.

Agricultural Problems

The area is considered by resident farmers to be a good farming region with relatively few farming problems. Most problems relate to regulations involved with the particular industries, although there are always some problems associated with stock diseases.

The dairy industry is suffering economic problems through mandatory large-scale increases in capital outlay caused by the introduction of bulk vat collection.

Most rural industries have experienced difficulties caused by increasing costs in machinery, transport and feed. These costs have not been completely paralleled by increase in the cost of such products as beef and pork.

There are minor weed problems, with a number of weed species occurring in the area. Alligator Weed causes blockages in some of the drainage channels and is sprayed once or twice a year with "Roundup" weedicide.

Weeds are a common problem for the commercial vegetable grower, the main weed species being Summer Grass, Kikuyu, Couch Grass and Bathurst Burr. Insects and diseases such as Downy Mildew and Red Spider are also a continuing problem but are controlled by spraying primarily with "Rulene" and "Morestan".

Agricultural Trends

Originally the now cleared portions of the area were almost completely used for agricultural purposes and dairying was the predominant land use. However, over the last 20 to 30 years, rural land has been modified by the growth of industry.

The dairy industry has shown a general trend towards the amalgamation of small enterprises into large economic concerns *(Planning Workshop Pty. Limited, 1977a)*. At present there are six dairies remaining on the Tomago 'run' which includes the Williamtown area and two more will probably be closing in the near future. The large Greenway Dairy, west of the Hunter River, is also likely to close, while dairies on Kooragang Island have been closed for some years. *Table 6.6* shows the comparative numbers of dairy farms in the area ten years ago and at present. The two horse breeding-cattle grazing and beef cattle grazing properties were also originally dairy farms until comparatively recently.

Horse breeding and beef cattle grazing appear to be gradually replacing dairying in the Tomago district, although both activities have been present for many years. Piggeries and poultry farms are relatively new in the area and most farmers intend to continue operations.

TABLE 6.6

COMPARISON OF NUMBERS OF DAIRY FARMS
IN THE TOMAGO-WILLIAMTOWN-RAYMOND TERRACE
AREA FOR 1970 AND 1980

Locality	Number of Dairy Farms Operating 1970	1980
Williamtown	20	5
Tomago	4	1
Hollowtree (near Motto Farm)	4	0
Raymond Terrace	3	0
Fullerton Cove	11	0
TOTAL	42	6

Source: *Hunter Valley Dairy Co-operative Co. Limited.*

Subregional Agricultural Activities

Rural land uses continue to dominate outside the area shown on *Figure 6.17* and within 10 km of the site. To the east, dairying, grazing and poultry farming activities are most evident, particularly south of Tomago Road and Cabbage Tree Road, and in the Williamtown area. There is very little agricultural land north of Tomago and Cabbage Tree Roads as far as Grahamstown Reservoir. Further from the site, approximately 15 km to the northeast at Medowie, is a stone-fruit growing district.

Dairying and grazing are the main land uses to the northwest and west of the area shown on the figure and fodder crops are also commonly grown.

To the southwest, in the Blackhill area, grazing, citrus fruit and stone-fruit growing are intermixed. The Blackhill area is an important fruit-growing area for the district but it is not of high regional significance.

6.11.3 Timber Production

Approximately 4 km northeast of the proposed site, Hardboards Australia Limited manages both native and planted pine forests for timber production. The managed native forest covers approximately 200 to 240 ha and contains Spotted Gum, Blackbutt, Rusty Gum and *Melaleuca* species, all of which are used in the Company's production processes. This forest has been maintained for approximately 40 years.

In 1966, planting of various tree species was commenced and continued each year until 1971. There is, at present, approximately 280 ha of planted forest, consisting predominantly of Slash Pine *(Pinus elliottii)* with some Radiata Pine *(Pinus radiata)* and Blackbutt *(Eucalyptus pilularis)*. Trees are not expected to reach full maturity until 35 to 40 years of age but some culling of the first plantings has been conducted. Timber from these trees is of low yield and is sold for fence posts. Higher production returns are expected as trees gain maturity.

Hardboards Australia Limited intends continuing the existing forestry practices with no extensions to the planted forest areas planned.

6.11.4 Urban Areas

The major concentrations of urban land use within close proximity to the site are listed in *Table 6.7*.

The closest concentration of residential settlement is Hexham, approximately 2.5 km to the west of the site. This area is zoned for industrial development and residential use is expected to decline over the next 15 years.

Within a radius of 7 km of the site, concentrations of residential settlement occur as discrete units while beyond this distance, the major urban settlement comprises the built-up area of Newcastle.

TABLE 6.7

URBAN SETTLEMENTS IN PROXIMITY TO THE SITE

Centre	Population* (1976)	Approximate distance from the site (km)	Direction
Hexham	300	2.5	west
Shortland-Sandgate	3225	5.5	south-southwest
Beresfield and Woodberry	5290	6	northwest
Mayfield West	6300	6.5	south-southeast
Raymond Terrace	7000	7	north-northeast
Thornton	1130	8	northwest
Williamtown	1500	12	east-northeast

* *Australian Bureau of Statistics (1976 Census).*

Figure 6.18 shows the locations of residences within a 4 km radius of the site. Details of residences within this zone north of the Hunter River, on Kooragang Island, and within the vicinity of the Hexham Bridge, are listed in *Appendix 11.*

South of the Hexham Bridge there are two groups of houses. On either side of Old Maitland Road, Hexham, 47 houses are interspersed with industrial users within an area zoned industrial. The houses are mostly of weatherboard and corrugated iron construction and are at least 50 years old. These residents have existing use rights, but it is intended that these sites be gradually converted to industrial use. Another group of 33 houses exists further to the south, opposite the Ash Island Bridge. These are located on land zoned Rural 1(g) - floodplain. The residents have existing use rights and, because of the zoning, there are no future development plans for this area.

Within the area shown on *Figure 6.18*, there are 157 occupied residences which support a permanent population in the vicinity of 460 persons. North of the Hunter River, there are 58 occupied residences, inhabited by 200 residents.

Residential land use is varied and includes normal suburban concentrations at Hexham, farm residences on rural holdings, houses on 1 to 2 ha blocks and houses on industrial land. This mix can be explained by the change in the character of the Tomago area from the original small holdings to an intermediate pre-industrial stage when the area was used for rural-residential use. With increasing industrialisation and subsequent industrial zoning, many of the houses are now located within an industrial zone.

Houses in the Hexham area are built predominantly of lightweight materials, are at least 50 years old and, in most instances, are in need of maintenance. Housing stock in the Tomago area to the west of the site is generally of a similar standard to that at Hexham. To the east of the site toward Williamtown, housing stock is of a much higher standard, there being a larger proportion of substantially constructed, brick and tile residences incorporating extensive improvements.

6.11.5 Industrial and Commercial Land Uses Near the Site

Details of the types of industry and businesses within close proximity to the site are listed in *Appendix 12*. Establishments have been listed broadly by industrial groups and geographically, north and south of the Hunter River.

North of the Hunter River

The majority of industrial and commercial users north of the Hunter River, shown on *Figure 6.18* occur within the Tomago Industrial Estate. The Estate is approximately 7.7 km^2 in area and extends from the junction of the Pacific Highway and Tomago Road at its western boundary for a distance of 4 km eastwards, to the Industrial Switchgear Pty. Limited's factory, which marks the eastern boundary.

The Estate commenced with the establishment of the Courtaulds textiles factory which was followed by a range of service industries. Currently the Estate is 15 to 20 per cent utilised. Further development is hindered by restricted access onto Tomago Road and lack of a suitable road network allowing the subdivision of land remote from Tomago land. The Port Stephens Shire Council has prepared a conceptual road layout for the Estate.

Apart from the industrial area at Heatherbrae, occupied by Hardboards Australia Limited, the Tomago Industrial Estate is the only area in the Shire which caters for heavy industrial users. Most industries are attracted to the Estate because of the comparatively low land values, ease of access from Maitland, Newcastle and Port Stephens, and the rural atmosphere. Current land values for fully serviced blocks, 1000 to 2000 m^2 in size, range from \$10,000 to \$15,000 depending upon position and access. Public transport is lacking in the area and this causes difficulties for young apprentices not old enough to drive.

The Estate is dominated by metal engineering firms and two of these, Carrington Slipways Pty. Limited and Allco Steel with 320 and 230 employees respectively, represent the major employers.

Approximately 1000 persons are employed on, or in, the vicinity of the Tomago Industrial Estate, primarily during daylight hours. An analysis of journey to work characteristics indicates that a large proportion of employees travel from the East Maitland-Tarro, Newcastle and Lake Macquarie areas. In contrast, only a small number are drawn from the Raymond Terrace and Port Stephens areas.

Other industrial areas within the Shire are located at Motto Farm-Heatherbrae and Nelson Bay, and are restricted to light industrial use.

South of the Hunter River

The majority of industries within the area shown on *Figure 6.18* south of the Hunter River are located at Hexham in the area bounded by the Pacific Highway and Old Maitland Road.

The Hexham Industrial area comprises approximately 60 ha, of which 47 per cent is used for industrial use, 11 per cent for other uses including residential, office and business, and 42 per cent remains vacant. The area is similar to the Tomago Industrial Estate, with a lack of access to the centre of the Estate and the dominance of metal engineering firms. The two largest employers are Hexham Engineering Pty. Limited and the Hunter Valley Co-operative Dairy Company Limited which employ in the vicinity of 200 persons each. Overall there are approximately 900 persons employed in an industrial and commercial capacity within this area and an analysis of journey to work characteristics indicate similar trends to that of the Tomago Industrial Estate.

There is an emerging trend for the area to be used predominantly for engineering, warehousing and automotive uses.

6.11.6 Recreational

Formal recreational facilities within proximity to the site include the Newcastle International Motordrome, a sports oval, two tennis courts, a bowling green and a recreation club which are owned and operated by the Courtaulds Bowling Club. The locations of these facilities are shown on *Figure 6.18*.

Other informal recreational activities include horse riding, trail-bike riding within the Tomago Sandbeds Water Catchment and water orientated pursuits associated with the Hunter River estuary, such as fishing, boating and water skiing. An important scientific and recreational use of the northern section of Kooragang Island is bird watching.

South of the Hunter River, the Hexham Bowling Club and adjacent sports oval form the main formal recreational facilities.

Approximately 10 km east of the site, Newcastle Bight beach provides for buggy and trail bike riding within the dunes, fishing, swimming and passive recreational activities.

6.11.7 Special Uses

The following special land uses occur within proximity of the site.

Hunter District Water Board - Tomago Sandbeds Water Supply Catchment

The Tomago Sandbeds Water Supply Catchment covers an area of 106 km^2 and adjoins the northern perimeter of the site. Apart from areas mined for mineral sands, the area remains relatively undisturbed in its natural state, and is a restricted area for the protection of the groundwater aquifer.

There are four categories of reservation, these being:

i. Privately-owned land bounded by restrictive covenant or agreement in favour of the Board.

ii. Water Reserves under the control of the Hunter District Water Board.

iii. Proclaimed Tomago Sandbeds Water Supply Catchment area.

iv. Freehold lands owned or vested in the Hunter District Water Board.

Water Reserves are the most restricted lands within the proclaimed catchments, and no developments are permitted within such areas. Within the Water Supply Catchment area boundaries (outside Reserves), any development allowed is subjected to strict controls and regulations imposed by the Hunter District Water Board.

The Tomago Detention Centre

This facility is located south of Tomago Road, opposite the site and comprises a group of seven accommodation units, a modern brick administration block and one residence. The centre has been in operation as a women's detention centre for 12 months and as a men's periodic detention centre for the past three years. Permanent inmates number between 20 and 25 women, while at weekends this figure is swelled by a further 25 to 50 men, who are engaged in district lawn-moving and gardening activities. The centre is operated by 15 staff, supplemented by a further two at weekends. One staff member resides at the centre.

It is proposed to change the use of the detention centre to cater primarily for male inmates, on a periodic basis, in the future. It is unlikely that inmates will be located permanently at this centre.

Tomago Public School

This school has been established since 1849 and operates as a one teacher primary school. Seventeen pupils from the Tomago area are presently enrolled and there are no plans to either upgrade or close this school.

Uniting Church, Tomago

This church is of historical importance, having been constructed in 1861 by the pioneering Windeyer family. It is located on a farming property zoned Non-Urban 'C' and is used once a month by the local community. The church is small in size and has been constructed from surplus sandstone, masonry and slate used in the construction of the adjacent Tomago House.

Tomago Progress Association Hall

This hall is located between Tomago Road and the Hunter River southeast of the site. At the time of establishment of the hall, the association met regularly, but interest has waned in recent times. The hall is hired to other groups from Tomago and Raymond Terrace for meetings.

6.11.8 Commercial Fishing and Prawning

Prawning

Commercial prawning is the main fishing industry in the Hunter River. Sixty trawlers regularly work the river, 30 of these in the vicinity of Hexham. Trawling may extend as far as Raymond Terrace, but the prawn spawning area upstream from Raymond Terrace is closed to trawlers *(Newcastle Fishermen's Co-operative)*. Most trawling is conducted in the north arm of the Hunter River and upstream from Hexham *(Ruello, 1976)*, although the deeper parts of the south arm and Fullerton Cove may also be trawled.

The prawning season in the river lasts from December to May each year. During winter, trawling may be carried out at sea or fishermen may gill net estuarine fish. Some crab trapping is also conducted in the river and in Fullerton Cove.

Table 6.8 shows catch sizes for the 1974 and 1978 financial years for species frequenting estuarine areas but not necessarily caught in the Hunter River. The monthly return estimates are considered conservative as catches are often underestimated *(Newcastle Fishermen's Co-operative)*.

TABLE 6.8

ESTUARINE FISH SPECIES AND CATCH SIZES (kg)

Fish Species	Financial Year 1974-75	1978-79
River Flathead, Mullet, Luderick, Bream and Jewfish	464,357	602,000
Prawns	116,000	142,000
Crabs	34,000	39,000
TOTAL*	1,533,000	2,120,000

Note: Estuarine-frequenting species are not necessarily caught in the Hunter River and may have originated from other localities.

* Includes both estuarine and ocean frequenting fish and crustaceans.

Fishing

The main commercial fish in the Hunter River is mullet, but jewfish is also a very important product of the river. Juveniles of many of the species listed in *Table 6.8* grow and develop in the river *(Ruello, 1976)* although most adults are caught at sea.

Fish and other marine species occurring in the Hunter River are listed in *Appendix 10.5*.

Commercial Importance of the Hunter River

Prawns and mullet represent the significant commercial 'fish' species caught in the river which is also important as a breeding ground; the main areas being upstream of Raymond Terrace and in Fullerton Cove *(Newcastle Fishermen's Co-operative)*. Juveniles are usually washed out to sea in flood times and later caught as adults over a widespread area of the coastline. The Hunter River estuary is considered a valuable long-term fisheries resource *(Ruello, 1976)*.

6.11.9 Extractive Industries

The potential of the site for the mining of coal, heavy minerals and glassmaking sands has been discussed in *Section 6.2.3* . Current extractive industries within proximity of the site is restricted to the extraction of sand for fill, construction and industrial purposes by S. and M.J. Graham at the site shown on *Figure 6.18*.

6.12 REGIONAL ECONOMIC BASE

The Hunter Region is 30,828 km^2 in area and comprises the local government areas of Newcastle, Lake Macquarie, Port Stephens Shire, Greater Cessnock, Great Lakes, Dungog, Gloucester, Singleton, Muswellbrook-Denman, Scone, Merriwa and Murrurundi. It is considered to be one of the most important in economic terms in New South Wales. The region's major economic contributions are in power generation, manufacture of steel and heavy engineering products, coal supply and exporting *(Hunter Regional Planning Committee, 1977)*. Full details of the region's economic base are provided in *Appendix 13*.

6.12.1 Primary Industries

Dominant primary industries within the Hunter Region are agriculture, fishing, forestry and mining. Total employment within these industries represented 9.7 per cent of the workforce, compared with 7 per cent for the State in 1976.

The rural productivity of the region has been consistently higher than the State average. While the region contains 2.67 per cent of the State's rural holdings, of which 95 per cent is located in the Upper Hunter, it accounted for 6.56 per cent of the State's agricultural value of production during 1977/78. Dairy, poultry and beef products represent the major agricultural land uses.

6.12.2 Manufacturing Industries

The manufacturing industry is centred in the Lower Hunter Subregion where 95.6 per cent of the workforce was employed during 1977. Within the region, 24.6 per cent of the workforce was employed in this sector in 1976.

The manufacturing industry has traditionally supported the region's economy, but recent trends indicate a decline in the region's share of the State level of manufacturing. From 1954 to 1977 this declined from 10 per cent to 8.7 per cent. The basic metals sector accounted for 50 per cent of the value of output and investment, and 65 per cent of the employment within the manufacturing industries in 1976.

6.12.3 Service Industries

Employment in this sector accounts for 60 per cent of the regional workforce. Much of the growth between 1954 and 1976 can be attributed to increasing female participation rates in the workforce. The wholesale and retail sector, and the community services sector are the major employers. Employment in the finance sector is under-represented compared with the State average.

6.12.4 Tourism

The major tourist attractions in the Lower Hunter Subregion include:-

- i. The Vineyards and Wineries
- ii. Lake Macquarie
- iii. Newcastle Beaches
- iv. Port Stephens.

The majority of visitors to the Hunter Region come from Sydney and country areas of New South Wales. Travel is by car, and flats or houses owned by friends or relatives are the most common type of accommodation. Few overseas visitors visit the region (*Morgan Polls, 1979)*.

Gross takings from tourist accommodation showed a 15 per cent increase over the period 1977-1979, while employment remained virtually static over the corresponding period.

Further details of the region's tourist industry are provided in *Appendix 13. 5*

6.12.5 Employment

In 1976, the labour force participation rate for the Newcastle Statistical Subdivision represented 40.9 per cent, of which 38.3 per cent were employed.

Although the percentage of employed remained stable from 1971 to 1976, the percentage of the labour force unemployed increased from 1.8 per cent in 1971 to 6.3 per cent in 1976. This was higher than the State average, where 5.19 per cent of the labour force was unemployed in 1976. In September 1979, 6.04 per cent of the State's labour force was unemployed. Current unemployment rates as a percentage of the workforce are not available for the Lower Hunter Subregion, but they are considered to be marginally higher than those for the State.

Employment by industry for the Newcastle Statistical Subdivision compared with the Hunter Region and the State is shown in *Table A13.7* within *Appendix 13*. In 1976, 5.9 per cent of the workforce in the Newcastle Statistical District was employed in primary industries compared with 7 per cent of the State. In this sector, mining was the major source of employment, absorbing 4.4 per cent of the workforce. The small number employed in agriculture (1.2 per cent) reflects Newcastle's heavy industrial bias.

Since 1971, there has been a 2 per cent increase in the number employed in the primary sector while the New South Wales figures have remained steady.

In 1976, 27.3 per cent of the workforce in the Newcastle Statistical Subdivision was employed in manufacturing, compared with 33 per cent in 1971. These figures are higher than those of the State, being 21 per cent in 1976 and 24.8 per cent in 1971. More recently, the importance of manufacturing as a source of employment is declining in both the subregion and the State. This decline is more rapid in the Newcastle district. Only the "Food, Drink and Tobacco" group has shown a consistent upward trend in employment from 1971 to 1976. The heavy reliance of the Lower Hunter on metal products and machinery is shown by the fact that 18.7 per cent of the total workforce or 68 per cent of the manufacturing workforce are employed in these industries.

Approximately 61.4 per cent of the workforce in the Newcastle Statistical Subdivision was employed in the tertiary sector. Of this figure, 40.4 per cent were women. This sector provides 78 per cent of female employment in the Newcastle district compared with 54 per cent of male employment.

Although the number employed in the tertiary sector has remained stable since 1971, the workforce doubled between 1954 and 1971. The rapid growth in this period was primarily in the service industries. In 1976, 17.9 per cent of those employed in the tertiary sector were employed in wholesale and retailing.

Table A13.8 in *Appendix 13* shows the number of persons unemployed in each occupational category in August 1979 for the Newcastle Statistical Subdivision. The number of unemployed construction workers and skilled electrical and metal tradesmen in 1979 was 776. By comparison there were 4327 unemployed semi-skilled and unskilled workers.

6.13 SOCIAL ENVIRONMENT

The site is within the Newcastle Statistical Subdivision which comprises an area of 2,948 km^2 incorporating parts of Cessnock and all of Lake Macquarie, Newcastle, Port Stephens and Maitland local government areas. In planning terms, this area is referred to as the Lower Hunter Subregion. Supporting tables to accompany this section are provided in *Appendix 14* and number *Table A14.1 to Table A14.11.*

6.13.1 Existing Population

The population of the Newcastle Statistical Subdivision at the time of the 1976 Census was 362,980 persons, representing an annual increase in population of 0.64 per cent since the previous census in 1971. The increase has been due to natural increase (births minus deaths) with 3,350 persons being lost by migration.

Within a 10 km radius of the site, which includes Raymond Terrace to the north, Beresfield to the west, and Jesmond to the south, the population is approximately 20,000 persons. Within the area shown in *Figure 6.18* there are approximately 460 residents, of which 200 live north of, and 260 south of, the Hunter River.

6.13.2 Population Characteristics

Subregional Population Characteristics

The age distribution of the population of the subregion and comparison with National percentages, are set out in *Table A14.1*.

The age structure of the Newcastle Statistical Subdivision differs substantially from the National percentage. Out migration of young adults seeking employment has resulted in a lower percentage of young people in the 0 to 39 age group, particularly in the 20 to 39 age range in the Newcastle Statistical Subdivision, while the percentage of residents in the 40 and over age group is higher than the National figures.

The masulinity ratio of 1:0.99 is similar to the ratio for the State. Males dominate the majority of age groups below 60 years and females dominate all age groups over 60 years.

The younger population resides predominantly in the growth centres of Lake Macquarie and Port Stephens, while an increasing number of older residents live in Newcastle City.

Population Characteristics of the Tomago Area

The average length of residency of persons living in the vicinity of the site, north of the Hunter River, is approximately 15 years and ranges from 2 months to 46 years. Most of the older residents settled in the area with either the establishment of the Courtaulds textiles factory, or were involved in agricultural pursuits. During the last 10 years, new residents have moved into the area because of the need to maintain a large non-urban area for their hobby, e.g. dog breeding, or were seeking a rural retreat. The lifestyle of the residents is distinctly rural; 90 per cent have their own vegetable gardens and many keep poultry.

The population south of the Hunter River comprises a high proportion of retired couples or elderly single persons. Their lifestyle is essentially urban orientated.

6.13.3 Population Growth and Trends

Population changes in the Lower Hunter Subregion between 1966 and 1971, and between 1971 and 1976, are shown in *Table A14.2*.

Between 1966 and 1976, the most significant factor was the decline in population in Newcastle City and the increase in the surrounding metropolitan areas. Between 1971 and 1976 Maitland City and Port Stephens Shire were the fastest growing centres with a 16 and 18 per cent increase in population, respectively.

It is likely that the population of Newcastle City may further decline due to the shortage of residential land and the demand for industrial and commercial sites. Of the suburbs within a 10 km radius of the site, only Minmi and Raymond Terrace had positive population growths of 11 per cent and 14.8 per cent respectively, while Hexham had the steepest decline of 30 per cent from 1971 to 1976.

The population growth rate in the Hunter Region has been slower than the State and declined from 1.99 per cent per annum in 1947 to 1.14 per cent per annum in 1976, compared with 1.98 per cent and 1.32 per cent respectively, for the State.

By the year 2001, population growth rates are expected to decline to 0.65 per cent per annum compared with the 2 per cent growth rates experienced during the post-war period *(Australian Government, 1975)*.

6.13.4 Accommodation

Housing Stock

Table A14.3 indicates the number of private dwellings for each local government area in the Lower Hunter Subregion for 1976, while *Table A14.4* provides an indication of the annual sales of houses and land together with average values for 1978. Average house values are lowest in Cessnock where new building activity is low and highest in the expanding Port Stephens Shire.

There has been a recent upsurge in building activity in the Lower Hunter, and in the Newcastle local government area there were 337 new homes approved during 1979, with an average cost of $30,551. The most popular areas for new homes were Elermore Vale (99 approvals), Marylands (52) and Wallsend (46), *(Newcastle Morning Herald, 1st February 1980)*. The average Newcastle house, including land, costs approximately $35,000; an increase of 20 per cent over 1978 prices.

The New South Wales Housing Commission provides low rent housing in several centres in the Hunter Region. Applicants for Commission homes are subjected to a means test based on their capacity to pay rent and need for accommodation. A family paying more than a fifth of its gross income for rent may be eligible, but other factors taken into consideration include health, present living standards, number of children and the availability of private accommodation.

The present waiting list for homes in the Lower Hunter is approximately one to two years for up to three bedroom accommodation and more than two years for four bedroom homes or aged units. Currently there are 1700 applicants in Newcastle and Lake Macquarie.

A breakdown of the number of Housing Commission homes within 15 km of the site and within the growth areas proposed by the Hunter Regional plan is set out in *Table A14.5*. Major developments planned by the New

South Wales Housing Commission are the second stage of the Booragul Estate, beginning 1980, which will provide approximately 500 houses.

Rental Accommodation

There is an acute shortage of houses and flats for rent in the Newcastle area because of the high demand for housing by University and College of Advanced Education students and the large number of young couples who, unable to obtain finance to buy or build their first home, choose to rent accommodation. Currently, rents for 3 bedroom houses average $80/wk.

Temporary Accommodation

There are 26 caravan parks in the Lower Hunter Subregion, with a total of 3278 sites. In Newcastle City and Raymond Terrace areas there are five caravan parks, details of which are listed in *Table A14.6*.

Most caravan parks within the Newcastle area are filled during holiday periods when a large percentage of tourists reside in the area, while in the Nelson Bay areas caravan parks are filled for most of the year.

Hotels and Motels

The number of hotels-motels in the Newcastle environs is shown in *Table A14.7*. The larger motels in Newcastle City are very heavily booked from Monday to Thursday, while the hotel-motels with water frontages at Nelson Bay and Lake Macquarie are heavily booked throughout the year.

6.13.5 Services

Education

Pre-Schools: There are approximately 20 private, 35 community and 8 State pre-schools in the Lower Hunter Subregion. In addition, there are 2 occasional-care centres, 2 family day-care centres, and 3 full-day care centres.

Primary Schools: There are approximately 138 State primary schools in the Lower-Hunter Subregion and 36 Catholic Education schools. The aim of the New South Wales Department of Education is to have one primary school of 21 classrooms per 1000 to 1400 homes. *Table A14.8* lists areas where additional education facilities are proposed. Most of these areas are the outer suburbs of Newcastle which are experiencing rapid growth.

Secondary Schools: There are approximately 33 State and 9 Catholic Education secondary schools in the Lower Hunter Subregion and there are plans for new high schools at Raymond Terrace and Rutherford.

Table A14.9, lists number of schools, pupil enrolments and average size of schools in Cessnock, Lake Macquarie, Maitland, Newcastle and Port Stephens local government areas. Both the Newcastle and Maitland Districts have a large influx of school children who commute daily to these areas to attend school.

Special Education: There are approximately eight special education schools in the Lower Hunter Subregion, and many primary and secondary schools have remedial classrooms and offer assistance to children with learning handicaps.

Technical Colleges: There are nine Technical and Trade Schools in the Lower Hunter Subregion. The demand for college entrance is high, especially in industrial-related courses, e.g. boiler making and electrical trades. Enrolments in 1980 for industry-related courses have been 30 per cent higher than in previous years. Part of this demand will be met when a new Technical College at Glendale is opened in 1981.

Tertiary Education: There are two tertiary institutions in the subregion; the University of Newcastle which has been established at Shortland since 1965, and has 35 departments, and the College of Advanced Education which specialises in teacher training.

Health

Apart from medical practitioners in private practice, health services in the Hunter Region have traditionally been provided through hospitals, baby health centres and ambulance services.

General Hospitals: The number of actual and permitted hospital beds in the Lower Hunter Subregion is shown in *Table A14.10*. Permitted hospital beds is the number of beds (including general surgical, general medical, pediatrics and obstetrics) based upon the Commonwealth Government set ratio of 3.5 beds per 1000 population.

In the Newcastle local government area there are six public and four private hospitals and, although these hospitals have a combined surplus of 1102 beds, most of these beds are permanently filled since the hospitals service a much larger area than their immediate environs.

Lake Macquarie Municipality contains one public and three private hospitals with a combined total of 288 beds. Port Stephens Shire has only one private hospital with twelve beds and both Lake Macquarie and Port Stephens hospitals are deficient in the number of beds available. As both areas are experiencing rapid growth, these deficiencies are expected to increase.

The Royal Newcastle and Mater Misericordiae Hospitals have specialist services not available at other general hospitals.

Specialist Hospitals: There are six psychiatric hospitals in the Lower Hunter Subregion and 0.9 obstetric beds per 1000 population. The subregion overall has a surplus of 285 geriatric beds, but Lake Macquarie and Port Stephens Shires have a combined deficit of 207 beds.

Other Health Services: There are approximately 79 dentists in the Lower Hunter Subregion. The demand for dental services is expected to decline in future as fluoride in water supplies reduces the incidence of dental caries and as school dental facilities are introduced.

The number of Baby Health Centres and Ambulances in the Newcastle district in 1976 are shown in *Table A14.11.* Most Newcastle suburbs have Baby Health Centres, but the rapidly growing areas of Port Stephens and Lake Macquarie have insufficient facilities and residents have to travel outside their immediate area for services.

6.13.6 Population Health Characteristics

The morbidity ratio of Hunter Region residents during the period 1975-77 was 102 compared with a base level for the State of 100 (*Health Commission of New South Wales, 1979)*. The crude death rate for the Hunter Region has been about 5 per cent higher than for New South Wales for at least 20 years *(Egger et al 1979)*.

The regional population suffers a higher mortality as a result of heart disease, bronchitis, maternal deaths, motor vehicle accidents and other causes, than the State level. Death as a result of pneumonia, arteriosclerosis, suicide, diarrhoea, tuberculosis, other infectious and parasitic diseases, alcoholism,perinata, accidents other than motor vehicle accidents, influenza, congenital anomalies and cerebrovascular disease is lower in the region than for the State.

6.13.7 Community and Recreational Facilities

There are approximately 88 welfare agencies in the Lower Hunter Subregion which provide most necessary services to needy groups.

A number of community health centres are available which offer a range of services including health checkups, immunisations, mental health services, pre-natal and post-natal care. At present, these facilities are located at Hamilton, Charlestown, Windale, Muswellbrook, Nelson Bay and Forster.

A wide range of natural and man-made recreational facilities exist within the Lower Hunter Subregion. These include the coastal waterways of Lake Macquarie and Port Stephens, the coastal beaches north and south of Newcastle, the vineyards at Pokolbin and numerous areas of natural bushland. Man-made facilities include the full range of sporting and cultural facilities that are available in capital cities.

6.14 CULTURAL ASPECTS

6.14.1 Archaeological Sites

The New South Wales National Parks and Wildlife Service has no records of archaeological areas on the proposed site.

A tree trunk at the entrance to the Courtaulds textiles factory, which bears an half-oval shaped cut believed to be made by aborigines, is the only remaining evidence of aboriginal occupation found in the area.

6.14.2 Historical Settlements

The area on the northern side of the Hunter River was first settled in the period 1837 to 1841 by farmers who accepted Crown grants ranging in size from 200 to 770 ha.

The first settlement grant was a parcel of land 259 ha, known as

"Kilcoy" adjacent to the river west of the proposed site. This grant was held in 1837 by two farmers, Messrs. Snodgrass and Mitchell, who also accepted a Crown grant in 1841 of 200 ha covering the proposed site. The 200 ha site was held in trust for Miss J.W. Snodgrass and Mrs. W. McLean (presumably daughters) and was known as the Tomago Estate.

The land east of the site, comprising 344 ha was settled by R. Windeyer in 1839 who built "Tomago House" in 1843. This house and adjacent chapel, built in 1861, are the only historic buildings remaining from these early days in the vicinity of the proposed site. Both buildings are classified by the National Trust of Australia (New South Wales) and are privately owned. Tomago House, which comprises ten rooms, four attics and cellars, with surrounding verandahs, is considered to be a fine example of early colonial architecture. It is constructed from stone quarried at Raymond Terrace and galvanised iron, which replaced the original slate roof. Local red cedar was used in the joinery. The house is set on 4.5 ha of landscaped grounds containing numerous native trees.

In 1854, interest in the potential of the area for coal mining was high. Mining activities were widespread in the valley and high quality coal had been discovered in Newcastle and Maitland. As a result, a Mr. Gordon, who had purchased the Tomago Estate, sank a shaft on the site in search of coal. Good quality coal was struck and mining operations established. Initially coal was transported by a horse-drawn dray to the banks of the Hunter River near the site, but later on the horse was replaced by a tram and engine. Coal was loaded onto 200 t ships which plied the river to Tomago. The remains of the old tramway embankment and railway cutting can still be seen on the western boundary of the Stauffer chemicals factory and on the southern side of Tomago Road, respectively.

The colliery experienced difficulties with trade and mining conditions and eventually closed about 1863. At this time, there were a number of buildings on or near the site. These included a manager's house and garden, overman's house, 36 miners' cottages, stables, dray shed, smithy, store, etc. The chapel on the Windeyers Estate, constructed during the mining period (1861), was probably built to provide services for the large mining community that existed in the area. No evidence of the colliery buildings remains on the site.

In 1922 the old Tomago mine was reopened as the Big Ben Colliery but closed down very shortly afterwards in 1924.

During the Second World War, an emergency airstrip was built on the northern part of the property and an army camp established on the western margin of the site. Concrete slab foundations from this period of occupation can be seen approximately 100 m northwest of the old colliery shaft.

At this time, the only means of access to the northern side of the Hunter River was by punt or ferry from Hexham. In 1945, an impetus to the construction of a bridge across the river was received when Courtaulds (Australia) Limited showed interest in the area as a site for a textiles factory. Construction of the present road bridge commenced in 1945.

Courtaulds (Australia) Limited purchased the proposed site in 1949-50 and constructed the present factory in 1950-51. Production of rayon and textiles commenced in 1952 and over 1200 people were employed. In the early 1970's the company experienced difficulties in maintaining competitiveness with overseas markets and closed in April 1976.

6.15 LANDSCAPE AND VISUAL ASPECTS

6.15.1 Subregional Scenery

The scenery of the Lower Hunter Subregion is dominated by a ridge and valley topography controlled by the underlying geology. The densely vegetated ridges and valleys in non-urban areas contrasts with the cleared, level, floodplains of the Hunter River and the heath vegetation of the coastal dune system.

The results of a visual analysis of the Lower Hunter Region by *Radford* *and Bartlett (1977)* indicated that areas of highest visual quality were associated with major water bodies and steep vegetated slopes. These included the eastern end of Port Stephens, Wangi Wangi Point and Pulbah Island on Lake Macquarie. Other areas of high visual quality comprised most of the foreshore of Lake Macquarie, the Mulbring Valley, the Williams River Valley and the coastal strip along Newcastle Bight. Areas having least visual quality are the Hunter River floodplain between Hexham and Maitland, and a small area at the northern end of Lake Macquarie.

It is suggested by *Reynders (1978)* that the high level of visual amenity within the Lower Hunter Subregion be maintained by the adoption of a 'green corridors' concept. This would involve the reservation of vegetated corridors along ridges and water courses that link areas of major recreational, ecological and visual importance, such as the forested western urban fringe, the eastern coastal landscapes and Lake Macquarie.

6.15.2 Scenic Value of the Site and its Environs

The site is located within the "Coastal Lowlands" landscape unit as defined by *Reynders (1978)*. This is one of 22 landscape units that have been defined in the Lower Hunter according to vegetation density and ridgeline position. These lowlands have been reported to have an interesting rural character with alternating open heath, farm or swampland and forest of varying densities.

The site itself is well vegetated and therefore, according to a visual preference survey conducted by *Radford and Bartlett (1977)* of Lower Hunter residents, would rank as having high visual quality, only being exceeded by coastal foreshores, rivers in a rural setting, and enclosed rural valleys. Visual preference decreased with an increase in man-made intrusions, so that adjacent industrialised areas would be ranked low to very low. The Hunter River, which is predominantly Mangrove-lined in this vicinity, would be ranked as having moderate scenic value according to the results of the survey.

The site and its environs contain a variety of visual elements which according to the results of the survey would be considered to vary from low to high in scenic appeal. The site comprises portion of a large forested belt reserved as the Hunter District Water Board's Tomago Sandbeds Water Supply Catchment Area.

6.15.3 Viewing Points

As a result of the flat topography and the dense vegetation, the site is relatively inconspicuous. The only features which enable the site to be identified are the stacks of the Courtaulds textiles and Stauffer chemicals factories. These can be seen only from close viewing points on Tomago Road and from a number of vantage points including the New England Highway at Tarro, the Pacific Highway at Sandgate, Maitland Road where it crosses the industrial railway line at Sandgate and the Pacific Highway between the Hexham Bridge and its intersection with Tomago Road.

6.16 REGIONAL PLANNING

6.16.1 Hunter Regional Plan

Plans and policies have been formulated by the New South Wales Planning and Environment Commission with consultant and specialist support to provide the basis for the Hunter Regional Plan. The Plan, which is not statutory, is intended to function as the guideline document for government and private initiatives in the region.

The Plan's goals and objectives can be described under the following five headings:-

- i. Social
- ii. Regional Economy
- iii. Land Use, Settlement and Transport
- iv. Natural Resources and Environment
- v. Management and Implementation.

The Plan allows for a population addition of 100,000 persons in the Lower Hunter Subregion and an increase in the labour force of 63,500 by the year 2001.

A recommended strategy for the Lower Hunter Subregion was selected from a number of alternative plans by a "Goals and Objectives Achievement" method. This strategy is illustrated in *Figure 6.19*.

The recommended strategy seeks to maximise the use of existing infrastructure so that most new growth in housing and in employment will occur as additions to existing areas of urbanisation. Major new growth is proposed in the localities of East Maitland-Thornton, West Maitland and Kurri Kurri. To reduce journey-to-work distances, it is proposed to encourage the formation of up to 12,000 additional jobs in these areas. Infill growth is planned for the northern parts of Lake Macquarie Municipality and emphasis is placed upon reducing the decline in population from inner city areas.

Employment growth is expected to continue in the Newcastle Central Business District and existing industrial areas, including Kooragang Island, but promotion of job growth in suburban areas is recommended.

The site is well located with respect to access from the proposed new growth areas and is supportive of the objective of continued growth within existing developments.

6.16.2 Newcastle Bight Study

A joint study involving the New South Wales Planning and Environment Commission and the Port Stephens Shire Council has been proposed. The objectives of the study are to produce a draft land use plan to resolve conflicting requirements in the Newcastle Bight area, and secondly, to prepare a management strategy that will ensure balanced development and control over the next 20 years.

The study area extends from the Port Stephens Shire boundary in the south, to Williamtown in the north and from Fullerton Cove in the west to Anna Bay in the east. The area is considered to be of regional significance in terms of its mineral resources, landscape and ecological elements, and in respect of the future port and industrial developments *(Port Stephens Shire Council, 1979)*.

6.16.3 Port Development

The present deepening programme for Newcastle Harbour will result in an average bed depth of 13.1 m below high water mark and will enable the entry of vessels having a deadweight of up to 120,000 tonnes. The deepening is expected to be completed by late 1981 or early 1982.

Further proposed developments within the Harbour precinct include:-

i. A new berth and associated unloading and storage facilities at Rotten Row for the discharge of alumina and coke for the aluminium industry.

ii. An extension of the existing wharf facilities on Kooragang Island to accommodate a planned woodchip loader.

iii. A second berth is to be constructed to duplicate the present facilities of the Port Waratah Coal Loader.

iv. A third coal loader is proposed for Kooragang Island with construction commencing in 1984/1985.

v. Possible further deepening of the south arm of the Hunter River.

An area adjacent to Cox's Lane, southeast of Williamtown has been set aside as a site for a possible port to supplement Newcastle Harbour. Its possible development will largely depend upon the future level of coal exports, and the time span that these levels can be catered for by the present facilities. Should a decision be made, development is not expected until next century. Rail linkages connecting the port site to the present network will be an integral part of the development.

6.16.4 Future Settlement Patterns

It is expected that future residential development will take place in those areas delineated by the recommended strategy of the Hunter Regional Plan. These areas include the following:-

i. Raymond Terrace: Approximately 1200 blocks are being subdivided in the area east of the township. Further land is zoned for residential use within this area and also within a zone between the Pacific Highway and the Hunter River, to the northwest of the town. Sufficient land is available to easily support a doubling of the present population of Raymond Terrace.

ii. Port Stephens: Sufficient land for residential use is available adjacent to existing development at Nelson Bay, Tanilba Bay, Fingal Bay and Anna Bay to support an increase in population of at least 10,000 persons.

iii. East Maitland-Thornton-Beresfield: A population increase of 16,000 persons can be readily accommodated within this zone. In Beresfield this would be achieved by infill development rather than expansion.

iv. Wallsend-Cardiff: A population increase of 9000 persons can be achieved in this area by a combination of infill development and expansion of existing areas. The latter include Elermore, Marylands, Elermore Vale and South Wallsend.

v. Newcastle: The infill development of the existing urban areas of Newcastle will assume greater importance as the need for the conservation of energy, largely by minimising journey to work distances, becomes more pronounced.

vi. Lake Macquarie: Development is expected to take place predominantly around the northern part of the lake and in the Redhead area.

vii. Kurri Kurri and West Maitland: Population growth within both these areas will depend upon the provision of sufficient job opportunities within the district. A total population increase of 30,000 persons has been allocated to these zones.

6.17 REGIONAL DEVELOPMENTS

Figure 2.1 shows the location of existing and proposed major developments within the Hunter Region. Capital investment estimates are based upon figures quoted in *Hunter Development Board (1980)*.

The Hunter Valley is expected to experience major industrial and resource development growth within the next decade. Anticipated future developments, having a capital investment in excess of $5m include the following:-

Coal Mining

There are an estimated eleven opencut and two underground mines which are likely to be developed within the next decade. The majority of these are located within the Upper Hunter. However future coal mining development may exceed this estimate, depending on market prices. Capital expenditure on new coal mines over the next five years is conservatively estimated at $600m.

Power Stations

Two major power stations are being constructed by the New South Wales Electricity Commission. The Bayswater power station which is located in the Upper Hunter, is to be constructed in four 660MW stages between 1985 and 1989, at an estimated cost of $450m. The Eraring power station which is situated on the western shore of Lake Macquarie is to be constructed over four 660MW stages between 1982 and 1985 at an estimated cost of $370m.

Aluminium Smelters

The existing Alcan Australia Pty. Limited aluminium smelter at Kurri Kurri is to be expanded to three potlines by 1985, at an estimated cost of $95m. An output of 135,000 t of aluminium is planned. Alumax of Australia Pty. Limited is planning to construct a two potline aluminium smelter at Lochinvar, between 1981 and 1984. The estimated capital investment for the project is $650m, and the planned output is 236,000 tp y of aluminium.

Industrial and Transport Developments

i. The Broken Hill Proprietary Company Limited is planning to upgrade its steelmaking plant, at an estimated cost of $32m. This is expected to be completed by 1983. The Company is also investigating the feasibility of a fifth blast furnace, which could be operational by mid-1985.

ii. The Sulphide Corporation Pty. Limited is planning to expand its smelter operation, at an estimated cost of $75m. A completion date of 1984 is anticipated.

iii. The natural gas pipeline currently being constructed between Sydney and Newcastle and the reticulation of natural gas in Newcastle is estimated to cost $70m and be completed by 1981.

iv. The Newcastle harbour deepening project, being undertaken by the Maritime Services Board is to be completed by 1982 at an estimated cost of $70m.

v. Electrification of the Gosford to Newcastle section of the main northern railway line is expected to be completed by 1983 at an estimated cost of $129m.

vi. In addition to these major projects, there are a number of major retail and office developments proposed for Newcastle.

vii. The conversion of coal to liquid fuel, has the potential to generate substantial associated industrial development. Coal deposits within Authorisation 102 which is located west of Muswellbrook is being investigated by the Department of Mineral Resources to determine its suitability for conversion to liquid fuel. Neither development times nor cost estimates are available, but an order of magnitude cost would be in the vicinity of $2.5 to $3 billion.

Water Storage Developments

The Water Resources Commission of New South Wales is constructing a major dam on Glennies Creek, at an estimated cost of $30m. The dam is expected to be completed by 1983. Four further sites are planned for future water storage in the region.

Special Environmental Studies

SECTION 7

SPECIAL ENVIRONMENTAL STUDIES

SUMMARY

This section presents the results of a series of field and laboratory research studies and computer analyses conducted to provide backup data for the surveys and investigations used in the assessment of the constraints imposed by the existing environment and the impact of the smelter proposal.

A major part of the investigations for the Company's proposal has been the development of a mathematical model to represent the dispersion of the gaseous and particulate pollutants emitted to the atmosphere.

Using an emission rate of 1 kg of fluoride per tonne of aluminium, experience with operating smelters and meteorological data from Williamtown, dispersion patterns have been prepared to predict monthly and annual, and maximum monthly average concentrations around the plant, annual and maximum monthly average concentrations on a regional scale and the average removal of fluorides (by absorption, etc.) around the plant and in the Tomago Sandbeds Water Supply Catchment area. The analyses consider gaseous and total fluorides.

A range of factors affecting dispersion was considered, the assumptions used in the model were verified, and it was concluded that the dispersion patterns are realistic and reliable for impact assessment purposes. The fact that 1 kg of fluoride per tonne of aluminium has been used for emissions when the Company believes that it will be less in practice represents a conservative constraint on the analysis and an additional safeguard. Total fluoride emission from the smelter is expected to be 0.76 kg/t *(Section 8.5.3.)*.

The dispersion patterns are used in *Section 9* to assess the impact of the proposal.

Studies are in progress to establish background levels of fluoride in vegetation and fauna. Preliminary results are presented in this section which indicate that the concentrations measured on and around the site are normal background levels.

A smelter at Tomago will adjoin the Tomago Sandbeds which are an important source of Newcastle's water supply. Preliminary results are provided of studies requested by the Hunter District Water Board to determine relationship among fluorides from the smelter, vegetation, soils and water quality in the sandbeds. The early indications from the studies show that the soils in the profile remove fluorides and the concentrations in the groundwater will be considerably less than 0.30 ppm after many years of operations. This level is below the 1 ppm added by the Board to water for drinking.

Other study results indicate that more fluorides pass to the soil from decomposed leaf litter than washed from leaves by rain and that over half of the fluoride associated with vegetation is lost in smoke during bushfires.

7.1 AIR POLLUTION DISPERSION MODELLING

7.1.1 General

A major part of the potential environmental effects of a smelter relate to the concentration of air pollutants, particularly the gaseous and particulate fluorides and in order to assess impacts, it was necessary to develop a method of predicting the dispersion of emissions.

Scale modelling, the measurement of existing sources and mathematical modelling were considered. The last of these was selected on the basis of practicality, the refinement of the modelling theory available and the existence of computer facilities which allow the testing of a large number of alternatives and the production of reliable results within time and economic constraints.

A brief summary of the model is given in this section to provide a background to the emission dispersion patterns.

A full description of the model and the assumptions made in its development are given as *Appendix 15* in *Volume 2* of this Statement. Also included in the Appendix are details of the emission data used in the model, the analyses carried out to derive suitable meteorological data and the tests undertaken to verify the assumptions. The results of the modelling are presented in *Section 7.1.6* and are used in the analysis of the interaction of the proposed smelter with the environment in *Section 9.*

7.1.2 Description of the Model

The model was based on the Gaussian *(Strauss, 1971)* equation for the diffusion of gas plumes, where the horizontal and vertical dispersion of a plume downwind of an elevated source is expressed by dispersion parameters. These parameters vary with distance downwind of the source and the meteorological conditions at any time. The Pasquill form of dispersion parameters was used which relates the parameters to one of six atmospheric stability categories varying from A - Very Unstable to

F - Very Stable. Expressing the parameters in this form was chosen because of the large number of stability categories defined when compared with other methods (e.g., only four Brookhaven categories).

The *Briggs (1969)* equations were used to estimate the initial rise of a heated gas plume. The form of the equations also depends on the atmospheric stability.

It has been recognised that a 'downwash' effect can be created by turbulence behind buildings when the wind is perpendicular to the structure. The effective height of an emission can be reduced and result in higher ground level concentrations of a pollutant. This effect was taken into account in the model by assuming a downwash factor of 0.6 when the wind was perpendicular to a building, a factor of 0.8 when wind was at 45 degrees to a building and no downwash for a parallel wind.

The fluoride emissions modelled are of two forms. Gaseous fluoride (Fg) is basically hydrogen fluoride, a highly reactive gas. Particulate fluoride (Fp) contains less reactive compounds of calcium, aluminium and fluorine. Because of their small particle size, the particulates generally behave as a gas and are transported to ground level by eddy diffusion. In order to estimate the rate of reaction (absorption) of gaseous fluoride and the rate of deposition of particulate fluoride, it was assumed that the plume is not reflected at ground level, and consequently the Gaussian equation was modified to model this effect. The possible break down or decay of the fluorides in the air was not considered in the model because no reliable value for a rate of decay was available.

Two stages were necessary to convert the short-term concentrations of fluoride predicted for each wind direction, wind speed and stability category to long-term averages.

i. The concentrations predicted for each of eight major wind directions were averaged over the relevant 45 degree wind sector.

ii. The Pasquill dispersion parameters which predict ground level concentrations equivalent to an average over a 10 minute period, were converted to the time intervals for which meteorological information was available (12 hours) by the use of empirical equations based on experience gained at aluminium smelters overseas.

7.1.3 Emission Data Used in the Model

A maximum emission rate of 1.0 kg of fluoride per tonne of aluminium produced was assumed for the purposes of the dispersion analysis and impact assessment. This rate assumes a maximum fluoride evolution rate of 30 kg/t, of which a minimum of 97.2 per cent would be collected by the hooding over the pots and transferred to the dry scrubbers. The minimum efficiency of the dry scrubbers was taken as 99.5 per cent.

Based on these assumptions, *Table 7.1* shows the emission levels calculated for the various pollutants.

TABLE 7.1

MAXIMUM LONG TERM ATMOSPHERIC EMISSION LEVELS
(expressed in kg/t of aluminium)

Emission Source	Gaseous Fluorides Fg	Particulate Fluorides Fp	Total Fluoride Ft	Particulates Excluding Fp	Sulphur Dioxide SO_2	Tar Vapour
Potline Buildings (roof vents)	0.54	0.30	0.84	0.90	0.6	
Dry Process Stacks	0.07	0.07	0.14	0.15	23.4	
Baking Furnace	0.02	0	0.02	0	0.8	0.06
Total	0.63	0.37	1.0	0.9	24.8	0.06

Section 8 states that the expected long-term average emission rates achieved by the smelter will be lower than those indicated in the table, hence the 1 kg.F/t.Al should be regarded as a worst case.

Other data needed for the dispersion and plume rise equations were provided by the Company based on experience with similar plants overseas. The four potroom buildings, which are actually line sources, were modelled as 10 point sources for each of the two outer potrooms.

A particle size distribution for the potline roof emissions showed that the particulate fluoride is of an aerosol size. Only 28 per cent of the particles have a diameter greater than 11 microns, 30 per cent are between 11 and 3.3 microns and 25 per cent are less than 1 micron. On the basis of these data it was decided that the dispersion and deposition of the particulate fraction would be predicted using the same equations as for the gaseous fraction.

7.1.4 Meteorological Data

Meteorological data from the RAAF base at Williamtown were used in the study. As the smelter site is approximately 13 km from Williamtown and both are on the coastal plain, the data from the RAAF base represent a reliable indication of the meteorological conditions on the site.

The proportion of each month when the atmospheric stability was in a particular Pasquill category was determined by the analysis of data on the vertical temperature gradient. This has been measured twice per day, at 9 am and 9 pm, over a period of some 25 years by the use of radiosonde balloon ascents. The resultant trend, as expected, showed the highest average instability in the summer months and highest average stability in the winter months.

The wind speed and wind direction data were also analysed for each month to give the proportion of readings in each of eight wind directions and at each of six wind speeds. The wind readings for 9 am and 9 pm were combined with the radiosonde readings to give the form of data required for the model. An analysis of the wind readings for eight times per day confirmed that the 9 am and 9 pm readings were representative of the total wind pattern and hence data for these times were used for the wind roses shown in *Figure 6.10*. A full breakdown of the data used in the model is given in *Appendix 15*.

7.1.5 Testing and Verification of the Model

The model developed for this study was fully tested to determine the accuracy of the assumptions. The main conclusion of the tests are as follows:-

i. For a non-buoyant plume, assuming eight or more sources per potline building gives an accurate prediction of ground level concentration beyond the immediate vicinity of the plant.

ii. The natural draught ventilation system for the potroom is designed to have a minimum flow rate of 20 m^3/s per pot at a minimum temperature rise of 10°C. There is only a minor change in ground level concentrations if rises of 15°C or 20°C (which could occur at certain times of the year) are assumed, particularly at moderate wind speeds.

iii. The assumption of a downwash factor of 0.6 for wind perpendicular to the potrooms will give a conservative estimate of ground level concentration up to 2 km from the smelter. Beyond this distance, the effect will be minimal.

iv. The assumption of two potline buildings being the emission sources rather than the actual case of four buildings, results in a slightly higher ground level concentration up to 1 km from the site and minimal effect beyond this.

In a subregional or regional analysis, further reduction in the number of emission sources has no significant effect on the estimates of ground level concentration beyond about 3 km.

7.1.6 Presentation of Results

The results of the dispersion analysis are presented in the following figures.

i. *Figure 7.1* - Predicted Monthly Average Ground Level Gaseous Fluoride Concentrations - January to June.

ii. *Figure 7.2* - Predicted Monthly Average Ground Level Gaseous Fluoride Concentrations - July to December.

The twelve drawings on these figures show isopleths (that is, lines through points of equal magnitude) of predicted monthly average ground level concentrations of gaseous fluoride emitted from the smelter. It should be noted that these isopleths are of concentrations which assume zero background gaseous fluoride.

Only gaseous concentration is shown because all other possible measures of concentration or deposition of fluorides will follow the same basic pattern, that is, if the ground level concentration at a particular point in January is twice that for July, then the deposition rate of particulate fluoride will also be double.

These dispersion patterns closely follow the average wind patterns described in *Section 6.6.5*. The maximum monthly ground level concentrations occur to the northwest, west and southwest of the site in summer (January, February, March, and to a lesser extent November and December). In winter and early spring (May through to September), the highest values are to the east and southeast. A more even distribution occurs in the autumn and spring months of April and October.

The monthly average ground level concentration of gaseous fluoride is not expected to exceed 2.0 $\mu g/m^3$ beyond the immediate vicinity of the buildings. Concentrations above 1.0 $\mu g/m^3$ are generally confined to the Company's property and adjacent existing industrial development.

iii. *Figure 7.3* - Predicted Annual Average Ground Level Gaseous and Total Fluoride Concentrations in the Vicinity of the Plant.

The data shown in *Figures 7.1* and *7.2* were averaged to give the annual average concentration of gaseous fluoride up to 5 km from the smelter centre. The result is shown in *Figure 7.3* which was also based on the assumption of zero fluoride background concentrations. The monthly averages of gaseous and particulate fluoride concentrations were also combined to give the annual average total ground level fluoride concentrations shown in a different colour on the figure.

It can be seen from the figure that a level of 0.5 $\mu g.Fg/m^3$ is only exceeded beyond the Company's property boundary to the immediate east and southeast of the site. The isopleth of 0.5 $\mu g.Ft/m^3$ extends some 1.3 km beyond Company property to the east and southeast and is just beyond the site to the southwest. By simple interpolation, it can be seen that the 0.3 $\mu g.Fg/m^3$ level would extend to the Hunter River in the southwest, south and southeast, to the International Motordrome in the west and approximately 2 km to the east along Tomago Road. The significance of these and other levels is discussed fully in *Section 9*.

iv. *Figure 7.4* - Predicted Maximum Monthly Average Ground Level Gaseous and Total Fluoride Concentrations in the Vicinity of the Plant.

The data used for *Figures 7.1* and *7.2* were examined to find the highest monthly average concentration of gaseous fluoride at each point. The isopleths of these maximums and those for the concentration of total fluorides are shown in *Figure 7.4*.

It was not practical to predict maximum concentrations for time periods less than one month because of limitations imposed by the data available. The significance of short period concentrations in terms of the response of vegetation is also questionable.

The isopleths indicate that the maximum monthly levels are approximately twice the annual average values.

v. *Figure 7.5* - Predicted Annual Average Ground Level Gaseous and Total Fluoride Concentrations for the Region.

This figure shows, on a scale of 1:100,000, isopleths of annual average concentrations of gaseous and total fluoride ($\mu g.Fg/m^3$ and $\mu g.Ft/m^3$). It covers a wider area than *Figure 7.3*. Of most interest in this figure is the 0.1 $\mu g.Fg/m^3$ isopleth which extends to the Hunter River in the west and north to the fringes of Hexham Swamp in the southwest, over the northern part of Kooragang Island to Fullerton Cove in the southeast, and approximately 4 km along Tomago Road in the east.

The figure shows that there is a potential for overlap with existing fluoride sources in the Kooragang Island area. However, concentrations due to the smelter at residential areas of Stockton and Mayfield will not result in significant increases in the existing levels.

vi. *Figure 7.6* - Predicted Maximum Monthly Average Ground Level Gaseous and Total Fluoride Concentrations for the Region.

This figure shows the isopleths of maximum monthly average concentrations of gaseous and total fluoride up to about 20 km from the site.

It covers a wider area than shown in *Figure 7.4*. By comparison with *Figure 7.5* it can be seen that the maximum monthly concentrations are about twice the annual average concentration.

The impact of these fluoride concentrations on flora and fauna are discussed in *Section 9*.

vii. *Figure 7.7* - Predicted Average Removal of Particulate and Total Fluorides Around the Site.

Based on non-reflection of the plume at ground level, a sink-image model was used to estimate the rate of fluoride removal at ground level. This is made up of particulate fluorides (Fp) which are deposited at the surface and gaseous fluorides (Fg) which are absorbed by vegetation, soil, water, etc. This is shown in *Figure 7.7* for the area around the site.

The units used are milligrams of fluoride per square metre per day ($mg.F/m^2d$). Assuming no washout by rainfall, consumption by animals, etc., then for the line representing 1 $mg.Ft/m^2d$, fluoride would accumulate at a rate of 0.37 gm/m^2y. The effect of this on sandbeds is shown in more detail in *Figure 7.8*.

viii. *Figure 7.8* - Predicted Average Removal of Particulate and Total Fluorides in the Tomago Sandbeds Catchment Area.

As part of the special studies conducted for the Hunter District Water Board, an estimate was made of the pattern of fluoride removal (consisting of deposition of particulates and absorption of gaseous fluoride) over the Tomago Sandbeds area. The results are shown in *Figure 7.8*. The potential impact of this removal is discussed in *Section 9*.

ix. *Figure 7.9* Predicted Annual Average Ground Level Concentration of Sulphur Dioxide.

This figure shows the average concentrations of sulphur dioxide which will occur in the region due to emissions from the smelter. The major source of sulphur dioxide is the four dry scrubber stacks which will be designed on the basis of State Pollution Control Commission standards to ensure that maximum ground level concentrations are acceptable.

7.1.7 Use of the Dispersion Patterns

The dispersion patterns provide a series of figures for use in the assessment of the impact of the proposal on soils, surface water, groundwater, flora, fauna and land use discussed in *Section 9*. As could be expected, the level of impact of fluoride (and sulphur dioxide) emissions on each of these natural features varies widely and, consequently, no one pattern of emission dispersion is adequate to assess effects uniquely. For this reason, one or more appropriate figures are used to provide the parameters for impact assessment in each case.

7.2 STUDIES OF FLUORIDE IN VEGETATION AND FAUNA

7.2.1 Vegetation

Three studies have been conducted to examine the existing fluoride levels in vegetation on and near the site and in the subregion, and to form the basis for the on-going monitoring programme described in *Section 8.13*.

Study 1 examined fluoride levels in dominant plant species growing within 5 km of the site.

Study 2 examined levels of fluoride in one species, Spotted Gum *(Eucalyptus maculata)* within a 40 km radius of the proposed site.

Study 3 examined fluoride levels in some horticultural crops and garden flora growing near the proposed site.

The results of these studies, which are discussed in detail in *Appendix 9.5*, have been used to provide background fluoride levels to be considered with the predicted emission levels from *Figures 7.1* to *7.8* in the assessment of impacts.

Study 1 : Fluoride Levels in Dominant Plant Species

Fourteen plant species were sampled on four occasions within 5 km of the smelter at the locations shown on *Figure 6.13.*

The species are representative of the dominant vegetation communities occurring on and near the site. Two representative samples of each species were collected from the tree canopy at each sampling point.

The results, presented in *Tables A9.1* and *A9.2*, show that the fluoride content of the leaves of the species sampled varied between 7.6 and 29 ppm.F. It was recognised by *Weinstein (1977)* that fluoride levels in most species of vegetation growing in areas free of fluoride emissions vary between 2 and 20 ppm.F and hence the results obtained to date suggest that abnormal concentrations are not present in vegetation around the proposed site.

Study 2 : Fluoride in Spotted Gum (Eucalyptus maculata)

Spotted Gum was taken as an emission indicator, as it is widespread throughout the Newcastle area and is known to be sensitive to fluorides around the Kurri Kurri smelter. A total of 25 sampling sites was established within a 40 km radius of Newcastle. Samples were collected on three occasions from the sites shown in *Figure 7.10*. The results for fluoride, presented in *Table A9.3*, range from 3.1 ppm near Cessnock to 26.2 ppm near a large industrial complex at Sandgate. Using Weinstein's range of 2 to 20 ppm.F to represent background, it would appear that anomalous concentrations of fluoride in Spotted Gum occur where these trees are close to sources of fluoride and the region as a whole has not been affected by the dispersion of fluorides. Further results over longer periods are needed to support this conclusion.

Study 3 : Fluoride in Vegetable and Garden Plants

Thirteen different vegetables and garden plants have been sampled from private residences on Tomago Road within 4 km of the proposed smelter site. Results, illustrated in *Table A9.4* in *Appendix 9.5*, show that levels range from 16.8 ppm in roses to 78.1 ppm in corn. Overall levels are generally less than 40 ppm. Samples showed no visible fluoride damage, but further surveying over longer periods is needed to establish normal conditions in the various species.

7.2.2 Animals

A total of 27 animals has been analysed for fluoride to establish existing background levels in fauna on or near the proposed site. Specimens collected were found dead in the area or were supplied by local farmers from animals sent to slaughter. An eel, fish and prawns were caught in the Hunter River and a rat was trapped on the site.

Fauna studies have shown that colonies of Koalas *(Phascolarctos cinereus)* occur within the Tomago Sandbeds area. Groups of three to four have been sighted in trees on the periphery of the sandbeds and on Hunter District Water Board roads and are thought to be relatively common throughout the area. A small group of two to three has been seen regularly in trees adjacent to the Courtaulds textiles factory. Two dead animals have been analysed for fluoride to establish background levels in Koalas. For comparison, additional Koalas were analysed from Taronga Park Zoo and Blackbutt Reserve.

Full details of these studies are given in *Appendix 10.6.*

Fauna Samples

The results of the analyses show that fluoride levels varied among the species from 458 μg.F/g in a Sacred Kingfisher to 2615 μg.F/g in a Kookaburra from the Tomago area. The latter analysis was the highest recorded in fauna from the area. Levels in fish in the Hunter River average approximately 450 μg.F/g, while in oysters levels range from 15 μg.F/g in two year old specimens to 136 μg.F/g in four year old oysters. Termites from the Tomago Sandbeds were analysed to give 55 μg.F/g.

Cattle average 1500 μg.F/g, pigs 300 μg.F/g and chickens 674 μg.F/g. A full list of analyses is presented in *Table A10.2.*

Levels in the rat, eel, cow, kookaburra and mud crabs are similar to those in published data from *Singer and Armstrong (1968)* and *Stewart et al (1979)* presented in *Table A10.1*.

Fluoride in Koalas

Analyses were conducted on liver, kidney, muscle, stomach content and bones from Koalas occurring on the site. The results in *Table A10.3* show that the levels of 3000 μg.F/g in the bones of Koalas from the site are similar to those obtained from Koalas at Taronga Park Zoo (≃3500 μg.F/g) and Blackbutt Reserve (3300 μg.F/g.).

The fluoride levels in Koalas were significantly higher than those measured in other fauna. This may be due to the ingestion of soil which forms part of the Koala's diet and is naturally high in fluoride, and also to the fact that they urinate infrequently, indicating high absorption efficiency of the kidneys. The fluoride may be absorbed via the kidney and blood to the bones.

7.2.3 Conclusion

The studies of background levels of fluoride in vegetation and fauna are too preliminary to establish base levels for comparison. However, the results indicate that the base levels are unlikely to be above those expected as normal background in an area relatively remote from industrial fluoride sources.

7.3 FLUORIDE IN GROUNDWATER

A series of laboratory experiments is being conducted to assess the possible effects of the emissions of fluoride from the smelter on groundwater quality in the Tomago Sandbeds. These studies were requested by the Hunter District Water Board, the authority with the responsibility of ensuring the quality of Newcastle's water supply.

Figure 7.11 illustrates conceptually the potential paths for emissions to reach the groundwater. The following four experiments were designed to examine factors affecting the progress of the emissions along the paths.

i. The washing of fluoride from the surface of leaves.
ii. Decomposition of vegetation high in fluoride.
iii. The movement of fluoride during bushfires.
iv. Transfer of fluoride from soils to groundwater.

The progress to date in the work is described.

7.3.1 Prediction of the Long-Term Fluoride Levels In the Tomago Sandbeds Aquifer

Figure 7.8 showing the pattern for the removal of emissions over the Tomago Sandbeds indicates that an average of 0.5 $mg.Ft/m^2.d$ could be expected around pumping stations 1 and 20. This level is equivalent to approximately 0.16 ppm F in the soil water over a year with a rainfall of 1156 mm. The levels that could be expected close to the smelter site are 5 $mg.Ft/m^2.d$ resulting in 1.6 ppm F in soil water over a twelve month period.

Experiments to predict the likely concentration of fluoride reaching the groundwater have been conducted using fluoride solutions ranging from 0 to 20 ppm.

The dispersion patterns show that concentrations in soil water of 20 ppm F would be rarely reached in areas near the plant. The concentration of 20 ppm F in soil water would require deposition of 63 $mg.F/m^2.d$ and such rates are rarely achieved, if ever, near the smelter. Consequently the concentration of 20 ppm F used in the experiments represents an absolute worst case.

7.3.2 Rainwash of Fluoride from Vegetation

Particulate and gaseous fluorides from the smelter may precipitate on the surface of leaves. An experiment was designed to test the potential for rainwater to transfer fluoride salts from the leaves to the soil surface. Details of the tests are given in *Appendix 6.8*.

Fluoride contaminated leaves collected adjacent to the existing aluminium smelter at Kurri Kurri were washed separately in distilled water and alconox/EDTA solution. Fluoride levels in unwashed leaves, in washed leaves and in the leachate from the leaves were analysed.

It was found that the percentage difference between the fluoride removed from the unwashed and distilled water washed leaves was very small (4 per cent) and in some cases negligible. Therefore, it appears that distilled water does not significantly wash fluorides from the outer leaf surface. This conclusion was further verified by the fact that the leachate from the distilled water wash contained only 0.3 per cent of the total fluoride in and on the leaf.

By comparison, the alconox solution 'washed' 44 per cent more fluoride from the leaf surface than the distilled water. Studies by *McCune et al (1965)* indicate that alconox solution may wash not only fluoride from the leaves but may leach fluoride from within the leaf and hence the use of alconox solution for washing the surface of leaves should be regarded with caution.

The distilled water washing procedure may be a more reliable indication of the soluble fluorides collected on a leaf surface. The low fluoride level of the leachate and the small difference in foliar fluoride levels of washed and unwashed leaves tends to indicate that transfer of fluoride from the leaf surface to the soil is negligible. Furthermore, under natural conditions, rainfall usually lasts for more than one minute and can occasionally last for up to two hours. The volume of water falling over a square centimetre in two hours can be as high as 114 ml. Therefore with such a large volume, even if most of the fluoride was washed from the outer leaf surfaces, insignificant concentrations of fluoride would reach the soil water.

7.3.3 Decomposition of Vegetation

The objective of this test was to estimate the decomposition rate of vegetation high in fluoride and the resultant movement of fluoride from the leaf litter to the surface soil layers.

A species common to both the Tomago site and the area surrounding the

Kurri Kurri smelter was used in the experiment. The common species is the Ball Honey-myrtle *(Melaleuca nodosa)* and the details are provided in *Appendix 6.8*.

Fresh leaf samples were obtained from areas close to the Kurri Kurri smelter and the Tomago site. Known weights of leaves were placed in separate fly mesh bags on the Tomago site and their decomposition carefully monitored. Half the bags were trampled to simulate animal disturbance which could affect the rate of decomposition. The experiment was commenced on the 2nd April 1980, and it is the intention that leaves will be sampled at 1, 3, 5, 8 and 12 monthly intervals. To date, results have been obtained for the first two sampling periods.

At the commencement of the experiment (T_0) and at the end of the first one (T_1) and three months (T_3) the fresh leaves and litter were analysed for fluoride and weight changes were measured. At the same times, total and water soluble fluoride, as well as organic content in the soils beneath the litter bags were determined.

The results to date show no sign of litter decomposition, in fact, an increase in weight occurred due to soil particles accumulating in the litter bags. With time, the weight loss due to decomposition should exceed the weight gain from the accumulation of soil. At time (T_3) there was a loss of fluoride from the litter signifying that decomposition and/or leaching of fluorides had occurred.

This loss of fluorides from the litter was reflected in the soils. The total fluoride levels in the soils beneath the high-in-fluoride litter increased by 40 to 75 per cent.

The increases in total soil fluoride in the soils beneath the high fluoride litter added to the water soluble fluoride contents. After three months, the water soluble fluoride level stabilised, possibly as a result of the gradual fixation of fluorides. After T_1, the amount of fluorides released into the soil as water soluble fluorides was less than the amount of fluorides fixed in the soil.

This test is still in progress and litter and soils will be analysed at the periods indicated.

7.3.4 The Movement of Fluoride During Bushfires

It is conceivable that fire through vegetated areas close to aluminium smelters may release fluoride to the atmosphere. Studies carried out by *Harwood and Jackson (1975)* showed that during a controlled burn 10 to 20 per cent of plant nutrients (potassium, phosphorus, calcium and magnesium) in a *Eucalyptus regnans* forest in Tasmania were lost from the total fuel as smoke and aerosols.

Consequently the experiment, described in detail in *Appendix 6.8,* was designed to examine the loss or release of fluoride from vegetation grown near an aluminium smelter.

Two plant species, *Melaleuca nodosa* and *Eucalyptus tereticornis,* which are relatively common on the Tomago site and near the Kurri Kurri smelter were used in the study.

The samples were oven dried and ashed in a muffle furnace until smoke had ceased emanating from the furnace. Two ashing temperatures used were 750^{o} and 500^{o} which represent a controlled burn and the lower limit of a controlled burn respectively *(Vines, 1968).* Fluoride analyses were conducted on the fresh leaves, ash, washed ash and wash liquid.

The results indicated that approximately 50 to 70 per cent of the fluoride in the green leaves of both species is released in smoke. Only 30 to 50 per cent of fluoride from the green leaf remains in the ash and, of this, 40 per cent is water soluble.

7.3.5 Transfer Mechanisms from Soils to Groundwater

Three separate studies were conducted to examine the absorption and adsorption of fluoride within two soil profiles from the Tomago Sandbeds. The locations of the two soil profiles are shown on *Figure 6.3* as S16 and S17 respectively.

Study 1 was designed to give an indication of the absorptive capacity of fluoride in each soil layer, however, it does not provide information on the behaviour of a whole profile. In practice, the fluoride solution passing from each layer of the profile will contain other ions such as calcium, magnesium, iron, aluminium and complex salts, as well as fluoride. Interaction of the fluoride with these ions and salts will occur at varying rates and under different conditions. It is possible for fluoride to be precipitated in one layer and totally taken into solution in the following layer due to the changed ionic environment of the filtrate.

Study 2 examined the absorptive capacity of the profile. The filtrate from each horizon was added to the next lower layer to ensure that not only fluoride but all the dissolved salts and ions from the preceding layer were present for reaction in the layer below.

Considering the worst case of 20 ppm F, the experiments indicate that the first horizon absorbs on average 75 per cent of the fluoride, the next horizon absorbs 75 per cent of the remaining fluoride in the soil water and so on. After the water has leached through a typical profile of seven layers the concentration of fluoride in soil water reaching the aquifer will be <0.02 ppm.F over 12 months.

The results using scrubber dust reflected the fact that only 10 per cent of the dust was soluble, consequently only 2 ppm.F would be available for active interaction with the soils. Even if 50 per cent of the fluoride in the dust was absorbed by the soil, only 0.0156 ppm.F would be expected to reach the groundwater after passing through seven soil horizons. This would be negligible when compared with the acceptable level of fluoride in water of 1.0 mg.F/1.

Studies 1 and 2 examined the absorption of fluoride solution in each soil layer. A third study was undertaken to examine the passage of fluoride through the profiles.

Study 3 experiments were designed to assess the time taken for all active sites on soil particles to be occupied by fluoride ions and the effect that continuous dilution has on fluoride absorption by soil.

Details of the techniques and results given in *Appendix 6.8* show that the profiles have the capacity to remove 99.9 per cent of water soluble fluoride leached from the soil surface.

The experiment also showed that at very low fluoride concentrations (<1 ppm.F), fluoride is still absorbed by the soil. This finding is significant since large areas of the Tomago Sandbeds will receive very low concentrations of fluoride emissions.

A 'flow through' experiment showed that using the highest possible surface fluoride concentration of 20 ppm, then after 4 years, leachate entering the aquifer near the smelter site will contain an average fluoride content of 0.6 ppm.

The possibility of this level being reached is very remote. In reality, it is likely that the maximum surface soil water fluoride concentrations per year will be 1.5 ppm. Assuming 1.5 ppm, studies 1 and 2 indicate that approximately 87 per cent of the soluble fluoride will be absorbed by the soil and the concentration of fluoride in the leachate reaching the groundwater will be less than 0.20 ppm which is well below the permissible level of 1 ppm fluoride in drinking water. The continuous flow of water into and out of the aquifer results in a 50 per cent dilution and hence concentrations of fluoride in the leachate will be less than 0.1 ppm.

With time, all the active sites on the soil particles available for absorption may become occupied by fluoride ions. It is difficult to predict when this is likely to occur but is unlikely to occur within the next 100 years.

7.3.6 Conclusion

The studies of the interactions between fluoride, vegetation and the sandy soils containing the aquifers of the Tomago Sandbeds are continuing.

The results obtained to date suggest that insignificant amounts of fluoride are washed from vegetation to the soil by rain water, but that soluble fluorides may move from decomposed leaf litter on the forest floor to the soil below.

Bushfires will mobilise fluoride associated with green leaves. About 50 to 70 per cent of the fluoride content will be released as smoke. Of the amount of fluoride remaining in the ash, some 40 per cent will be soluble.

The studies of the sandy soils of the Tomago Sandbeds indicate that most of the fluoride will be removed in the profile above the aquifer. After many years of operation, leachate reaching the groundwater will contain less than 0.3 ppm F through the action of natural dilution and assuming a worst case of 20 ppm F concentration in the soil water. In reality, levels will be nearer 0.1 ppm F and this, combined with the existing fluoride levels in groundwater of 0.08 ppm, will raise levels to 0.18 ppm F which is considerably less than the 1 ppm F added for dental health benefits.

Design and Operational Safeguards Developed to Minimise Impact

SECTION 8

DESIGN AND OPERATIONAL SAFEGUARDS DEVELOPED TO MINIMISE IMPACT

SUMMARY

The constraints identified in the studies of the existing environment in *Section 6* and the results of the special studies in *Section 7* were taken into account in the control of pollution from the components of the proposal.

This section examines each potential source of pollution in detail and the safeguards developed by the Company to reduce potential emissions, discharges and conflicts to levels which will be acceptable to regulatory authorities and residents. The best available pollution control technology has been incorporated in all aspects of the proposal.

Air pollution control is to be achieved by a fume collection and extraction system on the pots with subsequent treatment to remove gaseous and particulate fluorides and other particulate matter. The fumes from each pot are contained by hooding which fully encloses the pot. Since the pots are centre worked, it is only during the anode changing operation that a portion of the hooding is normally removed. This results in a high collection efficiency and is followed by a dry scrubbing system which removes virtually all fluoride from the fumes. Fluoride will also be removed from the fumes of the anode baking furnace by scrubbing prior to discharge.

Emissions of sulphur dioxide will be controlled so that the resultant ground level concentrations are below threshold values for human health effects. All transfer points in the handling system for the alumina and petroleum coke will be enclosed to prevent dust loss. Dust extraction and collection systems will be incorporated, and all emissions from the plant will meet the requirements of the New South Wales Clean Air Act.

Solid wastes will be disposed of off site in a controlled landfill operation. The location of the site is presently under investigation and will be the subject of a separate Environmental Impact Statement.

Pollution of the Tomago Sandbeds and the Hunter River will be prevented by the controls on all atmospheric emissions and by

collection, testing and treatment of all potentially contaminated water. Site runoff from the roofs and roads will be directed to a storage dam prior to treatment. Domestic waste water will be handled in a package treatment plant. Any process water will be treated prior to discharge and all discharges will meet the standards of the New South Wales Clean Waters Act.

Noise control during construction and operation of the smelter will be achieved by the selection of equipment, attention to plant design and maintenance of mufflers. The smelter will meet the requirements of the New South Wales Noise Control Act.

The technology proposed will protect both the external environment and the working place, and all personnel will be trained in safety procedures.

The visual impact of the development will be minimised by architectural design of buildings and the chosen layout of the smelter which retains a dense vegetation barrier. Additional planting and landscaping will be carried out to provide screening from the remaining viewing points and to improve the aesthetics of the proposal.

A programme of discussions with surrounding landholders interested in selling their properties has been initiated with the objective of extending Company-owned land over a period of time to provide an effective buffer zone.

A monitoring programme for air and water quality, vegetation, wildlife, stock, forage, fruit trees, garden plants and vegetables has been developed to provide data on background pollution levels prior to the start up of the smelter and as a control procedure after the operations have commenced. Company policy will be to undertake development work to improve emission controls and where practical, to implement improvements resulting from Aluminium Pechiney research and development activities around the world.

All aspects of environmental control and management will be co-ordinated by an Environmental Officer to be appointed by the Company.

ATYPICAL CONDITIONS

The safeguards included in the design and proposed operating methods of the smelter incorporate the most advanced technology available and the potential for accidents is very low. Micro-processors are used throughout the plant to regulate production processes and are designed to identify any irregularities should they occur. Systems have been incorporated in every stage of the smelting process to provide backup should atypical operating conditions arise.

The majority of power supply and distribution networks are duplicated to prevent total power loss. In the event of this unlikely occurrence, fume generation in pots will cease and fume within the hooding system will gradually escape and be discharged from the roof vents. Plant emergency power provided from onsite generators will supply lighting and other needs associated with a safe and orderly plant shutdown. An interruption to plant water supply is similarly unlikely due to a duplication of supply sources.

CONTROLS DURING CONSTRUCTION

The construction contractor will be required in the documents of contract to comply with all safeguards detailed in the Environmental Impact Statement and with conditions of approvals. Specified hours of operation will be complied with and any changes will first be approved by the relevant authorities.

Safeguards for the control of runoff will be built prior to construction to contain the activities. Discharges of water from the site will comply with the Clean Waters Act. A water tanker or hoses will be available to combat dust during site preparation, foundation construction and the handling of bulk materials. Waste water handling and disposal will comply with the requirements of the Hunter District Water Board and the State Pollution Control Commission.

Strict attention will be given to the control of construction noise. All noise generating plant and equipment will be properly silenced. Mufflers will be maintained in good condition.

Floodlighting will be shielded and directed away from residences.

The flow of building materials to the site will be regulated where possible and restricted to hours between 7.00 am and 6.00 pm on six days per week, excluding Sundays and public holidays.

8.1 PHILOSOPHY

All potential sources of pollution due to the proposed smelter are to be minimised by the incorporation of safeguards at the design stage and by strict supervision of precautions during operation. A monitoring programme is to be implemented as a measure of the efficiency of the plant safeguards and as a control to ensure that the levels of impact on surrounding areas do not exceed limits predicted in this Statement and required by pollution control authorities.

The Company's basic philosophy for the proposal is to combat sources of air, water and noise pollution at the source and this section of the Statement details the safeguards that have been developed for each component of the project. Pechiney's overseas experience indicates that the safeguards proposed will operate effectively and that contingency situations leading to large releases of pollution and impacts will not occur. From time to time various atypical conditions may modify the normal operating situations and the effect of these have been considered.

This section first describes the controls proposed for atmospheric emissions, atypical conditions and the conservation of electrical energy during operations. The safeguards for materials handling on the site, solid waste disposal, water pollution and operational noise controls are then presented. The proposed monitoring programme is detailed. The precautions to be taken during the construction stage are outlined.

Details are provided of the architectural and landscaping aspects to be taken into account when the final design stage for the proposal is reached.

The proposals to develop a buffer zone around the smelter, ensure worker health and safety, and manage all of the environmental aspects of the project are presented.

8.2 ATMOSPHERIC EMISSIONS

8.2.1 Types of Emissions

Atmospheric emissions from primary aluminium smelters include fluorides, particulates, hydrocarbons, sulphur oxides and carbon oxides. Of these, fluorides warrant particular attention because of their potential effects at low concentrations. Methods of fluoride control have been developed by the aluminium industry and their effectiveness has been demonstrated in source tests conducted by the *US Environmental Protection Agency (1979)* Experience has also shown that when fluorides are well controlled, the control of particulates and hydrocarbons is also satisfactory.

The information available on the behaviour of carbon monoxide indicates that a high proportion is converted to carbon dioxide as the gaseous emissions pass through the collection and treatment systems, and the overall emission levels are not a cause of concern. Emissions of sulphur dioxide from smelting are low compared with sources such as coal burning power stations and methods of treatment are not cost-effective. The use of tall stacks for dispersion is still the accepted method for control.

The following analyses concentrate on the emission, collection and control of fluorides, although relevant data on other emissions are included where appropriate.

8.2.2 Sources of Emissions

The sources and quantities of air pollutants at various stages of the smelter operation are given on the flowsheet in *Figure 8.1*. The principal emission sources are the reduction cells and the anode baking furnace. The cast house is a minor contributor. The reduction cells are hooded to allow capture and treatment of the bulk of the primary emissions. Secondary emissions are those that escape collection in the potroom and are exhausted through the roof ventilators. Hooding efficiency is thus a measure of the proportion of total emissions collected in the primary treatment plant and the level of efficiency is given in *Section 8.5*.

8.3 DETAILS OF PLANT DESIGN AND OPERATION TO CONTROL EMISSIONS

8.3.1 Pot Emissions

Composition

Pot emissions comprise both gases and particulates. Gaseous components were mentioned previously. Particulates originate from the volatilisation of the cryolite bath and subsequent condensation, from mechanical entrainment of bath material by the gas evolution from the cell surface, and from dusting of raw materials during handling. Particulates include alumina, cryolite, aluminium fluoride, sodium sulphate and carbon.

The following nomenclature is used in describing the pollution control technology:-

Fg - gaseous fluorides
Fp - particulate fluorides
Ft - total fluorides.

Emission Rates

Various researchers have investigated the effect of bath parameters and pot operations on emission rates *(US Environmental Protection Agency, 1979, and references therein)*. The relationships between variable factors such as temperature, bath ratio and alumina content and emission rates are difficult to quantify, and only the more easily observable effects in relation to pot operations have been studied.

Anode effects occur when bath alumina concentration in solution falls below approximately 1.5 to 2.0 per cent. A film of carbon-tetrafluoride collects beneath the anode, raises electrical resistance and increases the cell voltage and power requirements. Fluoride emission rates increase significantly, though exact quantification is difficult. The pots are normally fully hooded during these periods to allow a high collection efficiency.

During the anode changing operation, emission rates increase due to the removal of a section of the hooding and the brief exposure of the liquid bath to the atmosphere. A lesser increase is observed during, and for a period directly following the addition of fluoride compounds to the bath.

The tapping operation has very little effect on fluoride emissions, but may influence overall hooding efficiency.

While pot exhaust rates affect hooding efficiency, no precise relationship has been determined between exhaust rates and emission quantities.

8.3.2 Pot Design and Operation

The Company proposes to minimise fluoride emissions by minimising bath emission rates, by maintenance of high hooding efficiency and by effective treatment of primary emissions.

Reduction of Emission Rates

The careful selection of pot type and strict operational controls will ensure high cell efficiencies and aid significantly in reduction of overall emission rates.

Centre worked prebaked (CWPB) pots have been chosen to allow a high level of continuous control over bath parameters and operational variables. A pot microprocessor is to be used to check the alumina content of the electrolyte by monitoring various electrical parameters. As additions of alumina will be regulated without any manual intervention, the occurrence of anode effects will be greatly reduced. This safeguard works to detect and correct pot abnormalities by instituting an automatic anode quenching sequence. Connection to a central computer will provide a daily printout of performance data. The microprocessor will also maintain optimum anode-cathode distance in relation to pot operational status.

As individual microprocessor units can be rapidly replaced in case of malfunction, the cell conditions will be continuously maintained at optimum levels.

Hooding Efficiency

Maintenance of high hooding efficiency is a function of pot design and operation.

The proposed CWPB pots incorporate several design features to maximise fume collection. The most important of these is the ability to add alumina to the pot from the centre hopper without removing any of the hooding. Also, the pot hood roof and hood ends are integrated to the superstructure to prevent leakage. Constant cross-section anode stems used in the proposed pots allow more efficient sealing of the movable stem.

Eighteen removable aluminium panels along each side of the pot are to be well supported and sealed by the hood roof, hood ends and shell of the pot. The panels will be ribbed to reduce distortion during service. Continual inspection and replacement will ensure effective sealing is maintained.

Anode changing will necessitate removal of only two panels. This represents about 10 per cent of the total panel area. The highly mechanised anode and crust cranes to be used for changing anodes will minimise cycle time and reduce the period of panel removal.

Tapping will be through a small door in the fixed end of the pots and panel removal will not be required.

Pot fumes will be removed at a rate of 2.3 m^3/s at 80^oC, which is sufficient to maintain a negative pressure on the pot and prevent leakage.

8.3.3 Treatment of Pot Emissions by Dry Scrubbing

The fumes emitted by the reduction pots and collected by the hoods will be treated by an effective dry scrubbing process. Gaseous fluorides will be chemically absorbed onto alumina and then collected along with existing particulate fluorides by bag filters. The cleaned fumes will be discharged via a stack and the enriched alumina fed to the reduction cells. The system of dry scrubbing favoured by the Company at its other smelters is shown in *Figure 8.2*. It should be noted that some minor changes may be incorporated in the units to be installed at the Tomago smelter but the overall concept will remain and the collection and treatment of the fumes will be similarly efficient.

The fumes will be carried to the dry scrubbing treatment station by a collecting duct system which gathers the output of 120 pots. Four such stations will be provided between the potrooms as shown in *Figure 5.5*.

Each station will contain nine modular units, each comprising a venturi reactor connected to eight filter blocks. Each filter block contains twelve pleated fabric pocket bags suspended from a horizontal framework.

Fumes are admitted at the base of the vertical venturi reactor. Fresh alumina is fed just above the venturi-reactor throat and recirculated alumina slightly lower. Fresh alumina is introduced from a silo and is equally distributed into each of the venturi reactors. Alumina will be recirculated 5 to 10 times so as to reach a concentration in the fumes of 50 to 250 g/m^3. This results in a rapid and even alumina precoat of the filter fabric and an efficiency of submicronic dust collection close to 100 per cent. Enriched alumina retained on the filter fabric will be periodically and automatically removed to a hopper by a reverse flow of low pressure pulsed air, or mechanical bag shakers. It may then be recirculated from the bottom of the hopper, or drawn from an overflow for feed to the potline. Alumina is conveyed between the various storages by airslides.

Hydrogen fluoride is absorbed onto alumina as two bimolecular layers *(Baverez and De Marco, 1980)*. The maximum amount of hydrogen fluoride which can be absorbed at near 100 per cent efficiency by a specific surface of 1 m^2/g is 0.055 per cent w/w. To maintain this efficiency requires a minimum specific surface for alumina of 18.2 m^2/g. Experience has shown that contamination of alumina by submicronic dust raises this minimum to between 20 and 25 m^2/g. The alumina feed proposed for this smelter will have an average specific surface of 40 m^2/g. All Australian alumina has this property.

The efficiency of the absorption process varies with:-

i. The rate of gas diffusion, or fume turbulence.
ii. The contact time between alumina and fumes.
iii. The mass of fresh alumina injected.
iv. The specific surface of the alumina.
v. The average free space between alumina particles.

The proposed dry scrubber is designed to maximise the first four variables, and minimise the fifth. Further details on control efficiencies are given in *Section 8.5*.

Velocity at the venturi reactor throat is such that the alumina is uniformly distributed and carried upwards by the fumes. The induced turbulence at the throat is transmitted throughout the reactor, enhancing contact between the hydrogen fluoride and the alumina. Residence time in the reactor is approximately 1 s.

Typically, each fabric filter bag will have a surface area of 15.5 m^2, resulting in a filtering surface of 186 m^2 per block, and 1485 m^2 per filter. Total installed filter area will thus be 53,460 m^2. Flow velocity through the filters will be 2.0 cm/s.

Filter blocks can be inspected for damage through a hatch. If necessary, a single block can be bypassed, removed by a rail crane and replaced with a ready block in less than 20 minutes.

In the case of an interruption to fresh alumina supply, a scrubbing efficiency of 99.5 per cent will be maintained for at least 4 h by alumina recirculating within the dry scrubber.

8.3.4 Anode Baking Furnace Emissions

Baking furnace emissions originate from the following three sources.

i. The chemical composition of the anode raw materials give rise to solid products of combustion (smoke) and burned and unburned hydrocarbons. Oxides of sulphur are derived from sulphur in the pitch.

ii. Anode butt recycling can lead to a proportion of the bath material, which is high in fluorides, also being recycled. The proposal to clean the butts will remove the bath material and lead to lower rates of fluoride evolution.

iii. The use of coal or oil to provide furnace heating can lead to higher levels of sulphur dioxide emissions. The availability of natural gas for the Tomago project will eliminate this potential source.

8.3.5 Anode Baking Furnace Design and Operation

The anode baking furnace will be operated at a negative draught, preventing fume release into the working environment. Firing will be fuelled by sulphur-free natural gas. Volatiles evolved during anode baking will be utilised as part of the fuel supply to maximise energy efficiency and reduce emission levels. Operating temperature will be high, to provide maximum influe combustion of residual volatiles.

Recycled anode butts will be thoroughly cleaned by a two stage process before reuse. Initially, vibrating tables will be used to remove the bulk of the adherent bath and scrap. Any remaining surface contamination will be removed by shot blasting.

The collected fumes will be treated by dry scrubbing before discharge.

8.3.6 Anode Baking Furnace Fume Dry Scrubbing

To combat pollution from the baking furnace, the Company proposes to install an alumina dry scrubbing process to remove gaseous fluorides and tars. The principle of operation is similar to that described for pot fume scrubbing, with any tars and other carbon compounds being transferred to the reduction pots with the enriched alumina.
The following description of the process relates to pilot systems developed by Aluminium Pechiney. Minor details may be changed in the final design stages without affecting overall scrubbing efficiencies.

Fumes will first be cooled to 70°C by water sprays in a vertical cooling tower. To avoid the risk of condensation, and resultant high corrosion there is a sophisticated system of monitoring to control the water added to give a constant temperature at the exit. The tower is also insulated to further reduce the risk of condensation at the base. The amount of water used for cooling will vary with the temperature of the incoming gas but is expected to be about 6 m^3/h.

Fresh alumina will be contacted with the fume in a venturi reactor previously detailed. Alumina will be used on a once through basis. Approximately 2 per cent of total plant alumina feed will be used in this way.

Enriched alumina and dust will be collected on bag filters. The bake ovens will be provided with a filter station, comprising two filter blocks of twelve bags each. Surface area per filter block is 1485 m^2. Total fume exhaust rate will be 176,000 m^3/h at 70°C. Air velocity through the filter will be 1.7 cm/s.

The recycling of tars and carbon compounds with the enriched alumina may cause technical problems through a lowering of current efficiency in the pots. If so, the enriched alumina will be calcined in a closed loop, flash calciner, fired with natural gas to a temperature of between 700°C and 800°C. Tars and carbon dust would be burned at this temperature but the release of fluoride from the alumina would be minimised. Control over the temperature would be maintained by high excess air levels. Alumina would be separated from the exhaust gases by a cyclone and the gases rerouted to the dry scrubbing unit to capture any fluoride evolved during calcination. There will be no significant change in emission levels if a calciner is required.

8.3.7 Cast House Operations

Cast house furnaces will be fired with natural gas, eliminating sulphur oxide emissions associated with use of other fuels.

Degassing and fluxing will be performed by Spinning Nozzle Inert Flotation (SNIF) units or an equivalent system. The SNIF process involves injecting nitrogen, argon and/or chlorine into the liquid metal by means of graphite turbines which agitate the liquid and form fine gas bubbles.

Overall gas consumption is minimised and negligible gaseous pollution results.

8.3.8 Green Anode Shop

Liquid pitch will be used in anode manufacture to reduce dust loadings. All other dust sources will be provided with collection devices comprising air suction and bag filters. Recovered dust will be recycled.

Pitch fumes will be collected in an independent circuit and fixed by the injection of coke. The loaded coke particles will be stopped by filters and recycled to the anode manufacturing process.

8.4 ALTERNATIVE TECHNOLOGIES FOR CONTROL OF EMISSIONS

8.4.1 General

Section 8.3 describes the various processes developed by Aluminium Pechiney for emission control, and considered to be best suited to the constraints and conditions applying to the Tomago proposal.

Many different options were investigated during the planning process in reaching these conclusions. The following sections indicate the alternative technologies which were considered, but rejected for the reasons outlined.

8.4.2 Treatment of Primary Potline Emissions

The dry process for scrubbing primary potline emissions has been known for approximately ten years. The method's disadvantages lie in its recycling of minor impurities to the pots, and its ineffectiveness for reducing sulphur dioxide emissions.

Recycled impurities, especially phosphorus, will lower cell current efficiency. Carbon and iron may have similar effects. Control of these potential contaminants has to be maintained by tight specifications of feed alumina and strict attention to anode quality. Sulphur emissions are limited by use of low sulphur cokes.

The wet scrubbing process has lost favour because of its high cost, and also due to the production of a liquid effluent requiring subsequent treatment and disposal. Whereas the dry process uses alumina, the wet process uses large volumes of water in the form of very fine droplets. The collection of submicronic particulates requires a large pressure drop with associated high initial capital outlay on equipment and continuing high energy consumption rates. Economically, this process is less attractive than dry scrubbing.

A wet scrubber also produces a fluoride-rich liquor which must be either disposed of or treated and recycled. Disposal directly to the sea is possible in some cases. The Tomago site has no access to the sea and discharge to the Hunter River would contravene the New South Wales Clean Waters Act Regulations.

Treatment of the liquor with lime to precipitate fluoride would result in a dry mass of calcium fluoride of approximately 11,000 t/y. Without dewatering, a sludge mass of approximately 500,000 t would require disposal. Treatment of the liquor with sodium aluminate to recover fluoride in the form of cryolite is no longer considered viable. Before cryolite can be reused in the pots, it must be calcined. This process is energy expensive, gives rise to the release of fluoridated fumes and modern cell technology cannot use the quantity of cryolite produced.

8.4.3 Secondary Potline Emissions Treatment

Aluminium Pechiney has been in the forefront of development of the CWPB pot which eliminates the need to remove the hooding panels to add alumina to the pot. In side-worked pots, the removal of the panels for this purpose can reduce collection of the primary emissions to as low as 80 per cent, resulting in high levels of fluoride losses from the potrooms. The development of CWPB pots, which now attain a primary collection efficiency of 97.5 per cent, had as a basic aim the elimination of the need for scrubbing roof emissions. Any requirement to scrub roof emissions would render the Company's proposal uneconomic because of the high gas volume and the low fluoride concentration to be treated. In the USA, the last three smelters which used CWPB pots obtained the necessary operating permits without roof scrubbing.

Scrubbing of roof emissions is practical only using a wet method as the volumes of air are too great to be treated in a dry process. The available options are salt water scrubbing with disposal to the sea, or fresh water scrubbing with subsequent fluoride precipitation.

The initial capital investment involved in the collection and treatment of the estimated 4800 m^3/s of secondary emissions per potline is approximately $40 million *(United Nations Environmental Programme, May 1977. Aluminium Pechiney calculations 1980)*. This includes provision for liquid effluent treatment. The additional electricity requirement is 300 kW.h/t aluminium *(Herbst and Grant, 1977)*. Neither outlay can be justified for the Tomago proposal.

The use of 'spray curtains' *(Callaioline et al, 1970)* in the roof vents through which the secondary emissions can escape by means of natural draught is also considered unsuitable. Scrubbing efficiency is poor (30 to 50 per cent), high water flow rates are required, and natural draught flow rates decrease. The latter effect increases working place temperature and pollutant levels.

8.4.4 Baking Furnace Emissions

Several alternative methods for treating the baking furnace fumes were considered as options prior to the choice of dry scrubbing using alumina.

The problem of testing the baking furnace emissions relates mainly to tar evolution. The open furnace chosen allows tar from the pitch coking to enter the heating flue horizontally, be removed by combustion, and thus serve as a fuel for the furnace. Gaseous fluoride and sulphur oxide emissions are similar for the open and closed furnace *(US Environmental Protection Agency, 1979)*.

Baking furnace emissions can be treated in several ways to remove either tars or fluorides or both.

One technique is wet scrubbing using either salt or fresh water as indicated in *Section 8.4.2*. This alternative is not favoured for Tomago because of the difficulty of treating the liquid effluent before disposal to the Hunter River. Treatment by evaporation is not possible because of the negative net evaporation in the area. The potential for groundwater pollution of the Tomago Sandbeds was also a concern.

An alternative dry process relying on coke rather than alumina *(Berton et al, 1978)* was considered. The coke adsorbs the gaseous tar and is subsequently used for anode manufacture. The cleaning efficiency reaches 99 per cent, but as no fluoride or sulphur dioxide removal takes place, subsequent wet scrubbing or dry scrubbing with alumina would be required. A proportion of the sulphur dioxide would be removed in the former case if lime additions were made *(Slack and Hollinden, and Pfieffer)*. Calcium fluoride disposal problems would again arise.

Wet electrostatic precipitators have been demonstrated to be efficient in collecting tars from the open baking furnace, however, they are not as cost-effective as the preferred dry scrubbing process.

8.5 AIR POLLUTION CONTROL EFFICIENCIES

8.5.1 Source Emission Levels

The maximum cell emissions under the normal range of operating conditions at Tomago will be as follows:-

Gaseous fluorides (Fg)	-	18 kg/t of aluminium
Particulate fluorides (Fp)	-	10 kg/t of aluminium
Total fluorides (Ft)	-	28 kg/t of aluminium
Total particulates (including Fp)	-	40 kg/t of aluminium
Sulphur dioxide	-	24 kg/t of aluminium.

These quantities allow for increased source levels of fluorides due to the use of enriched alumina from the potline and baking furnace dry scrubbers. The sulphur dioxide emission level is based on 3 per cent sulphur content in petroleum coke.

Anode baking furnace evolution rates will be:-

Gaseous fluorides (Fg)	-	0.25 kg/t of aluminium
Particulate fluorides (Fp)	-	Nil
Total fluorides	-	0.25 kg/t of aluminium
Tar vapour	-	0.6 kg/t of aluminium
Carbon particulates	-	1.2 kg/t of aluminium
Sulphur dioxide	-	0.8 kg/t of aluminium.

Maximum tar vapour evolution in the green anode shop will be 0.7 kg/t aluminium. Dust emission rates cannot be estimated, but will be minimised in all cases, and dust collected where possible.

8.5.2 Efficiency of Hooding and Dry Scrubbing

Potline emission levels are based on a hooding efficiency (or primary collection efficiency) of 97.5 per cent, and a dry scrubbing efficiency of 99.9 per cent.

The figure of 97.5 per cent for hooding efficiency has been determined from both measurements and by calculation. Measurements have been made by Pechiney on four pots operating in a completely enclosed building, allowing collection and monitoring of all emissions. Calculations were based on *US Environmental Protection Agency* data for all emission rates under various operational conditions. Details of both methods are included in *Appendix 16*.

A dry scrubbing system similar to the one proposed at Tomago is operating on the anode baking furnace emissions at the Eastalco smelter in Maryland, U.S.A. Efficiencies achieved in the recovery of fluorides have exceeded those assumed in this Impact Statement, which are expected to be as follows:

Fluorides	92 per cent
Tar vapour	90 per cent
Carbon particulates	99.9 per cent.

8.5.3 Atmospheric Emission Levels

On the basis of these efficiencies, total fluoride emissions are expected to be below 0.76 kg/t of aluminium on an average annual assessment. Levels of emissions from the various sources are summarised in *Table 8.1*. A more conservative emission level for fluorides of 1 kg/t of aluminium was adopted for dispersion modelling and impact assessment purposes.

TABLE 8.1

ANNUAL AVERAGE ATMOSPHERIC EMISSION LEVELS
EXPECTED FROM THE TOMAGO SMELTER
(expressed in kg/t of aluminium)

Emission Source	Gaseous Fluorides Fg	Particulate Fluorides Fp	Fluoride Ft	Particulates excluding Fp	Sulphur dioxide SO_2	Tar Vapour
Potline Buildings (roof vents)	0.45	0.25	0.70	0.75	0.6	
Dry Process Stacks	0.02	0.02	0.04	0.15	23.4	
Baking Furnace	0.02	0	0.02	0	0.8	0.06
Total	0.49	0.27	0.76	0.9	24.8	0.06

The predicted emission levels for fluoride are below those normally specified by overseas agencies for mass emission limits. Some limits are listed in *Table 8.2*. The concentration of fluoride in any gaseous emission will not exceed the level of 0.02 g/m^3 specified in the New South Wales Clean Air Act. Other limits specified in the Act relating to visible emissions, sulphur dioxide, chlorine and solid particles will also be met. The treated gases will be discharged to atmosphere through 60 m stacks at each of the dry scrubbing units. The exact stack height will be determined by the State Pollution Control Commission to provide efficient dispersion of sulphur dioxide. As a result, average ground level concentrations of this gas will be well below limits at which any impact may arise.

TABLE 8.2

MASS EMISSION LIMITS

Country		Limit (kg.F/t.Al)
U.S. Federal	Potline	0.95
	Anode Baking Furnace	0.05
	Total	1.00*
Federal Republic of Germany	Stack	1.0
	Roof	0.8
	Total	1.8
Norway, Spain	Total	1.0
British Columbia, Canada	Total	1.5

* 1.25 kg.F/t.Al never to be exceeded has recently been adopted.

8.6 ATYPICAL CONDITIONS

8.6.1 Introduction

Table 8.1 defines annual average atmospheric emission levels from the plant. At times, these levels may be exceeded as a result of atypical operating conditions. The following discussion describes possible variations from normal operation and the extent to which they may modify the conclusions in the preceding sections.

8.6.2 Pot Startup

Pots will come on line at a rate not exceeding ten per week, and never more than four per day.

In all pot startups, an initial two day cathode heating process is undertaken, whereby resistance heating is provided by short-circuiting the anode and cathode. Minor amounts of tar fume are evolved at this stage.

In the case of the first two pots to be brought into production, bath materials will be melted in situ. Fluoride evolution rates will be high as a result of the elevated temperature (around 1000^{o}C) and prolonged anode effects.

Subsequent pots will be provided with molten bath material from cells already on line. Addition of the molten bath results in an anode effect of approximately 15 minutes duration, which must be manually quenched. At this stage, it is not possible to operate with the cell panels in position and the hooding efficiency will be reduced.

Pot operations require approximately seven days to stabilise. During this period, temperatures remain elevated and bath emission rates are correspondingly increased. Stainless steel panels, which are better able than the normal aluminium panels to withstand the high bath temperature, will be used to ensure high hooding efficiencies are maintained.

Scrubber efficiency during startup will be the same as during normal operations. Alumina additional to that required by the reduced number of pots will be circulated to maximise fume/alumina contact.

Table 8.3 illustrates the emission levels expected during pot startup. The results presented have been derived from actual operating data collected at Aluminium Pechiney's smelter at St. Jean de Maurienne in France.

On average, 1½ pots will be started per day. Assuming, however, a worst case situation in which 2 pots are started daily for six consecutive days, the increased emissions for assessment purposes will be equivalent to 100 pots operating normally. This calculation is as follows

$$\text{Equivalent normal pots} = \frac{2 \times (40.04+2.04+1.83+1.73+1.63+1.53)}{0.98^{*}}$$

$$= 100$$

(*0.98 kg/t Al : Fluoride emission level ex pots used for impact assessment. Additional 0.02 kg/t Al ex baking furnace brings overall plant total to 1 kg.F/t Al).

TABLE 8.3

EMISSION LEVELS DURING POT STARTUP

Time	Pot Status	Bath Emission Rate (kg/tAl) Ft.	Collection Efficiency %	Emissions (kg/tAl)		
				Dry Process Stack	Roof Vent	Total
Day 1	Cathode heating	0				
Day 2	Cathode heating	0				
Day 3	Molten Bath addition	80	50	0.04	40	40.04
Day 4)		40	95	0.04	2	2.04
Day 5)		36	95	0.03	1.8	1.83
Day 6)	Pot	34	95	0.03	1.7	1.73
Day 7)	Stabilising	32	95	0.03	1.6	1.63
Day 8)		30	95	0.03	1.53	1.53
Day 9)		28	97.5	0.04	0.7	0.74

A total of 480 pots is to be commissioned in the proposed plant. Hence the ten week period spanning the startup of the last 100 pots will be significant in terms of overall plant emissions.

The majority of pots already online will be operating at emission levels considerably less than 0.98 kg.F/tAl. Therefore, the overall plant emissions will not exceed the amount of 1 kg F/t Al upon which the assessments of impact in this Statement are based, as demonstrated below.

Pots	1 - 360	360 @ 0.74 kg.F/tAl
Pots	361 - 468	108 @ 0.98 kg.F/tAl
Pots	469 - 480	equivalent to 100 @ 0.98 kg.F/tAl
Ring Furnace		480 @ 0.02 kg.F/tAl

Hence overall weighted average emission rate

$$= \frac{(360 \times 0.74) + (108 \times 0.98) + (100 \times 0.98) + (480 \times 0.02)}{480}$$

= 1 kg.F/tAl.

8.6.3 Pot Operational Irregularities

Hooding efficiencies and long term emission levels quoted previously take into account the difficulties which may be encountered in normal pot operations. The most significant of these which affect emission levels are indicated below.

Anode Failure

Approximately 0.1 per cent of anodes fail in service and completely or partially fall into the bath. Removal is facilitated by a special grab fitted to the pot tending machine. The operation requires the removal of two panels for a period of up to 10 minutes.

Alumina Feed Problems

Alumina may be over or under fed for a variety of reasons. Microprocessor failure may result in either. Although microprocessor interchange is very rapid, the interruption to steady control can cause either high bath temperatures due to excess alumina, or anode effects due to a lack of alumina. In both cases, fume evolution rates increase.

Alumina shortage can result from failure of the central hopper feeding system. Spare hoppers are provided for this reason and changeover is achieved in approximately 5 minutes. During this period, hooding efficiency is reduced as the hopper forms an integral part of the hooding system.

The Company is very experienced in handling these irregularities and in minimising the length of time producing higher than normal emissions.

8.6.4 Equipment Failure

Dry Scrubbers

Excess scrubber capacity is provided for both the potlines and the baking furnace.

Each potline scrubbing station comprises nine separate fan/venturi/filter units. Only eight units are required to process the primary emissions, leaving one unit on standby. The bake oven station consists of two fan/venturi/filter units provided with an additional spare fan on standby. Each venturi is connected to eight filter blocks, any one of which may be bypassed, removed and replaced with a ready block in less than 20 minutes.

In the case of an interruption to the fresh alumina supply, the scrubbing efficiency of 99.5 per cent will be maintained for at least 4 h by the recirculating alumina within the potline dry scrubbers. No recirculating facility is provided for the anode baking furnace scrubber, with the result that an interruption to alumina feed will cause discharge of untreated fume to atmosphere. Such an occurrence will be very infrequent. Aluminium Pechiney has experienced no problems in scale formation in smelters operated overseas. However, if this problem develops, the affected dry scrubber unit could be shut down for the maintenance of the nozzles which feed fresh alumina into the dry scrubber venturis.

After considerable investigation, the US Environmental Protection Agency has set a never to be exceeded figure for total fluoride of 1.25 kg/t.Al relative to a long-term average performance of 1.00 kg/t.Al. Tomago Aluminium Company Pty. Limited expects that, with the aim of achieving a long-term average emission of 0.76 kg/t.Al, 1.00 kg/t.Al will be a realistic, never to be exceeded, figure for the Tomago smelter.

8.6.5 Services Failure

Power

A total plant power failure is most unlikely as the supply is to be evenly divided between two separate sources, namely Liddell and Eraring Power Stations.

However, in the case of total power loss, electrolysis and hence fume generation in the pots will virtually cease. Fume within the hooding system, and that additionally generated by the bath temperature, will gradually escape from the pots and be discharged from the potroom roof vents. Plant emergency power will be provided by two onsite generators. It will be sufficient only to provide lighting and other needs associated with a safe and orderly plant shutdown.

An interruption to supply for a period of 20 minutes or less will result in negligible additional emissions on startup. Following a more lengthy power cut, major anode effects will occur on startup. These will not be cured by automatic quenching, but will require manual poling. Fume evolution rates increase and collection efficiency decreases during this period.

The majority of power supply and distribution networks are duplicated. Both pots and pollution control equipment can be completely supplied by either source, providing full backup in the case of supply difficulties.

Water

An interruption to plant water supply is similarly unlikely due to a duplication of supply sources. The major plant process water consumers do not use or need water for any pollution abatement processes, with the exception of the anode furnace fume cooling tower, which consumes very minor amounts of water. On-site storage of water will provide any necessary backup.

Compressed Air

Duplicate compressors are provided to maintain continuity of supply. Pot tending machines are provided with individual integral units to allow uninterrupted pot maintenance.

8.6.6 Raw Material Supply Difficulties

All raw materials will be stocked in sufficient quantities either on site or at the port facilities to prevent any supply deficiencies under any circumstances which can be reasonably anticipated. No increase in emissions is expected to arise as the result of any raw material shortages.

8.7 POWER CONSERVATION

8.7.1 Design and Operational Provisions

Smelter profitability depends on careful energy management and a basic design that incorporates the latest pot technology. To achieve the highest practical energy efficiency it is necessary to minimise voltage drop across the pot and maximise current efficiency and thermal stability in the cell.

Voltage drop across the pot is dependent on the alumina concentration in the bath and passes through a minimum at an alumina content of from 2 to 4 per cent which varies with the acidity of the bath. Careful monitoring of the alumina ratio in the bath and maintenance at an optimum pre set ratio will ensure significant savings in electrical energy consumption. Optimisation of busbar design will also minimise energy losses.

Current efficiency will be maximised by minimising the quantity of liquid aluminium that is reoxidised by coming in close proximity to the anodes. In order to maintain high thermal stability in the cell a 'pad' equivalent to about one week's production of liquid metal will be maintained at the bottom of the cell to act as a liquid cathode. Magnetic fields created by current flow through the busbars and the cell itself generate electromagnetic (Laplace) forces which cause the metal surface to be unstable. Careful design of the aluminium busbars and their layout will minimise magnetic effects that reduce current efficiency. Pechiney research has led to busbar arrangements that have reduced the vertical magnetic fields in a pot by a factor of 6 to 7 with important energy savings.

The Pechiney design technology to be used in the Tomago smelter will ensure that the smelter is capable of operating at an energy efficiency comparable to any in the world. The key to achieving high energy efficiency in potline operation is the use of the microprocessor fitted to each pot that measures and controls pot resistance and voltage and alumina content in the bath and regulates these parameters to maintain the pot at optimum current efficiency.

Losses in the conversion from AC to DC current will be minimised using silicon rectifiers of the latest design and increasing the number of cells in the potline. The substation conversion factor at the Tomago smelter will be approximately 98 per cent.

Natural gas consumption in the anode baking furnace will be minimised by a furnace design in which volatiles emitted during baking are drawn into the combustion section where they contribute to the furnace heat requirements. Natural gas consumption is to be further minimised by using a sophisticated burner control system. The burners are controlled to match a pre set temperature programme designed to give optimum fuel usage. Heater gases are recirculated within the furnace to preheat anodes in the entry section of the furnace.

8.7.2 Alternative Technology

Smelter technology to be used at Tomago is the culmination of 90 years of refinement of the Hall-Heroult process. This process remains the only commercial process currently available for the large scale production of aluminium from alumina.

A process involving the conversion of alumina to aluminium chloride which is then electrolysed to yield aluminium and chlorine is still at the pilot plant stage. Although this is claimed to offer prospects for a reduction in electric power consumption significant operational problems have to be overcome and it is not viable at present.

8.8 MATERIALS HANDLING SAFEGUARDS

Alumina, petroleum coke and pitch will be delivered to the smelter in fully enclosed road transporters.

Alumina and petroleum coke will be transferred to storage silos by means of gravity discharge from the trucks through a flexible coupling to an enclosed below-ground hopper, and thence via airslide and bucket elevator to the silo. At all times the materials will be fully enclosed, preventing loss or spillage. The hopper will be maintained at negative pressure by withdrawing dust laden air through bag filters. The filter catch is to be recycled.

Liquid pitch will be pumped into a heated storage tank. Transfer hoses will be regularly inspected to prevent leakage occurring.

All subsequent alumina, coke and pitch handling will employ fully enclosed, spillage free systems.

New or used anode assemblies will be transported between potlines and the anode plant by special hooded trailers, preventing spillage and dust generation. The trailers will be regularly cleaned and the reclaimed bath materials recycled.

Liquid aluminium will be transferred to the cast house in special transport ladles, designed to prevent spillage. Solid product will generate no wastes in either handling or storage.

Spent cathode material will not normally be stored on site (*Section 8.9.2)*. Movement of this material and all other solid wastes through and from the site will be in fully enclosed vehicles.

In the unlikely event of any material spillages, the Company will undertake immediate cleanup action, in addition to the normal continuous programme of mechanical sweeping of roads and process areas.

8.9 SOLID WASTE DISPOSAL

8.9.1 Waste Generation

Table 8.4 lists the solid and non-aqueous liquid wastes generated on site.

Spent cathodes are the major solid waste. With an average life of 48 months, 120 pots will ultimately be rebuilt annually.

During the process the carbon cathode blocks and part of the thermal insulation layer become inpregnated with fluoride, sodium, iron and cyano-complexes. Replacement is necessary when the cathode swells and splits and allows ingress of liquid aluminium.

The degree of impregnation varies from cell to cell, depending on

TABLE 8.4

SOLID AND NON-AQUEOUS LIQUID
WASTE GENERATION

Source	Type	Description	Quantity	Disposal
Delining shop	Spent cathodes	Mixed size fraction, various solid components (see *Table 8.5)*	8944 t/y	Offsite controlled landfill
Bake oven	Used refractories	Spalled bricks, some sodium and fluoride adsorption	2300 t/y	
	Pitcrane bag filter dust	Fine coke powder	500 t/y	
Potline	Failed anodes	Solid anode pieces with adherent bath	300 t/y	
Green anode shop	Coke losses	Fine coke granules and powder	440 t/y	
Rodding shop	Spent anode waste	Carbon scraps	1110 t/y	
	Spent shot	Cast iron pellets	150 t/y	
	Refractories	Spalled bricks	70 t/y	
Ladle cleaning shop	Refractories	Spalled bricks	70 t/y	
Cast house	Refractories	Spalled bricks	170 t/y	
Plant sweeping	Spilled material	Mixture of coke, bath Carbon and other materials	800 t/y	
Dross Treatment shop	Fluxing slags	Solid metal chlorides	3100 t/y	Solid for regeneration
Miscellaneous	Casting lubricant	Soluble oil (liquid)	75 l/y	Removal by contractor
	Packaging and domestic wastes, office wastes	Packaging materials, paper, putrescible wastes etc.	350 t/y	Offsite landfill disposal by contractor
	Waste oil	Spent oils from mobile machinery and equipment (liquid)	100,000 l/y	Removal by contractor

operating conditions and cell life. *Table 8.5* lists the breakdown of the spent cathode material into its components and the quantity of contaminants present.

TABLE 8.5

SPENT CATHODE ANALYSIS

SPENT CATHODE COMPONENTS		
Description	Quantity	
* Cast Cathode Blocks	3608 t/y	
Carbon Slabs	388 t/y	
Lining Paste	733 t/y	
Alumina	132 t/y	
Refractories	2043 t/y	
Impregnation reaction product	1040 t/y	
SPENT CATHODE ANALYSIS - CONTAMINANTS (weight per cent)		
Description	Average	Maximum
Fluoride (asF^-)	10	15
Sodium	12	18
Calcium	3.6	5
Aluminium	2.6	3
Iron	0.2	0.3
Sulphur	0.2	0.3
Cyanide (as CN^-)	100 ppm	400 ppm

* Cathode blocks (1920 t/y), cathode bars (1320 t/y), cast iron(368 t/y)

Used refractories account for 2610 t/y. This quantity does include the refractories derived from cathode delining. The used materials contain combinations of alumino-silicates with minor impregnations of fluoride and sodium.

8.9.2 Disposal Method

Solid wastes will be disposed of off site in a controlled landfill operation. The Company has commenced investigations to locate a geologically and environmentally suitable site to serve the smelter from the commencement of operations. A separate Environmental Impact

Statement will be provided to assess the selection and operation of the site before it is required some four years after smelting commences.

Spent cathode material will be transported by enclosed truck to the disposal site as it is generated. Approximately two loads per week day will be removed. To allow for transport interruption, undercover storage will be provided at the smelter adjacent to the delining shop to cater for two weeks normal generation of spent cathode waste. Complete roofing of the storage area will prevent water ingress and leachate generation. As a further precaution an impermeable base will be provided ringed by perimeter drains to prevent surface flows contacting the waste.

Used refractory bricks, failed anodes and carbon wastes will be similarly treated, with minimal on-site storage prior to removal to the off-site disposal facility.

Packaging, domestic and office wastes will be collected by contractors and disposed of at Council controlled landfill sites. The quantities will not exceed those generated in the past by the former Courtaulds textiles factory and no additional landfill capacity will be required as a result.

Similarly, oil wastes will be removed by contractor. Estimates of waste oil volumes for the Hunter Region *(James B. Croft and Associates, 1975)* indicate a total annual figure of approximately 4.5 Ml. The quantity generated by the smelter will not significantly alter this volume. Soluble oil waste will increase by approximately 10 per cent the volume currently generated in the region. It will be removed from the plant by the contractor.

Fluxing slags derived from the dross treatment shops will be sold for regeneration of valuable metal constituents.

8.9.3 Alternative Technology

Treatment of spent cathode wastes is currently expensive, only partially successful and usually results in the exchange of contaminants from one form to another.

Smelters are divided into two groups, those able to separate the carbon from the refractories, and those that must treat the carbon and refractories together.

In the former case, steam treatment or pyrohydrolysis can be applied to the carbon segment to remove a portion of the contaminants. Steam treatment eliminates carbides and nitrides, but fluoride, sodium and their compounds remain in the extremely dense carbon.

Pyrohydrolysis has only been applied to Soderberg pot carbon fume. Irrespective of the treatment process, the refractory lining impregnated with contaminants remains and separate controlled disposal is still the most practical option.

The delining procedure to be used at Tomago would require the treatment of the carbon and refractories as one.

Before any treatment could be undertaken, the mixture would need to be crushed to a fine particle size. This process requires initial large expenditure in plant and imposes a burden of continued high operating costs. Experience has also shown that the crusher efficiency is low because of plastic infiltration of aluminium.

Once ground, the particles can be leached with water and the fluorides precipitated with calcium chloride. However, this process produces a sludge of calcium fluoride and a liquor with approximately 10 mg/l of fluoride. Safe disposal methods are still required for both of these products.

At this stage, controlled landfilling is the only practical and viable method open to the Company for cathode waste disposal. However, the options available will be continually reviewed as the results of research on this subject throughout the world comes forward.

8.10 WATER POLLUTION CONTROLS

8.10.1 Sources of Polluted Water

Site runoff and domestic waste water are the major sources of water which will require treatment prior to discharge. Process cooling system water losses will be sufficient to negate the need for additional purge. No solid waste leachate will be generated.

Site runoff will contain suspended solids, oil and grease washed from the surface of sealed trafficked areas, and particulate fluorides emanating from both ground areas and the roofs of the potline buildings.

The process cooling water system will serve the cast house, carbon plant, dross treatment shop and the delining shop. Makeup will average 92 m^3/h and will be filtered and demineralised before addition to the circuit. It will replace evaporative losses of 85 m^3/h and losses to the plant drainage system of 7 m^3/h.

It is estimated that the average rate of consumption of water for domestic purposes will be 10 m^3/h with a peak demand of 25 m^3/h at shift changes. This usage is based on a daily allowance of 300 l/man. The waste water resulting will be high in suspended solids and biochemical oxygen demand. *Table 8.6* lists waste water characteristics.

8.10.2 Treatment

Site Runoff

All runoff from disturbed and trafficked areas of the site will be collected by the system of drains indicated in *Figure 8.3*.

The drains will be of semicircular concrete dish construction adequate to handle a 1 in 10 year, 1 hour rainfall of 57 mm/h. The runoff will be directed towards a settling dam in the southeast corner of the site for suspended solids and fluoride removal.

TABLE 8.6

WASTE WATER GENERATION

Source	Quantity	Description
Runoff:		
(i) 1 in 10, 1 hour rainfall of 57 mm/h	17,000 m^3/h	Average quality (as measured at existing smelters) pH - 7.0 Fluoride - 25 mg/l
(ii) Average rain day in March, wettest month	3,100 m^3/d	
(iii) Average rain day in July, driest month	1,350 m^3/d	
Domestic:		
(i) Average	10 m^3/h	High in suspended solids and biochemical oxygen demand.
(ii) Shift changes	25 m^3/h	
Process Cooling Water (losses directed into runoff collection system)	7 m^3/h	pH - 7.2 Fluoride - 7 to 10 mg/l Suspended solids - 50 mg/l

The capacity of the settling dam has been estimated on the basis of total retention of runoff from the 1 in 10 year, 1 hour rainfall, a roof area of 15.2 ha, a sealed pavement area of 9.7 ha and a grassed area of 25.0 ha. A runoff coefficient of 0.9 was assumed for sealed areas and 0.2 for the grassed areas. The dam capacity will be approximately 17,000 m^3 and will be lined with an impermeable membrane to prevent loss into the sand on the site. Both the inlet and the settled water outlet will be provided with baffles to remove oil and grease.

An emergency spillway with a baffle will be provided for storm flows higher than the design flow. In the case of overflow, substantial diluting flows would reduce the concentration of contaminants to below those specified in the New South Wales Clean Waters Act.

The average fluoride concentration of runoff collected in the settling dam is expected to be 25 mg/l. This will be reduced to 10 mg/l by the addition of calcium chloride and the precipitation of calcium fluoride.

Clear supernatent with a fluoride concentration of approximately 10 mg/l will be discharged to the Hunter River. The average annual runoff drained by the Hunter River is estimated to be $1.7 \times 10^9 m^3/y$ (*State Pollution Control Commission, Coffey, 1973)*. Based on river width and depth, it is calculated that approximately 80 per cent of this volume passes down the north arm of the Hunter River, directly fronting the smelter site. Hence on the basis that high levels of plant runoff coincide with high river flows, discharge is unlikely to occur into river flows less than $3.73 \times 10^6 m^3/d$. $(\frac{80}{100} \times \frac{1.7 \times 10^9}{365})$.

Superimposed on the river flow characteristics is the effect of tidal flushing. Daily interchange of water in the estuary is estimated by the Department of Public Works to be approximately 5 per cent. Hence the dilution water available for plant discharge is $186,500 m^3$ $(\frac{5}{100} \times 3.73 \times 10^6)$. Therefore in the three runoff situations described in *Table 8.6*, dilution factors will be 1 : 9, 1:50 and 1:148, respectively taken over a daily discharge. Resultant fluoride concentration of the river water will thus be insignificantly affected. In the case of 1 in 10, 1 hour rainfall of 57 mm/h, the dilution factor will probably exceed 1 : 9 due to higher river flow rate.

The total amount of calcium fluoride generated per year in the settling dam will be 21 t as a dry mass, or approximately 1000 t as a sludge. This material will be periodically removed and dewatered by either flocculation or filtration, prior to disposal with the solid wastes described in *Section 8.9.2*.

Process Cooling Water

Process cooling water losses will be directed to the runoff treatment dam. Quantities are not significant in comparison to those already detailed.

Domestic Wastes

All domestic waste waters will be collected in a closed drainage system and treated by a package sewage treatment plant which will be designed to give a 20:30 standard effluent. The effluent will be discharged to the Hunter River.

8.10.3 Discharge Requirements and Controls

All discharges into the Hunter River will be controlled by the New South Wales Clean Waters Act, 1972. It is expected that in the future, the Hunter River in the vicinity of the site will be classified as Class C: Controlled Waters. All discharges will be limited on this basis.

Regular monitoring of all discharge streams will be undertaken and the results provided to the responsible authorities.

8.10.4 Waste Water Recycling

The possibility of recycling waste waters to the smelter rather than discharging to the Hunter River was closely examined by the Company, but found to be impractical on several grounds.

Reuse of site runoff for process cooling was studied. The requirement for absolute purity of process cooling water (hence its filtration and demineralisation) is imposed as a result of its use in direct cooling of cast aluminium. The recycling of runoff water would require an expansion of water treatment facilities by a factor of approximately two. In addition, demineraliser regenerations would be much more frequent, producing waste streams of high ionic content.

Use of either runoff or domestic wastes for ground irrigation purposes was rejected as a safeguard for the Tomago Sandbeds. This decision was taken in the knowledge that the groundwater flow is considered to be towards the river rather than to the sandbeds. By discharging to the river any opportunity for contamination of the sandbeds cannot arise.

8.11 SAFEGUARDS TO PROTECT THE TOMAGO SANDBEDS

The Company proposes to protect the quality of water in the Tomago Sandbeds by preventing or minimising the movement of potential pollutants into the aquifer.

The only smelter emissions that will in any way be incident on the sandbeds are airborne gaseous and particulate fallout. The dry scrubbing system plus the high primary collection efficiency of 97.5 per cent will minimise the overall fluoride emissions from the plant. The residual secondary emissions may contact the catchment area, depending on wind conditions and details of predicted quantities and effects on groundwater quality are discussed in *Section 9.5* Details of environmental studies being undertaken to test predicted effects are described in *Section 7.3*.

No solid wastes will be stored or buried on the site or in the catchment area, and hence no leachates will enter the groundwater from such sources.

Any spillage will be cleaned up. All site runoff and any process water leaks will be collected and treated in an impervious storage dam before discharge to the Hunter River. Domestic wastes will be collected separately, treated and discharged to the Hunter River. Hence, neither solid nor liquid wastes will enter the groundwater of the Tomago Sandbeds.

8.12 NOISE CONTROLS

Noise levels are to be controlled during the construction and operating stages. The safeguards during construction are considered in *Section 8.14*.

Noise control safeguards have been incorporated into the proposal in the selection of the basic processes and units and by detailed design to minimise predicted source levels.

Basic noise control measures will include:-

i. The use of electrical power in the smelting process will result in low overall noise levels in the potroom.

ii. The design of the potroom roof vents take advantage of natural ventilation and removes the need for exhaust fans which can be significant noise sources.

iii. The proposed pot design incorporates centre-feeding of alumina which results in lower noise levels than those associated with side-worked pots.

iv. The various pot operations are to be undertaken by electric cranes.

v. Diesel units for hauling various materials, anodes and products around the site will be silenced and the mufflers maintained in good condition.

vi. The activities in the green anode plant including ball milling, screening and shot blasting will all be carried out in acoustically sealed and insulated areas and will be remotely controlled. Maximum use will be made of acoustic shielding to separate workers from any noisy plant unable to be enclosed.

vii. All compressors will be silenced. Particular attention will be given to units outside of buildings. Modern designs which emit low noise levels will be selected.

viii. Noise attenuation will be assisted by having the majority of the noise sources operating within buildings. Cladding with acoustic properties will be used where desirable.

ix. Workshops, and vehicle and plant maintenance activities will be enclosed in buildings.

Sound level measurements made at Pechiney's most modern smelter in the Netherlands indicate that the fixed plant can be expected to generate levels between 73 dB(A) and 90 dB(A) outside of the external walls. Truck levels around the plant generate a maximum of 96 dB(A) at 1 m. Sound levels measured at an existing smelter in the Hunter Valley were found to be of similar magnitude.

The noise levels from the individual buildings after the incorporation of safeguards are used in *Section 9* to assess the impact from the Tomago smelter.

8.13 MONITORING PROGRAMME

8.13.1 Scope

The Company will monitor air, noise, water and other environmental parameters as outlined below, to provide background data prior to start-up, to ensure that all requirements and conditions of the various licences and approvals are met and to give early indications of any potential significant impact on the environment of the site or in the area of influence of the smelter.

8.13.2 Raw Materials

Each shipment of pitch and coke, as well as weekly and monthly composite samples will be analysed for sulphur.

8.13.3 Emissions Monitoring

Potroom Roof Emissions: All emissions from the potline will be monitored on a continuous basis. At least ten sites will be sampled along the length of each potroom. The type of instrumentation and sampling techniques will be decided after consultation with the State Pollution Control Commission. The Alcan cassette method may be appropriate.

Dry Scrubber and Anode Baking Furnace Emissions: Gaseous and particulate fluoride emissions and total particulate emissions will be monitored weekly. Representative samples will be tested for gaseous and particulate fluoride, total particulate matter and sulphur dioxide.

Stack Emissions: Temperature and volumetric rate of all stack emission will be monitored continuously.

8.13.4 Ambient Air Quality

The existing air quality monitoring programme will be continued and involve the following monthly analyses:

i. Twenty stations with paper cylinders treated with calcium formate to monitor atmospheric fluoride levels.

ii. Nine dust fallout stations for measuring total dust fallout, total fluoride levels in dust, concentration of water soluble fluoride and organic content of dust.

In addition, the following stations will be installed.

i. *Dual Tape Monitors*

Six RAC ambient fluoride dual tape monitors will be installed; one will be located on the Company boundary where highest ambient fluoride concentrations are expected; three will be located at other positions on the boundary, and the other two outside the boundary. At each dual tape sampler site, provision will be made for the installation of a second monitor to check data.

The sixth dual tape sampler and a continuous sulphur dioxide monitor will be mobile units and could be regularly relocated to monitor potential problem areas. Dual tape stations will be set to sample over differing time intervals; those at and within the boundary fence will be set to sample over 24 hours while monitors outside the boundary will be monitored on a weekly basis. The sample and chemical analysis procedures will be chosen in consultation with the State Pollution Control Commission.

The Company will monitor the concentrations of ambient fluoride and sulphur dioxide at least twelve months prior to commissioning of the smelter.

ii. *Meteorological Station*

A continous monitoring meteorological station will be installed on the site to provide additional information to that available from Williamtown. In particular, the station will determine the microclimatic influences of vegetation and topography and the following meteorological parameters will be monitored on a continuous basis.

* Wind speed (strong gusts to very gentle breezes).
* Wind direction and sigma-theta measurements.
* Atmospheric pressure.
* Incoming solar radiation.
* Ambient air temperature.
* Humidity.

Rainfall will be determined twice daily. Evaporation data available from the Hunter District Water Board will be used.

All the meteorological data will be processed and stored in a computer filing system.

iii. *Wind and Temperature Monitor*

The Company is investigating the feasibility of installing a wind and temperature monitor at the top of the existing tall stack to give more regular data on temperature profile than is available from Williamtown. The practicality of having several of the above functions fully automated to facilitate data processing is also being evaluated.

The purpose of monitoring these parameters is to validate the mathematical and physical models of atmospheric dispersion for the particular conditions which will exist on the site.

8.13.5 Vegetation Sampling

Vegetation samples will be collected on a monthly basis from points located at distances of 0.5, 1, 2, 4, 6 and 10 km from the site on each of the eight cardinal compass points. A 50 m by 100 m grid will be set up at each site and samples of overstorey, understorey, ground cover and forage of the dominant species will be collected and analysed for fluoride. Additional vegetation samples will be collected from sites up to 30 km from the smelter. The technique of analysis will be decided in consultation with the State Pollution Control Commission.

All cultivated vegetation, orchards, and market gardens within a 10 km radius of the plant and selected forage to a radius of 20 km, will be monitored at monthly intervals for fluoride. Samples of vegetation collected will be forwarded to the State Pollution Control Commission on request.

With the smelter operational, the measurements will allow further correlations between emission levels and measured atmospheric fluoride levels and levels in vegetation. Fluoride in vegetation will be a major method of assessing the impact of the smelter on surrounding areas.

8.13.6 Monitoring of Wildlife and Farm Animals

If long term grazing of farm animals continues within a 10 km radius of the smelter, regular veterinary surveys of herds will be carried out. These will include urine and bone sampling and teeth inspections as an indicator of possible fluoride damage.

Two apiaries will be maintained within 1 km of the smelter and bees will be analysed regularly. Bees are very susceptible to fluoride and thus are good pollution indicators for the aluminium smelting industry.

A detailed ecological survey covering vegetation and animals will be carried out at yearly intervals. Trapping will be conducted during this survey to ascertain the influence, if any, of the smelter on animal populations. Samples of bone from the dominant animal species will be analysed for fluoride.

Any wild animals, of interest, found dead in the area will be analysed for fluoride.

8.13.7 Koala Monitoring Programme

Since Koalas are known to occur on the smelter site, detailed population studies will be conducted within the area of influence of the smelter prior to construction, during construction, then at twelve monthly intervals after commissioning of the smelter. These studies will assess the effects of various stages of development of the smelter on the Koala population. Further detailed studies will be conducted should a survey show that the Koala population is affected by the smelter development.

8.13.8 Water Quality

i. *Waste Water Quality*

A programme of water quality management will be developed appropriate to the water circulation and waste water treatment system, described in *Section 8.10*. All waste water and recirculating wastes will be regularly tested as part of the process control in the plant.

The flow rate of discharge from the site, via a single channel to the Hunter River, will be automatically monitored and sampled at regular intervals. The samples will be analysed for fluoride, pH, conductivity, turbidity, BOD, oil and grease. Samples will be tested twice each year for the full range of substances specified in the New South Wales Clean Waters Act.

ii. *Groundwater*

Groundwater quality will be monitored on a monthly basis on at least five bores located within the Tomago Sandbeds. More remote bores will be sampled to give background information for comparison. Samples are to be analysed for soluble fluoride, pH and conductivity. The method of sample collection will be determined after consultation with the Hunter District Water Board.

Samples may be collected from the top, middle and bottom of the water table to ascertain the effect, if any, the smelter is having on the groundwater quality. Selected samples will be analysed for trace metals at six monthly intervals.

iii. *Rainfall*

A total of at least ten rain gauges will be located around the smelter within the Tomago Sandbeds area; five will be located at the groundwater sampling stations, the rest to be located within an 8 km radius of the smelter. The gauges will be serviced monthly and analysed for fluoride, pH, and total soluble salts. The water collected by the dust deposition gauges will also be analysed for fluoride.

iv. *Surface Water*

At present water samples are being collected from 25 sites including ponds, fresh water streams and estuarine areas. If required, additional monitoring sites will be selected in accordance with the requirements of authorities. All sites are to be sampled at monthly intervals and analysed for fluoride, pH, and conductivity.

8.13.9 Noise Levels

Noise studies will be continued on a six monthly basis to determine accurate background noise levels for the site. Similar studies will be initiated when the smelter is in full operation to determine the effect of the smelter on the overall noise climate.

8.13.10 State Pollution Control Commission Auditing

The Company will comply with the requirement of the State Pollution Control Commission that all vegetation and bone samples are stored in a dry condition in clearly labelled plastic vials.

Regular auditing will be conducted by the Commission to check the accuracy and reliability of the environmental monitoring results.

8.13.11 Data Collection

All environmental data will be computer filed; the type of system to be decided on in consultation with the State Pollution Control Commission. A report will be supplied annually to the State Pollution Control Commission detailing the ecological changes in the area of impact.

8.14 CONTROLS DURING CONSTRUCTION

The following safeguards and precautions will be implemented in the construction stage to minimise inconvenience to residents in proximity.

8.14.1 Air Quality

As most of the construction works for the preparation of the site will be on sand, little dust will be generated. A water tanker or hoses will be used to suppress any dust generated from unsealed gravel roads or debris from the demolition of existing buildings on the site.

8.14.2 Water Quality

There will be no runoff from disturbed sandy areas. Precautions will be taken to ensure that spent oils removed from plant and vehicles are disposed of safely off the site. Garbage and any building debris likely to generate polluted waters as a result of leaching will be taken from the site and disposed of safely at the Council landfill.

Temporary sanitation facilities will be provided for construction workers. Effluents will be disposed of at the facility operated for the purpose by Port Stephens Shire Council.

There will be no water discharges on the site to contravene the requirements of the Hunter District Water Board for the protection of the Tomago

Sandbeds.

8.14.3 Noise Levels

Earthmoving plant clearing the area is expected to generate noise levels up to 110 dB(A) at 1 m. After this initial stage noise will be generated by trucks bringing materials to the site, by plant including cement mixers, compressors, cranes, loaders and various automatic hand-held tools, by activities including steel fabrication and erection, formwork construction and from workshop and assembly areas.

Contractors will be requested to give preference to modern plant and equipment generating low noise levels and equipped with silencers. It is expected that the noise levels from the various items of plant and construction activities will reach maximum values in the range of 90 dB(A) to 110 dB(A) at 1 m.

Construction activities will generally be undertaken in daylight hours.

8.15 LANDSCAPING AND ARCHITECTURE

8.15.1 Landscaping

The conceptual designs outlined in this Statement are indicative of the Company's proposals for the extensive landscaping of the Tomago Site. Formalised planting plans and specifications are to be prepared during the design documentation stage, after the details of the site layout are finalised.

Objectives

The objectives of the landscape scheme are as follows:-

i. Planting is to be of a similar scale to the buildings and structures on the site.

ii. Planting is to be compatible with the surrounding, indigeneous vegetation, so that the site will form an extension of the natural landscape.

iii. Screen-type planting will be used to limit views to the smelter from nearby residences.

iv. The planting will serve as an additional, on-site pollution filter.

Existing Landscape

Dense vegetation covers most of the site with the exception of the grassed areas surrounding the former Courtaulds textiles factory. *Plate 8* is typical of the density of Rusty Gum and Bloodwood, Dry Sclerophyll Closed Forest to Woodland around the proposed smelter location. The canopy is relatively uniform in height and averages 20 m overall. The site is relatively flat and the soils are sandy with poor water retention properties.

The Proposed Landscape Scheme

Figure 8.4 illustrates the extent and location of the proposed planting around the facilities. Approximately 20 ha will be planted.

Two main types of planting are planned. Mass planting to serve a screening function will be used to infill bare areas between and surrounding the existing Courtaulds buildings and the proposed smelter buildings. The smaller areas adjacent to the administrative block will be planted with amenity-type planting.

The purposes of the mass planting are:-

i. To reduce the visual impact of the buildings and structures.

ii. To reduce low level wind speeds in the vicinity of the plant while increasing high level turbulence.

iii. To serve as a pollution filter. Overseas research has shown that leaves of woody plants are able to accumulate air pollutants and thus serve a filtering role *(Knabe, 1977)*.

The purposes of the amenity-type planting are:-

i. To provide suitable areas for recreational use by employees.

ii. To provide shade to buildings and car parks.

iii. To soften the outline of the buildings.

iv. To introduce colour, fragrance and avifauna to the site by the selection of suitable tree and shrub species.

Additional landscaping is planned at the following locations:-

Disused Airstrip: Planting is proposed in the area adjacent to the potlines to reduce the wind funnel effect of the former airstrip. This planting will also eliminate a sight-line from the Pacific Highway along the airstrip to the smelter.

Disused Easements: A number of disused easements exist within the site and it is proposed to plant these to reduce the lineal exposure of the wooded areas to airborne pollutants.

The Former Mineral Sand Mining Area to the Northeast of the Smelter: Consideration will be given to the planting of this area so that exposure of the adjacent forest is minimised.

A perimeter firebreak, up to 100 m in width, will be planted with stabilising grasses.

Species Selection

Vegetative species will be selected from plants indigeneous to the site, supplemented by other native species compatible from visual and site-suitability aspects. Additional species selected for colour and fragrances will be planted in the areas adjoining the buildings.

Table 8.7 presents a preliminary planting list based upon site surveys and fumigation tests undertaken by Dr. Doley at the University of Queensland to determine relative levels of fluoride susceptibility. It is expected that the list will be expanded and modified during the detailed design phase of the project.

TABLE 8.7

PRELIMINARY PLANTING LIST

Scientific Name	Common Name	Height (m)	FUNCTION: Screen Planting	FUNCTION: Amenity Planting	SUITABILITY: Fluoride Resistant (1)	SUITABILITY: Indigineous to the site and environs
TREES:						
Acacia decurrens	Green Wattle	12	x	x		
Angophora costata	Smooth-barked Apple	12	x	x		x
A. floribunda	Rough-barked Apple	20	x			x
Banksia integrifolia	Coast Banksia	8	x			x
Casuarina glauca	Swamp Oak	10	x		x	x
C. littoralis	Black She-oak	10	x			x
C. torulosa	Forest She-oak	20	x	x		x
Eucalyptus botryoides	Bangalay	20	x			x
E. crebra	Narrow-leaved Ironbark	15	x		x	x
E. grandis	Flooded Gum	30	x			x
E. gummifera	Red Bloodwood	12	x			x
E. robusta	Swamp Mahogany	15	x	x		x
E. tereticornis	Forest Red Gum	17	x			x
Melaleuca quinquenervia	Broad-leaf Paperbark	10	x	x	x	x
SHRUBS:						
Acacia aulocacarpa	Hickory Wattle	5	x		x	
A. falcata	Sickle Wattle	4				x
A. longifolia	Sydney Golden Wattle	5	x	x		x
A. myrtifolia	Myrtle Wattle	1	x			x
A. sauveolens	Sweet-scented Wattle	2		x		x
A. terminalis	New Year Wattle	2	x			x
Banksia collina	Hill Banksia	3	x			x
B. marginata	Silver Banksia	4	x		x	
B. robur	Large-leaved Banksia	2		x		x
B. serrata	Red Honeysuckle	4		x		x
B. spinulosa	Honeysuckle	2	x			x
Callistemon citrinus	Red Bottlebrush	5		x		x
C. linearis	Narrow-leaved Bottlebrush	2		x		x
C. salignus	Pink Tip White Bottlebrush	5	x			x
Grevillea sericea	Pink Spider-flower			x		x
Leptospermum flavescens	Common Tea-Tree	3		x		x
Melaleuca nodosa	Ball Honey-myrtle	3	x			x
GROUND COVERS & CLIMBERS:						
Baeckia ramosissima				x		
Dampiera diversifolia				x		
Hardenbergia violacea	Purple Coral Pea			x		
Kennedia rubicunda	Dusky Coral Pea			x		
Pandorea pandorana	Wonga Wonga Vine			x		

Key: (1) Relatively resistant to fluorides. Based upon fumigation tests by Doley, University of Queensland.

Implementation

The success of the proposed planting scheme will depend upon achieving a quick cover of bare areas to avoid sandblasting and root exposure of young seedlings and to prevent soil erosion. Two alternatives are possible and will be evaluated. The first is to plant the bare areas with stabilising grasses to achieve a quick crop cover, followed by the planting of tree and shrub seedlings. The second is to cover the bare areas with a stabilised hay or similar mulch material and hydroseed using treated native seed.

Areas of amenity-type planting will be established by conventional means.

A further determining factor is the susceptibility of young seedlings to higher than ambient levels of fluoride. The suitability of species will be evaluated in both fumigation tests and from on-site observations. The effective landscaping achieved at operating smelters indicates that this aspect will not pose a problem.

Maintenance

Trees and shrubs will be watered regularly during the first twelve months and thereafter during dry periods. Maintenance will include regular mowing and fertilising of lawn areas, the removal of weeds around trees and shrubs and the replacement of surface mulches.

Regular visual inspections of vegetation within the Company's perimeter zone will be undertaken, especially along exposed faces such as the fire-break, roads and easements. Damaged trees will be replaced by species proven to be resistant in the smelter environment as part of the normal maintenance programme.

Effectiveness

The proposed landscaping programme will be established and maintained to meet the objectives stated above. It is expected that the planting for low level screening and for amenity purposes will become increasingly effective after about five years. Mature heights will not be attained for at least ten years.

8.15.2 Appearance of Buildings and Structures

Figure 5.1 and *Plate 1* illustrates the visual characteristics and spatial layout of the proposed development and its relationship to the existing Courtaulds buildings.

In common with the majority of industrial architecture, function has dictated the form of the buildings and structures, and has resulted in predominantly long, low buildings.

Site unity will be achieved at the new smelter by the use of similar design criteria, materials and colour for each of the buildings and structures.

Buildings

Major buildings on the site will be:-

i. The four potlines and associated dry scrubber units. The potlines are long, low buildings, 800 m long, 22 m wide and 21 m in height above ground level. *Figure 5.7* shows a typical cross section and elevation of the potline, while *Plate 2* shows an interior view of a potline at the St. Jean de Maurienne aluminium smelter, in France. *Plate 5* provides an external view of a typical dry scrubber unit.

ii. The four buildings which house the anode manufacture and storage facilities are long narrow buildings with a maximum height of 24 m above ground level. *Figure 5.10* provides details of the building containing the anode baking furnace.

iii. The cast house is approximately 200 m long by 100 m wide and 24 m in height.

iv. The green anode shop is approximately 42 m in height, and is a strong vertical element in contrast to the potlines and cast house. *Figure 5.9* illustrates the external profile of this building.

v. The maintenance shop and general warehouse will be similar in height to the potline buildings.

vi. The laboratory and technical offices.

vii. The change rooms and shower facilities.

Because the taller buildings and structures, which include the green anode shop, will be visible above the tree line it is proposed that these taller structures will be painted a light tone such as beige, gold or off-white. Smaller horizontal panels and structural steel frames will be finished in a contrasting, deeper tone. Translucent fibreglass sheets which are used to increase internal natural lighting levels, will also provide additional interest to the large expanses of cladding. Non-glare weathered aluminium cladding will be used.

The change room, technical offices and laboratory will be constructed to a high architectural standard using heavy weight materials such as a high concrete block or brick. The existing Courtaulds' administration block is to be renovated and refurnished to house the managerial and administrative staff.

While the proposed buildings will be constructed from different materials to the predominantly brick-walled and asbestos-roofed Courtaulds buildings, they will be a similar height and will share the same emphasis of the horizontal plane.

Structures

Major structures comprise the raw material storage silos, the electrical substation, the dross treatment plant, the water storage tower and cooling towers and the five stacks. It is predicted that only the green anode shop, stacks, alumina and coke storage silos will be visible above the tree line.

The four dry scrubber stacks and the anode baking furnace stack are the tallest structures, being 60 m in height. The coke storage silos are approximately 35 m in height and 26 m in diameter. The alumina storage silos are 29 m in height above ground level. These will be steel structures finished in a suitable colour such as beige.

The remaining structures are similar in height to the potlines and anode manufacturing buildings.

8.16 WORKER HEALTH AND SAFETY

The technology proposed by the Company and described in *Sections 5* and *8* has been developed to protect both the external environment and the working place. Measures outlined will ensure that maximum levels of chemical substances and physical agents in the working environment are less than standards and recommendations accepted by international authorities *(IPAI, 1977 and American Conference of Governmental Industrial Hygienists, 1978)*.

Gaseous emissions in the potroom will be minimised as a result of high hooding efficiency. Average contaminant levels over 8 hours will be well below the Australian National Health and Medical Research Council Hygienic Standards for Atmospheric Contaminants (1979) of 2 mg/m^3 hydrogen fluoride, 2.5 mg/m^3 fluoride as fluorine, 55 mg/m^3 carbon monoxide, 13 mg/m^3 sulphur dioxide and 10 mg/m^3 nuisance particulates.

Cell and pot-tending machine design will provide little opportunity for alumina spillage. Feed to pot hoppers will be by means of a coupled, fully sealed delivery line from the pot-tending machines.

Dust sources in the anode manufacturing process will be controlled by air suction and collection. Pitch fumes will be removed by scrubbing with coke. Total Benzene Soluble Organics, minus the oil mist or aliphatic content, will be below 0.2 mg/m^3.

Maintenance of negative pressure in the baking furnace will prevent emission to the working environment.

Use of the SNIF degassing device or equivalent in the cast house will prevent escape of chlorine or its compounds into the workroom.

Noise exposure associated with the smelter operation will be subject to the controls of the Factories (Health Safety Hearing Conservation)

Regulation 1979, which aims at protecting the hearing of employees.

Plant design, layout and operation, place strong emphasis on providing a safe working environment in which potentially harmful exposures of any kind are either eliminated or minimised.

Jobs will be designed to provide interest and satisfaction. All personnel will be trained in safe and efficient job performance. A detailed safe working programme will be maintained.

All prospective personnel will be medically examined to establish suitability for the work to be performed. Periodical re-examinations will be provided. Medical checks will include hearing, eyesight, lung function, urinary fluorides, and general health. All personnel will be able to consult with the Medical Officer free of charge. Detailed medical records will be maintained.

Through plant design, controlled operating procedures and training, exposures to heat, noise, dust, sulphur dioxide, carbon monoxide, carbon dioxide and benzene soluble organics will be maintained within safe limits. Education programmes will be provided relating to health and use of protective equipment. Workplaces will be regularly monitored by qualified personnel to check emissions and exposures and to ensure that all legislative and Company standards are maintained.

A medical centre will be established and a part-time Medical Officer will visit the plant on several days per week. The centre will be attended Monday to Friday by qualified first-aid personnel. All supervisors will be trained in first-aid plus additional personnel on each shift.

Emergency first-aid equipment and procedures will be maintained in each department and personnel will be trained in its use. Emergency transport will be provided in case of serious accident.

Shower and locker rooms will be provided and maintained at a high standard of hygiene. Heated lockers will be provided to keep clothing dry.

Well equipped air conditioned lunch rooms will be available near work areas. Sanitary and drinking water facilities will be provided.

Planning of amenities and other facilities will provide for employment of both males and females.

8.17 DEVELOPMENT OF A BUFFER ZONE

On the basis of the safeguards proposed in the preceding pages of this section, the Company believes that it can operate the proposed smelter with minimum impact on the surrounding areas. However, the possibility is recognised that certain combinations of operational and meteorological conditions could lead to the potential for effects beyond the boundaries of the site. The Company also accepts that there is a basic incompatibility between heavy industry, such as the smelter and residential development.

It is the intention of the Company to set aside a reserve area around the plant which will be free of buildings and equipment. In this area, tree planting will be enhanced or initiated and only such uses as parking or employee recreation areas will be permitted. Because of constraints on orientation and siting of major components of plant, some additional properties will be purchased in order to complete this zone of passive use.

The land, at present the subject of discussions by the Company, falls into two categories. The first is the non-industrial land uses within the existing industrial zone where average ground level concentrations of fluorides may exceed 1 $\mu g/m^3$, based upon the results of the dispersion model described in *Section 7*. Although there will be no harmful effect on humans in this zone, vegetables, crops, various fruit trees and sensitive native vegetation may be affected. Grazing animals are likely to be affected through the consumption of vegetation with high fluoride levels.

The second category involves areas where the average ground level fluoride concentrations are predicted to be in the range of 1.0 to 0.3 $\mu g/m^3$. Again, although there will be no harmful impact on residents, sensitive vegetation and grazing animals may be affected.

The Company will discuss the possibility of purchasing properties from persons owning land in these two categories should they be concerned and express an interest in selling.

Some sensitive species of garden vegetables, fruit trees and flowers may be affected in areas subject to ground fluoride concentrations down to about 0.1 $\mu g/m^3$. The Company will discuss any possible problems with concerned residents on a case by case basis.

The programme of consultations and negotiations with property owners around the smelter will continue into the operating stages and will be varied according to experience and the results of the monitoring programme. The Company has as its objective, the development of a buffer area containing safe uses around the smelter but is anxious not to disturb land owners when no risk of significant impact exists.

The area to the immediate north of the plant is within the Tomago Sandbeds Water Supply Catchment. Part of this area will be owned by the Company and the remainder by the Hunter District Water Board which controls all development in the sandbeds area. The Company is supporting research and investigations on the potential effects of fluorides on the sandbeds and will maintain close liaison with the Board in the assessment of the impact of the smelter in practice.

8.18 ENVIRONMENTAL MANAGEMENT

Control of emissions and the achievement of a clean environment require good equipment, proper training of operators, scrupulous maintenance of the plant and careful monitoring of the entire systems performance.

The Company, as part of its attitude of maintaining stringent pollution control standards and providing the public with information concerning the smelter operation, will employ an Environmental Officer to implement the Company's environmental objectives; to develop and control monitoring procedures, both on the site and within the subregion; to ensure that the pollution control equipment is functioning correctly and that emissions are within the limits set by Licence conditions; and to liaise with local residents and the public in general.

Records of the monitoring programme will be made available to the State Pollution Control Commission, who will carry out independent checks at regular intervals. Monitoring results which are not within specified limits for safe operations will initiate immediate investigations.

Company policy will be to undertake development work to improve emission controls and to implement improvements resulting from Aluminium Pechiney research and development activities around the world.

The Analysis of the Impact of the Proposal

SECTION 9

THE ANALYSIS OF THE IMPACT OF THE PROPOSAL

SUMMARY

This section analyses the impact of the fully safeguarded proposal on the total environment. The conclusions on the impact of the smelter are as follows:-

PHYSICAL IMPACT OF CONSTRUCTION

The construction of the smelter will have no significant impact on the topography, drainage pattern and potential for soil erosion on the site. The extent and possible effects of the abandoned underground coal mine workings will be clarified but no unusual foundation conditions are expected.

No endangered or unusual floral species will be lost and the microclimate will not be affected significantly in the clearing of 45 ha of vegetation. Special studies and surveys are to be conducted to gauge the impact on displaced fauna and minimise the impact if practical.

ENERGY RESOURCES

Approximately 3.9 million kilowatt hours of electricity, 10.8 million litres of diesel fuel and 1.1 million litres of petrol will be consumed during construction. When operating, the smelter will use about one seventh of the capacity of Eraring Power Station, about 3 per cent of the New South Wales electrical generating capacity and about 7 per cent of the projected total energy consumption for 1986. About 1.4 million tonnes of coal will be required each year to provide electrical energy for the project. This is less than 6.7 per cent of the projected exports from the northern New South Wales coalfields in 1985. Over a 50 year life the smelter will consume only 0.4 per cent of the measured and indicated reserves of black coal on the northern New South Wales coalfields. The Energy Statement prepared for the proposal indicates that the smelter's energy requirements represent only a small proportion of the State's generating capacity and will not result in significant depletion of the State's or Nation's resources.

The proposal will prevent extraction of the 30 million tonnes of coal underlying the site. This resource is not required at the present time.

MINERAL RESOURCES AND CONSTRUCTION MATERIALS

The smelter will consume 0.04 per cent of Australia's measured bauxite reserves per annum. Industrial and heavy mineral sand resources will not be affected by the proposal. Reserves of construction materials are adequate to meet the requirements of the project and the growth of the region.

NOISE LEVELS

Two houses to the east of the site on Tomago Road will receive peak noise levels of 56 dB(A) in daylight hours during construction. The Company has options to purchase these houses. Sources of operating noises will be reduced to background at the boundary of the property. Heavy vehicles hauling raw materials and products between the smelter and the port at Newcastle will be a source of disturbance to residents living on Tomago Road between the site and the Pacific Highway on six days per week between 7 am and 6 pm.

SMELTER EMISSIONS

Dust: Eleven residences east of the site will receive an increase in dust levels of about 0.06 g/m^2.mth during operation of the smelter. This will be a 3 per cent increase on existing dust levels and does not represent a significant impact.

Steam: Steam from cooling towers will condense adjacent to the plant and will not inconvenience residents.

Fluoride and Air Quality: Tomago Public School, Tomago House and nineteen residents on Tomago Road will be exposed to fluoride levels greater than 1.0 $\mu g.Ft/m^3$ on occasions. There should be no impact on health.

Sulphur Dioxide: Sulphur dioxide levels are expected to increase by up to 1.0 $\mu g/m^3$. This is a 4 per cent increase on existing levels and an impact will not be significant.

Soil: Fluorides will accumulate in soils close to the plant and will not affect soil productivity significantly.

Surface Water: The small fresh water lagoon on the Company's property will receive emissions estimated to result in fluoride concentrations in the water of greater than 1 mg/l. Tidal flushing, fresh water inflows and the volume of estuarine water will dilute fluoride concentrations discharged to and deposited in the Hunter

River. There may be an increase in fluoride concentrations of 0.02 ppm in the Hunter River. This would be well below the acceptable level for Controlled Waters specified in the New South Wales Clean Waters Act. There will be no significant impact on other water bodies.

Groundwater: An average fluoride concentration in groundwater of 0.18 mg/l is expected which is well below the recommended level of 1 ppm fluoride in drinking water for dental health benefits. There will be negligible impact on groundwater of the Tomago Sandbeds during construction and operation of the smelter.

Native Vegetation: Sulphur dioxide will have no significant impact on native vegetation. Fluoride emissions may result in long-term changes in dominance, structure and composition of the Tomago Sandbeds' vegetation within the annual average 0.5 $\mu g.Ft/m^3$ isopleth. This area is mainly on the smelter site and on land zoned industrial. The Mangrove-Salt Marsh and Swampland communities will not be affected.

Crops and Forage: Sensitive crop and forage species occurring in pasturelands within the annual average 0.3 $\mu g.Ft/m^3$ isopleth will be at risk. This area includes a dairy, horse and cattle grazing properties east of the site on Tomago Road and part of a mixed grazing property west of the site. Barley and sorghum crops within the 0.1 $\mu g.Ft/m^3$ isopleth may also be at risk.

Garden Plants, Vegetables and Fruit: There will be no impact on commercial stone fruit orchards and vineyards since the nearest properties are well outside the 0.1 $\mu g.Ft/m^3$ zone. A commercial vegetable farm may experience fluoride levels up to 0.5 $\mu g.Fg/m^3$ on occasions and sensitive species may be at risk. Sensitive garden species, fruit and vegetables grown in household gardens may be atrisk within the 0.3 $\mu g.Fg/m^3$ zone.

Wildlife: Increased fluoride levels are expected in native fauna within the 0.3 $\mu g.Ft/m^3$ zone. At higher concentrations, death or reduced fecundity within individuals may occur. It is likely that tolerant species will increase in number while sensitive species decline. Reduced productivity and simplification of vegetation communities may result in major changes to habitat, species number and diversity. The impact on wildlife may be significant.

Grazing Animals: Grazing stock at the dairy, beef, mixed beef and horse breeding properties near the site will be at risk if grazed permanently within the 0.3 $\mu g.Fg/m^3$ isopleth.

Aquatic Fauna, Pets and Bees: No risk to pets or aquatic fauna is expected. Honey Bees are sensitive to fluoride and impacts on bee populations will be monitored.

Human Health: Residents near the smelter will not be exposed to harmful levels of fluoride and sulphur dioxide.

EMISSIONS FROM OTHER SOURCES

There will be an overlap at a concentration of 0.1 $\mu g.Fg/m^3$ in the area between Kooragang Island, the western side of Fullerton Cove and the north arm of the Hunter River. Pasture and forage crops, fruit and garden plants sensitive to this emission level may be affected in this zone on occasions. An overlap at less than 0.02 $\mu g.Fg/m^3$ occurs with fluoride sources centred on Lochinvar and Kurri Kurri. Emission at these levels will have no impact on land use or sensitive plant and animal species.

VISUAL IMPACT

Visual impacts as a result of the project will be minimal due to the densely vegetated zone surrounding the site. The green anode shop, dry scrubber stacks, water tower and coke storage silos will be visible from distant viewing points and these structures will be painted to blend with the skyline and minimise the impact.

TRANSPORTATION SYSTEM

The proposal will result in increased heavy vehicle traffic on Cormorant Road, Industrial Drive, Pacific Highway and Tomago Road. An impact of approximately 100 per cent increased heavy vehicle traffic can be expected on Tomago Road between 7 am and 6 pm, six days per week. Traffic volumes on other routes during operation of the smelter will be increased by approximately 10 per cent or less. Similar increases are expected for workforce vehicles, at peak times seven days per week. The impact on Tomago Road and possible congestion and delays along the route at peak periods are recognised as unavoidable effects of the project.

LAND USE

Planning: The site is in an industrial zone and no rezoning will be required. Minor restrictions on certain land uses in adjoining areas may be necessary.

Agricultural Land Use: The dairy, horse and cattle breeding properties close to the smelter may require changes to the established agricultural land use patterns. The need for change is expected to be mainly within the 0.3 $\mu g/m^3$ isopleth but may extend to specific uses within the 0.1 $\mu g/m^3$ isopleth.

Urban Land Use: The smelter will not alter the use of residential land other than restrict horticultural species which may be cultivated in household gardens.

Industrial and Commercial Land Use: The smelter will not adversely affect existing industrial and commercial land uses. Benefits will accrue to some firms through subcontracting during the construction and operation of the smelter. Increased demand for industrial blocks close to the site is likely.

Tourism and Recreation: The smelter will have no adverse effects on existing recreational facilities near the site, or recreational use of the Hunter River. The site is too distant from major tourist attractions of Lake Macquarie, Port Stephens, vineyards at Pokolbin, and beaches to have any impact.

Tomago Road is not important for tourist traffic. There will be a benefit to the tourist industry through the provision of educational tours through the plant.

Some conflicts could arise during the construction phase when there is competition with tourist activities for occupancy of caravan parks and other temporary accommodation.

Special Uses: There will be no significant impact on Tomago School, Uniting Church, Progress Association Hall, Detention Centre or Tomago Sandbeds Water Supply Catchment area.

RESIDENTS IN PROXIMITY

Residents between the site and the Pacific Highway on Tomago Road will experience higher traffic and noise during operation of the smelter. This will result in reduced amenity and increased road safety hazards and noise. Some restrictions on horticultural crops, fruit trees, garden plants and vegetables will be necessary close to the site.

SOCIAL IMPACTS

Predicted Population Changes: The largest increase in population of up to 8300 will coincide with the peak construction workforce during 1983. This will reduce to approximately 6000 in the long term.

Housing and Accommodation: The estimated demand for additional temporary accommodation during the construction phase will be approximately 1000 units between 1981 and 1983 reducing to 250 in 1985. Temporary accommodation facilities may be strained in the short term.

Between 750 and 1500 additional houses will be required to accommodate the permanent population generated by the proposal. There should be sufficient houses and residential land to meet demands.

Health and Education Services: The project will have no significant impact upon educational, health, recreational and community facilities. There will be no impact on areas of historical significance.

THE ECONOMIC IMPACT

Capital Investment: The project will provide a direct stimulus to the economy of the Hunter Region and Nation through the initial investment of approximately $600 million. An estimated 83 per cent of the investment will be spent in Australia.

Main expenditures during the operation of the smelter will be salaries and wages, rates and taxes to local, State and Commonwealth Governments, maintenance, power, raw materials and transport costs. Salaries and wages will amount to an estimated $15 million per year.

Employment: The proposal will provide up to 1500 jobs on site during construction. An additional 420 to 600 jobs should be created indirectly in related industries. From 1985 onwards when the smelter is in operation, there will be 800 permanent jobs on site. Total new employment in the Hunter Valley resulting from the project will stabilise between 1400 to 2200 jobs.

The smelter will provide permanent jobs for approximately 560 unskilled and semi-skilled persons who will be trained by the Company,and 200 tradesmen.

It is estimated that up to 5400 permanent jobs will be created in Australia as a result of the project. Fifty per cent will be located in New South Wales. The Hunter Region will receive about 80 per cent of the new jobs in the State.

Income Effects: During construction an estimated $52 million is expected to be generated throughout Australia due to income multiplier effects. About $26 million should pass to people in the Hunter Region. When operational, the payroll income of $15 million will generate an additional income of between $21 million and $36 million throughout Australia due to indirect effects. Of this amount, between $7 million and $17 million will pass to the Hunter Region.

Infrastructure - Costs and Benefits: Benefits which the State Government will receive as a result of the smelter include harbour and berthing charges, payroll, consumption and income taxes, land tax and fuel tax. Costs include the wharf facilities, upgrading of Tomago Road and road maintenance costs. The State Government and authorities will receive an estimated net benefit of $60 million during the 52 year life of the smelter.

National Economic Impact: The project will result in over $300 million in export earnings for the Nation. This is 2.3 times the combined export value of the Australian raw materials inputs and is in accordance with the Commonwealth Government's policy that mineral products be upgraded before export. The export of aluminium will bring 30 times the value of the equivalent amount of export bauxite and upgrading of the raw material requires 25 times as many people as the equivalent mining operation. The smelting of aluminium provides 2.7 times as many jobs as production of the equivalent amount of alumina. It is expected that all raw materials, except for petroleum coke, aluminium fluoride and cryolite, will be purchased in Australia.

REGIONAL DEVELOPMENT AND PLANNING

The project will assist in the achievement of the Hunter Regional Plan's economic goals by substantial direct investment and job creation within the region. The smelter's location is in accordance with the recommended strategy of the Plan as it maximises the use of existing zoning and infrastructure and minimises disruption to existing and planned settlement patterns.

Regional developments which are related to the smelter include two power stations supplying power and supporting mines, the transmission lines from the power stations to the smelter, the unloading and loading facilities for raw materials at Kooragang Island and to a lesser extent the transport routes which connect these developments.

9.1 SCOPE

This final section of the Statement analyses the interaction of the fully safeguarded smelter proposal on the local, subregional and regional environments of the Tomago site.

The physical impact of the smelter construction on the site is considered first. The impact on energy resources, mineral resources and construction materials are then assessed. An Energy Statement is provided.

An assessment is made of the impact of the construction and operation of the smelter on the noise climate around the site.

The effects of the emissions to the atmosphere on air, surface and ground-water quality, soils, flora and fauna and land use in areas around the site are next considered.

The visual impact of the smelter and the impact of road transport of raw materials and products between the smelter and the port are assessed for the site and the transport route respectively.

Many of these assessments consider the potential impact of the smelter on aspects of the environment of the areas adjoining the site. A section has been presented to bring all of these aspects together and conclude as to the impact of the proposal on the residents and properties in the Tomago area.

The broader implications of the proposal are then considered in analyses of the impact on the social and economic aspects of the subregion and region, and on regional planning and development.

The information in the previous sections of the Statement has been drawn on in the analysis. The dispersion patterns and laboratory studies described in *Section 7* form the basis for the assessment of impacts resulting from emissions to the atmosphere on the environment described in *Section 6*. The Energy Statement examines the impact of smelter operations on energy resources. The sociological and socio-economic surveys described in *Section 6* are the basis for the assessment of the impact of the proposal on these aspects. Cost-benefit studies consider the economic implications.

The Summary in front of this Section presents the findings of the interaction analysis. The Summary and Overview at the beginning of the Statement concludes as to the overall impact of the smelter.

9.2 THE PHYSICAL IMPACT OF THE SMELTER CONSTRUCTION

9.2.1 Topography

The site is flat to gently undulating with little variation in elevations. The landforms are typical of the Tomago Sandbeds. They are not prominent or important features and have already been altered by clearing and levelling for coal mining operations and the construction of the Courtaulds textiles factory. The preparation of the site for both the preferred and alternative plant layouts will not cause major changes to existing landforms and hence is not a significant impact.

9.2.2 Geology and Foundation Conditions

The preferred layout for the smelter is partly on rock units of the Tomago Coal Measures and partly on sand units. It is also on the site of the former Tomago Colliery shaft.

With the exception of a small area adjacent to the former shaft, there is no evidence of subsidence on the site from underground coal mining. Substantial structures including the Courtaulds textiles factory and Stauffer chemicals plant are located on areas probably undermined without visible damage. Coal mining operations ceased over 55 years ago and it is the opinion of Mines Inspectors from the New South Wales Department of Mineral Resources that the overlying rock units are competent and no further subsidence will occur. Test drilling will be conducted prior to construction to determine any further action necessary.

The abandoned colliery workings are not expected to present any major problems.

9.2.3 Drainage Pattern

The smelter site is mostly underlain by sandbeds and there are no permanent flowing water channels. The proposed development will not alter existing stream courses or runoff patterns. The collection of runoff from an area of 15 ha comprising the smelter roof and sealed pavement areas will create a drainage pattern on the site. An adequate system of drains and dams has been provided to control the flows and ensure only treated discharge leaves the property. There will be no impact on the drainage courses of adjoining properties from discharges.

9.2.4 Soil Erosion

Rainfall on the sandbeds infiltrates through the soil to the groundwater table and the sandbeds are not prone to erosion. Earthworks for the smelter will not result in increased soil erosion of the sandbeds.

The electrical substation in the preferred plant orientation is located partly on bedrock of the Tomago Coal Measures. Clearing and levelling of the clayey soils on the bedrock units will be confined to the actual plant site and 100 m fire zone. Catch drains and other drainage works will ensure that there will be no increase in erosion of the clayey soils in this area.

The alternative plant orientation is located entirely on sandbeds and hence will have no impact on soil erosion.

9.2.5 Microclimate

Clearing of vegetation for the proposed plant will provide a funnel for westerly and easterly winds. Winds are expected to become turbulent in the vicinity of the high ground to the west of the plant. Both these effects should improve the dispersion of airborne emissions from the plant and help lower the average ground level concentrations.

It is also expected that a thermal buoyancy effect will be induced on the site due to the action of the smelter as a heat source and the loss of vegetation cover. This effect will contribute to greater dispersion of gaseous emissions, particularly on occasions of weak low level inversions.

The humidity of the area around the cooling towers will be raised by water losses. A steam plume may be visible on winter mornings or during periods of high humidity on warm days. These effects are expected to be very localised and will have no impact on areas away from the immediate vicinity of the plant.

9.2.6 Clearing of Vegetation

Approximately 45 ha of native vegetation will require clearing for both the preferred and alternative plant orientations.

The vegetation to be cleared for the preferred orientation includes the Rusty Gum *(Angophora costata)* - Red Bloodwood *(Eucalyptus gummifera)* Open-forest Association which is well conserved in New South Wales. The area involved is between the disused airstrip and the Courtaulds textiles factory and has already been considerably disturbed.

The preferred layout also involves clearing some of the Spotted Gum - Ironbark Association which forms a margin to the Rusty Gum - Red Bloodwood Association immediately north of the Courtaulds textiles factory. This association is well conserved in New South Wales and as it has been logged on the site its value is low.

A small section of the Ball Honey-myrtle Closed Scrub to be cleared is in a virgin state and appears to have been unaffected by the sand mining operation. It is poorly represented in the area and is poorly conserved in New South Wales.

The clearing of easements and the sand mining operations in the past have not resulted in the introduction of weeds on the Tomago Sandbeds. However, weeds could become a problem at the edge of the Spotted Gum - Ironbark Association at the western end of the preferred layout. Management of the site will ensure any weed infestations are controlled.

Clearing for the alternative orientation would affect a similar area to the preferred plant layout. The area involved is more centred on undisturbed bushland and a substantial amount of the Ball Honey-myrtle Closed Scrub would have to be removed.

Clearing the preferred plant location will have significantly less impact on vegetation than for the alternative orientation.

9.2.7 Effect of Clearing on Fauna

The removal of 45 ha of native vegetation will result in a reduction in the habitat of those animals utilising the site, which in turn will lead to a depletion of the animal populations. This applies particularly to the animals with relatively small territories, such as the Brush-tailed Possum.

Most of the land to be cleared for the preferred orientation is disturbed and therefore of reduced value to native fauna. No land containing locally rare habitat will be cleared.

In contrast, clearing for the alternative orientation would result in removal of part of the Ball Honey-myrtle Closed Scrub containing relatively more rare habitat. Apart from this area being less disturbed, a greater ecotonal length would be cleared.

Clearing for the preferred orientation will have less impact on native fauna than clearing for the alternative proposal. However, there will be an unavoidable impact as some individuals will be lost.

9.3 THE IMPACT ON ENERGY RESOURCES AND ENERGY STATEMENT

A full Energy Statement prepared in accordance with the guidelines issued by the Energy Authority of New South Wales is presented in *Appendix 17*. A summary of the main aspects of this Statement are presented below.

9.3.1 Electrical Power Generation

The New South Wales Electricity Commission has firm plans to expand the generating capacity of thermal power stations in New South Wales to meet projected growth demands expected to rise at between 5 per cent and 6 per cent per year.

In June 1979, the capacity of New South Wales thermal power stations was 7300 MW. By 1985, this is expected to rise to 10,100 MW with the completion of Eraring Power Station and expansion of Vales Point and Wallerawang. Further proposals under construction and consideration by the Commission are a four unit power station at Bayswater in the Hunter Valley and a three unit station at Mt. Piper in the western coalfields. These plants will boost New South Wales power station generating capacity to 14,400 MW in 1987.

9.3.2 Construction Energy Requirements

The energy to be consumed by the proposed smelter during the construction phase (1980 to 1985) consists of approximately 3.9 million kilowatt hours of electricity, 10.8 million litres of diesel fuel and 1.1 million litres of petrol. This energy will be used during the normal range of constructional activities, including on-site fabrication of steelwork and plant, workshop power and fuels used to power mechanical equipment, and are usual for a project of this magnitude.

9.3.3 Operational Energy Requirements

Table 9.1 shows the energy requirements of the proposed smelter at full production compared with the forecast future use patterns for New South Wales.

The table indicates that the proposed smelter will consume:

i. About one seventh of the capacity of Eraring Power Station planned for 1985.

ii. About 3 per cent of the New South Wales electrical system capacity planned for 1987.

iii. About 7 per cent of the total New South Wales electrical energy consumption in 1985.

This level of consumption will not result in significant depletion of the State's or Nation's energy resources.

TABLE 9.1

ENERGY REQUIREMENTS OF THE SMELTER AND FORECAST FOR NEW SOUTH WALES

Energy Source	Forecast N.S.W. Supply or Consumption (1985/86)	Smelter Requirements	Percentage Total
1. Primary Energy (10^{15} J)	1409.4	39.47	2.8
2. Electrical Total generating capacity (MW) in 1987	14,400	380	2.64
3. Electrical Energy (GWh)	48,600	3200	6.58
1. Natural Gas (m^3)	1.28×10^9	21.2×10^6	1.66
4. Diesel Fuel (1)	2196×10^6	1.08×10^6	0.05
5. Bunker Oil (1)	6646×10^6 (Australia)	6.19×10^6	0.09

Sources:
1. Demand for Primary Fuels in Australia (1978). *Department of National Development (Table 7)*.
2. Information supplied by Electricity Commission of New South Wales.
3. Extrapolation of 1970/71 to 1978/79 consumption data plus 1986 smelter consumption.
4. *Department of National Development (Table 16)*
5. *Department of National Development (Table 15)*

9.3.4 Coal Consumption

Approximately 1.4 mt of coal will be required each year to provide electrical energy to the Tomago smelter allowing for 30 per cent efficiency in the conversion of coal to electrical energy in thermal power stations and a 5 per cent transmission loss. This is less than 6.7 per cent of projected exports of black coal from the northern New South Wales coalfields in 1985 *(Joint Coal Board, 1979)*.

The insitu measured and indicated reserves of black coal on the northern New South Wales coalfields have been assessed at 17,600 mt *(Joint Coal Board, 1979)*. The Tomago smelter will consume 70 mt of coal over a 50 year life, which is approximately 0.4 per cent of these reserves. The allocation of this proportion of the State's coal resources to the proposed smelter will have no significant impact on any other economically viable industry or domestic use dependent on coal.

9.3.5 Coal Sterilisation

Both the preferred and alternative plant layouts are underlain by 30 mt of high fluidity coking coal at depths between 81 m and 335 m. Possible impact on site coal resources will relate to reduced recovery rates if surface subsidence is to be avoided.

This quantity of coal represents 0.2 per cent of the measured and indicated reserves of the northern New South Wales coalfields *(Joint Coal Board, 1979)*, and its loss does not justify the selection of an alternative location for the smelter. The loss is, in effect, a temporary loss as the recovery of the coal by future generations after the economic life of the smelter is not being inhibited. In this respect it is useful to remember that sand mining, a coal mine, military camp and a textiles factory have used areas of the site in this century and none of these uses now exist.

9.4 THE IMPACT ON MINERAL RESOURCES AND CONSTRUCTION MATERIALS

9.4.1 Bauxite

Australia's bauxite resources have been measured at 1763 mt with an additional 4416 mt indicated or inferred. Most of these resources are located on Cape York Peninsula (59 per cent of measured and 60 per cent of indicated or inferred). At full capacity, the plant will consume

880,000 t of bauxite (430,000 t of alumina) per annum. Consequently, resources of bauxite are more than adequate to supply the proposed smelter for in excess of 2000 years.

Allowing for an expected Australian aluminium smelting capacity of 1.4 mt of aluminium in 1985, Australia's bauxite resources are sufficient to supply the domestic aluminium industry for in excess of 300 years.

9.4.2 Industrial Sands

Low dunes capped with sand suitable for the manufacture of colourless glass products are located northeast of both the preferred and alternative plant layouts and hence will not be affected by the proposed development.

9.4.3 Heavy Mineral Sands

All known economic grades of heavy minerals in this area have been mined. Although no prospecting has been carried out on the plant site, on geological grounds, the New South Wales Department of Mineral Resources considers that there is no potential for mining.

9.4.4 Construction Materials

The quantities of construction materials required during the building of the smelter is shown in *Table 5.2*.

These materials will be trucked to the site, primarily from local sources.

The New South Wales Geological Survey has carried out surveys of construction materials in the lower Hunter Valley (*Chesnut and Gobert 1975, Smith 1978)*. These studies have shown that there are adequate sources of sand, gravel and road materials in the region to cater for the expected growth.

The proposed smelter will utilise a small proportion of the available estimated reserves and impacts on these resources will not be significant.

9.5 THE IMPACT OF CONSTRUCTION AND OPERATION OF THE SMELTER ON NOISE LEVELS

9.5.1 Procedure

Noise studies were conducted to examine the sound levels for the component operations of the smelter and the noise climate associated with the proposal as a whole.

Readings were taken at a smelter operated by the Company in the Netherlands and also at the smelter at Kurri Kurri. The data were analysed to determine the levels which will be exceeded 10 per cent of the time (L_{10}).

The sound level measurements taken within buildings, outside buildings, and adjacent to fixed items of external equipment such as transformers are given in *Table 9.2.*

TABLE 9.2

EQUIVALENT SOURCE NOISE LEVELS

	Noise Levels within buildings dB(A)	Noise Levels at 1 m outside building/or 1 m from exposed plant dB(A)
Potroom	83	73
Dry Scrubbers:		
Bag Filter Fans	-	84
Air Compressors	-	85
Cast house	90	85
Anode Manufacture:		
Green Anode Shop	93	83
Bake Oven	86	80
Rodding Shop	85	75
Substation:		
Transformers	-	77
Workshop		90
Trucks (Peak noise level)		96

The levels for the component operations were added to obtain the effect of the plant. As the smelter will be operated continuously, the noise from the fixed plant will be constant for both day and night.

The attenuation due to distance and ground absorption were calculated. Attenuation was taken as 20 $\log_{10}R$ for point sources such as the green anode shop and 15 $\log_{10}R$ for line sources such as the potrooms. In each case R is the distance from the source in metres. A reduction of 15 dB(A) per 100 m was allowed for ground absorption. This value is at the lower range of the values measured at a number of sites in the Hunter Valley and best fits the terrain and site conditions at Tomago.

9.5.2 Predicted Noise Climate

The predicted L_{10} night time and peak day time sound level contours are presented in *Figure 9.1* and *Figure 9.2* respectively. These values represent residual sound levels after the operational safeguards have been applied.

The night time sound levels due to the plant, which do not include the noise of truck movements on the site, require a maximum distance of 650 m from the source to dissipate to a level equivalent to the existing average night time background. The major source is noise from the workshop. Other items of plant with a lower source noise attain background levels between 550 m and 300 m from the source.

Two of the major noise sources, the compressors and fans associated with the dry scrubber system, will be shielded by adjacent buildings and will not contribute significantly to the overall noise climate.

The trucks transporting, loading and unloading raw materials and products will be the dominant day time noise sources. Peak noise levels of trucks travelling around the perimeter roads of the plant and along Tomago Road have been analysed as a worst case. A distance of 230 m is required to dissipate the noise associated with the truck operation to the existing average day time background level of 46 dB(A). For the minimum day time background level of 41 dB(A), 350 m is required to dissipate truck noise levels. Noise levels of 70 dB(A) at 20 m are currently experienced in the Company's property from trucks travelling along Tomago Road.

9.5.3 Assessment of Impact

Operations

Background night time noise levels at the residences along Tomago Road average 35 dB(A). Since attenuation due to distance and sound absorption will reduce the source noise from the smelter to levels less than 30 dB(A) at the nearest house, residents will not be affected by an increase in noise at night time.

Day time operation of the plant and truck movements on the Company's property will not create noise levels above background (41 dB(A)) at any residences in the vicinity of the proposed smelter. However, truck movements associated with the delivery of materials and the transport of products to the port will result in peak noise levels above background at houses along Tomago Road. In *Section 9.9* it is estimated that the increase in vehicles due to the smelter will average about 100per cent of the projected 1986 traffic loadings. Sound levels generated by these movements are likely to exceed 65 dB(A) at houses and will represent an unavoidable impact due to the proposal. The fact that the increases in heavy vehicle numbers will be restricted to day time hours and would have been realised when the Tomago area was zoned for industry mitigate the impact.

Construction

Maximum noise levels of earthmoving plant and other equipment needed for the preparation of the site and the fabrication and erection of the various buildings are expected to be 110 dB(A). This source will result in peak noise levels of up to 56 dB(A) at the closest residences along Tomago Road, shown on *Figure 9.1* as numbers 24 and 25. There will therefore be an unavoidable impact at these residences during the construction phase.

The impact will be reduced in significance by several factors. Firstly, the two residences which would receive the highest noise level will be partially screened by a low sand dune. Secondly, the majority of construction operations will be carried out in daylight hours when background noise levels are higher. Thirdly, operations in a particular area will not be constant and the average noise levels will be substantially less than the peak.

The heavy vehicles delivering materials and plant will also contribute to increased noise levels at houses along Tomago Road during construction. The nature of increased noise will be similar to those already generated in the industrial zone at Tomago.

9.6 IMPACT OF SMELTER EMISSIONS

9.6.1 Basis for Impact Assessment

Table 9.3 lists the emission dispersion figures and isopleths that have been used to assess impacts on the site environment and describes the significance of each isopleth for impact assessment.

9.6.2 Air Quality

Dust

Since the site is underlain by sand, ambient dust levels are low (1.95 $\pm$ 0.18 g/m^2.mth) and only 46 per cent of the level measured by the State Pollution Control Commission in Newcastle for October to November 1977 (4.22 $\pm$ 0.27 g/m^2.mth).

Dust may increase during construction but the levels are expected to be low and confined within the site boundaries.

Fine and coarse particulates of alumina, carbon and frozen droplets of bath will be emitted by the smelter after start up. Coarse particulates will be deposited on the roofs of the potrooms and immediate surrounds and will be collected in runoff during rain periods. *Figure 7.7* shows the pattern of dispersion of the finer particulates (Fp) close to the smelter. Approximately eleven occupied residences east of the site will receive an average of 2.0 mg.Fp/m^2.d, which is approximately 0.06 g/m^2.mth. These residents will be marginally inconvenienced by the predicted 3 per cent increase in the dust deposition rates. Residents outside this zone will receive lower levels of dust and impacts will be minimal.

Footnote: Gaseous concentrations : 1 ppb.HF (by volume) = 0.9 μg.HF/m^3

TABLE 9.3

PARAMETERS FOR IMPACT ASSESSMENT

Component	Dispersion Pattern (Figure No.)	Isopleths	Significance of Isopleth
Air Quality	7.7 7.3 7.4	2.0 mg.Fp/m^2.d All	Dust levels. Shows predicted monthly average ground level concentration for comparison with most air quality standards.
Soils	7.7 7.8	5 mg.Ft/m^2.d 0.5 mg.Ft/m^2.d	Show likely particulate and gaseous deposition on soil surface surrounding the site. For impact assessment the Ft isopleths have been considered assuming all emissions are deposited on the soil.
Surface Water	7.7 7.8	5 mg.Ft/m^2.d 0.5 mg.Ft/m^2.d	Shows likely deposition on surface water bodies assuming all emissions are deposited on the surface of water. Provides estimates of likely concentrations in water bodies.
Groundwater	7.7 7.8	5 mg.Ft/m^2.d 0.5 mg.Ft/m^2.d	Provides indication of fluoride levels deposited on soil and hence maximum concentrations available for transmission to the groundwater. *Figure 7.8* shows pattern of dispersion over entire Tomago Sandbeds Water Supply Catchment.
Native Vegetation	7.1 7.2	0.5 μg.Fg/m^3	Figures indicate variation in fluoride dispersion each month and hence provide data for prediction of short term and seasonal effects.
	7.4	0.5 μg.Ft/m^3	Indicates maximum levels that can be achieved in any one month. For impact assessment this figure is considered the worst case.
			Sensitive native species can show damage at levels of 0.5 μg/m^3 on a 3 month average.

TABLE 9.3 (cont'd)

PARAMETERS FOR IMPACT ASSESSMENT

Component	Dispersion Pattern (Figure No.)	Isopleths	Significance of Isopleth
Forage	7.1 7.2	0.5 μg.Fg/m^3 0.1 μg.Fg/m^3	*Figures 7.1* and *7.2* indicate monthly variations in fluoride dispersion and provide data for prediction of short-term and seasonal effects. Although the Fg is a measure of the most reactive portion of the emissions Ft have been considered as the worst case for impact assessment.
	7.3	0.3 μg.Ft/m^3	Barley, sorghum and clover species are known to be sensitive within the 0.5 μg/m^3. Sorghum may experience effects within the 0.1 μg/m^3. Limits on forage levels indicate that effects may occur within the 0.3 μg/m^3 isopleth *(SPCC, 1980)*.
Garden plants, vegetables and fruit	7.3 7.4	0.5 μg.Ft/m^3	Stone fruit orchards, gladioli and other sensitive species should be grown outside the 0.1 μg/m^3 zone. Grapes considered sensitive within the 0.1 μg/m^3 zone *(SPCC 1980)*.
	7.5	0.1 μg.Ft/m3	Barley, citrus species, sorghum clover and other similar species of equivalent sensitivity should be grown beyond the 0.5 μg/m^3 isopleth *(SPCC 1980)*.
Wildlife	7.3 7.4	0.3 μg.Ft/m^3	Sensitive native species may be at risk within the 0.3 μg/m^3 zone *(SPCC, 1980)*.
Grazing animals	7.3	0.3 μg.Ft/m^3	Cattle grazing should be carried on outside the 0.3 μg/m^3 zone on a long-term basis *(SPCC, 1980)*.
Human health (Current limit set by the Australian Health and Medical Research Council on hydrogen fluoride in the workplace is 2.0 mg/m^3.)			

Note: *SPCC = State Pollution Control Commission.*

Steam

On some mornings, a steam plume will be visible near the cooling towers. Dust particles within the steam will be dispersed adjacent to buildings on the site as the steam condenses and will not inconvenience nearby residences.

Gaseous and Particulate Fluorides

Standards specified for ambient fluoride are detailed in *Appendix 18*. Examples of allowable monthly average concentrations of gaseous hydrogen fluoride are 0.82 $\mu g/m^3$ in Kentucky, 1.2 $\mu g/m^3$ in Tennessee, 1.0 $\mu g/m^3$ in Ontario and 0.45 $\mu g/m^3$ in Newfoundland. All of these concentrations are far lower than those which may cause adverse effects on human health.

Figure 7.4 shows that the predicted maximum monthly concentration of gaseous fluoride exceeds 1.0 $\mu g/m^3$ to the east and southeast of the site for approximately 1 km along Tomago Road. The area affected includes Tomago Public School, Tomago House and nineteen other residences.

The 0.5 $\mu g.Fg/m^3$ isopleth of maximum monthly concentration (*Figure 7.4*) covers almost 6 km of Tomago Road east from the Pacific Highway and encompasses an additional 30 houses to the west, southwest, east and southeast of the site. The fishing huts on the northern edge of Kooragang Island also fall within this zone.

Sulphur Dioxide

The height of the stacks on the dry scrubber units has been specified at approximately 60 m to meet the requirements of the State Pollution Control Commission for predicted ground level concentrations of sulphur dioxide.

Existing sulphur dioxide levels measured by the Commission at North Stockton for the January to September 1979 period were 25 $\mu g/m^3$ (measured as acid gases). *Figure 7.9* indicates the pattern of dispersion of sulphur dioxide emissions from the smelter and shows that the levels are expected to increase by up to 1.0 $\mu g/m^3$, that is by 4 per cent. This represents a negligible increase and the impact from sulphur dioxide emissions will not be significant.

9.6.3 Soil

Figures 7.7 and *7.8* have been used to assess the impact of particulate and total fluoride emissions deposited on the soil surface surrounding the smelter. The figures show that more than 5 mg.Ft/m^2.d or 1825 mg.Ft/m^2.y will be deposited adjacent to the plant and that the levels of deposition drop significantly beyond the Company's boundary.

Rainfall provides the mechanism for the transfer of water soluble fluorides into the soil. Soluble fluorides may be derived directly from fallout or from the decomposition of vegetation. Experimental work described in *Appendix 6.8* suggests that between 40 and 75 per cent of fluoride in leaves high in fluoride may be passed to the soil on decomposition.

If it is assumed that all the fluoride emissions directly deposited on the surface within the 5 mg.Ft/m^2.d isopleth are soluble in rainfall (1156 mm each year), then more than 1.5 mg.F/1 would be found in the soil water within the upper horizons of the profile. Experimental work (*Appendix 6.8*) has shown that fluorides tend to be fixed in these horizons, that the levels decrease rapidly with depth and do not add significantly to the concentrations in groundwaters. Some minor increases in fluoride levels in vegetation may result from the uptake of soil fluoride, but these have not been found to be significant *(Hansen et al, 1958 and McClenahen, 1976)*.

It follows that in the worst situation close to the smelter, and after assuming that all the fluorides are soluble, which is not the case, then the deposition on the surface will have no significant impact on soil productivity. Beyond the 5 mg.Ft/m^2.d isopleth and the Company's property, increases in soil fluoride levels caused by emissions from the smelter will be insignificant and soil productivity will be unaffected.

Details of the complexing processes and the effects of fluoride on soils are given in *Appendix 4.3*. *Section 9.6.5* considers the relationships between fluorides, soils and groundwaters further.

9.6.4 Surface Water

The main water bodies within the zone of influence of the proposal are the Hunter River and the small, fresh water lagoons and swamps on the site and in the Tomago Sandbeds Water Supply Catchment area.

Figure 7.7 shows the annual average deposition of fluoride emissions around the smelter and forms the basis for impact assessment on surface water bodies. *Figure 7.8* has been used to predict the impact on the more distant water areas.

Fresh Water Quality

The small fresh water lagoon adjacent to the disused airstrip falls within the 5 mg.Ft/m^2.d isopleth and will receive the highest fluoride levels.

A concentration in the lagoon of 3.65 mg.F/1 would be reached if conditions of zero rainfall and total solubility of fluorides are assumed, however, absorption by the vegetation canopy and dilution by rainfall will reduce this level and fluoride contents of the order of 1 mg.F/1 (1 ppm.F) should occur. No significant impact on water quality is expected. This prediction will be verified by the regular monitoring programme proposed.

The fresh water lagoons more remote from the smelter will receive lower levels of emissions. Grahamstown Reservoir shown in *Figure 7.8* will receive less than 0.010 mg.Ft/m^2.d which will result in a concentration of less than 0.002 mg.F/1 and a negligible impact.

Estuarine Water Quality

Atmospheric Emissions: Combinations of tidal flushing, fresh water inflows and the large volume of water in the Hunter River will ensure that the fluoride emissions from the smelter will have no significant effect on the water quality of the Hunter estuary.

Discharges from the Smelter: All discharges from the smelter will be to the Hunter River. As indicated in *Section 8.10.2*, the fluoride content of discharges after treatment during wet weather will not exceed 10 ppm (=10 mg/1). Assuming a dilution factor of 1 in 50, corresponding to the

Footnote: Fluoride in water : 1 ppm (weight) = 1 μg/g = 1 mg/l.

wettest month and hence highest discharge (*Section 8.6*), the fluoride level in the river is not expected to increase by more than 0.02 ppm. This level does not take into consideration the additional dilution caused by increased river flow. At other times the increase in fluoride levels in the Hunter River will be significantly less than this concentration.

The existing fluoride levels in the Hunter River at Tomago are approximately 1 ppm, therefore the effluent from the proposed smelter may cause the fluoride content to increase to 1.02 ppm, which is well below the acceptable fluoride level of 1.5 ppm for Class 'C' : Controlled Waters, specified in the New South Wales Clean Waters Act.

Figure 7.9 shows the predicted pattern of sulphur dioxide emissions from the smelter. Background sulphate levels in fresh water bodies on the site average 187 mg/l. Consequently, predicted concentrations will not add significantly to existing levels.

9.6.5 Groundwater

The safeguards proposed by the Company to control runoff and drainage and dispose of solid process wastes safely off the site will ensure that the gaseous and fine particulates emitted to the atmosphere are the only potential source of contamination of the groundwater aquifers.

Figure 7.7 shows the pattern of emission dispersion in the vicinity of the smelter and *Figure 7.8* the distribution of fluoride emissions over the larger area of the Tomago Sandbeds.

Figure 7.7 indicates that levels of 5 $mg.Ft/m^2.d$ can be expected on the Tomago Sandbeds close to the site and have the potential to move through the soil to the groundwaters.

Quantities of fluoride greater than 1825 $mg.F/m^2.y$ will be deposited within the 5 $mg.Ft/m^2.d$ isopleth. Assuming that all the emissions are soluble in water and that no complexing occurs with soil ions in the sand, approximately 1.5 mg.F/l in the soil water would be available for leaching to the groundwater table by rainfall (1156 mm per year).

However, these assumptions need to be qualified because not all emissions are soluble or have the ability to be transferred from the soil to the groundwater. The experimental investigations described in *Appendix 6.8* examined the potential for fluoride to be transferred to the soil by washing from vegetation, decomposition of the leaf litter and from the products of bushfires, and the mechanism for transferring fluoride from the soil to the groundwater. The results obtained using fluoride solutions up to 20 mg/l, that is 13 times more concentrated than the predicted absolute maximum soil water concentration within the 5 mg.Ft/m^2.d isopleth, showed that the soil absorbs an average of 87 per cent of the fluoride in the soil water.

On this basis approximately 0.2 mg.F/l would reach the groundwater table, where the dilution of groundwater flows would further lower the level to 0.1 mg.F/l. Combined with the existing background fluoride levels in the groundwater of 0.08 mg.F/l, an average level of 0.18 mg.F/l would result, which is well below the recommended level of 1 ppm fluoride in drinking water for dental health benefits.

This analysis was based upon the worst situation of the highest fallout close to the smelter. Nearly all of the Tomago Sandbeds area will receive fluoride levels substantially less than this maximum and it is concluded that overall the proposal will have no significant effect on groundwater quality. The comprehensive programme of monitoring proposed by the Company will watch the conditions closely, but at this stage all evidence points to there being no problems and the effect of the smelter on the quality of Newcastle's water supply should not be a cause for concern.

The sulphur dioxide emitted from the smelter is not expected to increase the quantity of sulphates in soil and groundwater significantly. Predicted levels are expected to be below 250 mg/l, the New South Wales recommended standard.

9.6.6 Native Vegetation

Sensitivity of Native Vegetation to Fluoride

A summary of the potential physiological, mutagenic and biochemical effects of fluoride emissions on vegetation is given in *Appendix 9.6.*

Footnote: Fluoride in vegetation 1 ppm (weight) = 1μg/gm = 1 mg/kg.

Figures 7.1, 7.2, 7.3 and 7.4 have been used as the most appropriate dispersion patterns to assess the impacts. Although gaseous fluorides are the most reactive emissions and considered the more damaging to plants, the Ft isopleths have been used to allow for the background foliar fluoride levels on the site *(Section 7.2)* and a conservative appraisal.

Table 9.4 lists the known sensitivities of native vegetation reported by *Doley and Henry (1978), Hutchison (1979) and The State Pollution Control Commission (1980).* As specified in *Section 2.6*, the 0.5 $\mu g/m^3$ isopleth has been taken to represent the zone in which sensitive Australian vegetation is at risk when the three month average of gaseous fluorides exceeds this level. *Table 9.5* lists areas of assemblages within the isopleths.

Figures 7.1 and 7.2 showing the monthly variations in fluoride levels indicate that in summer the largest area within the 0.5 $\mu g.Fg/m^3$ isopleth is west of the site, to the east and southeast in autumn and winter, and occurs on the site in spring. The vegetation will respond according to the seasonal variations in fluoride levels.

For example, the Spotted Gum - Ironbark Association to the west of the smelter site is within the 0.5 $\mu g.Fg/m^3$ isopleth during November to March and outside it for the other months. The Ball Honey-myrtle Scrub occurs within it during the April to September period and outside it for the remaining five months. *Table 9.4* indicates that the former species are more sensitive than the latter.

The response of the vegetation shown in *Figure 6.13* close to the plant is likely to be as follows:-

> *Spotted Gum - Narrow-leaved Ironbark:* Ten per cent of the area within the 0.5 $\mu g.Ft/m^3$ shown in *Figure 7.4* is covered by the Spotted Gum - Ironbark Association. The sensitive Spotted Gum is expected to be damaged by smelter emissions, but the more resistant Narrow-leaved Ironbark should not be seriously affected. In the long term, the Narrow-leaved Ironbark may become the dominant species in the association.
>
> As the Spotted Gum - Ironbark Association is entirely within the boundaries of the Company's property the effects on the species will be confined to the site. The Company proposes to replace species affected by emissions by more resistant species as part of its management policy.

TABLE 9.4

KNOWN SENSITIVITIES OF MAJOR NATIVE TREE SPECIES

Species	Sensitivity	Source and Comments
*Grey Mangrove *(Avicennia marina)*	R	*Hutchison (1979)* found foliar necrosis after 1000 µg.F/g in the leaves. Similar levels were also found in mangroves growing near a fluorine chemical plant (*State Pollution Control Commission, 1980*).
*Spotted Gum *(Eucalyptus maculata)*	S	*Murray (1979)* and *Doley (1980)* found significant visible damage to the foliage and growth habit of trees near an aluminium smelter. *State Pollution Control Commission (1980)* also states the *E. maculata* is sensitive to fluoride.
*Forest Red Gum *(Eucalyptus tereticornis)*	S	*State Pollution Control Commission (1980)* states that this species is sensitive to fluorides. *Doley (1975)* found the species to be resistant, from fumigation trials.
*Ball Honey-myrtle *(Melaleuca nodosa)*	R	*Murray (1979)* and *Doley (1980)* found that this species can tolerate high foliar fluoride levels at distances close to an aluminium smelter without major plant damage.
*Broad-leaved Paperbark *(Melaleuca quinquinervia)*	R	*State Pollution Control Commission (1980)* and *Doley (1975)* suggest that this species is tolerant to fluorides.
*Grey Gum *(Eucalyptus punctata)*	S	*State Pollution Control Commission (1980)*
Small-leaved Apple *(Angophora bakeri)*	S	*State Pollution Control Commission (1980)*
Golden Wattle *(Acacia longifolia)*	S	*State Pollution Control Commission (1980)*
Gosford Wattle *(Acacia prominens)*	S	*State Pollution Control Commission (1980)*
*Red Banks Grevillea *(Grevillea banksii)*	I	*State Pollution Control Commission (1980)*
Red Ironbark *(Eucalyptus sideroxylon)*	I	*State Pollution Control Commission (1980)*
White Honeysuckle *(Banksia integrifolia)*	I	*State Pollution Control Commission (1980)*

(continued)

TABLE 9.4 (cont'd)

KNOWN SENSITIVITIES OF MAJOR NATIVE TREE SPECIES

Species	Sensitivity	Source and Comments
*Red Bottlebrush (*Callistemon citrinus*)	R	*State Pollution Control Commission (1980)*
*Brush Box (*Tristiana conferta*)	R	*State Pollution Control Commission (1980)*
*Narrow-leaved Ironbark (*Eucalyptus crebra*)	R	*State Pollution Control Commission (1980)*
*Swamp Oak (*Casuarina glauca*)	R	*State Pollution Control Commission (1980)*

Key: Resistant (R) = foliar fluoride levels >500 mg/kg cause damage.
Sensitive (S) = foliar fluoride levels <50 mg/kg cause damage.
Intermediate (I) = foliar fluoride levels 200 mg/kg cause damage.
*Species occurring on or near the Tomago site.

TABLE 9.5

AREAS OF VEGETATION ASSEMBLAGES WITHIN THE Ft ISOPLETHS (ha)

(Figure 7.4)

Assemblage	>1.0	1.0 to 0.5	0.5 to 0.2	0.2 to 0.1
Swamp Mahogany Broad-leaved Paperbark	5.89	16.04	25.19	173.75
Ball Honey-myrtle	25.10	11.16	---	---
Rusty Gum-Red Bloodwood	121.3	110.18	148.1	51.32
Spotted Gum-Ironbarks	5.0	36.88	5.06	
Blackbutt-Rusty Gum	---	31.25	93.96	
Scribbly Gum-Red Bloodwood	---	23.78	49.79	
Forest Red Gum	---	---	9.38	
Mangroves	---	5.4	237.7	63.3
Salt Marsh	---	---	78.5	46.88

Ball Honey-myrtle and Broad-leaved Paperbark: These species within the Swamp Mahogany - Broad-leaved Paperbark Association make up 9 per cent and 6 per cent respectively of the assemblages within the 0.5 μg.Ft/m^3 isopleth. They are considered to be resistant and should show little damage.

Forest Red Gum: Approximately 0.9 per cent of the area within the 0.2 μg.Ft/m^3 isopleth is covered by the Forest Red Gum, a species known to be sensitive to fluorides. This species may exhibit seasonal damage, but is unlikely to be permanently affected as it occurs 1.5 km from the smelter.

Swamp Oaks and Paperbarks: Resistant species such as Swamp Oaks and Paperbarks are not expected to show any visible foliar damage except in locations very close to the smelter. The Grey Mangrove and Swamp Oaks are 1 to 2 km away and well outside the 1.0 and 0.5 μg.Ft/m^3 isopleths. The impact is likely to be insignificant.

Other Tree Species: Little is known of the sensitivity of the predominant tree species. The Rusty Gum and Red Bloodwood communities cover 430 ha, 54 per cent of which occurs within the expected 0.5 μg.Ft/m^3 isopleth. *Doley (1980)* has suggested that the bloodwood species are sensitive to fluoride and, if so, the impact on these stands could be significant. All the eucalypt species are expected to be affected to varying degrees when close to the plant.

Mangrove-Salt Marsh Areas: Figures 7.1 and *7.2* show that the Mangrove-Saltmarsh areas of Kooragang Island and Fullerton Cove are outside the 0.5 μg.Fg/m^3 isopleth for every month. About 5.4 ha of Mangroves fall within the 1.0 and 0.5 μg.Ft/m^3 isopleth on *Figure 7.4*.

Studies have been conducted on the effects of fluoride on Grey Mangrove *(Avicennia marina)* and Sand Couch *(Sporobolus virginicus)* occurring in the Mangrove-Salt Marsh areas of Kooragang Island and Fullerton Cove. *Doley (1975)* and *Hutchison (1979)* found that the Grey Mangrove is moderately resistant to fluorides. Even within 200 m of a fluoride manufacturing plant, where fluorides were highly concentrated, visible foliar damage and lack of flowering were observed but loss of the assemblage had not occurred.

Although no experimental work has been done on other species within the Salt Marsh assemblages it is considered that fluoride tolerance correlates with salt tolerance *(State Pollution Control Commission, 1980)*.

Henry and Doley (1978) found that Sand Couch developed slight tip necrosis and a reduction in photosynthesis when fumigated with 7.5 μg.F/m^3. It was concluded that, if considering visible injury only, the species was resistant but if considering growth rate, the species is intermediate in its tolerance. Since the main Sand Couch areas are outside the 1.0 μg/m^3 isopleth they will not be significantly affected by fluoride emissions from the plant.

It is concluded that the Mangrove-Salt Marsh areas will not suffer any significant damage from fluoride emissions from the proposed smelter.

Ecological Significance

It is likely that the long-term effects of fluoride emissions on the vegetation of the Tomago Sandbeds will result in a change in structure and composition of plant communities. The changes will be more noticeable among the sensitive species in close proximity to the plant.

O'Connor et al (1974) found during fumigation studies that seedlings of Acacia and Eucalyptus displayed visible signs of foliar damage after only three hours exposure to 1 ppm sulphur dioxide. *Figure 7.9* shows that this concentration is considerably higher than those expected around the plant. The predicted sulphur dioxide levels from the smelter should have no impact on flora.

The programme of continuous monitoring proposed by the Company will ensure that any changes occurring in the vegetation of the perimeter zone are recognised and measures taken to correct the condition and manage the plant communities.

9.6.7 Crops and Forage

Sensitivity to Fluoride

Table 9.6 lists areas of grazing land within the Ft isopleths shown on *Figure 7.4*. *Figures 7.1, 7.2* and *7.3* have been used to assess seasonal effects and to predict the annual average fluoride levels.

Section 6 describes the areas under cultivation.

TABLE 9.6

SURFACE AREAS OF AGRICULTURAL LAND
USES WITHIN THE Ft ISOPLETHS OF FIGURE 7.4

Land Use (ha)	Isopleths (μg.Ft/m^3)			
	>1.0	1.0 to 0.5	0.5 to 0.2	<0.2
Dairying	34.4	63.8	178.0	90.6+
Cattle Grazing	6.3	62.5	7.5	-
Horse Breeding	21.9	119.4	90.6	40.6+
Mixed Grazing	36.3	430.0	525.0	143.8+
Land which has been cultivated/improved at some time but not in agricultural use	10.0	31.3	131.2	45.0+
Total	108.9	707.0	932.3	320.0+

Table 9.7 lists the known sensitivities of the various crops and forage species grown.

TABLE 9.7

SENSITIVITY TO FLUORIDE EMISSIONS OF
CROP AND FORAGE SPECIES

Sensitive	Intermediate	Resistant
Barley	White Clover	Alfalfa (Lucerne)
Sorghum	Field Corn	Sunflower
Sweet Corn	Oats	
	Wheat	

Sensitive: Foliar fluoride levels of 50 mg/kg cause damage
Intermediate: Foliar fluoride levels of 200 mg/kg cause damage
Resistant: Foliar fluoride levels of 500 mg/kg cause damage.

Note: Sensitivity of Kikuyu, Couch, Paspalum, Buffalo Grass and Rye Grass are unknown.

Source: *State Pollution Control Commission (1980).*

Based on the criterion in *Section 2.6* that such plants as barley, and clover should be grown beyond the 0.5 μg.Ft/m^3 annual average isopleth, the following guidelines were used for impact assessment. Sensitive species will generally be affected within the 0.3 μg.Ft/m^3 zone but some very sensitive species, such as sorghum, may be affected within the 0.1 μg.Ft/m^3 isopleth. Species of intermediate sensitivity may be at risk within the 0.5 μg.Ft/m^3 isopleth, while resistant species can tolerate higher fluoride levels. The forage levels in *Section 2.6* were also adopted. The limit of 35 mg/kg has been taken as being equivalent to 0.3 μg.Ft/m^3.

Impact Assessment

Figure 7.3 shows that the predicted 0.3 μg.Fg/m^3 annual average fluoride isopleth encompasses the dairy, grazing properties for horses and cattle and a portion of a mixed grazing property east of the site. Species listed as being intermediate to sensitive may be at risk on these properties.

The horse breeding-cattle grazing property on the Pacific Highway is expected to receive levels between 0.3 and 0.1 μg.Ftm/^{3} and hence barley and sorghum crops could be damaged. Parts of the dairy property and the buffalo grass farm occur within the 0.5 μg.Ftm/^{3} zone. White Clover on the dairy will be affected by emissions but the lucerne is expected to be resistant.

Regular attention to the bent grass on the greens of Courtaulds bowling club will result in no damage to this grass species.

Figures 7.1 and *7.2* showing monthly variations in fluoride levels suggest that the areas of pastureland to the southeast and east of the site may be affected in the winter months from April to September. Any impacts may be exaggerated by the tendency for increased concentration of fluorides during winter when the fluorides are not diluted by the rapid growth of leaf blades *(Suttie, 1977)*. It is concluded that damage to sensitive to intermediate pasture species would be most likely in winter in the pasturelands to the southeast and east of the proposed smelter in the 0.5·μg.Ft/m^3 maximum isopleth.

Existing background levels in species sampled from the locations shown on *Figure 6.13* indicate that Couch Grass (*Cynodon dactylon*) had an average fluoride concentration of 10.5$\pm$1.5 ppm (*Table A9.2*) and Water Couch (*Paspalum paspaloides*) at Fullerton Cove, 6 km from the nearest fluoride source on Kooragang Island showed levels of 11.5 ppm (*Murray, 1980*). These levels are all below the threshold of high sensitivity. Levels measured in species on Kooragang Island averaged 56.4 ppm and ranged from 13 to 138 ppm (*Murray, 1980*) but effects on plants showing these levels have not been documented.

9.6.8 Garden Plants, Vegetables and Fruit

Sensitivity to Fluoride

Appendix 9.4 suggests that a large number of ornamental plants and vegetables are grown within the vicinity of the smelter site. The relative resistance of these species to fluoride emissions may vary in a similar manner to native vegetation, crops and forage.

Figures 7.3 and *7.4* have been used to assess the effects on species surrounding the proposed smelter. *Figures 7.5* and *7.6* show the limits of the 0.1 μg.Ft/m^3 isopleth in the region and have been used for commercial orchards and vineyards. Plants and vegetables are watered frequently and impact assessment was based on the Fg isopleths to allow for the fact that particulates may be washed from the leaves.

Table 9.8 indicates that species of fruit considered sensitive to emissions include stone fruits such as peaches, plums and apricots, and grapes. Garden shrubs showing high sensitivity are freesias, gladioli, pines and pittosporum. The criteria in *Section 2.6* specify that orchards growing stone fruit and gardens growing gladioli and other sensitive species should be sited outside the 0.1 μg.F/m^3 isopleth and certain citrus species and other plants of intermediate to high sensitivity should be sited outside the 0.5 μg.F/m^3 isopleth.

> *Stone Fruits:* Stone fruit orchards occur at Medowie, approximately 15 km to the northeast of the smelter, and at Black Hill approximately 12 km to the west. Both areas are sited well outside the maximum monthly 0.1 μg.Fg/m^3 isopleth (*Figure 7.6*)

TABLE 9.8

SENSITIVITY TO FLUORIDE EMISSIONS
OF FRUIT, VEGETABLES AND GARDEN SHRUBS ETC.

Sensitive	Intermediate	Resistant
	FRUIT	
Apricot Blueberry Grape Peach Plum Prune	Apple Cherry Grapefruit Orange Strawberry Tangerine	Fig Pear
	VEGETABLES	
	Pepper Sweet Potato Spinach Tomato	Asparagus Bean Cabbage Carrot Cauliflower Celery Cucumber White Potato Squash
	GARDEN SHRUBS, ORNAMENTAL TREES, ETC.	
Freesia Gladiolus Pine # Pittosporum	Aster Azalea Frangipanni Geranium Norfolk Island Pine Narcissus Red Oleander Poinsettia Rhododendron Rose Violet	Camellia Camphor Laurel Chrysanthemum Roman Cypress Dahlia Hibiscus Marigold Garden Pea Poplar Privet Weeping Willow

Key:

# Various varieties
Sensitive = foliar fluoride levels <50 mg/kg cause damage
Intermediate = foliar fluoride levels 200 mg/kg cause damage
Resistant = foliar fluoride levels >500 mg/kg cause damage.

Source: *State Pollution Control Commission (1980)* and the annual average 0.1 μg.Fg/m^3 isopleth *(Figure 7.5)* and will not be affected by emissions from the proposed plant.

Grapes: Grapes vary in their sensitivity to fluoride *(Weinstein 1977, Brewer et al, 1957, Doley, 1980)*. Concentrations of fluoride causing visible injury in grape leaves have been found to range from 20 ppm upwards *(Brewer et al, 1957; Cox, 1980)* with seasonal variations. The fruits typically accumulate only low levels of fluoride (for example, 1.3 ppm) whereas leaves from the same area may contain 100 ppm *(Brewer et al, 1957)*. Visible damage to leaves during the early growing season may be associated with reduced photosynthetic activity and a decrease in the sugar content in fruit which is considered undesirable.

The closest commercial vineyard to the proposed smelter is 30 km to the west of the site. As the locations are well outside the 0.1 μg.Ft/m^3 annual maximum monthly isopleth, there will be no significant impact due to the smelter.

Commercial Vegetable Growing: Figure 7.4 indicates that a commercial vegetable garden is located outside of the 0.5 μg.Fg/m^3 isopleth but within the 0.2 μg.Fg/m^3 zone.

Weinstein (1977) states that most common vegetables are intermediate to tolerant in sensitivity to fluorides and deterioration only occurs when the concentrations are high enough to limit plant growth and inflict visible damage. *Magill, Holden and Ackley (1956)* found that exposure to fluoride concentrations greater than 1.2 μg/m^3 for 7 to 9 days was necessary to cause slight injuries to tomatoes, cucumber and squash. As levels of 1.2 μg.F/m^3 are predicted to be restricted in any one month to areas within 1 km of the plant, damage to these vegetables is regarded as unlikely. The greatest potential for damage to sensitive species will occur in the winter months when 0.2 μg.Fg/m^3 may be exceeded, however, as most vegetables are spring/summer crops the risk will be low.

It is concluded that vegetable growing will not be significantly affected by the smelter operations. The Company's monitoring programme will maintain a continuous watch for damage.

Orchids: An orchid nursery occurs on the 0.5 μg.Fg/m^3 annual average isopleth shown on *Figure 7.3*. The effects of fluorides on orchids are unknown but, because most are grown under cover, the impacts are expected to be less than for plants grown in the open. The Company will provide a glasshouse to protect sensitive orchid species cultivated at the orchid nursery.

Nurseries: The nurseries at the Rutile and Zircon Mines (Newcastle) Limited plant and at Motto Farm are outside the 0.5 μg.Fg/m^3 maximum monthly isopleth but within the maximum 0.1 μg.Fg/m^3 zone. Only the Rutile and Zircon Mines (Newcastle) Limited nursery occurs within the annual average 0.1 μg.Fg/m^3 zone. Although the most sensitive species at the nurseries may be affected occasionally, the plants are not normally kept for long periods and significant damage is unlikely to occur. The monitoring programme will detect any impact and control measures will be taken.

Pines: Studies have shown that varieties of pines are sensitive to fluoride emissions. Pine species occurring within the grounds of Tomago House include Bunya Pine *(Araucaria bidwillii)*, Norfolk Island Pine *(Araucaria heterophylla)* and Radiata Pine *(Pinus Radiata)*. Radiata Pine is also grown in the grounds of Tomago School and the pine plantations of Hardboards Australia Limited consist of Slash Pine *(Pinus elliottii)* and Radiata Pine. Only the sensitivity of Norfolk Island Pine is known and is rated as intermediate. It has been found that old pine needles are more resistant than young needles. Analyses of a pine species from house 22 on Tomago Road *(Figure 6.18)* gave results of 39.2 ppm and no visible damage was observed.

Both Tomago House and the school occur within the 0.5 $\mu g.Fg/m^3$ isopleth of *Figure 7.3*. Because of the relative sensitivity of pines to fluoride emissions it is considered likely that these pines will be at risk from emissions. The pines of Hardboards Australia Limited are beyond the 0.1 $\mu g.Fg/m^3$ maximum levels and are not expected to be damaged.

Domestic Gardens: The fruit, vegetables, garden shrubs and ornamental trees listed as sensitive in *Table 9.8* will be at risk when grown within the 0.3 $\mu g.Fg/m^3$ annual average isopleth. All the gardens attached to houses on Tomago Road, from house 18 to house 53 shown on *Figure 6.18* are likely to be affected.

Within the 0.5 $\mu g.Fg/m^3$ isopleth, it is expected that species listed as resistant will suffer no ill-effects, but other species of intermediate sensitivity may be at risk. This zone contains houses 19, 22 and 24 to 33 on Tomago Road.

A preliminary analysis of some garden and vegetable plants at Tomago showed that background levels range from 16.8 ppm in roses to 49.6 ppm in hibiscus at house 22 *(Table A9.4)*. These are within the range found by the *State Pollution Control Commission (1980)* which can cause damage in intermediate to sensitive species. No visible damage was observed in species sampled.

9.6.9 Wildlife

Sensitivity to Fluoride

Little is known of the sensitivities of Australian native fauna to fluoride. A summary of studies on the effects of fluoride on fauna overseas is given in *Appendix 10.7*.

Generally, these studies have shown that fluorides affect wildlife in much the same way as domestic stock and are passed up the food chain from plants to herbivores to carnivores. *Suttie (1977)* suggested that the minimum tolerance level of wildlife species would be unlikely to be lower than that of the most sensitive domestic species of cattle. Adopting levels recommended by the State Pollution Control Commission, sensitive native species may be at risk within the zone where the annual average is 0.3 $\mu g.Ft/m^3$.

Figure 7.3 shows that the 0.3 $\mu g.Fg/m^3$ and 0.5 $\mu g.Ft/m^3$ isopleths are similar. Since both particulate and gaseous fluoride may have an impact on animals, the 0.3 $\mu g.Fg/m^3$ isopleth will encompass a marginally larger area if particulates are included. The present ambient air fluoride levels of 0.06 $\mu g.F/m^3$ will only slightly increase the zone of impact. The predicted 0.3 $\mu g.Ft/m^3$ isopleth contains a large portion of the Tomago Sandbeds vegetation and Mangrove-Salt Marsh communities bordering the Hunter River on Kooragang Island.

Mangrove-Salt Marsh Communities: The Mangrove-Salt Marsh vegetation is largely resistant to fluorides and since this community does not support any permanent populations of native mammals or reptiles, and those birds that do occur are migratory or at least nomadic, the impact of fluoride emissions is expected to be insignificant.

Tomago Sandbeds Communities: Since most of the mammalian, reptilian and some avian fauna occurring in the Tomago Sandbeds are sedentary and territorial, effects of emissions are expected to be higher. Details of the likely effects of emissions from the plant on native fauna is given in *Appendix 10.7*.

It is concluded that increased fluoride levels will occur in the native fauna within the zone of influence and this may result in the death or reduced fecundity of individuals within species. With increasing distance from the smelter the effect of fluoride will be decreased, but the effects and their rate of decrease will differ for each species. It is also likely that tolerant species will increase in number while sensitive species decline. The degree of this change will be in accordance with average ambient fluoride levels and the absorption rate of plants.

The possible effects on native vegetation described in *Section 9.6.6* could have a significant impact on native fauna. Death of some trees, reduced productivity and a simplification of vegetation communities would result in major changes to habitat. Subsequent changes in species numbers and diversity could be expected within the 0.5 $\mu g.Ft/m^3$ isopleth.

9.6.10 Grazing Animals

Sensitivity to Fluoride

Grazing animals ingest fluoride through grazing on pasture and forage high in fluoride.

Section 9.6. 7 describes the potential effects of emissions on forage and hence, indirectly, the effects on livestock. *Table 9.9* lists the dietary tolerance of grazing animals.

TABLE 9.9

DIETARY FLUORIDE TOLERANCES OF DOMESTIC ANIMALS
(Annual Average)

Animal	Reference[b] (ppmF)	Pathology[c] (ppmF)
Beef or Dairy Heifer	40	30
Mature Beef or Dairy Cow	50	40
Finishing Cattle	100	NA[e]
Feeder Lambs	150	ID[f]
Breeding Ewes	60	ID
Horses	60	40
Finishing Pigs	150	NA
Breeding Sows	150	100
Growing or Broiler Chickens	300	ID
Laying or Breeding Hens	400	ID
Turkeys	400	ID
Growing Dogs	100	50

Note: the ppmF refers to dietary dry matter and assumes the ingestion of a soluble fluoride such as NaF.
b - published data levels could be ingested without clinical interference in normal performance
c - pathologic changes occur
NA[e] not applicable
ID insufficient data

Source: *National Academy of Science (1971).*

The performance of stock is not affected at these tolerance concentrations although some signs of excess fluoride ingestion may be present *(Suttie 1977)*. Excess levels of fluoride in the diet lead to damage in the teeth and bones where the fluorides concentrate. The degree of damage depends on numerous factors and effects range from teeth mottling and joint stiffness to loss of teeth and severe lameness. Dairy heifers are most susceptible but beef heifers and all cattle are considered sensitive. The general view is that levels considered safe for young beef and dairy cattle will also be safe for all grazing stock.

Assessment of Impact

The 0.3 $\mu g.Fg/m^3$ (annual average) isopleth has been generally equated with a level of 35 mg/kg in forage and hence the 0.3 $\mu g.Fg/m^3$ isopleth shown on *Figure 7.3*. Grazing stock will be at risk if grazed permanently in this area which includes part of the horse breeding properties east and west of the site and the dairy and beef cattle grazing properties to the east.

Continual monitoring of forage fluoride concentrations will enable risk periods to be identified. Control measures to be taken may include the movement of cattle or the provision of feed from external sources before fluoride toxicity develops.

Most risk to stock will occur to the southeast and east of the smelter site during the winter months. Fluoride levels are predicted to be highest in this area during this period when growth is dormant and the forage tends to concentrate fluorides. The area considered most susceptible is the dairy farm 1.5 km southeast of the smelter in the 0.5 $\mu g.Fg/m^3$ zone. In the summer months, levels are likely to range between 0.1 and 0.2 $\mu g.Fg/m^3$ in this area. In the summer (October to March), levels will be highest to the southwest, west and northwest of the smelter and grazing stock will be at risk in these areas at this time.

Although impacts outside the 0.3 $\mu g.Fg/m^3$ zone are considered unlikely, the isopleth itself may be mobile and also is based on average concentrations. Higher concentrations of fluoride could therefore occur temporarily beyond the 0.3 μg.Fg/m^3 average concentration isopleth, but for any one month, should not extend beyond the annual maximum 0.5 μg.Ft/m^3 isopleth shown in *Figure 7.4*.

Table 9.10 summarises stock numbers and grazing areas likely to be affected within the 0.3 μg.Fg/m^3 isopleth.

TABLE 9.10

STOCK AND LANDUSES IN THE 0.3 μg/m^3 (max) ZONE

Land Use	No. of Stock Cattle	Horses (stud)	Basis of Land Use
Dairying	60		Sharefarming
Horse-breeding	270*	100	Owner/Operator
Cattle grazing			
Beef cattle grazing	100		Owner/Operator
Mixed grazing	Variable		Predominantly leasehold.

* Number overestimated as total property in northwest with 200-250 head of cattle) is not affected but total stock number has been used.

Within the zone of influence, feed for chickens and pigs is imported from outside the area and if feed and water supplies are covered, no fluoride from the smelter will enter the diet of these animals.

9.6.11 Aquatic Fauna, Pets and Bees

Aquatic Fauna: Waste water discharges from the plant will be diluted by the flow and tidal flushing of the Hunter River. *Wright and Davison (1973)* examined fluoride levels in invertebrates and vertebrates near the discharge outlet of an English aluminium smelter and found that sea water diluted the fluorides sufficiently to bring the concentrations in organisms to background. The existing fluoride levels in the Hunter River at Tomago will not be significantly increased. It follows that the intertidal invertebrates and the birds that feed on them will not be affected and there will be no impact on estuarine fauna.

Domestic Pets: Pets within the zone of influence of the proposal will not be affected as their food is derived from outside sources.

Bees: Atmospheric fluorides slowly reduce honey bee populations through the ingestion of particulate fluorides on pollen and nectar *(USA Department of Agriculture)*. As bees utilise the flowering plants of the Tomago Sandbeds and the Mangroves of the Hunter River estuary, the potential exists for an adverse impact. The monitoring programme proposed for the smelter will include hives managed by the Company and those of local farmers.

9.6.12 Human Health

Residents living within proximity to the site are not expected to be exposed to harmful levels of hydrogen fluoride.

The current limits set by the Australian National Health and Medical Research Council for atmospheric fluorides in the work place are 2.5 mg/m^3 for elemental fluorine and 2 mg/m^3 for hydrogen fluoride. Air containing these levels can be safely inhaled for an 8 h/d, 5 d/wk.

The maximum atmospheric fluoride levels at the site boundary are predicted to be of the order of 1.0 $\mu g/m^3$ or about 2,000 times less concentrated than the limits set for atmospheric fluoride in the work-place. Beyond the site boundary, atmospheric fluoride levels decrease to 0.5 $\mu g/m^3$ at distances of 2km.

Fluoride enters the body indirectly through food and water, rather than being absorbed directly through the skin. All foods contain fluoride, sometimes in more than traces, e.g. sardines contain 40 ppm fluoride *(Hodge and Smith, 1970)*. Where fluoride levels in drinking water are low, an average diet contains 0.25 and 1.5 mg/d of fluoride *(Hodge and Smith, 1977)*. If the drinking supply is fluoridated, then this level increases to between 3 mg/d and 4 mg/d. Fluoride intakes of 5 to 8 mg/d can occur without any adverse effects on health *(Hodge and Smith, 1970)*. *Moller and Gudjonsson cited in Tourangeau (1944)* estimate that it would take 10 to 20 years of ingesting 20 to 80 mg/d of fluoride before crippling fluorosis will occur.

The six major effects of fluoride on man are listed in *Table 9.11*. The table shows the number of times each dose is greater than the probable daily intake from air containing 10 ppb fluoride, which is approximately 12.5 $\mu g/m^3$.

TABLE 9.11

MAJOR EFFECTS OF FLUORIDE

Effect	Dose	Time	Amount	Number of times the amount exceeds the probable intake from air at 10 ppbF
Death	Single	2 - 4 h	2500-5000 mg	50000-100000
Kidney injury	Repeated	Months	>100 ppm[b]	2500[d]
Thyroid injury	Repeated	Months or Years	>50 ppm	1200[d]
Body weight loss	Repeated	4 or more Years	40 ppm[c]	1000[d]
Crippling fluorosis[a]	Repeated	10-20 Years	20-80 mg or more	500-2000 or more
Mottled Enamel[a]	Repeated	First 8 years of life	2-8 ppm or more	50-200 or more

Note: a. Effect in man
b. In water
c. In feed
d. Assuming factors to translate animal exposure to man.

Source: *Hodge and Smith, (1970)*

The consumption of cattle grazed in the vicinity of the smelter is not expected to affect human health. Up to 99 per cent of the fluoride intake of cattle is accumulated in their bones *(National Academy of Science, 1971)*. Prolonged boiling of bones from animals suffering from fluorosis does not release the fluorides fixed in the bones and consequently there is no human health hazard in consuming soups and stews prepared from such bones. The increase in fluoride content in milk from cows suffering from fluorosis is negligible *(Allcroft, 1957; Oelschlager et al, 1972)*. Similarly, it has been shown that the increase in fluoride content of meat and eggs of hens, ducks and geese fed excessive amounts of fluoride, is negligible *(National Academy of Science, 1971; Allcroft, 1965)*.

A potential mechanism for fluoride intake within the zone of influence is the consumption of vegetables grown within the zone. No appreciable fluoride increase occurs in vegetables grown on soils rich in fluoride and any hazard, if it exists, would arise from surface contamination of vegetables *(World Health Organisation, 1970)*. It has been estimated that leafy vegetables grown in areas contaminated by fluoride emissions increase the total average fluoride intake by approximately 1.7 per cent *(Jones, 1971)*. However, the practice of discarding the outer and older leaves, and of washing vegetables, would keep daily intake amounts below this slight increase over the long term. A Task Force to the *Canadian Public Health Association* found that unwashed edible vegetables had a fluoride content of 1.4 mg/kg wet weight. Washing reduced the fluoride content to 0.86 mg/kg wet weight.

There is no likelihood of increased fluoride from drinking water as all houses within proximity to the site are connected to a reticulated water supply. Newcastle's drinking water has a fluoride concentration of approximately 1 mg/l. *Zipkin et al (1958)* have demonstrated that water fluoride concentrations of 5 to 8 mg/l are associated with bone fluoride concentrations of 4000 to 6000 mg/l. At this level, approximately 10 per cent of the population would develop osteosclerosis. Evidence indicates that fluoride concentrations of up to 2 mg/l in drinking water produces no harmful effects *(National Academy of Science 1971)*.

Sulphur dioxide emissions from the smelter are not expected to cause a reduction in the health of nearby residents. As shown in *Figure 7.9* the average concentration of sulphur dioxide at the site boundary is 1 $\mu g/m^3$ and this is considerably lower than the Australian National Health and Medical Research Council standard of 13 mg/m^3.

9.7 THE EFFECT OF EMISSIONS FROM OTHER SOURCES IN THE HUNTER VALLEY ON THE TOMAGO SITE

Figure 1.2 shows the interaction of other sources of emissions in the Hunter Valley on those predicted for the Tomago smelter.

The existing and proposed power stations, which are a significant source of fluoride, do not overlap with predicted emissions from the proposed smelter and were not included in the model for the Hunter Region.

Sources of fluoride close to the Tomago site are the brickworks at East Maitland, chemical works on Kooragang Island, the steel works complex at Mayfield and other fuel burning sources in the Newcastle area. Sources in the Upper Hunter areas are the existing Alcan smelter at Kurri Kurri which is undergoing expansion and the proposed smelter at Lochinvar near Maitland.

Each of these existing or future sources was considered in the modelling of the dispersion pattern shown in *Figure 1.2* which shows that there is an overlap at a concentration of 0.1 $\mu g.Fg/m^3$ in the area between Tomago and Kooragang Island, the western side of Fullerton Cove and the north arm of the Hunter River.

Since native vegetation occurring in this area consists primarily of Mangrove and Salt Marsh Communities which are salt tolerant and hence likely to be fluoride resistant, there will be minimal impacts on native vegetation and wildlife.

The most sensitive pasture and forage crops, vegetables and garden plants, such as grapes, stone fruits, gladioli and sorghum may be affected within the 0.1 $\mu g.F/m^3$ zone encompassing the Tomago and Kooragang Island areas.

The predicted additional concentration at the Tomago site due to existing sources on Kooragang Island is approximately 0.04 $\mu g.Fg/m^3$ which approximates the level of 0.06 $\mu g..Fg/m^3$ measured on the site during the study period for the Statement. The level at Rotten Row on Kooragang Island due to the Tomago smelter would be about 0.07 $\mu g.Fg/m^3$ and adds only slightly to existing levels.

Overlapping at concentrations of only 0.02 $\mu g.Fg/m^3$ occurs with sources centred at Lochinvar and Kurri Kurri and these emission levels will have no effect on land uses within the area or sensitive plant and animal species.

9.8 VISUAL IMPACTS

Visual impact as a result of the proposal is expected to be minimal due to the densely vegetated zone surrounding the site and the proposed landscaping programme. *Figure 9.3* shows the locations from which the plant can be viewed. Visible elements include the buildings described in *Section 5.3*, vehicle movements to and from the site, the transmission lines and night time glow from artificial lighting.

Buildings and Structures

The majority of buildings are a maximum of 25 m in height and are of a similar height to the present Courtaulds textiles buildings and the general level of vegetation. These buildings can only be seen from a zone 500 m wide either side of the entrance from Tomago Road. Other structures which exceed this general height are:

i. The Green Anode Shop, which is 42 m in height and will be clad with coloured sheeting.

ii. The four dry scrubber emission stacks and the emission stack to the Anode Baking Furnace which are all 60 m in height. These are to be free-standing, painted steel structures.

iii. The reinforced concrete, water tower which is 35 m in height.

iv. The coke storage silos which are 35 m in height. These are steel structures which will be painted.

These structures will be visible above the level of vegetation and viewing points will be similar to those for the existing Courtaulds stack.

Light colours, such as gold or beige are proposed for the finished surface of those structures which project above the tree line. For all viewing points, other than those in close proximity, these structures will be silhouetted above the tree line and will be seen against the skyline. The selection of light colours will visually reduce the bulk and hence the impact of the structures when compared with a similar sized, dark coloured structure in which the edges are clearly defined.

The majority of buildings will be clad in profiled, aluminium sheeting, which will be allowed to weather naturally. The resulting, dull, light-grey finish will not be visible from viewing positions beyond the site boundary.

Plates 7 and 8 provide an impression of the structures from the site entrance, Tomago Road and along the Hunter District Water Board easement to the southeast of the smelter.

Figure 9.3 indicates the visibility of the smelter from more distant viewpoints. *Figure 9.4* shows a cross-section between Tarro and the site, and between Sandgate and the site respectively. These sections show that most of the smelter will not be visible above the general tree-line.

The high standard of architectural safeguards will ensure that the visual impact resulting from these elements is minimal.

Emissions

Emissions of hydrogen fluoride and sulphur dioxide are colourless and will not be visible. Unburnt hydrocarbons which may be generated during the start-up of the anode baking furnace will be removed in the dry scrubber and their intensity will be lower than specified by the New South Wales Clean Air Act. A plume of condensed steam is expected to occur at the two cooling towers on some mornings in winter. However, the number of occasions when this plume would be visible above the dense vegetated zone and surrounding buildings is expected to be low.

Vehicles

The vehicles most likely to be identified with the operation will be the fully enclosed alumina-carrying units. These will travel along the route between the site and Rotten Row via Hexham Bridge. They are not expected to add to the visual impact of the existing vehicles on the proposed route.

Transmission Lines

The route of the transmission line and its effect on the landscape in the vicinity of the smelter is shown in *Figure 8.4*. The transmission line will result in a cleared zone through the vegetated perimeter zone, but its location will not increase the visibility of the smelter from external viewpoints. The exact width of clearing will not be known until the line is surveyed, but is expected to be about 70m.

Night Lighting

External lighting units will be of a non-glare type and will be orientated towards items of plant, so that users of Tomago Road and adjacent residents will not be affected by glare. The visual effect of the lighting will be a uniform glare, not unlike other major industrial plants.

9.9 IMPACT ON THE TRANSPORTATION SYSTEM

Section 4 considered the options to transport raw materials and products between the smelter and port facilities in Newcastle. Road haulage was shown to be the most appropriate alternative. This section evaluates the impact of this mode of transport on the favoured route.

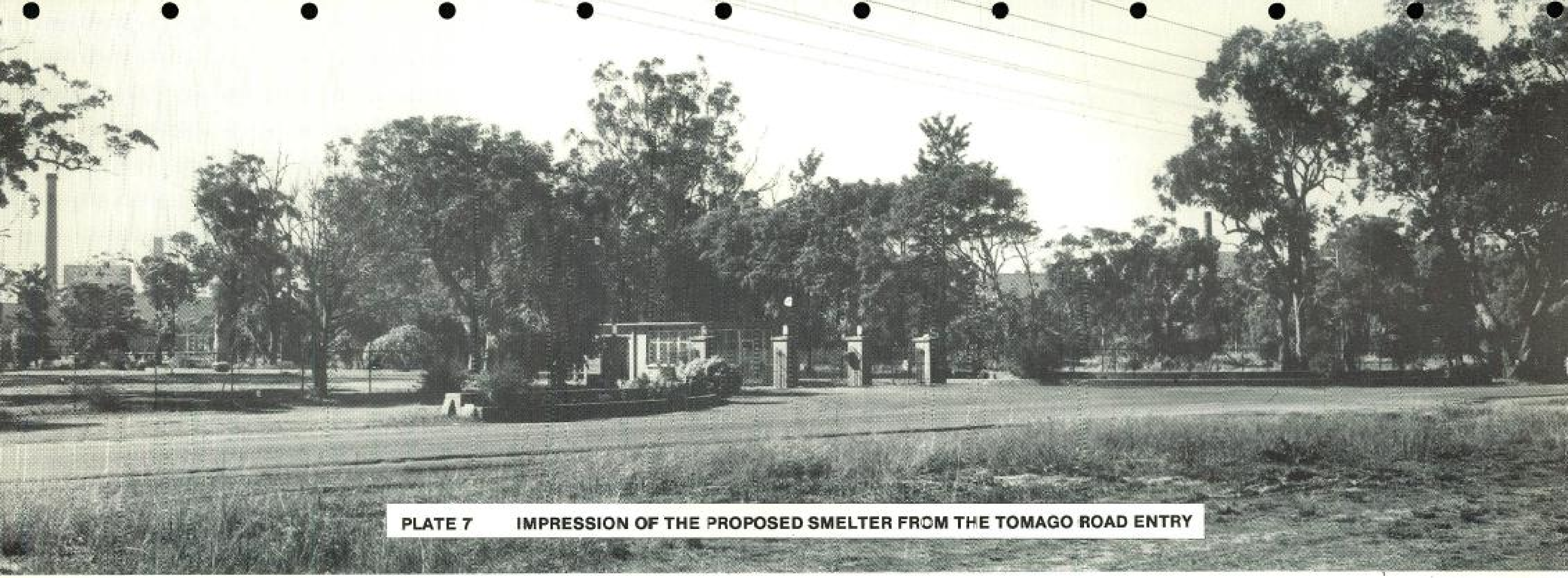


PLATE 7 IMPRESSION OF THE PROPOSED SMELTER FROM THE TOMAGO ROAD ENTRY

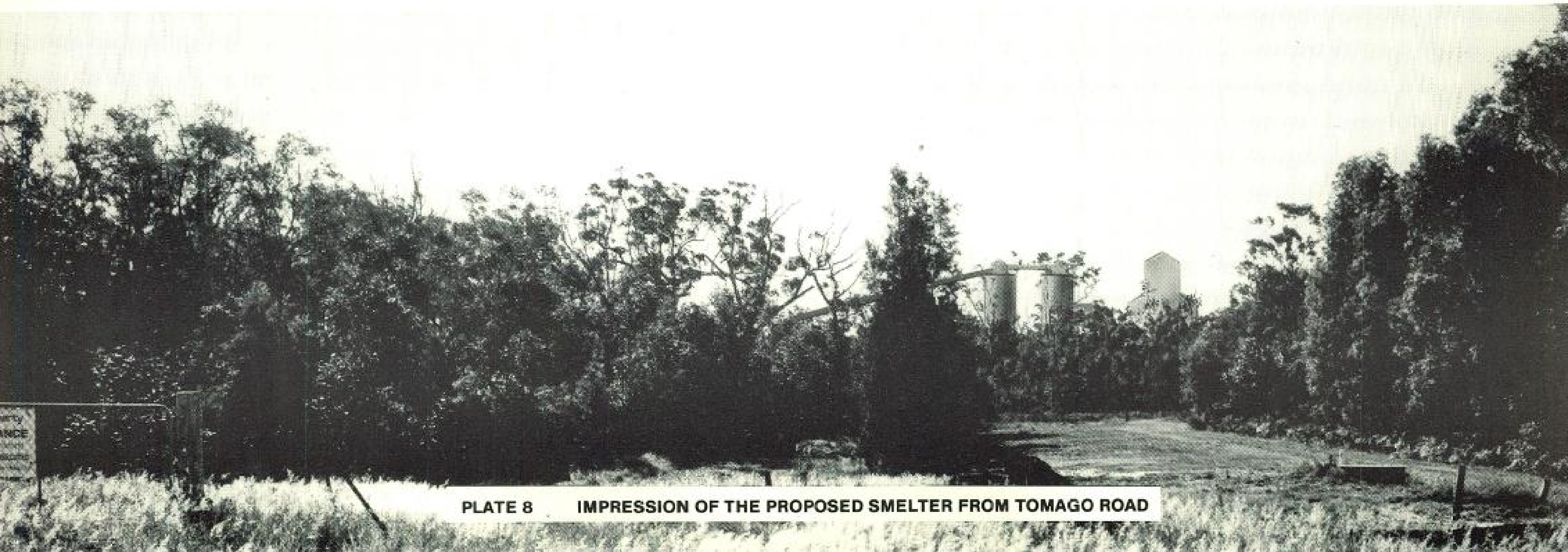


PLATE 8 IMPRESSION OF THE PROPOSED SMELTER FROM TOMAGO ROAD

Details of the traffic route and the present road traffic volumes are given in *Appendix 19* and used in the following analysis.

9.9.1 Heavy Vehicles

Consideration was given to alternative routes and haulage times to minimise the potential environmental effects of hauling raw materials to the smelter and finished product to the Port of Newcastle. The proposed route is Tourle Street, Industrial Drive, Pacific Highway and Tomago Road. Only vehicles transporting special heavy loads and unable to negotiate the Hexham Bridge may move via Stockton Bridge, Nelson Bay Road and Cabbage Tree Road.

Various options were considered for the number of haulage days per week and hours per day. The potential increase in traffic for each option is given in *Table 9.12*. The number of trips generated by the smelter proposal includes the return trips by empty vehicles and the traffic during the construction phases. The future volumes of traffic expected on the favoured route were extrapolated from current volumes. The maximum and minimum annual growth rates predicted by the Department of Main Roads are 10 per cent and 5 per cent respectively. For this study the minimum rate of 5 per cent was used as a worst case for the additional loadings due to the smelter.

The option favoured by the Company is for materials haulage between 7 am and 6 pm on six days per week, excluding Sundays. This will eliminate the potential impact of additional traffic noise during the night particularly on Tomago Road when existing heavy vehicle numbers are low. It is accepted that this haulage plan will contribute further to road congestion and the annoyance of motorists, however, it was decided that the resultant impact was preferable to that of adding to the discomfort of residents along the route at night time. The Company is prepared to consider alternative plans for scheduling truck movements to minimise impacts.

TABLE 9.12

INCREASE IN HEAVY VEHICULAR TRAFFIC-ALTERNATIVES FOR DURATION OF HAULAGE-WEEKDAYS

Duration	Days of haulage	(a) TOMAGO ROAD PACIFIC HIGHWAY-SMELTER			(b) PACIFIC HIGHWAY TOMAGO ROAD TO NEW ENGLAND HWY.			(c) PACIFIC HIGHWAY NEW ENGLAND HWY TO INDUSTRIAL DRIVE			(d) INDUSTRIAL DRIVE PACIFIC HIGHWAY TO MAUDE STREET		
		Predicted heavy vehicle traffic	Volume increase	% increase	Predicted heavy vehicle traffic	Volume increase	% increase	Predicted heavy vehicle traffic	Volume increase	% increase	Predicted heavy vehicle traffic	Volume increase	% increase
						CONSTRUCTION STAGE 1 - 1982/83							
7am-3pm	6	133	130	98	1267	130	10	2812	103	4	1218	20	2
						CONSTRUCTION STAGE 2 - 1984/85							
7am-3pm	5	147	240	163	1398	240	17	3100	207	7	1343	159	12
	6		217	148		217	16		186	6		138	10
7am-6pm	5	181	240	133	1732	240	14	3963	207	5	2110	159	8
	6*		217	120		217	13		186	5		138	7
7am-10pm	5	203	240	118	1944	240	12	4235	207	5	2447	159	6
	6		217	107		217	11		186	4		138	6
						FULL PRODUCTION - 1986							
7am-3pm	5	162	280	173	1541	280	18	3417	280	8	1481	276	19
	6		234	144		234	15		234	7		230	16
7am-6pm	5	200	280	140	1909	280	15	4369	280	6	2326	276	12
	6*		234	117		234	12		234	5		230	10
7am-10pm	5	224	280	125	2143	280	13	4669	280	6	2698	276	10
	6		234	104		234	11		234	5		230	9

* preferred option.

Haulage of construction materials will generally be between 7 am and 3 pm, Monday to Saturday inclusive.

The increase in future traffic volumes due to the construction and operation of the smelter is discussed below for the four major sections of the preferred route.

Tomago Road

Construction: Present traffic patterns indicate an average of 15 heavy vehicles per hour use the Tomago Road during daylight hours and an average of 4 heavy vehicles per hour at night. A total of approximately 200 heavy vehicles per day use the Tomago Road at present, with a predicted increase to 281 vehicle movements by 1986. The 98 per cent increase in heavy vehicular traffic during the first stage of construction and 120 per cent increase during the second stage will necessitate upgrading of the existing road between the Pacific Highway and the smelter. The Company will co-operate with the relevant authorities to reconstruct the section of Tomago Road west of the smelter to a standard suitable to accept both construction and production traffic.

It is possible that there may be a slight increase up to 5 vehicle trips per day during the construction period between the smelter and Williamtown.

Operational: Up to 234 heavy vehicle movements per day are expected to be generated during operation of the smelter. This traffic will result in an average of 20 movements per hour on the road or an increase of up to 117 per cent in predicted traffic. The residents on this road will be the most affected by smelter traffic as the increased volume will be very noticeable.

Pacific Highway - Tomago Road to New England Highway

Construction: There will be an increase of up to 10 per cent in the number of heavy vehicles using the Pacific Highway over Hexham Bridge for the initial construction stage of approximately 20 months during 1982/83. During the second stage the heavy vehicular traffic will increase up to 13 per cent on anticipated 1984/85 figures due to the operation of the first potline concurrent with the construction. This may lead to some congestion on Hexham Bridge and the intersection of the Pacific Highway and New England Highways.

Operational: As with Tomago Road heavy vehicles will average up to 234 vehicle movements per day, 6 days per week during full smelter operation. This will create an increase of 12 per cent in the projected heavy vehicular traffic.

The increase of 12 per cent is the largest proportional increase on any of the major roads. Traffic congestion and deterioration of road conditions would be greatest in this section as the road is only two lanes. Congestion due to smelter traffic would be greatest when passenger vehicles of smelter employees peak during shift changeovers.

Saturday traffic will be approximately the same as during the week for total traffic volumes but the heavy vehicular traffic will only be about 60 per cent of the week day levels.

Pacific Highway - New England Highway to Industrial Drive

Construction: There will be a 5 per cent increase in heavy vehicle traffic on this part of the route during the second stage of construction. Other options have a higher or equal impact on traffic flows.

Operational: The traffic volume of 234 truck movements per day will produce only a 5 per cent increase in total heavy vehicles between 7.00 am and 6.00 pm, Monday to Saturday.

This 7.4 km section of the haul route is four and six lane dual carriageway. The heavy vehicular traffic increases due to the smelter on this length of road will have no significant effects.

Industrial Drive and Tourle Street

Heavy vehicle traffic increases will be in the order of 6 to 10 per cent during second stage construction and full operation of the smelter between the Pacific Highway and Maude Street and 3 to 5 per cent respectively between Maude Street and Tourle Street. The increases in heavy vehicles on Tourle Street will be approximately 5 per cent during the second construction stage and 8 per cent during the operational stage.

9.9.2 Passenger Vehicles

General passenger traffic volumes will also increase in the vicinity of the Pacific Highway, New England Highway and Tomago Road. This traffic, generated by transport of employees, will be concentrated at times corresponding to the start and finishing of shifts.

Construction: During the construction period the workforce is expected to peak between 1200 and 1500 employees. This will generate up to 1800 passenger vehicle trips per day, divided between the two peak periods of 6 am to 8 am and 3 pm to 5 pm. Each vehicle is expected to carry an average of 1.5 passengers.

Operation: A total of 900 vehicle trips can be expected during weekdays and 684 vehicle trips on weekends. *Table 9.13* indicates the predicted pattern of light vehicle traffic generated throughout the day. The source/destination for these trips is estimated to be 45 per cent Newcastle-Lake Macquarie region; 35 per cent Maitland-Cessnock region; 15 per cent Raymond Terrace and 5 per cent Williamtown-Nelson Bay. Each vehicle is expected to carry an average of 1.7 passengers.

TABLE 9.13

PASSENGER VEHICLE TRIP DISTRIBUTION
DURING SMELTER OPERATION

Time	Number of Trips	
	Weekday	Weekend
6 am to 7 am	70	52
7 am to 8 am	282	52
2 pm to 3 pm	70	52
3 pm to 4 pm	70	52
4 pm to 5 pm	230	
10 pm to 11 pm	52	52
11 pm to 12 pm	70	52

Tables 9.14 and *9.15* list those roads for which there will be an appreciable increase in traffic volumes. The traffic volumes used for comparison are those predicted for 1986 when the smelter becomes fully operational.

TABLE 9.14

ADDITIONAL MAXIMUM PASSENGER VEHICLE TRAFFIC GENERATED AT PEAK TIMES (WEEKDAYS) - 1986

Periods	Tomago Road (west)	Old Punt Road	Pacific Highway (New England intersection to Tomago Road	Pacific Highway south of New England intersection	New England Highway north of S.H.10 intersection
Morning 7 am to 8 am					
Existing Traffic (per hr)	301	Min.	1587	4933	3995
Smelter Traffic (per hr)	268	43	226	127	99
Percentage Increase	89	-	14	3	2
Evening 4 pm to 5 pm					
Existing Traffic (per hr)	345	Min.	1825	5499	4549
Smelter Traffic (per hr)	219	35	184	104	81
Percentage Increase	63	-	10	2	2
Night 11 pm to 12 mid.					
Existing Traffic (per hr)	56	Min.	297	1024	829
Smelter Traffic (per hr)	67	11	56	32	25
Percentage Increase	120	-	19	3	3

TABLE 9.15

ADDITIONAL MAXIMUM PASSENGER VEHICLE TRAFFIC GENERATED AT PEAK TIMES (WEEKENDS) - 1986

Road	Morning			Evening			Night		
	Existing Traffic (per hr)	Smelter Traffic (per hour)	Percentage Increase	Existing Traffic (per hr)	Smelter Traffic (per hour)	Percentage Increase	Existing Traffic (per hr)	Smelter Traffic (per hour)	Percentage Increase
Tomago Road (west)									
Saturday	115	50	43	235	50	21	172	50	29
Sunday	75	50	67	280	50	18	69	50	72
Old Punt Road - Both	Min.	8	-	Min.	8	-	Min.	8	-
Pacific Highway (New England intersection to Tomago Road									
Saturday	605	42	7	1238	42	3	901	42	5
Sunday	380	42	11	1436	42	3	352	42	12
Pacific Highway south of New England intersection									
Saturday	1517	24	2	3103	24	1	2257	24	1
Sunday	953	24	3	3597	24	1	881	24	3
New England Highway north of SH10 intersection									
Saturday	332	19	6	679	19	3	494	19	4
Sunday	366	19	5	1383	19	1	339	19	6

9.9.3 Effects of Increases

As discussed in *Section 9.5* residents along Tomago Road will experience significant increases in noise levels. The few residents along other sections of the route will notice little difference in the noise climate because of the existing heavy traffic loadings.

The Company's proposal to upgrade Tomago Road between the plant and the Pacific Highway will prevent deterioration in the road surface.

Old Punt Road will probably be used by employees living in Raymond Terrace. This road will be able to carry the increased loadings and reduce the traffic using the Tomago Road - Pacific Highway intersection.

Passenger vehicle traffic is not seen as a problem on the local road system as the total numbers are likely to be less than when the Courtaulds plant was in operation.

The Pacific Highway between Tomago Road and the New England Highway receives a greater loading than other arterials in the area and it is the road most likely to have increased maintenance and congestion problems. Most congestion will occur at peak periods when Hexham Bridge may also act as a bottleneck.

It is expected that peak traffic congestion will occur for approximately 6 months during the second stage of construction when up to 1800 construction and 500 production crew vehicle trips will be made per day. The right turning traffic from the Pacific Highway to Tomago Road may experience particular difficulties.

Increases in traffic on other arterials, the Pacific Highway and the New England Highway, should not exceed 6 per cent and will usually be of the order of 2 to 4 per cent. The impact of the smelter traffic on these roads will be small but nonetheless add to volumes.

It is believed that the major area of road congestion will be from the smelter to the southern side of the Hexham Bridge. The fact that the industrial zone at Tomago is being promoted and the options exist to expand industrialisation in the area in general point to the need for a detailed redesign of the road system and for an additional bridge crossing of the Hunter River.

9.10 THE IMPACT ON LAND USE

9.10.1 Definitions of Geographical Areas Used in the Assessment

The following three level geographical hierarchy was used in assessing the impact of the smelter upon existing land use.

i. *Local Effects:* These refer to the area of land within the 0.5 μg.Ft/m^3 isopleth shown on *Figure 7.4*. This zone of approximately 20 km^2 in area extends from the vicinity of the Ponderosa Caravan Park west of the smelter, to a position on Tomago Road approximately 1 km east of Campbell Street (house 58 shown on *Figure 6.18*). The 0.5 μg.Ft/m^3 isopleth was adopted as it is the level at which some garden plants are affected. *Table 9.16* shows areas of land use within the 0.5 μg.Ft/m^3 isopleth.

TABLE 9.16

LAND USE WITHIN 0.5 μg.Ft/m^3 ISOPLETH

(Figure 7.4)

Land Use	Area (ha)	Percentage
Agricultural	826	40.2
Industrial (1)	92	4.5
Residential	13	0.6
Special Purposes (2)	4	0.2
Recreation	39	2.0
Natural Areas (3)	810	39.5
Cleared, Non-agricultural	266	13.0
Total	2,050	100.0

Note: 1. Industrial land use refers to land beind used for industrial purposes irrespective of zoning, or vacant industrial land which is subdivided and ready to be occupied.

2. The Tomago Sandbeds Catchment Area has not been included within the special purposes category, as it transcends a number of land use categories.

3. This includes the surface area of the Hunter River which is 120 ha.

ii. *Subregional Effects:* These refer to the area shown on *Figure 7.6,* which extends between Salt Ash to the east, Charlestown - Boolaroo to the south, East Maitland to the northwest and Raymond Terrace to the north. The area of the zone is approximately 850 km^2. An estimated population of 200,000 persons or approximately two thirds of the Lower Hunter Subregion's population resides in this area. For assessment purposes, the influence of emissions from the smelter has been restricted to the area within the 0.1 $\mu g.Ft/m^3$ isopleth which covers 163 km^2 or approximately 20 per cent of the defined subregional area in the figure. The zone extends from near Hardboards Australia Limited plant to the north of the smelter and includes the eastern portion of Tarro to the west, the eastern part of Hexham Swamp and the industrial railway on Kooragang Island to the south and Fullerton Cove to the east. *Table 9.17* shows areas of land use within the 0.1 $\mu g.Ft/m^3$ isopleth.

TABLE 9.17

LAND USE WITHIN 0.1 $\mu g.Ft/m^3$ ISOPLETH

Land Use		Area (ha)	Percentage
Urban		330	2
Natural Areas:	Forest	2,800	17.2
	Swamp	2,500	15.3
	Mangroves	780	4.8
	Water	2,000	12.3
Cleared Areas -	includes agricultural and industrial	7,890	48.4
Total		16,300	100.0

iii. *Regional Effects:* These refer to the Hunter Region of some 30,828 km^2 in area.

9.10.2 Planning

Rezoning of the site or alteration to Interim Development Order Number 23 covering the area will not be required as the smelter will be in an existing industrial zone. The Company will seek approval from the New South Wales Department of Main Roads to maintain the existing access onto Tomago Road.

Local Effects

Table 9.18 lists the areas of each category of land zoning within the 0.5 μg.Ft/m^3 isopleth.

TABLE 9.18

AREAS OF ZONED LAND WITHIN THE 0.5 μg.Ft/m^3 ISOPLETH

Zone	Area (ha)	Percentage
1(a) Non-Urban 'A' (40 ha minimum)	5	0.5
1(b) Non-Urban 'B' (40 ha minimum/ restricted)	98	5.0
1(c) Non-Urban 'C' (floodplain)	641	31.0
4(a) Industrial - General	847	41.0
5(a) Special Uses	335	16.0
6(a) Existing Open Space - Recreation	5	0.5
Total[(1)]	1,930	94.0

Note: 1. The total area within the 0.5 μg.Ft/m^3 isopleth is 205 ha. This includes the surface area of the Hunter River which is 120 ha.

The major land zones are General Industry, Non-Urban 'C' (floodplain) and Special Uses - predominantly the Hunter District Water Board Tomago Sand-beds Catchment area. The smelter site occupies approximately 62 per cent of the General Industrial Zone north of the Hunter River.

The establishment of the smelter will not require the rezoning of land within the 0.5 μg.Ft/m^3 isopleth, however, restrictions may be needed on the type of future use within each of the zones. These could cover the commercial growing of vegetables, stone fruits, grape vines and flowers and the grazing of animals on a long-term basis.

Subregional Effects

Table 9.19 lists the area of each category of land zoning within the 0.1 μg.Ft/m^3 isopleth. The total area within this isopleth is 163 km^2 or 20 per cent of the defined subregional area.

TABLE 9.19

AREAS OF ZONED LAND WITHIN THE 0.1 μg.Ft/m^3 ISOPLETH

Zone	Area (ha)	Percentage
Rural 'A' - 1(a)	130	0.8
Rural 'B' - 1(b) Arterial road frontage	821	5
Rural 'C' - 1(c) floodplain) Rural 'G' - 1(g) floodplain) Rural 'H' - 1(h) floodway)	5,661	34.7
Residential 'A' - 2(a)	243	1.5
Residential 'D' - 2(d) Development Control Plan area	90	0.5
General Industry 4(a)	3,614	22.2
Light Industry 4(b)	35	0.2
Special Uses - 5(a) and 5(b) (Includes Hunter District Water Board Tomago Sandbeds Catchment 1602 ha)	1,724	10.6
Open Space 6(a) Recreation	100	0.6
Open Space 6(d) Proposed Open Space	11	0.1
Rural Environment Protection 'B' 7(b) Estuarine Wetlands	1,871	11.5
Total (1)	14,300	87.7

Note: 1. The total area within the 0.1 μg.Ft/m^3 isopleth is 16,300 ha. This includes the surface area of the Hunter River and Fullerton Cover which is 2000 ha.

The major land zones are similar to those within the 0.5 μg.Ft/m^3 isopleth. These comprise:-

i. *Floodplain*, on which uses are restricted to agriculture without the consent of the council.

ii. *General Industry*. The majority of land (2700 ha) in this category is located on Kooragang Island. The future use of much of the area, apart from the present industrial land, is dependent upon the outcome of a study undertaken by the Kooragang Island Advisory Committee, which is currently before the Minister for Public Works.

iii. *Rural Environment Protection 'B'*. This comprises land located within the boundary of Hexham Swamp. Future use is restricted to ensure conservation of the wetlands.

iv. *Special Uses.* The Hunter District Water Board Tomago Sandbeds Catchment area is the main area of land in this category. Land use is strictly controlled and under the jurisdiction of the Hunter District Water Board.

These existing land zones are compatible with the establishment of a smelter, as they restrict the type of development which may be undertaken, or in the case of the general industry zone, the type of development which is permitted. No conflicts with the proposal are anticipated.

As in the zones within the 0.5 $\mu g.Ft/m^3$ isopleth, it may be necessary to consider restrictions on the type of future agricultural land use permitted on a commercial basis. These could include the cultivation of fluoride-sensitive horticultural species and the long-term grazing of cattle in areas likely to be affected.

9.10.3 Agricultural Land Use

Local Effects

There are 775 ha of land use for agricultural purposes within the 0.5 $\mu g.Ft/m^3$ isopleth. The distribution of uses is shown in *Table 9.7*. Most of the land is to the north of the Hunter River and represents 3.5 per cent and 2.8 per cent respectively, of the rural holdings of the Port Stephens Shire and Newcastle City Council in 1975/76.

The changes most likely to follow the establishment of the smelter are:-

i. The dairy, 1 km east of the smelter is at risk. This property is the last operating in the Tomago area and one of the six remaining on the Tomago 'run'. The decline in dairying within the area over the past ten years is shown by reference to *Table 6.6* and is due to changing land use and reduced profitability of smaller-scale operations. *Table A13.2 in Appendix 13*, indicates that the average value of production for a dairy holding in Port Stephens Shire was \$24,700 during 1977/78.

   The dairy in question runs a high proportion of stud cattle in its herd on an area of 98 ha. It would seem at this stage that importing feed and lot feeding the dairy herd would be uneconomical. The Company is having discussions with the owner of this property.

ii. There are two horse studs located 1 km west and 2.5 km east of the smelter respectively, and a third stud also running cattle 2 km to the northwest. A small part of the latter property is within the 0.5 $\mu g.Ft/m^3$ isopleth but outside of the 0.3 $\mu g.F_g/m^3$ annual average isopleth. These three properties combined run approximately 100 stud horses and 270 head of cattle on 141 ha within the 0.5 $\mu g.Ft/m^3$ isopleth.

Statistics are not kept for the value of production from horse studs but the average value for cattle was $4,200 per holding in the Port Stephens Shire for the 1977/78 financial year. The value of stud horses varies considerably, but an average price of $4000 for thoroughbreds and between $800 and $4000 for Palominos are reasonable estimates.

The establishment of the smelter may require feed to be imported if the two closest studs are to continue in their present use. The Company will monitor changes in these areas.

iii. The beef cattle grazing property located 1.5 km east of the smelter is at risk. Approximately 100 head of cattle are run on 69 ha. Currently, their value will vary between $50 per head for vealers and $500 for breeding stock.

The average value of production per holding in the Port Stephens Shire for beef cattle was $4,200 per annum in the 1977/78 financial year. Recent rises in beef prices have increased the revenue per holding. The farm income represents the main source of income for this property.

The property is within the 0.3 $\mu g.Fg/m^3$ annual average isopleth and it is likely that long-term grazing will not be possible. The alternatives of either short-term grazing or other agricultural land use will need to be considered.

iv. The areas between the larger properties are used sporadically for mixed grazing and do not function as main sources of income for any particular farmer. Restricted grazing may be possible in these areas.

The establishment of the smelter is likely to result in the properties in close proximity becoming uneconomical to operate if owners are required to import feed and lot-feed their animals. The alteration of the existing use to one which is less susceptible to fluoride emissions is an alternative to be considered.

Subregional Effects

Agricultural land use within the area of the 0.2 $\mu g.Ft/m^3$ isopleth shown on *Figure 7.4* consists of 2068 ha of dairying, cattle grazing, horse breeding, mixed grazing, poultry, pigs and horses for the petfood industry. The distribution of uses is listed in *Table 9.7*. The zone between the 0.2 µg.Ft/m^3 and 0.1 µg.Ft/m^3 isopleths represents the outer limit of the effects of the smelter on agriculture and contains mainly grazing properties. Existing agricultural uses should not require alteration, other than the growing of fluoride-resistant crops. For example, sorghum grown on the horse and cattle property 4 km to the northwest of the site could be replaced by a more resistant species.

9.10.4 Urban Land Use

Local Effects

The 0.5 µg.Ft/m^3 isopleth contains 56 occupied residences and a population of about 160 persons. The houses occur to the north of the Hunter River as shown in *Figure 6.18*. Ten small fishing huts used only at weekends are within the isopleth south of the Hunter River. Details of the residences are shown in *Appendix 11*.

The main impact of the smelter will be the restrictions on the species of shrubs and plants selected for gardens. Grazing stock will have to be kept out of the area.

Subregional Effects

Residential settlements within the 0.1 µg.Ft/m^3 isopleth include Hexham, Tarro, part of Beresfield and Woodberry and Heatherbrae. New residential development is not planned for this area and any additional settlement will result from infilling of existing, vacant, zoned land. Further residential development is not to be allowed in Hexham which is zoned for industry and is subject to flooding.

The smelter is not expected to alter the use of residential land other than impose minor restrictions on the types of fluoride-sensitive horticultural species which may be cultivated.

9.10.5 Industrial and Commercial Land Use

Local Effects

The smelter will not adversely affect existing industrial and commercial land uses. Existing industries, particularly steel fabricators on the Tomago Industrial Estate are likely to benefit from sub-contracting during construction and maintenance work when the plant is in operation. The establishment of the smelter should result in increased demand for industrial blocks in the Estate. New small industries will benefit both private developers and the Port Stephens Shire through increased revenue. It is also possible that an increase in workforce may result in the extension of the existing bus service through the industrial estate.

Subregional Effects

The smelter development will benefit existing industries in industrial areas at Rutherford, Kurri Kurri, Mayfield-Waratah, Cardiff and Kooragang Island. These firms will be competitively located to undertake work during the construction and operational stages. The smelter may result in increased competition for labour amongst industries.

9.10.6 Tourism and Recreation

Local Effects

Recreational facilities within the zone include the sports oval, tennis courts, bowling green and club house owned by the Courtaulds Bowling Club, the Newcastle Motordrome and the Hunter River. It is not expected that the smelter will have any significant impact on these facilities or on the existing recreational usage patterns.

The smelter is likely to result in increased membership levels of the Courtaulds Bowling Club. In the short-term this may cause overcrowding and overuse of facilities, but it is the intention of the Company to work with the Club to meet the needs of a greatly increased membership. In this regard, the Company will provide assistance with the construction of a swimming pool for the use of Tomago residents and Club members. This will more than compensate for the loss of a small dredge pond on the site which is used illegally by a small number of the local community. The effects of fluorides on the bowling green will be minimised by the regular watering and mowing that is undertaken as part of normal upkeep.

The Company plans to set aside a section of the site with river frontage for use by fishermen and picnickers. This area will be provided with appropriate amenities and maintained by the Company. Landscaped picnic areas are to be located on the smelter site for use by visitors.

The smelter will not affect existing recreational usage of the Hunter River.

The Ponderosa Caravan Park, which is located 1.5 km west of the site, represents the closest tourist facility. The caravan park is likely to benefit from the increased temporary accommodation requirements of workers during the construction phase. In the longer term, the identity of the park as a tourist facility and hence its economic viability is not likely to be affected by the smelter. The use of the adjoining roads by heavy vehicle traffic moving to the plant represents the most significant impact. However, the effects should not be any worse than those experienced by similar facilities located elsewhere on highways. Attention will need to be given to the selection of appropriate shrubs and trees in garden areas.

Subregional and Regional Effects

The major tourist attractions within the defined areas include Lake Macquarie, Port Stephens, the vineyards and wineries at Pokolbin and beaches to the south and north of Newcastle. These features are located approximately 20 km south-southwest, 35 km northeast, 40 km west, and 10 to 20 km south to east of the smelter, respectively. The use of these attractions and other natural assets of this area which include Hexham Swamp, Fullerton Cove and bushland areas will not be affected by the location of the smelter.

The addition of an aluminium smelter will further reinforce the industrial base without causing a deterioration of the natural attributes of the subregion. The proposal will provide a positive benefit to the tourist industry by the provision of educational tours through the plant and the establishment and maintenance of picnic facilities adjacent to the plant entry and along the river foreshore within the site.

The main impact of the smelter upon the wider use of Newcastle and its surrounding region by tourists and recreationalists is likely to relate to its visibility and the implications of a larger population using tourist and recreational facilities.

The smelter will be shielded from the majority of viewpoints by the existing vegetation. Of the total number of structures and buildings on site, only a small proportion will be visible above the tree line. Emissions from the smelter will be essentially colourless and not noticeable.

The site has frontage to Tomago Road, which provides a cross route from the Pacific Highway to Nelson Bay Road and Port Stephens. This route is not used as extensively by tourists as either the Pacific Highway or Nelson Bay Road and the additional heavy vehicle traffic moving to the entrance of the plant is not expected to be a source of inconvenience. The situation on Sundays and holidays will not be changed.

Possible conflicts between the project and tourism may arise during the construction stage, when there will be competition for occupancy of caravan parks, motels and other temporary accommodation. Longer term effects of the project on tourism will include increased demands on natural areas and recreational facilities as a result of an increased population. However, by comparison with usage rates of similar areas and facilities in capital cities, those of the subregion will remain relatively uncrowded.

9.10.7 Special Uses

Local Effects

Special uses include part of the Hunter District Water Board's Tomago

Sandbeds Water Supply Catchment area, the New South Wales Department of Corrective Services' Tomago Detention Centre, the Tomago Public School, the Tomago Uniting Church and the Tomago Progress Association Hall.

Recent announcements by the New South Wales Department of Corrective Services indicate that the Tomago Detention Centre located opposite the smelter site is to house temporary inmates in the future. It is expected that the main impact of the smelter proposal will be noise caused by the heavy vehicles accelerating and decelerating in Tomago Road at the approaches to the site.

Pupils attending the Tomago Public School, located between 800 m and 900 m east of the smelter, will not be affected by increased sound pressure levels, emissions, odours or increased traffic levels generated by the proposal. Increases in school enrolments as a result of the smelter are not expected to be significant as the school has a very small catchment area and there are larger schools at Raymond Terrace and Williamtown. Future residential development within the school catchment is unlikely, apart from rural residences.

Likely effects to the school will be the possible restriction on the type of plants that can be grown and the risk to existing pine trees. These effects are discussed in *Section 9.6.8*.

The Tomago Uniting Church and the Tomago Progress Association Hall are used infrequently and the smelter is not expected to cause any change to the existing usage patterns.

9.10.8 Mining

The likely impact of the project upon reserves of coal, glassmaking sands, heavy minerals and construction materials is discussed in *Section 9.4*. The project may result in the expansion of the sand quarrying operation located some 2.5 km east of the site. This sand may be suitable for use in brickwork and for filling purposes. The quarry is located behind a row of houses in Tomago Road and at present its operation is not a cause of concern.

9.11 THE IMPACT OF THE SMELTER ON RESIDENTS IN PROXIMITY

Sections 9.1 to *9.10* have considered the impact of the proposed smelter on aspects of the environment surrounding the site. The matrix in *Table 9.20* summarises the impact on residents living in the houses in close proximity shown in *Figure 6.18*.

The most significant impacts during the construction phase will be noise generated by heavy vehicle traffic and the building activities. Residents along Tomago Road between the site and the Pacific Highway can expect increased disturbance from vehicle movements in daylight hours. Residents in houses 24 and 25 may experience levels up to 56 dB(A) from the construction works according to the effectiveness of low sand dunes as shields between the plant and the houses.

The impact due to heavy vehicle traffic will continue when the smelter becomes operational. Residents on Tomago Road to the west of the plant will experience higher noise levels from the haulage of raw materials and products. Increased passenger vehicle traffic should be of less concern as the numbers of cars will be lower than when Courtaulds plant was operating. However, it is expected that people will have become accustomed to the quieter life since the factory closed and will require time to readjust to the expanded activity.

The smelter will result in a loss of amenity and rural life style when the existing quiet locality again becomes busy and noisy. This change was always inevitable because of the industrial zoning given to Tomago and it can be expected that the conditions for living will continue to become less attractive as the industrial area is further developed.

The matrix indicates that residents need not be concerned for their health but can expect to be more restricted in their out of door activities. The increased road traffic will contribute to reduced safety for children and elderly people, gardening pursuits will be less attractive due to the restrictions on the plants which should be grown and the opportunity to keep horses and cattle on small areas will be gone unless they are hand fed exclusively. The Company has recognised these changes and proposes to construct a swimming pool for residents near the Courtaulds bowling club and provide picnic facilities and a waterfront reserve on the Hunter River near the site. These amenities and opportunities for employment at the plant should help to compensate for other losses and minimise the impact of the proposal. Residents in areas with restrictions have been invited by the Company to discuss their concerns and the purchase of their properties is an option open to negotiation.

9.12 THE SOCIAL IMPACTS

9.12.1 Social Setting of the Tomago Site

The smelter will be positioned centrally with respect to employees living in the developed areas of East Maitland-Thornton/Beresfield, Newcastle City, Western Lake Macquarie and Raymond Terrace. The location also provides potential employees new to the region with a wide choice in selecting a place of residence.

Table 9.21 indicates the likely places of residence of permanent employees at the smelter based upon existing journey to work patterns of employees at the Tomago Industrial Estate.

The social effects resulting from an increased population associated with the smelter have been quantified on a subregional basis. Even within the locations shown in *Table 9.21* there will be considerable locational variation and impacts will vary accordingly.

Locational patterns may also vary on a time scale. Initially, some Hunter Valley employees may elect to remain at their existing residence and commute for a one to two year period until their occupational status becomes established, before moving closer to the smelter. This is the pattern that is generally followed by Lower Hunter coalminers, who transfer to Upper Hunter employment. A similar situation may develop for non-Hunter Valley employees, who may rent a residence before permanently

TABLE 9.20

IMPACT OF THE SMELTER ON RESIDENTS IN PROXIMITY

	5	6	7	8	9	10	11	12	13	14	16	17	18	19	20	23	24	25	26	27	28	29	30	31	32	33	33A
Health	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Water Quality	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Noise Pollution	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	M	M	M	M	L	L	L	L	L	L	L	L
Visual Pollution (site)	L	L	L	L	L	M	M	M	M	M	M	M	M	M	M	L	L	L	L	L	L	L	L	L	L	L	L
Agricultural Land Use	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L
Traffic Volumes	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	M	M	M	M	M	M	M	M	M	M	M	M
Safety	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	M	M	M	M	M	M	M	M	M	M	M	M
Crops and Forage	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L
Garden Plants, Vegetables and Fruit	L	M	M	M	M	L	L	L	L	L	L	L	M	H	H	M	H	H	H	H	H	H	H	H	H	H	H
Grazing Animals	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L
Amenity	H	L	L	L	L	H	H	H	H	H	H	H	H	H	H	L	L	L	L	L	L	H	L	L	L	L	L

	35	36	37	38	39	40	41	42	43	44	45	46	48	49	50	51	53	54	55	56	57	58	59	60	61	62
Health	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Water Quality	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Noise Pollution	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Visual Pollution (site)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Agricultural Land Use	L	H	H	L	L	L	L	L	H	H	H	H	L	L	L	L	L	L	L	L	L	L	M	M	M	M
Traffic Volumes	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Safety	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Crops and Forage	L	H	H	L	L	L	L	L	H	H	H	H	L	L	L	L	L	L	L	L	L	L	M	M	M	M
Garden Plants, Vegetables and Fruit	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	L	L	L	L	L	L	L	L	L
Grazing Animals	L	H	H	L	L	L	L	L	H	H	H	H	L	L	L	L	L	L	L	L	L	L	M	M	M	M
Amenity	L	H	H	L	L	L	L	L	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L

KEY:

Health:	High	>2.5mg/m^3	Noise Pollution:	High	>50dB(A)	
				Medium	40-50dB(A)	
				Low	<40dB(A)	
Water Quality:	High	>5ppm.F	Agricultural Land Use:	High	>0.3μg/m^3	
	Medium	1-5ppm.F		Medium	0.3-0.1μg/m^3	
	Low	<1ppm.F		Negligible	<0.1μg/m^3	

Traffic Volumes and Safety:	High	>10% increase
	Medium	2-10% increase
	Low	<2% increase
Crops and Forage: (annual av.)	High	>0.3μg/m^3
	Medium	0.3-0.1μg/m^3
	Negligible	<0.1μg/m^3
Garden Plants Vegetables and Fruit	High	>0.5μg/m^3
	Medium	0.3-0.5μg/m^3
	Low	<0.3μg/m^3
Grazing Animals: (annual av.)	High	>0.5μg/m^3
	Medium	0.3-0.5μg/m^3
	Low	<0.3μg/m^3

HIGH (H) MEDIUM (M) LOW (L)

TABLE 9.21

ESTIMATED RESIDENTIAL LOCATION OF
DIRECT OPERATIONAL EMPLOYEES

Location	Number	Percentage
East Maitland-Thornton/ Beresfield	240	30
Newcastle City	200	25
Western Lake Macquarie	160	20
Port Stephens Shire including Raymond Terrace	160	20
Kurri Kurri/West Maitland	40	5
Total	800	100

Note: Assumes 1 residential unit per employee.

establishing closer to the smelter. It is probable that in the longer term employees may move to areas closer to the smelter such as Raymond Terrace.

Additional locational parameters which are directly relevant to the smelter include its proximity to the coastline and Lake Macquarie. These natural assets may have a greater influence on location than journey to work distance.

9.12.2 Local Public Attitudes to the Development of an Aluminium Smelter.

Attitudes to the development of a smelter on the Tomago site were sought from residents within the area shown on *Figure 6.18*. The characteristics of the local population are provided in *Section 6* and the results of the interviews with residents in *Appendix 20*.

The Hunter River forms a geographical barrier within the local area surrounding the site and interview results varied between residents north and south of the Hunter River.

Eighty-six per cent of the residences to the north of the river were visited and 50 householders were interviewed. Of these, 30 per cent were concerned with the prospects of a smelter being constructed on the site, 56 per cent were not concerned and 14 per cent were undecided.

Most of the residents expressing concern were relatively new to the area and were located along Tomago Road to the east of the site. The main reasons for concern are listed in *Table A20.1* and are summarised as:-

i. A likelihood of deterioration in human health.

ii. The further alteration of the area from its present rural character.

iii. Opposition to governmental decision-making in which the local population were not consulted.

Of the residents who were unconcerned, only three based their opinions upon experience with aluminium smelters elsewhere. Increased employment opportunities was the predominant reason given by those in favour of the smelter development. Generally it was considered that dust and noise levels would not be higher than present levels, although all residents were adamant that adequate pollution control equipment should be provided.

Ten residents living to the south of the river were interviewed. It was apparent that because of their geographical isolation and the fact that the site is not visible from Hexham, most of the residents were not aware of the proposed development. Some people expressed concern at the smelter proposal and were worried about discharges to the Hunter River affecting the quality of fish and other aquatic fauna.

9.12.3 Predicted Population Changes

Table 9.22 presents an estimate of the increase in population of the subregion as a result of the project. The figures were derived using the direct, indirect and induced employment estimates from *Table 9.26*.

TABLE 9.22

ESTIMATED INCREASE IN THE SUBREGION POPULATION AS A RESULT OF DIRECT AND INDIRECT EFFECTS OF THE PROJECT

	1981	1982	1983	1984	1985	1986	1987	1988 onwards
Predicted Population[1] without smelter	382400	386800	390800	394900	399000	403100	407300	411500
Population Increase (construction phase)	4500	5600	5600	4500	1900	-	-	-
Population Increase (operational phase)	250	300	2700	2900	3800	4500	5000	6000
Maximum Total[2] Population Increase	4800	5900	8300	7400	5700	4500	5000	6000
Minimum Total[3] Population Increase	2400	3000	4200	3700	2900	2300	2500	3000
Estimated Minimum Population	384800	389800	395000	398600	401900	405400	409800	414500
Estimated Maximum Population	387200	392700	399100	394900	404700	407600	412300	417500

Note: 1. Population predictions adapted from the Hunter Regional Plan.
2. Assumes all additional population is from outside the region.
3. Assumes 50 per cent of new jobs are filled by the unemployed in the region.

It is expected that during the construction stage, the proportion of single employees will be lower than for major projects in more remote locations. It was therefore assumed that the construction workforce will consist of 60 per cent single and 40 per cent married personnel respectively.

The indirect population associated with the construction phase was assumed to approximate that associated with the operational workforce.

Population increases resulting from the operation of the smelter will also include induced effects as well as the direct and indirect effects. It was assumed that 30 per cent of the operational workforce will be single and that 70 per cent will be married. For the married component, it was further assumed that 30 per cent were from married couples and that 70 per cent were from average families of four.

The results of the analysis indicate that the largest increase in population up to 8300 persons will coincide with the peak construction workforce during 1983 and this will reduce to approximately 6000 in the long term, that is from 1988 onwards.

Over the seven year period from 1981 to 1988 when the population increase will be highest, the growth rate will increase marginally from the 1.01 per cent per year used in the Hunter Regional Plan population forecasts, to 1.08 per cent per year. The increase in population as a result of the smelter will be insignificant compared with the total population of the Lower Hunter Subregion at any one time. This increase represents 2.1 per cent of the total population in 1983 and 1.5 per cent from 1988 onwards. These are maximum figures. If it is assumed that up to 50 per cent of the jobs will be filled either directly or indirectly by unemployed residents within the region, the population increase will be of the order of 1.1 per cent in 1983 and 0.7 per cent from 1988 onwards.

It is likely that the increase in employment opportunities created by the smelter will reduce the out-migration trend of 20 to 39 year old adults seeking employment outside the region. Persons moving into the region are more likely to be under 40 years of age and this will assist in bringing the regional age distribution closer to the national values.

9.12.4 Housing and Accommodation

Construction Phase

In line with most large construction projects it is likely that a large proportion of the workforce will be of a transient nature and will elect to procure temporary accommodation. This will be found in caravan parks, rental flats and houses and dormitory type facilities. There will be a lower demand for permanent housing accommodation.

On the basis that 50 per cent of the construction workforce will be recruited from local residents, estimated demand for additional temporary accommodation during the construction phase will be approximately 1000 units between 1981 and 1983, reducing to 250 in 1985.

There are 26 existing caravan parks within the Lower Hunter subregion with a total of 3278 sites. *Table A14.6* indicates that there are 600 sites within a 10 km radius of the site. The Ponderosa Caravan Park, which is the closest park to the site, has sufficient space to double its capacity to provide an additional 150 sites. A new caravan park of 120 sites is being constructed at Fern Bay approximately 20 km from the site and will be operational in late 1980. Planning is at an advanced stage for a new caravan park at Anna Bay with a first stage capacity of 180 sites and ultimately 320 sites. An additional 600 sites should be available at these caravan parks.

Rental accommodation has been in strong demand over recent years in Newcastle and surrounding areas and is not likely to improve in the short term. No additional accommodation appears to be planned.

Temporary accommodation facilities may be strained during the construction phase, especially during the initial stages when there is likely to be a time lag in meeting the demand. This may also cause an impact to the tourist industry during peak school holiday periods, although price increases at these times may regulate the demand. A number of proposed major developments listed in *Section 6.17* are likely to create competition in seeking a workforce and are expected to generate accommodation problems in the short term.

Operational Phase

The estimated number of additional houses required to accommodate both the direct workforce and the extra population as a result of indirect and induced effects is shown in *Table 9.23*.

A total of between 750 and 1500 additional houses will be required to accommodate the extra population generated by the project.

TABLE 9.23

ESTIMATED ADDITIONAL HOUSING REQUIREMENTS
FOR THE OPERATIONAL WORKFORCE
(Cumulative Figures)

	1981	1982	1983	1984	1985	1986	1987	1988 onwards
Houses for direct[1] workforce	60	80	370	400	550	550	550	550
Houses for indirect population			290	320	420	690	750	980
Minimum total housing requirements[2]	30	40	330	360	490	620	650	760
Maximum total housing requirements	60	80	660	720	970	1240	1300	1530

Comments: 1. Houses are allocated only for the married population, assumed to represent 70 per cent of the workforce.
2. It is assumed that up to 50 per cent of the workforce will be recruited from unemployed residents within the region.

As shown in *Table A14.3*, there were up to 9800 unoccupied private dwellings within the subregion in 1976 and there is sufficient land available within proximity to the site to accommodate the additional 1100 houses that may be required. Up to 1200 blocks are being subdivided at present in Raymond Terrace alone. Additional residential land is available at Port Stephens, East Maitland, Thornton, Beresfield, Wallsend, Cardiff and Kurri Kurri. *(Section 6.16.4)* All these locations are within easy access of the project.

Only a small percentage of the direct workforce is likely to be eligible for New South Wales Housing Commission homes. The indirect and induced population is more likely to be catered for by this type of accommodation.

It can be concluded that there will be sufficient houses and residential land to meet the accommodation demands of the workforce and additional population. However, the building industry is currently operating close to full capacity and may not be able to cater adequately for the additional demand for new houses. This may result in a continuation of the present 20 per cent annual increase in house prices and in lengthy home construction delays due to the shortage of skilled labour.

9.12.5 Education and Health Services

Education

New enrolments at local public schools in 1980 were less than for the previous year for the first time. This trend is expected to continue as the population growth rates decrease and lessen the impact of an increase in school-aged children as a result of the proposal.

Based upon the assumption that primary school aged children will make up 12 per cent of the projected population increase, it was estimated that new enrolments resulting from the proposal will vary from a maximum of between 500 and 1000 in 1983 to between 350 and 700 in 1988. If high school aged children make up 8 per cent of the population increase, the new enrolments at high schools will range from 340 to 670 in 1983 to between 290 and 580 in 1988.

The shift in population from the older, inner suburbs to the more rapidly growing outer suburbs, is being allowed for by educational planners. As outlined in *Table A14.8* there are plans for nine new primary schools and three new high schools in these areas and extensions proposed for eight existing schools.

It is expected that most housing construction associated with the additional population generated by the project will take place in those suburbs where new schools are planned, or where extensions to existing schools are proposed. There is sufficient capacity in schools within the inner suburbs to cope with an influx of pupils. In addition, there is currently an oversupply of trained teachers. It is not expected that the project will create an impact upon educational facilities.

Health

As shown in *Table A14.10*, there was a surplus of 1140 hospital beds in the subregion and, as a result, health services are expected to cope with the additional population resulting from the project. Specialist facilities at the Royal Newcastle and the Mater Misericordiae Hospitals are expected to be able to handle any industrial accidents which might occur at the smelter. Experience from Alcoa's Point Henry smelter has shown that less than an average 20 hospital bed days may be required each year for persons injured in accidents at the smelter *(Kinhill Planners Pty. Limited, 1980)*.

Additional baby health centres to those listed in *Table A14.11* may be required in the outer suburbs likely to be settled by the projected population associated with the smelter.

9.12.6 Recreational and Community Facilities

Although the subregion has more than adequate recreational and community facilities, there is likely to be a demand for neighbourhood facilities in the outer suburbs presently experiencing intercensal population growths in excess of 10 per cent. These are also the locations in which marginal population increases will occur as a result of the project. As the population increase will be distributed throughout the region, normal forward planning procedures should identify and implement additional facilities as required.

A review of current staff requirements in many of the governmental and private welfare agencies may be necessary in view of the expected population increase resulting from this project and from other major projects in the region expected to be operational during this decade.

9.12.7 Areas of Historical Interest

The construction of the smelter will obscure the remains of the entry to the former Tomago - Big Ben Colliery. There is very little evidence remaining from the mine and associated pit head development and it is considered that the site is not of historical significance.

Other items of historical interest in the vicinity of the site include the National Trust classified, Tomago House and grounds, and the adjoining Windeyer Chapel. The levels of sulphur dioxide emissions in the vicinity of these buildings is not expected to cause deterioration of the stone or slate through the chemical action of sulphates.

9.13 THE ECONOMIC IMPACTS

9.13.1 Capital Investment

Construction Phase

The project will provide a direct stimulus to the economy of the Hunter Region and the nation through the initial investment of approximately $600 million. This investment detailed in *Table 9.24* will be expended on buildings, plant and equipment, pollution control safeguards and initial design costs between late 1980 and 1985. The difference between the estimated total direct expenditure of $446 million and the overall investment of $600 million is due to forecast escalation increases.

TABLE 9.24

ESTIMATED DIRECT CONSTRUCTION EXPENDITURE
($ million)*

Item	1980	1981	1982	1983	1984	1985	Total Expenditure
Civil Work (site preparation, concrete construction, roadworks etc.	1	31	4	10	2	-	48
Equipment - local origin (including steelwork)		35	63	28	37	24	187
Equipment - overseas origin		13	24	11	13	9	70
Transportation, taxes and duties		1	8	5	2	2	18
Erection		4	22	15	9	8	58
Design Costs	10	16	13	11	10	5	65
Total direct expenditure	11	100	134	80	73	48	446
Pollution Control Equipment included in the above costs		10	11	7	6	3	37

* 1980 base date, unescalated dollars.

The majority of initial expenditure will be within Australia. *Table 9.25* shows that only an estimated 17 per cent will be spent overseas on specialised equipment. At this stage, the proportion to be spent within the region cannot be precisely estimated, however, a high proportion of equipment, skilled labour, steel and basic construction materials will be obtained from local sources.

TABLE 9.25

ESTIMATED CAPITAL EXPENDITURE BREAKDOWN
(Percentages)

Item	Per cent
Civil works material	7
Site labour for civil works	7
Structures and equipment supplied from Australian sources	49
Site labour for erection of structures and installation of equipment	15
Equipment supplied from overseas	17
Freight and duty	5
	100

The percentage of funding from Australian sources is expected to approach the Australian equity interest percentage. Thus a substantial proportion of the interest and dividend payments will contribute to the national economy.

Operational Phase

The main items of expenditure during the operation of the smelter will be salaries and wages, taxation to local government, State and Commonwealth Governments, maintenance costs, the purchase of raw materials, including power, transport costs and indirect expenses.

The largest continual operating expenses to be spent in the region will be for the supply of power and for salaries and wages to employees. When fully operational, salaries and wages to employees will amount to an estimated $15 million per year (in 1980 dollars).

9.13.2 Employment

Procedures

The employment opportunities created will be dependent upon the economic implications of the proposal. The economic impact has been assessed by an input-output analysis, which subdivided the regional economy into industry sectors. The transactions or financial flows between sectors in a given year were used to estimate the degree of dependence of one sector on other sectors.

A 25 x 26 transactions matrix for the Hunter Region has been prepared by *Garlick (1979)* from surveys of operations during the 1976-77 financial year. *Garner (1980)* included an additional column and row to allow for the aluminium industry in a study for the Lochinvar smelter. The similarity in size between the Tomago Smelter and the Lochinvar Smelter allowed the multiplier figures to be applied in this analysis.

Type I multipliers used in this study account for the direct and indirect effects and represent the likely minimum economic impact of a development. As the indirect effects represent the local industry support of a development they are usually felt immediately.

Type II multipliers account for direct, indirect and induced effects and represent the likely upper limit of economic impact of the project. They take longer to be felt and in this assessment a three year time lag following the start up of the project has been adopted.

Induced effects are considered only for the operational phase and not for the shorter construction period.

Employment Changes in the Region

Table 9.26 shows the predicted number of jobs that will result from direct, indirect and induced effects during the construction and operation of the smelter.

Indirect employment is a result of the extra income generated between related industries that benefit from the construction and operation of the smelter. Induced employment is a result of the feedback effects from increased consumer spending, through increased personal income.

These figures are estimates only, as the size of the actual construction workforce will be dependent upon the contracting arrangements.

Estimates of the operational workforce are more accurate, being based upon similar overseas operations of the Company.

TABLE 9.26

ESTIMATED TOTAL NEW EMPLOYMENT WITHIN THE HUNTER REGION AS A RESULT OF THE PROPOSED DEVELOPMENT

	1980	1981	1982	1983	1984	1985	1986	1987	1988 onwards
Direct Construction Workforce	50	1200	1500	1500	1200	500	-	-	
Direct Operational Workforce	-	90	120	560	610	800	800	800	800
Indirect Employment (Construction)	-	770	960	960	770	320	-	-	-
Indirect Employment (Operational)	-	-	-	420	460	600	600	600	600
Induced Employment (Operational)	-	-	-	-	-	-	380	470	800
Total New Employment.	50	2060	2580	3440	3040	2220	1780	1870	2200
Labour Force Projections*	148900	150300	152000	153700	155500	157200	159000	160800	162500

Notes: 1. These figures are order of magnitude figures only.
2. A delay of 3 years for induced employment figures has been adopted.
* Labour force projections as used in the Hunter Regional Plan.

Indirect and induced employment resulting from the smelter have been calculated using the multipliers shown in *Table 9.27*.

TABLE 9.27

EMPLOYMENT MULTIPLIERS - HUNTER REGION

Construction phase	:	Type I (direct and indirect)	1.64
Operational phase	:	Type I (direct and indirect)	1.75
	:	Type II (direct, indirect and induced)	2.75

Source: *Garner (1980)*

Construction Phase

The construction phase is scheduled to commence late in 1980 and progress to the end of 1984. It is expected that up to 960 new jobs will be generated elsewhere in the region, in addition to the 1200 to 1500 jobs created at the smelter site. Because of the temporary nature of this phase, Type II or induced multiplier effects have not been included.

In August 1979, there were 305 skilled building and construction workers and 4327 semi-skilled and unskilled males registered as unemployed in the subregion. The reduction in unemployment for this sector will depend upon the permanent workforce employed by the major building contractors and their attitudes to recruiting locally.

The effect of the construction phase therefore, will be to reduce regional unemployment levels in the short term, i.e. over the period 1981 to 1984.

Operational Phase

Permanent employment generated elsewhere in the region will vary from 420 to a maximum of 1400 in addition to the 800 jobs generated on the site. In the long term, i.e. from 1988 onwards, total new employment attributable to the smelter will stabilise within the range of 1400 to 2200 jobs.

Labour force projections developed in the Hunter Regional Plan using a 'medium' growth rate of 1.15 per cent per year, indicate that an additional 17000 jobs will need to be generated between 1980 and 1988 if unemployment is not to exceed a predicted level of 4 per cent of the total labour force. This projection includes a reduction of 3500 in unemployment levels. For this strategy, the manufacturing industry is seen as the key to the upswing in the resource and support sectors of the Lower Hunter economy. The generation of up to an additional 2200 jobs by the project in the long term will provide 13 per cent of the jobs needed to meet these projections.

Based upon 1979 figures, there is a potential male workforce available within the subregion of 4327 semi-skilled and skilled workers and 319 skilled electrical and metal tradesmen. Direct employment in the smelter operation will provide jobs for 200 tradesmen and approximately 560 unskilled and semi-skilled persons who through training will become semi-skilled and skilled.

There will be a strong demand for skilled tradesmen and it is likely that many will have to be attracted from outside the region, particularly as a number of other major projects are likely to eventuate at the same time. These developments have been listed in *Section 6.17* and include the expansion of the Alcan aluminium smelter at Kurri Kurri, the Alumax aluminium smelter at Lochinvar, the Eraring power station at Dora Creek and the Bayswater power station at Muswellbrook. Increased levels of enrolment in trade courses at Technical Colleges is expected to lessen this projected shortage.

Approximately 80 per cent of employees will be in the production, process workers and labourers sector and this will add to the heavy reliance on this sector in the region. In 1976, 37.3 per cent of employees were employed in this category in the subregion.

The effect of the operational stage of the smelter will be to reduce levels in regional unemployment, especially for semi-skilled and unskilled workers. This will result in a more stable employment situation.

Employment Changes in New South Wales and Australia

Additional employment to be generated in New South Wales and Australia is shown in *Table 9.28*.

TABLE 9.28

ESTIMATED TOTAL EMPLOYMENT GENERATED BY THE PROJECT THROUGHOUT NEW SOUTH WALES AND AUSTRALIA

	Workforce	New South Wales	Australia
Construction	1200-1500	2000-2500	2300-2800
Operation	800	1100-2600	2600-5400

These estimates are based upon employment multipliers shown in *Table 9.29*.

TABLE 9.29

EMPLOYMENT MULTIPLIERS - NEW SOUTH WALES AND AUSTRALIA

	Construction Phase		Operational Phase	
	Type I	Type II	Type I	Type II
New South Wales[1]	1.67	2.66	1.33	3.13
Australia[2]	1.88	3.61	3.3	6.7

1. In the absence of State input-output tables, similar employment multipliers to those developed for Queensland by *Mandeville and Jensen, 1978*, have been adopted for N.S.W.
2. The 1968-69 Australian input-output tables, which represent the latest data available were used to assess the effects on the national economy.

It is estimated that during the construction phase, total additional employment generated outside the region will range between 1100 jobs and 1300 jobs.

Of the total number of up to 5400 permanent jobs created in Australia as a result of the project, approximately 50 per cent, or 2700 jobs, would be located in New South Wales. The Hunter Region would provide approximately 80 per cent of the new jobs created within the State. It is envisaged that a significant proportion of jobs created outside the region would be located in the Northern Territory and Queensland where the alumina is to be produced.

9.13.3 Income Effects

Income multipliers which indicate an increase in household income attributed to each dollar invested in the construction and operation of the smelter were used to estimate indirect income effects. *Table 9.30* presents the income multipliers used in the analysis.

TABLE 9.30

INCOME MULTIPLIERS - HUNTER REGION AND AUSTRALIA

	Construction Phase	Operational Phase	
	Type I	Type I	Type II
Hunter Region[1]	1.43	1.49	2.15
Australia[2]	1.87	2.39	3.38

1. Source: *Garner (1980)*
2. *National Accounts Input-Output Tables, 1966-67.*

The direct wages bill during the five year construction period is expected to total about $60 million. As a result of this extra household income, and thus increased spending power, an estimated $52 million is expected to be generated throughout Australia due to indirect effects. Of this amount, about $26 million should accrue to householders within the Hunter Region.

During the operation of the smelter, wages and salaries will amount to $15 million in 1980 dollars. This income will generate an additional income of between $21 million and $36 million throughout Australia due to indirect effects. Of this amount between $7 million and $17 million will accrue to householders in the Hunter Region.

9.13.4 Infrastructure Cost-Benefit Analysis

Method

An analysis was carried out to investigate the costs and benefits to the New South Wales Government, and its authorities, of the infrastructure required for the Tomago Aluminium Company Pty. Limited smelter proposal. Any infrastructure supplied by the Company is not included in this analysis, for example, the on-berth facilities at Rotten Row.

The infrastructure costs included are those associated with the construction of a raw materials unloading berth at Rotten Row, the upgrading of 2 km of Tomago Road and additional road maintenance costs caused by the transport of raw materials and products between the smelter and the Port of Newcastle.

No allowance has been made for the infrastructure costs associated with the supply of electricity to the proposed smelter, or for the tariff payable for it. These are subject to an agreement between the New South Wales Electricity Commission and Tomago Aluminium Company Pty. Limited. However, the Premier of New South Wales has stated that "the terms negotiated for supply of electricity to the three aluminium smelters ensure that the Electricity Commission will make a profit, after allowing for all capital costs and recurrent costs" *(Newcastle Morning Herald, May 20, 1980)*.

The arithmetic of the cost-benefit analysis is unaffected by this omission since the electricity tariff will cover its costs. These will balance each other and the profit would add to the total net present value calculated.

The benefits which the State Government will receive as a result of the smelter establishment include:

i. Those associated with the infrastructure costs, i.e. harbour and berthing charges.

ii. Those which willaccrue as a result of increased employment e.g. payroll and consumption taxes and income taxes returned from the Commonwealth Government as part of the income tax sharing agreement.

iii. Other revenues such as land tax and part of the fuel tax paid as a result of road transport.

Costs

The cost of the Rotten Row berth, estimated by the Maritime Services Board of New South Wales to be $6.4m, is to be shared amongst the Alcan smelter, the Lochinvar smelter and the Tomago smelter. Therefore the infrastructure cost has been allocated on the basis of use. It is anticipated that the proposed Tomago smelter will account for 37 per cent of raw material throughput of the berth, hence the infrastructure cost allocated to the Tomago smelter is $2.37m. The dredging and landfill operations are expected to begin late in 1980 with the wharf completion expected by mid 1982.

Tomago Road will be upgraded to a standard which will accommodate the volumes of raw materials and output transported along 2 km to the proposed smelter. This work is expected to be executed in 1981 at a cost of $300,000 (in 1980 dollars).

The transport of raw materials from Rotten Row and aluminium to the Port of Newcastle is expected to incur additional road maintenance costs upon the New South Wales Department of Main Roads. An estimate of this annual cost has been included in the analysis, derived from information contained in the reports of the Commission of Inquiry into the New South Wales Road Freight Industry. This cost would be approximately $90,000 per annum in 1980 dollars, at full capacity operation of the smelter.

It is assumed that the Rotten Row berth is financed by government borrowing and the interest payable therefore becomes a charge against the users of the berth. As previously stated the proportion relevant to the Tomago smelter is 37 per cent. The real interest rate in 1980 is 1.8 per cent. This rate will increase over the repayment period under the assumption that the rate of inflation will fall to 8 per cent by 1985. The repayment period is assumed to be over nine years.

Benefits

Associated with the cost of constructing the Rotten Row berth as well as the use of the Port of Newcastle for exporting aluminium, are the charges which will be levied by the Maritime Services Board of New South Wales. These are harbour charges which depend on the material being shipped and berth charges which are based on the gross registered tonnage of the vessel involved. Current Maritime Services Board charges have been adopted. At full capacity this revenue will amount to $522,000 for harbour charges and $82,000 for berthing charges in 1980 dollars.

The employment created at the proposed smelter and indirectly in other industries will generate revenue benefits for the New South Wales Government. These revenues include payroll tax, income tax and consumption and like taxes.

Payroll tax liability will arise at the smelter itself. Because of the threshold level of wages and salaries applicable to the liability it is not known what amount of tax will be paid as a result of employment multiplier effects. Only the smelter payroll tax is included in the analysis.

The income effects outlined in *Section 9.13.3* will mean increased income tax paid to the Commonwealth. Under the Income Tax Sharing Agreement, approximately 12 per cent of this will be returned to the State Government in the year after it is paid.

Additional spending will result from the income effects which will generate additional Government revenue as sales taxes, stamp duties, gambling and similar taxes.

Land tax will be payable on the land owned by Tomago Aluminium Company Pty. Limited which will be of the order of $100,000 per year (1980 dollars and rates).

Fuel tax will be paid on the fuel consumed in transporting raw materials and output between the smelter and the port. This tax is levied by the Commonwealth Government and, although it is not an "earmarked" tax, it has been estimated that 48 per cent is returned to the New South Wales Government in the form of road grants (*Commission of Inquiry into New South Wales Road Freight Industry, Vol. IV, Text, p3/20)*. This amount has been estimated at $19,000 per year at full production of the smelter.

Results

Results of the cost-benefit analysis are provided in *Appendix 21*. The analysis indicated that there are net costs to the State in the first two years, due to costs associated with the berth construction. However this situation is reversed after 1982, when net benefits accrue to the State in return for the supply of infrastructure.

During an assumed fifty two year life of the smelter, the State Government and its authorities will receive a net benefit of $60.4m, calculated at net present values. That is, the Government will gain this amount by agreeing to provide all of the infrastructure, including electrical infrastructure necessary for the project to proceed.

9.13.5 National Economic Impact

Export Value of Component Raw Materials

The processing of Australia's natural resources prior to export is consistent with Commonwealth Government policy. Elemental aluminium can be exported in the form of bauxite, alumina or as the aluminium metal. The further processing of bauxite before export increases Australia's export earnings as well as providing additional employment and income.

To produce one tonne of basic aluminium at the smelter would require two tonnes of alumina which in turn requires four tonnes of bauxite. At prices of $1550, $217 and $12 per tonne respectively, exported aluminium metal is 3.5 times more valuable than the equivalent amount of export alumina and 30 times more valuable than the equivalent amount of export bauxite.

In employment, the smelting of aluminium metal directly provides 2.7 times as many jobs as alumina refining and 25 times as many jobs as bauxite mining and export, for the equivalent output.

Raw material inputs required for the proposed Tomago smelter include coal, in the form of electricity and alumina, both of which could be exported. In addition, petroleum coke must be imported. Before the coal could be exported it would have to be washed resulting in about a one-third loss of quantity. The coal equivalent of the electricity needed for the smelter would be 1.4 mt per annum. This could be beneficiated to produce one million tonnes per annum of exportable coal with 0.4 mt lost each year.

Table 9.31 shows the annual export revenue which could be earned from the shipment of coal and alumina and the foreign exchange saved by not importing petroleum coke as an alternative to aluminium smelting.

TABLE 9.31

ANNUAL EXPORT VALUE OF RAW MATERIALS

Material	Quantity MTPY	Unit Price $/tonne	Export Value $M
Coal	1.0	35	35
Alumina	0.43	217	93
Petroleum coke	0.09	198	18*
TOTAL EXPORT VALUE			146

* Export revenue equivalent

Export revenue earned from the sale of 220,000 t of aluminium each year, at $1550 per tonne would be $340 million which is 2.3 times the combined value of raw material inputs.

Furthermore, considerable employment is generated as a result of the smelter operation. The conversion of coal to electricity to satisfy the needs of the smelter, will provide about 170 jobs directly. Additional employment will be created in industries supplying goods and services to the smelter.

As outlined in *Section 9.13.2*, the construction of the smelter and associated infrastructure will create up to 2800 jobs within Australia. More significant is the creation of up to 5,400 permanent jobs as a result of the smelter's operation.

Of the total 1980 capital cost of the smelter alone, some $440 million which includes start-up costs will be spent within Australia. Additional investment will occur in related industries and in the provision of associated infrastructure.

Aluminium smelting offers a significant avenue for the more beneficial use of our natural resources in providing value added above that which would result from raw material exports as well as promoting a substantial growth in employment.

Value Added in Local Processing

Table 9.32 provides the estimated distribution of the project's sales dollar, projected over a 16 year period.

TABLE 9.32

DISTRIBUTION OF REVENUE

Item	Percentage of Sales Dollar
Operating Costs	68
Depreciation	6
Interest	3
Tax	10
Retained Earnings	6
Dividends	7
	100

Note: All raw materials apart from petroleum coke, aluminium fluoride and cryolite are expected to be purchased within Australia.

9.14 REGIONAL DEVELOPMENT

9.14.1 Associated Developments

Projects which are related to the smelter proposal include two power stations and their supporting coal mines, the transmission lines connecting the power stations and the smelter, the unloading and storage facilities for raw materials at Kooragang Island and, to a lesser extent, the transport routes which connect the various sites.

The assessment of the impact of the collective effects of these proposals is beyond the scope of this Statement, however, some general conclusions appear obvious.

9.14.2 Economic Implications

The developments will generate substantial employment and income, both direct and indirect within the region. Total additional employment in both the construction and operational phases for major projects in the Hunter Region between 1980 and 1985 has been estimated to peak at 11,500 in 1983 *(Department of Industrial Relations, N.S.W.)*. Of this total, the Tomago smelter will contribute 3400 jobs in 1983, reducing to 2200 jobs thereafter.

Should there still be unemployment in this period, the new developments will greatly reduce the levels and probably result in a labour shortage. The significance of training programmes will become apparent and in this respect the apprentice training scheme to be introduced by the Company will be an important contribution. The new developments will also incorporate on-the-job training and improve the levels of employee skills.

In the short term the demand for skilled tradesmen will result in competition for construction workforces among projects and lead to delays and added costs. Contractors' abilities to recruit and hold suitable labour will be tested.

The increased income will be redistributed throughout the region and boost the regional economy. There is already considerable evidence to indicate that local boom conditions have already arrived as investments and payments for services are creating supply problems.

There are no reliable indicators to suggest that the new developments will not add to regional prosperity and be reflected throughout the community.

9.14.3 Planning

The task of the planners will be a difficult one if the requirements for land, facilities and services are to be met, prosperity spread evenly and the integrity of the environment maintained.

The new developments will assist in achieving the Hunter Regional Plan's economic goals by substantial direct investment in the region and the creation of additional permanent jobs. The increase in population as a result of additional jobs combined with continuing expenditure from operating projects will add to the region's economic base.

The location of the Tomago smelter is in accordance with the recommended strategy of the Hunter Regional Plan, i.e. it seeks to maximise use of existing infrastructure and cause minimum disruption to existing and planned settlement patterns. The site is situated within a large existing industrial estate, which has ample space for the accommodation of peripheral industries normally associated with major industrial plants. It is well located with respect to the existing main road network. Heavy traffic between the port and the site will travel along existing main road routes for most of the trip. Journey to work distances are minimal as the site is located centrally to the closest urban areas. Ready access is also available from Port Stephens, Kurri Kurri and the western side of Lake Macquarie by existing main roads.

Experience at the Alcan aluminium smelter at Kurri Kurri has shown that up to 50 per cent of employees reside within close proximity to the smelter, another 40 per cent of employees locate within 10 to 15 km of the plant and that only 10 per cent choose to live at distances of 20 to 25 km from the site. The Tomago site's proximity to the coast and its accessibility may mean that employee distribution will be more widespread than for the Kurri Kurri smelter.

Apart from the incorporation of special provisions within local environmental plans concerning agricultural land use activities as discussed in *Section 9.10.3*, the smelter and its associated developments should not require alteration to regional planning concepts developed in the Hunter Regional Plan.

The situation with other developments is less favourable in that conflicts may be generated with existing and long established activities and values. In this respect the proposals for the western side of Lake Macquarie require a large planning input to be implemented successfully. Difficulties are not expected in providing for an expanded population, but in creating an industrial character in areas better suited for other uses.

9.14.4 Land Use

Appendix 13 discusses the importance of the Hunter Region as an agricultural region in the State. It represents 2.67 per cent of the area of the State's rural holdings and produces 6.56 per cent of the value of agricultural production in 1977/78.

The local and subregional effects of the smelter on land use patterns were discussed in *Section 9.10*. The wider regional effects of the associated developments are expected to be similar and continue the trend of increasing land consumption for industrial and urban uses and reducing rural activities. These effects are part of an Australia-wide change from a rural-based economy to one which is more reliant on mineral exports and manufactured products. Within the region, mining, industrial and associated infrastructure developments are occupying increasing areas of former agricultural land and in some cases competing with the rural activities for the same labour.

The demand for industrial land is expected to increase and farming activities close to urban and industrial zones are becoming more difficult to sustain. Problems particular to rural pursuits including the difficulties of the small producer and of economies of scale are adding to strain and the demise of the industry in many areas.

9.14.5 Social Impact

The potential impact of the smelter proposal on the social and cultural fabric of the subregion was shown in *Section 9.12* to be minimal. The associated and similar developments will add to the impact and result in increased demands for housing and serviced land, temporary accommodation, shopping, commercial and recreational facilities and educational, health, social and welfare services. The extent and magnitude of a collective impact is not known but it is suggested that the Lower Hunter has the resources to accommodate these changes. The long-term economic benefits of industrial expansion in the region should outweigh any short term inconvenience caused by delays and shortages.

Of greater concern are the small numbers of residents who may feel disadvantaged by being in proximity to a proposed development. This factor was recognised at Tomago and the Company is negotiating with concerned residents living close to the smelter. It is the Company's policy that people should not suffer hardship or discomfort as a result of the project.

It is important that in broad-scale planning for the mutual good and in academic analyses of the costs and benefits at regional, State and National levels, the well being of the minority directly affected is not disregarded as being of too little importance.

9.14.6 Tourism and Recreation

The changing character of the region from a predominantly rural-based economy to one which is more industrialised may modify tourist interests but may not affect the income from tourism. In fact the increased income expenditure in the region detailed in *Section 9.13* is likely to result in the upgrading and expansion of tourist facilities, especially accommodation. An expansion in hotel accommodation is already planned for Newcastle.

With the possible exception of the developments proposed for the western side of Lake Macquarie, new projects are not likely to intrude into the main areas of interest to tourists, the beaches and waterways and the vineyards of the Upper Hunter Valley.

Increased road traffic is not likely to be a deterrent as regional traffic volumes will still be low compared with those experienced commonly in capital cities.

Any shortfall in tourist motel and caravan park accommodation as a result of the demands of construction workers in the short term should be offset by a greater diversity of accommodation and recreational facilities developed to meet regional population growth.

In general it is suggested that the developments proposed for the Lower Hunter Valley will have little adverse impact on tourism and is likely to be beneficial.

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