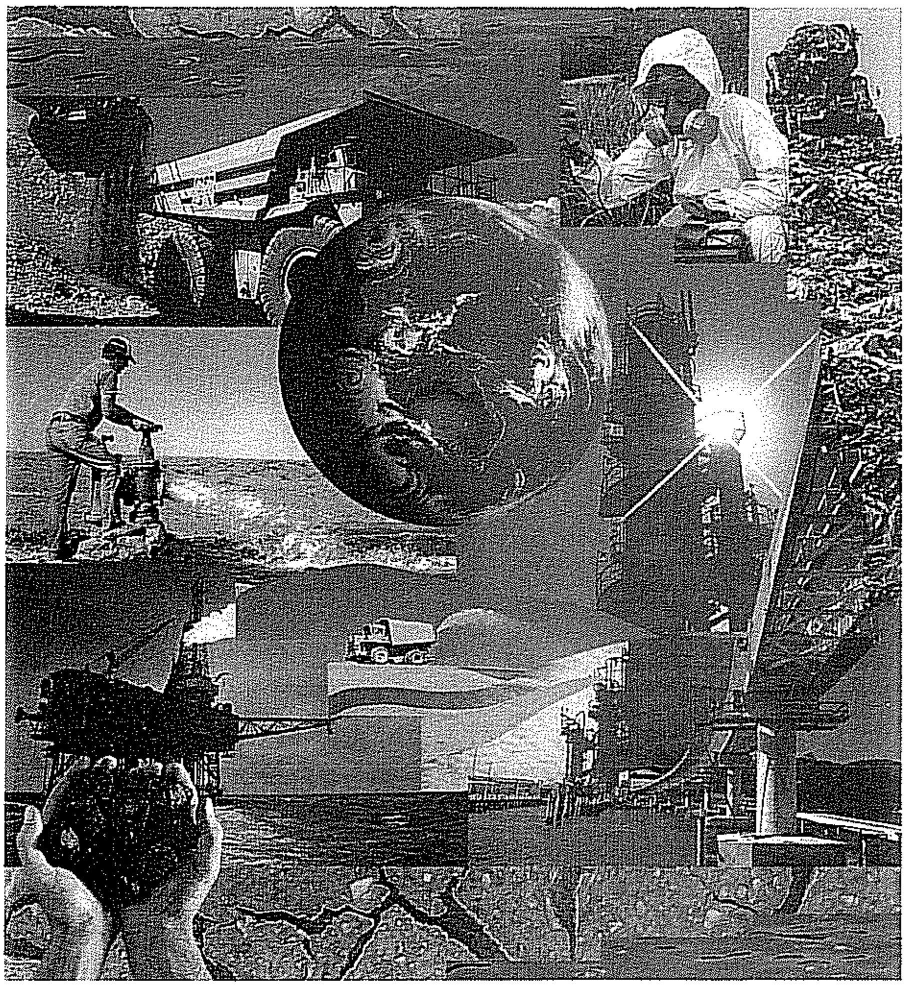
BHP

STEEL RIVER PROJECT - REMEDIAL ACTION PLAN ENVIRONMENTAL IMPACT STATEMENT



PREPARED FOR
BHP LONG PRODUCTS DIVISION

MAY 1997
Project No. A8600246
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Woodward-Clyde

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CLAUSE 50 CERTIFICATE

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979
(Section 77)

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This statement has been prepared on behalf of:

BHP Long Products Division
PO Box 196B
NEWCASTLE NSW 2300

being the proponents of the proposed development described below:

Site Remediation Works
Steel River Project Site
being land bounded to the north by the South Arm of Hunter River,
to the east by Tourle Street, to the south by Industrial Drive
and various industrial properties, and to the west by the
Pacific Highway and government railway

The proposed development is to be carried out on land shown in the maps included in this EIS which is described as part Lot 12 in Deposited Plan 842850.

The contents of this Statement, as required by Clause 51 of the Environmental Planning and Assessment Regulation, 1994, are set forth in the accompanying pages.

Certificate:

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

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

Signature: Michael J. England
Name: Michael England
Date: 16/5/97

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FOREWORD

The Steel River Project is a proposal to develop an industrial park on the Hunter River at Mayfield. The innovative industrial park is proposed to attract industrial, employment generating investment to the region and stems from an initiative of BHP, the NSW government, community representatives and other key stakeholders.

Initial environmental investigations were carried out by BHP on the land which is situated at the corner of Tourle Street and Industrial Drive at Mayfield. At that stage the project was identified as the West of Tourle Street or WOTS Project. A desire to create an employment generating project on the site resulted in masterplanning investigations of the site which was given the temporary name of the Mayfield Project. As the project took shape, the name Steel River Project was selected.

A draft Environmental Impact Statement and a draft Remedial Action Plan were prepared for the proposed remediation works that would be required before the site could be used for the Steel River Project. These drafts were circulated for comment and review before being combined into this single document.

What is an Environmental Impact Statement (EIS)?

An EIS is undertaken by, or on behalf of, a proponent for a project which has the potential to significantly affect the environment.

It is necessarily a document using specialist terms and abbreviations but every effort has been made to present it using plain English.

The environmental impact assessment process ensures that the effects of a project on the physical environment are considered along with social, economic and technical issues.

The Steel River Project Remedial Action Plan EIS complies with the environmental impact assessment process by addressing the following matters:

- describing the development proposal;

- reviewing the existing environment;
- determining the likely effects of the proposal on the environment;
- assessing alternatives; and
- outlining proposed safeguards, and environmental management and monitoring arrangements.

The EIS meets all of the legislative requirements with regard to an environmental impact study in NSW, namely the Environmental Planning and Assessment Act 1979 and its 1994 Regulation (as amended).

What is a Remedial Action Plan (RAP)?

A RAP is prepared for a site where previous detailed site investigations indicate that the potential exists for the site to pose unacceptable risks for human health or the environment.

The RAP is based on information contained in previous investigations and on the proposed use of the land. It demonstrates how it is proposed to reduce risks to acceptable levels. In doing this, the RAP sets remediation goals which ensure that the site will be brought to a condition suitable for the proposed use of the site, and that the site will pose no unacceptable risk to human health or to the environment. The RAP also establishes the most appropriate remedial strategy for the site.

The Steel River Project Remedial Action Plan EIS complies with the contaminated sites reporting process by addressing the following matters:

- setting remediation goals to protect the community, future users of the site and the environment;
- determining the most appropriate remedial strategy;
- identifying approvals or licences required from regulatory authorities;
- establishing the validation and monitoring requirements for the remedial action;

- describing the extent and duration of remediation required; and
- outlining site management arrangements.

About the EIS

The Steel River Project Remedial Action Plan EIS is unusual in that it has been prepared to meet the requirements of the NSW government authorities and Newcastle City Council in terms of their responsibilities for ensuring the full assessment of the potential environmental impacts of a proposal, as well as their responsibilities for ensuring the safe management and use of contaminated lands.

The EIS forms part of a set of documents prepared for the Steel River Project. Most of these documents deal with the form of the future development of the site, how that development will be carried out, and the environmental controls that will apply to the future industrial park.

It is not a document which is intended to justify the future use of the land, although potential future uses are discussed. The aim of the EIS is to assess the potential impacts that might result from actions to manage, in a responsible manner, contaminants that presently exist at the site so that the site is suitable for future use which differs from the existing use. It describes and assesses the work that needs to be undertaken on the site before the industrial park can be started.

The Project

The Steel River Project involves a proposal for the development of an industrial park on land between Industrial Drive and the Hunter River, located to the west of Tourle Street at Mayfield.

The project has evolved through the Newcastle Beyond 2000 Committee Technical Steering Committee which was set up in July 1995 and consists of representatives of all levels of government, the community, BHP and other key stakeholders.

The proposal which is the subject of this EIS, is the remediation of the site to improve its environmental characteristics by locating and managing identified contaminants in a responsible manner. Remediation would take place through the capping of the site by the introduction of fill material and the grading of that material to a landform which suits future use of the site.

The effects of the remediation of the site on all aspects of the environment were assessed, focussing on: the appropriate form of remediation; landform, geology and soils; hydrology and water quality; socio-economics; meteorology and air quality; noise; flora and fauna; archaeology and heritage; landscape and visual; traffic and transportation; land use and property; statutory planning controls; current ecological issues; hazards and risks; and cumulative impacts.

The Document

The EIS is one of a series of documents which will be placed on exhibition for public comment. These documents include:

- The EIS (incorporating the RAP) for the remedial works.
- The Masterplan outlining the proposed industrial park.
- The Strategic Impact Assessment providing the environmental performance goals for future industries wishing to establish themselves within the industrial park.
- The Draft Local Environmental Plan which prescribes the regulatory controls and standards which will apply to future use of the site.

To assist in the readability of the EIS, a glossary of terms and abbreviations is provided which explain in plain English the meaning of the term and what the abbreviation stands for. Some of the more technical information is presented in a simplified form within the body of the EIS while the specialist and technical information is presented in the Appendices.

The page numbering system used in this EIS is intended to provide a unique number for each page and to help readers identify exactly where they are in the document. The first of these numbers indicates the chapter number with the second number indicating the sequential page number from the beginning of the chapter.

For ease of reading and analysis, the EIS has been divided into a number of parts that group together associated chapters. These parts include:

- **Part A - Background**

  Part A contains Chapter 1 and outlines the environmental impact assessment process, the scope of the study, and an overview of the Mayfield area.

- **Part B - The Project**

  Part B of the EIS comprises Chapters 2 to 4, which describe the proposed remedial works. It justifies the need for the project investigation and states a number of objectives for the proposed works. It also includes a discussion on the range of alternatives to the proposed project.

- **Part C - Consultation**

  Part C contains Chapter 5 which gives details of the consultation process undertaken for this study.

- **Part D - Environmental Assessment**

  Part D of the EIS contains Chapters 6 to 16 which deal with aspects of the environment which were assessed for potential impacts. The chapters cover the existing environment, impacts of the proposal, and recommended safeguards to protect the environment from harm.

- **Part E - Other Environmental Matters**

  Part E consists of Chapters 17 to 19 which cover a number of additional environmental matters for consideration during the environmental impact assessment process. It also includes the assessment of cumulative impacts.

- **Part F - Environmental Management**

  Part F of the EIS contains Chapters 20 and 21 and outlines the proposed management and monitoring that would be implemented during the remediation of the site to minimise impacts on the environment.

- **Part G - Findings**

  Part G presents the findings of the EIS in Chapter 22. It also lists the safeguard measures required for the project and the project justification.

ACKNOWLEDGMENTS

The study team wishes to acknowledge and thank members of the community who generously contributed to the preparation of this Environmental Impact Statement. We also wish to thank individuals, organisations and government authorities who participated in the studies and provided their assistance.

NOTES ON THE TEXT

As a determination on the project will only be made after the Environmental Impact Statement has been on public display and submissions considered, the future conditional tense is used throughout this document when describing the project, alternatives and assessing impacts.

'Would' is, therefore, used throughout the text in preference to 'Will'.

If, it is decided to proceed with the project after a determination is made, all 'would' references should be interpreted as 'will'.

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μm
AADT :
ABS
ADI
AHD
am
AMCL
ANZECC

ARI
ARMCANZ

BHP
BoM
BTEX
CAMBA

CASANZ
CBD
CFC's
CO_2
CWR
dB
DLWC
DUAP
EF ACT
EIS
EMD
EMF
EP&A Act
EPA
EPI
ESD
ESP ACT
FAO

g/m^2/month	:	Grams per square metre per month
ha	:	Hectare
HASP	:	Health and Safety Plan
IGAE	:	Intergovernmental Agreement on the Environment
JAMBA	:	Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment
kg/m^3	:	Kilograms per cubic metre
km	:	kilometres
L/sec	:	Litres per second
LEMP		Landfill Environmental Management Plan
LEP	:	Local Environmental Plan
m	:	Metres
m^3	:	Cubic metres
m^3/D	:	Cubic metres per day
mg/kg	:	Milligrams per kilogram
mg/L	:	Milligrams per litre
mm	:	Millimetres
NHMRC	:	National Health and Medical Research Council
NIOSH	:	National Institute for Occupational Safety and Health
NPW ACT	:	National Parks & Wildlife Act
NSW	:	New South Wales
NSW NPWS	:	New South Wales National Parks and Wildlife Service
OSHA	:	Occupational Safety and Health Administration
PAH	:	Polyaromatic Hydrocarbons
pm	:	Post meridian
PPE	:	Personal Protective Equipment
PTWI		Provisional Tolerable Weekly Intakes
QA/QC	:	Quality Assurance/Quality Control
RAMSAR	:	Convention on Wetlands of International Importance
RAOU	:	Royal Australasian Ornithologist Union
REP	:	Regional Environmental Plan
RL	:	Reduced Level
ROTAP	:	Rare or Threatened Australian Plants
RTA	:	Roads and Traffic Authority
SEPP	:	State Environmental Planning Policy
TCLP	:	Toxicity Characteristic Leaching Procedure
TDS	:	Total dissolved solids
TPH	:	Total Petroleum Hydrocarbons
TSC ACT	:	Threatened Species Conservation Act, 1995
TSP	:	Total Suspended Particulates
USCG	:	U.S. Coast Guard
USEPA	:	United States Environmental Protection Agency

WMMA	Waste Minimisation and Management Act, 1995
WMMR	Waste Minimisation and Management Regulation, 1996

GLOSSARY OF TERMS

AHD	-	Australian Height Datum. The standard reference level used to express the relative elevation of various features. A height given in metres AHD is essentially the height above sea level.
Ameliorative	-	To make better, improve.
Aquifer	-	Geological formation, group of formations, or part of a formation capable of transmitting and yielding significant quantities of water.
Aquiclude	-	A geologic formation, group of formations, or part of a formation through which virtually no water moves. Clay is an example.
Aquitard	-	A saturated, but relatively poorly permeable bed, formation or group of formations that does not transmit or yield water freely.
Arisings	-	Contaminated materials derived from other areas of the site.
Background level	-	The level or concentration of the substance or compound, being measured prior to additional activity.
BHP Datum	-	Is a reference level used by BHP to express the relative elevation of various features. To convert BHP Datum to AHD, 12.51 is subtracted.
Biodiversity	-	Refers to the variety of ecosystems and species of plants and animals that can be found in nature. There are three levels at which biodiversity is important: genes, species and ecosystems.
Bioremediation	-	A remediation technology that uses micro-organisms to accelerate the degradation of contaminants in soil or groundwater.
Bund	-	A barrier designed to contain materials within a specific area.
Capping	-	Method of remediation which minimises the potential for infiltration and isolates contamination from human and environmental receptors.
Carcinogenic effect	-	A toxicological effect which results in the transformation of normal cells into cancer cells (neoplasia). These may then multiply rapidly and spread to other tissues.
Containment	-	To stop the uncontrolled movement of materials.
dB(A)	-	The sound level or noise level most appropriate to the human ear is usually expressed in terms of decibels (dB),

which is measured as the 'A weighting' filter incorporated in sound level meters.

Designated Development	-	Development (by reference to type, purpose or location) under the Environmental Planning and Assessment Act which requires an environmental impact statement.
Ecologically Sustainable Development	-	Means using, conserving and enhancing the community's resources so that ecological processes, on which life depends are maintained and the total quality of life, now and in the future can be increased.
Emission	-	The release of constituents into the atmosphere (e.g. gas, steam or noise).
Environmental Impact Statement	-	A formal description of a project and an assessment of its likely impact on the physical, social and economic environment. It includes an evaluation of alternatives and economic justification of the project. The EIS is used as a vehicle to facilitate public comment and as the basis for analysing the project prior to determining the project under relevant legislation.
Estuarine	-	River environment which is influenced by tides.
Fly Ash	-	Light ash component from the coal used to fire the boilers.
Geochemistry	-	Chemistry of the geologic formation.
Groundwater	-	Subsurface water contained within the saturated zone.
Groundwater Mound	-	An area within a natural groundwater surface which is preferentially raised up above the surrounding water levels. Groundwater mounds arise beneath areas where infiltration of surface water occurs at a higher rate that surrounding areas, for example, beneath infiltration ponds, dams, tailings dams and reservoirs.
Habitat	-	The particular local environment occupied by an organism.
Hazardous Waste	-	Any waste that because of its physically, biologically or chemically damaging properties, is capable of causing danger to the life or health of any living thing if it is released into the environment.
Hydraulic gradient	-	The change in static head per unit of distance in a given direction.
Hydrocarbon	-	Compound of hydrogen and carbon. Examples of hydrocarbons include oil and petroleum.
Hydrochemistry	-	Chemistry of groundwater.
Hydrology	-	Surface water and groundwater and their interaction with

		earth materials.
Inert Waste	-	Any non-liquid waste that, when it is disposed of, is not potentially hazardous or capable of undergoing an environmentally significant transformation.
Infiltration	-	The process of surface water soaking into the soil.
In-situ	-	In its original place.
Inter-generational equity	-	The principle that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
Interceptor Trench	-	A trench which creates a drawdown condition in the surrounding area which induces an inward groundwater flow effect in the vicinity of the trench.
Katabatic wind	-	Air which is cooled by the ground at night and flows over sloping land to a valley as cold-air drainage.
L_{A10}	-	Incident noise - the noise level which is exceeded for 10% of the sampling period and is considered to be the average maximum noise level.
L_{A90}	-	Background noise - the noise level which is exceeded for 90% of the sampling period and is referred to as the average minimum or background noise level.
Landfarming	-	Involves the bacteriological breakdown and volatilisation of hydrocarbons during tilling or reworking of the contaminated soils spread to a shallow depth over the ground.
Leachate	-	Liquid released by, or water that has percolated through, waste and which contains dissolved and/or suspended liquids and/or solids and/or gases.
Non-carcinogenic effect	-	A toxicological effect which adversely effects the organism, but does not involve the transformation of cells to cancer cells.
Paleotopography	-	Buried topographic features.
Pan evaporation	-	Evaporation is defined as the quantity of water vapour transferred from a free water surface to the atmosphere. The measurement of evaporation in Australia has been standardised in recent years and observations are now taken by the Class A pan evaporimeter.
Perched groundwater	-	Unconfined groundwater separated from an underlying body of groundwater by an unsaturated zone and supported by an aquitard or aquiclude.
Permeability	-	The property or capacity of a porous rock, sediment, clay or soil to transmit a fluid.
pH	-	A rating used to measure the acidity or alkalinity of a

substance or liquid.

Pickling - Materials that are to be plated or galvanised are frequently pickled in a weak acid solution and then rinsed in hot water to remove all foreign matter.

Piezometer - A pipe in which the elevation of the water level or potentiometric surface can be determined. The pipe is sealed along its length and open to water flow at the bottom.

Porosity - In soils, porosity is the ratio of the volume of the soil voids to the total volume.

Potentiometric Surface - A surface which represents the standing or total hydraulic head. It represents the levels to which water will rise in tightly cased wells in an aquifer system. The watertable is the potentiometric surface of an unconfined aquifer.

Precautionary Principle - The principle that if there are threats of serious or irreversible environmental damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

Proponent - The body putting forward a proposal; in the case of this EIS, BHP is the proponent.

Recovery well - Constructed to impose an inward groundwater flow gradient whereby contaminated groundwater is extracted from a series of recovery wells and pumped to the surface.

Rehabilitation - Restoration of an area, disturbed by a particular landuse i.e. mining, to a suitable landform and environmental quality.

Remediation Criteria - Upper concentration level to which contaminants of concern will be remediated to.

Retention/Sedimentation ponds - A pond constructed to temporarily contain wet weather run-off and allow suspended matter to settle to the bottom for surface water quality management.

Risk assessment - Process by which scientific data (i.e. soil, surface water, groundwater, sediment quality) are analysed to describe the likelihood of harm to humans or the environment. It is used to facilitate the management of risk

Screening - The separation of fine and coarse materials through a physical process.

Silt fence - A geotextile product used to limit sedimentation transfer in overland water flow.

Site remediation - The clean-up or mitigation of pollution and/or

	contamination of soil and waters by various methods.
Slag	- A non-metallic by-product resulting from the smelting and refining of metals.
Soil washing	- A volume reduction process in which the larger particles of soil are separated from the finer particles.
Species	- Any of the taxonomic groups into which a genus is divided.
Stabilisation	- Method of preventing migration of contaminants.
Taxon	- (pl. taxa) The named classification unit to which individuals or sets of species are assigned, such as species, genus and order.
Thermal desorption	- A remediation technique which uses a heat source for volatilising organics from the soil, and an off gases treatment system and a particulate collection system for removing particulates.
Total Suspended Particulates	- Concentration of lead and other heavy metals in air according to EPA sampling methods and analysis.
Validation	- Assurance that specified end points of remediation criteria have been met.
Vapour Extraction	- Involves the removal of volatile organic compounds from subsurface soils by mechanically drawing or venting air through the soil matrix.

PART A

BACKGROUND

EXECUTIVE SUMMARY

PART A - BACKGROUND

Introduction

This Environmental Impact Statement (EIS) has been prepared by AGC Woodward-Clyde Pty Limited for BHP Steel Long Products Division, Newcastle. The EIS has been prepared to assess the potential environmental impacts of the proposed remediation of the Steel River Project site located on the south bank of the South Arm of the Hunter River at Mayfield West, NSW. The Project site has an area of some 104 ha and has been predominantly used by BHP for waste storage and disposal.

The assessment of environmental impacts of the proposal was carried out in accordance with Part 4 of the Environmental Planning & Assessment Act and the Environmental Planning and Assessment Regulation, 1994. The effects of the proposal on soils and landform, water quality, air quality, the noise environment, flora and fauna, traffic and transportation, surrounding land uses, the socio-economic environment, and heritage and archaeology are assessed in the EIS.

PART B - THE PROJECT

Needs and Objectives

The proposed remediation works would improve the environmental characteristics of the site by locating and managing identified contaminants in a responsible manner, thereby reducing potential environmental and human health risks associated with the future use of the site. This would enable future redevelopment of the site for industrial purposes. It is also a condition of the licence issued by the Environment Protection Authority that remediation occurs prior to any future redevelopment of the site.

Remediation of the Project site would allow realisation of a number of benefits. These benefits include:

- on-site containment of contaminated materials and groundwater without adversely affecting the local environment and without unnecessarily occupying off-site landfill space;
- reduction in risk to the health of future on-site workers and the surrounding community; and
- stimulation of the local economy through the future redevelopment of the site.

Study Area and Alternatives

The Mayfield West area is located to the north-west of Newcastle CBD and is one of the older industrial areas in Newcastle. Mayfield West also has some areas of established housing and commercial land use to the south of the Project site.

A variety of remedial technologies were considered for the remediation of contaminated soils at the Project site. The capping option was considered the most appropriate remediation technique as it is environmentally sound, has low technical risk, can be readily implemented and is cost effective. The process consists of the containment of contaminated material which then limits the potential for human or environmental exposure to site contaminants and allows the land to be redeveloped for industrial purposes.

Alternative methods for the control and prevention of potentially contaminated groundwater reaching the Hunter River were considered. The most cost effective option for minimising off-site groundwater flow is to cap and recontour the site to minimise the potential for infiltration and hence the generation of contaminated groundwater.

Consequences of No Action or Deferral

If the project did not proceed or was deferred, the site would not present an unacceptable risk to human health or the environment but contaminants currently present in soils and groundwater at the site would not be contained and would not be remediated. If no remediation works are undertaken, redevelopment of the site for industrial purposes would not occur.

Project Description

The main features of the proposal include:

- Management of contaminated soil and groundwater in situ;
- Importation of Coal Washery Reject (CWR) and movement of some on site material for the purposes of capping and recontouring the site;
- Reduction of surface water inflow and hence the generation of contaminated groundwater; and
- Creation of a site which is suitable for future industrial redevelopment.

CWR would be imported to the Project site by road from the Macquarie Coal Preparation Plant using a designated route.

PART C - CONSULTATION

The community and statutory authorities participated in the planning process at an early stage of the proposal. At a Planning Focus Meeting held 19 December 1996 statutory authorities were given the opportunity to make comments or voice concerns regarding the proposed works. The main avenue of consultation with the community is through the *Newcastle Beyond 2000 Committee Technical Steering Committee.* The Committee provides an avenue within which representative community groups could examine potential future uses of the site and raise concerns relating to the impact of the proposal on the local environment and surrounding community.

PART D - ENVIRONMENTAL ASSESSMENT

Landform, Geology, Soils and Geotechnical

The topography of the study area is mostly flat with an elevation of approximately 7.5 to 9.5 m AHD. The main topographic feature of the site is a natural knoll in the south-eastern corner which rises to approximately 27.5 m AHD. There is also a topographic high of similar elevation running along part of the southern portion of the site.

Apart from the natural knoll the geology underlying the site consists of fill materials. estuarine muds and bedrock formations. Estuarine muds. comprising natural clays with interbedded fine silts and sand layers, are overlaid with man-made fill. The fill layer generally varies between 7 m and 12 m thickness and comprises exotic materials including blast furnace slag, CWR, fly ash and smaller quantities of tarry materials. The Tomago Coal Measures bedrock formation underlies the entire Project site and comprises sandstone, siltstones and shales of Permian age.

Excavating and transporting material within the site. temporary stockpiling of material, and the importation of CWR material could give rise to sediment transportation. However. with the use of appropriate safeguard measures these impacts would be minimal.

Water Quality and Hydrology

Groundwater at the site generally flows northward to the Hunter River or eastwards into the adjoining steelworks along the former Platt's Channel. Groundwater seeps have been observed entering the Hunter River along a surface zone extending from the low tide level up the fill embankment.

Water quality monitoring programs indicate that the concentrations of manganese in groundwater is within background concentrations. Groundwater contains polyaromatic hydrocarbons (PAHs) with lower concentrations of phenolic compounds and again lower concentrations of benzene, toluene, ethylbenzene and xylene compounds. Groundwater seeps at the site have been found to contain slightly elevated concentrations of total petroleum hydrocarbons and manganese, and to a lesser extent copper, lead and zinc. PAH concentrations were below or near the laboratory detection limits.

As the topography of the site is mostly flat, surface water tends to pond on the site and either gradually infiltrates to groundwater during periods of extended and/or heavy rainfall or evaporates during dry periods. Where surface water runoff is generated, the prime contaminant of concern would be manganese which is contained in the materials which cover the surface of the site.

Water quality data does not indicate deterioration of river water quality adjacent to the Project site. The quality of river water adjacent to the site is generally similar to conditions in the North Arm of the Hunter River which is removed from the region of potential influence of the Steel River Project site.

The remedial works would contribute to minor and localised effects on the hydrology of the site due to reduced infiltration. Remedial works would improve the quality of surface and groundwater at the site, provided water management strategies are implemented.

Socio-economic

Overall, the socio-economic impacts of the project are positive. Containment of the contaminants would have positive benefits for the local community as it would enable the release of valuable industrial land for redevelopment and would generate local employment opportunities.

Implementation of an appropriate remediation strategy would ensure that there would be no health risk to on-site workers. In addition the implementation of safeguards and an on-site monitoring program would ensure that the environmental impacts which may be generated by the proposed remediation works do not affect the health and safety of the surrounding community.

Meteorology and Air Quality

Fugitive dust particulates are presently a major atmospheric pollutant in the Mayfield area, with mean annual dust deposition rates exceeding the NSW EPA amenity based criteria of 4 g/m^2/month.

During the remediation works, dust would be generated from loading, unloading, material spreading operations, any excavation at the Project site, and from the loading operations at the Macquarie Coal Preparation Plant. However, these effects would be minimised by implementing dust management strategies such as watering exposed areas and stockpiles, and controlling vehicle speed along haul roads.

Noise and Vibration

During remediation of the site, noise generation would primarily be from heavy machinery used to spread materials and from vehicles transporting material used for capping the site. However, the implementation of a Noise Management Plan would ensure sound levels emitted by the proposed works would comply with noise level restrictions in the NSW EPA's Construction Noise Guidelines, and would have negligible impact on surrounding areas.

Flora and Fauna

The proposed works would result in the removal of two areas of grassland and a small area of boundary plantings on the site. The remnant stand of native trees and shrubs in the southwestern section of the site as well as the majority of mound, boundary and cultural plantings are not expected to be significantly impacted upon by the proposed works.

Although not recorded on the site, one flora species and three fauna species of conservation significance could be supported by the type of habitat found on-site. However, it was concluded that the proposed works are not expected to pose significant adverse effects upon the survival of these species.

Archaeology and Heritage

A field survey of the Project site did not identify any Aboriginal archaeological sites. However, given that numerous Aboriginal archaeological sites have been found throughout the Newcastle region and that the subject site is in close proximity to the South Arm of the Hunter River, it is highly likely that it was once occupied by Aborigines. Had Aboriginal sites such as open campsites, shell middens and artefact scatters once been present at the site they would have been buried, destroyed or disturbed by past activities.

A search of the NSW NPWS Register of known Aboriginal Sites revealed 92 recorded sites within a 10 km radius of the Project site. None of these sites or historic sites listed by the Australian Heritage Council or the NSW National Trust occur on site.

As the NSW NPWS, Australian Heritage Council or the NSW National Trust registers did not list any items of Aboriginal or heritage significance on the site and items were not identified during the field survey, it was predicted that the proposed remediation activities would not impact on any known items or areas of archaeological or heritage significance.

Landscape and Visual

The landform, vegetation and land uses of the site and surrounding areas combine to make up two land units within the study area namely the riverfront industrial and urban land units. The riverfront industrial complex dominates the riverfront landscape to the east of the site. A range of industrial facilities dominated by the BHP Iron and Steel Works site characterise this predominantly flat landscape. The urban land unit dominates the landscape to the south and is characterised by both established and relatively new, moderately-sloping residential suburbs of Mayfield, Mayfield East and Mayfield West.

An observation study undertaken at vantage points surrounding the site indicated that given the low key visual nature of the proposed works and the existing screen plantings on-site, the impact on the visual amenity of the local environment as a result of the proposed works would be negligible.

Traffic and Transport

The proposed works would give rise to a small increase in traffic as a result of personnel commuting to and from the site, trucks hauling CWR for capping and recontouring the site and mobilisation and demobilisation of heavy equipment. The designation of a specific route to be used by trucks transporting CWR and the erection of temporary signage to warn oncoming traffic and to identify the entrance/exit to the site, would reduce potential impacts on the existing traffic environment.

Land Use and Property

The Project site is located in the north-western section of the Port of Newcastle. The Port is an important focus for the Hunter Region's transportation network and economy and has traditionally supported an industrial employment base for Newcastle. Industrial activities centre on manufacturing, coal resource related industries and steel. Residential areas are concentrated to the south of the Project site and there are also several areas of open space which are used for recreational activities.

Mayfield West is dominated by industrial and residential land use. The industrial areas of Mayfield West are concentrated to the north of Industrial Drive. The residential areas are concentrated to the south of Industrial Drive and are generally well established. Current uses on the Project site include hot metal pits and a Boral slag crushing plant as well as the Boral Concrete Plant and Mayfield West Fire Station.

The proposed remediation would enable the site to be redeveloped for industrial land uses which would satisfy strategic planning land use outcomes for the area. Remediation would be carried out in a phased manner which would allow continuation of current land uses on-site in the short to medium term. Safeguard measures would be implemented to ensure that the proposed works would have minimal impacts on surrounding land uses and the riverine environment.

Statutory Planning and Controls

The Project site is located within Newcastle City and is governed by the provisions of Newcastle Local Environmental Plan 1987 (LEP 1987). The site is zoned 4(b) General Industrial apart from the south-eastern natural knoll feature which is zoned Ecclesiastical pursuant to the provisions of Newcastle LEP 1987. Remediation of the site and its future potential use for industrial purposes is permissible with development consent.

The only State Environmental Planning Policy applicable to the subject land is State Environmental Planning Policy No. 11 - Traffic Generating Development.

PART E - OTHER ENVIRONMENTAL MATTERS

Ecologically Sustainable Development

The Commonwealth Government defined ecologically sustainable development (ESD) as: 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future can be increased'. The principles which would assist in the achievement of ESD include:

- The precautionary principle.
- Inter-generational equity.
- Conservation of biological diversity and ecological integrity.
- Improved valuation and pricing of environmental resources.

Through the development of environmental and economic safeguards, and the inclusion of mitigation measures in project costings, the proposal has demonstrated a commitment to these principles.

Cumulative Impacts

Cumulative impacts can result from a number of different elements within a project as well as from a number of different projects with interacting impacts in the same locality. The cumulative impact of a project is a combination of each elemental impact of the project. The impact of individual projects within a locality is also considered to be cumulative.

As each remediation phase would be staged and the impact of the individual factors is minimal, no significant cumulative impact is anticipated from the project. The cumulative impact of remediation with other known projects proposed for the area is also considered to be minimal.

PART F - ENVIRONMENTAL MANAGEMENT

Environmental management of the proposed remedial works would ensure that the project has minimal impact on the physical, social and economic environments of the region. An Environmental Management Plan incorporating appropriate safeguard measures for the detailed design of the project and the contractual arrangements associated with the remedial activities, would ameliorate adverse impacts on the environment.

The Plan would be made available to council, government departments, statutory authorities, the community and all other interested parties and would be reviewed and updated where necessary.

PART G - FINDINGS

The proposed remedial activities are designed to contain groundwater contaminants at the site by reducing groundwater flows to the Hunter River, and contains soil contaminants within the site. This would reduce the environmental and human health risks associated with future use of the site and enable the release of valuable industrial land for redevelopment. In addition, the local economy would be stimulated by creating employment opportunities and encouraging industry to relocate or establish itself in the Mayfield area.

The assessment of the possible effects of the proposed remediation works on the environment indicates that there would be no major adverse physical, biological or social impacts. The implementation of safeguards detailed in the Environmental Management Plan would ensure the effective mitigation of any environmental impacts which may arise during remediation works.

1.0
INTRODUCTION

1.1 THE ENVIRONMENTAL IMPACT PROCESS

The Environmental Planning and Assessment Act, 1979 (EP&A Act) provides a system of environmental planning and assessment for New South Wales (NSW). It is a requirement of the EP&A Act that an assessment of the environmental impacts of a proposal must be undertaken prior to any decision to proceed with that proposal.

This Environmental Impact Statement (EIS) has been prepared in accordance with Part 4 of the EP&A Act and the Environmental Planning and Assessment Regulation, 1994 (the Regulation). Part 4 deals with environmental planning control and relates to development which is controlled by an environmental planning instrument (EPI).

The proposed site remediation works are identified in Schedule 3 of the Regulation as designated development and hence Section 77(3) (d) of the EP&A Act requires that an EIS be prepared and accompany a development application. Clause 52 requires that the EIS shall have regard to the requirements of the Director-General of Planning. A copy of these requirements is included in Appendix A.

The EIS must also include a certificate required under Clause 50 of the Regulation.

The overall environmental impact assessment process for this EIS is shown in Figure 1.1.

1.2 APPROVALS REQUIRED

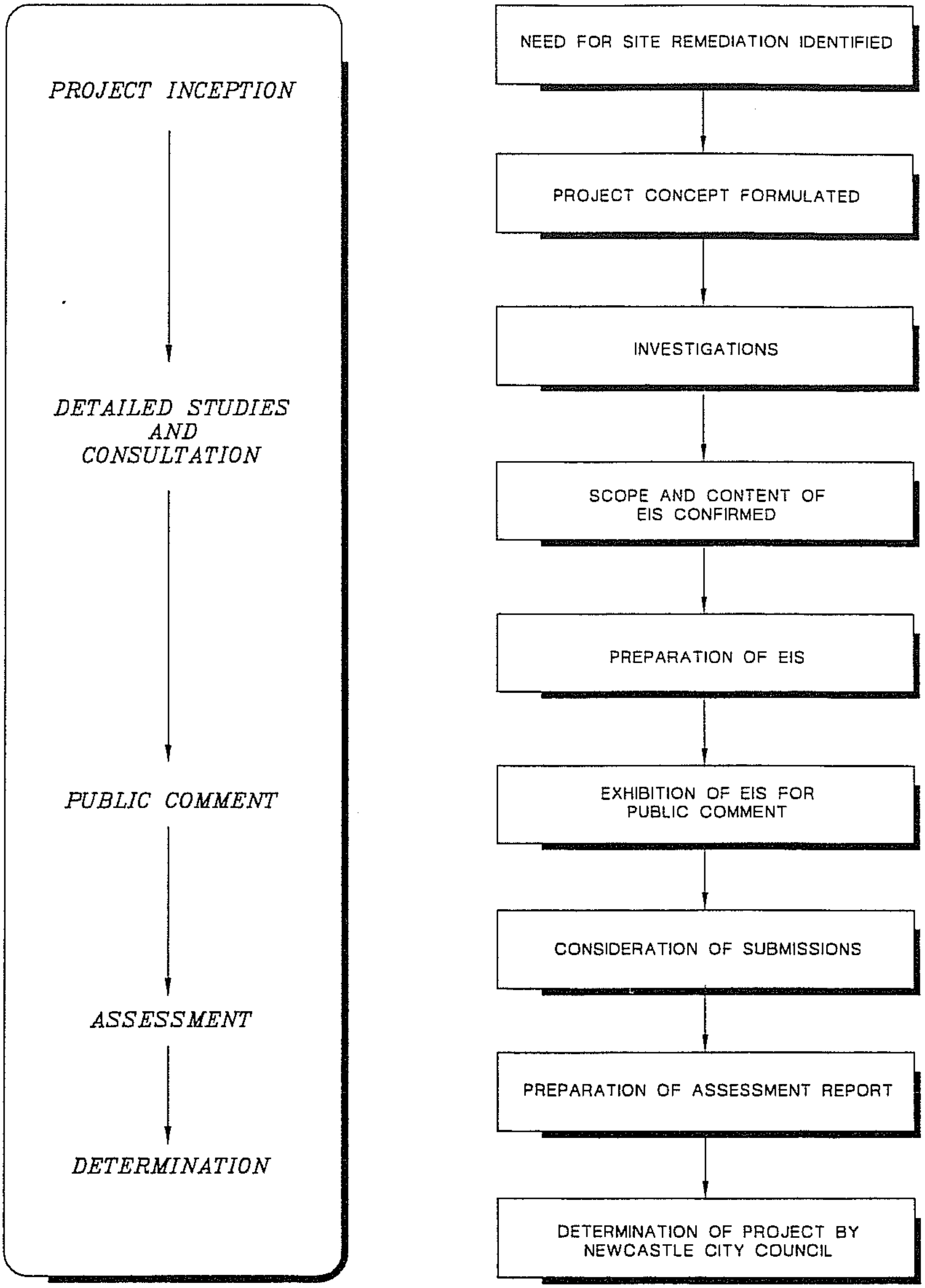
On submission of the EIS, a number of approvals would be required for the project to proceed. The relevant statutes which set out these requirements include those listed in Table 1.1.

TABLE 1.1 - LIST OF STATUTES

Statute
Clean Air Act, 1961
Clean Waters Act, 1970
Dangerous Goods Act, 1975
Environmental Offences and Penalties Act, 1989
Environmental Planning and Assessment Act, 1979
Local Government Act, 1993
National Parks and Wildlife Act, 1974
Noise Control Act, 1975
Occupational Health and Safety Act, 1983
Pollution Control Act, 1970
Protection of the Environment Administration Act, 1991
Rivers and Foreshores Act, 1948
Soil Conservation Act, 1938
Waste Minimisation and Management Act, 1995
Water Act, 1912

A number of approvals would be required by the statutes listed in Table 1.1..Examples of some of these statutory approvals include:

- Development Consent under the Environmental Planning & Assessment Act, 1979;
- Pollution Control Approval under the Pollution Control Act, 1970;
- Licence under the Clean Waters Act, 1975;
- Licence under the Clean Air Act, 1961, for the use of scheduled premises;
- Licence under the Noise Control Act, 1975, for the use of scheduled premises;
- Permit under the Soil Conservation Act, 1938;
- Licence under the Water Act, 1912;
- Permit under the Rivers and Foreshores Act, 1948; and
- Licence under the Waste Minimisation and Management Regulation, 1996.



Woodward-Clyde

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

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CAD FILE NO: Q.045	APPROVED: CS
DATE: 16/5/97	STATUS: FINAL

TITLE
ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

FIGURE
1.1

A4

Contractors would also be required to comply with all statutory requirements which relate directly to work practices.

1.3 INTERDISCIPLINARY INVESTIGATIONS

The preparation of the EIS has involved interdisciplinary investigations by a number of technical experts.

The study team members are listed in Appendix B.

The investigations included:

- a review of relevant information;
- consulting with the community;
- consulting with Newcastle City Council, and relevant government departments and statutory authorities to identify their requirements for matters to be addressed;
- scoping of relevant issues;
- responding to issues raised during the consultation phase;
- undertaking specialist studies, field work, research and assessment of findings;
- evaluating information; and
- analysing and presenting information.

1.4 SCOPE OF ENVIRONMENTAL IMPACT ASSESSMENT

Specialist assessments were conducted in the following matters:

- heritage;
- earthworks impacts;
- cumulative effects;
- current ecological issues;

- environmental monitoring and management;
- fauna;
- flora;
- geotechnical considerations;
- hydrology;
- land use, planning and zoning;
- meteorology and air quality;
- noise impacts;
- socio-economic issues;
- topography, geology and soils;
- traffic and transportation;
- visual analysis;
- waste management; and
- water quality.

The scope of work undertaken for this EIS has been established to meet the requirements of:

- relevant government legislation;
- the community through the Newcastle Beyond 2000 Committee Technical Steering Committee;
- Department of Urban Affairs and Planning (DUAP);
- relevant government departments and statutory authorities; and
- the proponent.

1.5 THE PROPONENT

The Broken Hill Proprietary Company Limited (BHP), was incorporated in 1885 and began as a miner of silver, lead and zinc at Broken Hill in NSW. Thirty years later, BHP commenced steel making activities in Australia and expanded its mining activities to satisfy the raw material requirements of the steel making operations. BHP subsequently became involved in large-scale mining and the export of raw materials used for steel making and, in the 1960s, took its first step into the petroleum industry. More recently, while continuing to build on its three main businesses - Minerals, Steel and Petroleum - BHP has become involved in a number of specialist support activities in the Service Companies Group.

Today, BHP is one of the world's largest diversified resource companies, with operations in more than 20 countries and over 100 years' experience in the resource industry. BHP is also Australia's largest publicly owned company and 68th largest company in the world. It is the second largest producer of both iron and manganese ore, the second largest producer of copper, and the sixth largest producer of coal in the Western world.

1.6 OVERVIEW OF THE MAYFIELD AREA AND PROJECT SITE

The suburb of Mayfield West is located in northern Newcastle and has a history of development dating back to the time when Newcastle was first settled (Figure 1.2). Mayfield West is presently dominated by a mixture of residential, industrial, commercial and recreational land uses.

The Steel River Project site is bounded by the South Arm of the Hunter River to the north, Tourle Street and the Australian Manganese EMD Plant to the east, an industrial railway to the west and industrial land (south-western corner) and Industrial Drive (south-eastern corner) to the south. The majority of the site comprises reclaimed land from the former waterway known as Platt's Channel and the site also includes land from Spit Island, a former low lying wetland which was originally separated from the mainland by Platt's Channel.

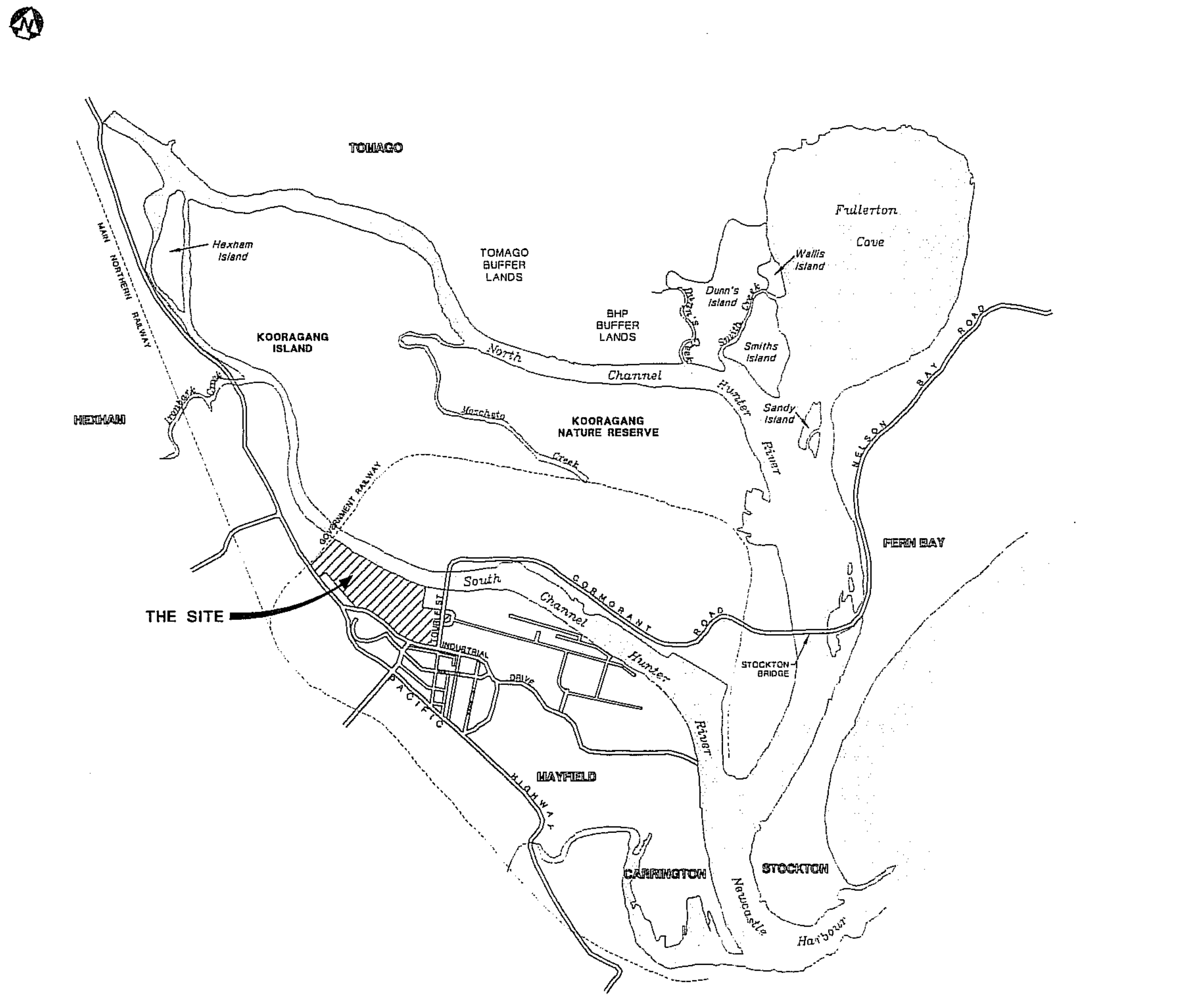
The history of BHP activities at the Project site dates back to 1935, when BHP first commenced waste disposal activities on the site. Waste materials disposed on the site included spent acid from pickling operations, waste tar, general refuse such as old bricks ironmaking and steel making slags, coal washing sludges and coarse reject.

In 1950 an Act was passed by the NSW Parliament which provided for the reclamation of Platt's Channel and the subsequent linking of Spit Island with the mainland. Over the following years, predominantly blast furnace slag, coal washery reject (CWR) and lesser quantities of some tarry materials were used to fill the land to its present level.

1.7 BACKGROUND TO THE PROJECT

Historically the Steel River Project site was used by BHP for waste raw materials storage and waste disposal. After waste disposal activities at the site ceased, numerous environmental investigations were undertaken by BHP and various consultants namely Environmental and Earth Sciences, Robert Carr and Associates, AGC Woodward-Clyde and CMPS&F (Appendix C). Environmental assessments included investigations of soil and groundwater quality, soil gas surveys, hydrogeological studies, an environmental and human health risk assessment and an audit of environmental investigations. These investigations were undertaken with the purpose of characterising levels of contaminants at the site and assessing the suitability of the site for future redevelopment.

The environmental investigations identified a number of environmental issues associated with the fill materials and groundwater, and with elevated levels of organic contaminants in some areas of the site. On the basis of these findings, it was concluded that remediation of the site would be required prior to any future widespread redevelopment for industrial purposes.



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DATE: 16/5/97 | STATUS: FINAL

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
REGIONAL SITE LOCATION PLAN

FIGURE
1.2

A3

Woodward-Clyde

PART B

THE PROJECT

2.0 NEEDS AND OBJECTIVES

2.1 OBJECTIVES

The overall objective of site remediation is to provide appropriate management of on-site contaminants and reduce to acceptable levels the potential for environmental exposure to contaminants so that the area may be redeveloped or used without risk to human health or the environment.

In addition to the broader objective stated above, BHP has developed specific objectives for the Steel River Site Remediation Project. The specific project objectives are listed as follows:

Safety Objectives:

- to safeguard public health and the health of personnel participating in the remedial activities; and
- to ensure the remedial activities are undertaken in accordance with a site specific Health and Safety Plan (HASP).

Environmental Objectives:

- to improve the environmental characteristics of the site by managing identified contaminants in a responsible manner;
- to minimise the potential for contaminants from past activities to harm the environment; and
- to minimise environmental impacts during remediation by implementing appropriate pollution control measures.

Social Objectives:

- to manage the potential for identified contaminants to impact on the locality; and
- to minimise the impact of the proposal on the surrounding community and nearby residences.

Economic Objectives:

- to return the site to a condition which makes it suitable for future and/or alternative uses.

2.2 STATE AND REGIONAL POLICIES

The Hunter Regional Environmental Plan 1989 (REP) was gazetted in December 1988 (Amendment No. 1 - 14 September 1995, Amendment No. 2 - 5 October 1995) and provides a policy framework for development of the Hunter Region. The REP was prepared following recognition of the substantial structural changes over a number of years to the economic base of the Region. The manufacturing sector is in decline but coal resource related industries and service industries have contributed to employment growth.

The REP seeks to ensure that sufficient zoned and serviced industrial land is provided in locations appropriate to the needs of industry, while ensuring protection of the environment. If industrial land is to be developed for a purpose other than industry, the REP states that the reduction in industrial land should not jeopardise job opportunities in the area.

Remediation of the Steel River Project site would provide land for industrial development which would have the potential for significant direct and indirect employment benefits in the Newcastle area.

Guidelines for environmental protection in the REP clearly set out pollution controls, waste disposal and environmental hazard issues to be addressed should a site be developed for industrial purposes. These measures would ensure that development is carried out in an environmentally responsible manner, while still allowing for stimulation of the local economy.

2.3 PROJECT DEMAND

Future rationalisation of BHP operations will result in a significant reduction in employment opportunities in the Newcastle Industrial Area. An industrial park has been proposed by BHP for the site to mitigate potential job losses associated with any rationalisation. To enable industrial development to proceed, the site needs to be brought to a condition suitable for industrial redevelopment. Future development of all of the site is only possible if contaminated areas of the land are remediated.

A human health risk assessment identified some potential risk to human health of site workers if the site were redeveloped. This is associated with polyaromatic hydrocarbons (PAHs) in surface soils on the site. The EPA has also required that discharge of groundwater from the site be addressed. Remediation would mitigate potential risks from soils and groundwaters.

2.4 PROJECT BENEFITS

Remediation of the Steel River Project site would allow realisation of a number of benefits which are discussed below.

2.4.1 Containment of Contaminants

The proposed remedial activities would ensure contaminated soil and groundwater are managed without affecting the local environment. This would remove the potential for on-site contaminants to cause environmental degradation at a later date. Management of contaminated materials would prevent direct contact with receptors and would control generation of contaminated groundwater.

2.4.2 Ultimately Reduce Risks to Human Health

The proposed remedial activities would ensure that any future industrial redevelopment of the site can be undertaken with minimal risk to the health of on-site workers or the surrounding community. A human health risk assessment of the Project site indicated a potentially unacceptable human health risk to future on-site workers only if tar and specifically PAH compounds were found to be present in surface soils which workers may come into contact with. The human health risk assessment defined concentrations of PAH compounds which should not be exceeded in the surface soils.

2.4.3 Stimulation of the Local Economy

On completion of a remediation program the site could be redeveloped for industrial purposes, providing a positive incentive for industry looking to relocate or establish itself in the Mayfield area. The establishment of industry in the area would benefit the local community and Newcastle region by creating employment opportunities, generating government revenue and stimulating the local economy.

2.5 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

In 1990, the Commonwealth Government issued a discussion paper on Ecologically Sustainable Development (ESD). That paper included a discussion on the concept of using resources on an ecologically sustainable basis as well as principles to aid in the formation of an ESD strategy and methods that could be used to give the concept practical effect. These principles as they relate to the proposed remedial activities for the Steel River Project site are outlined below:

- **Improvement of material and non-material well being:**

  For further development to meet more effectively the aspirations of society and improve material and non-material well being, both economic and environmental considerations would need to be taken into account when making decisions. The proposed remedial activities would contribute to the quality of life by providing a site suitable for redevelopment which would generate employment opportunities, improve the aesthetic value of the area and increase property values.

It is also widely recognised that the environment contributes to material and non-material well being. By the remediation of contaminants and by improving the aesthetic value of the area, the proposed remedial activities would be consistent with these principles.

- **Advancement of inter-generational equity:**

The distribution of economic benefits across generations and long-lasting effects on the environment are key issues in the consideration of inter-generational equity as it relates to the proposed remedial activities. Therefore, appropriate consideration must be given to the economic benefits of the proposed development and the effects on the environment, while balancing the needs of present and future generations.

Remediation of the Project site would enable use of the land as a productive resource, capable of redevelopment without harm to people or the environment, which will provide jobs for this and future generations.

- **Advancement of intra-generational equity**

The equitable distribution of economic and social benefits of a proposed development is one of the cornerstones of achieving intra-generational equity. It requires that all people have access to meaningful and safe employment, and that the occupational health and safety of workers should achieve the highest level. A further key requirement of intra-generational equity is the effective participation of the public in the decision making process.

The proposed remediation would achieve intra-generational equity by:

- enabling the site to be redeveloped for future industrial purposes which would benefit the local economy;

- ensuring that the land can be redeveloped in a manner which is not harmful to the natural environment or to the health and safety of future workers on site; and

- involving the Newcastle Beyond 2000 Committee Technical Steering Committee in the planning and preparation of the EIS, and in particular during the EIS exhibition phase.

- **Maintenance of the ecological system and the conservation of biodiversity:**

  Development has a direct impact on ecology and the environment. The proposed remedial activities would ultimately prevent potential off-site impacts (such as the addition of contaminants to the Hunter River) and therefore would be consistent with the principle of maintaining ecological systems and conserving biodiversity.

- **Accounting for global ramifications:**

  Some of the world's major environmental problems are global rather than local in nature (for example, the accumulations of greenhouse gases). Like any country contemplating measures to reduce global pollution, Australia is likely to have to coordinate its actions with those of other countries. The global dimension of ESD carries with it implications for Australia's relationships with other countries.

- **Caution in dealing with risk, uncertainty and irreversibility:**

  Many environmental effects associated with remediating contaminated sites require the use of caution, particularly when dealing with risk and irreversibility. The use of an anticipatory and cautionary approach in this EIS makes allowance for uncertainty about the way in which a natural system would respond. Basic ecological research contained in the baseline studies enables the degree of uncertainty about how the natural environment would respond to human activity to be reduced.

Schedule 2 of the EP&A Regulation identifies a number of principles of ESD. These principles are:

- Precautionary Principle;
- Inter-Generational Equity;
- Biological Diversity and Ecological Integrity; and
- Valuation and Pricing of Environmental Resources.

These principles are addressed in detail in Chapter 17.

2.6 JUSTIFICATION FOR INVESTIGATION OF THE PROJECT

The issues raised throughout Chapter 2 ranging from remediation objectives, State and Regional policies, the state of the environment, the existing demand for the project, and the benefits of the project, provide justification for further investigation of the proposal. Part D of this EIS describes the investigations which examine the environmental, economic and social issues associated with remediation of the site.

3.0

STUDY AREA AND ALTERNATIVES

3.1 REGIONAL AND LOCAL CONTEXT

The Mayfield area and the surrounding region is an established area of Newcastle with a mixture of urban uses and activities. The region is dominated by industrial, residential and commercial land uses, however, there are also several areas of open space including Stevenson Park and Kooragang Nature Reserve. The numerous parks and reserves have important recreational value and are used by joggers, walkers, team sports, and cyclists and the Hunter River is used for boating and fishing.

The Mayfield area is located to the north west of Newcastle CBD. It is one of the older industrial areas in Newcastle, with large areas occupied by industry and land as yet not taken up for industrial purposes. There are also some areas of commercial land use and established housing, to the south of the subject site.

3.2 SITE LOCATION AND HISTORY

3.2.1 Steel River Project Site Location

The Steel River Project site is approximately 104 ha in size and is bounded by the South Arm of the Hunter River to the north, Tourle Street and the Australian Manganese Company Pty Limited's (AMCL) Electrolytic Manganese Dioxide (EMD) Plant to the east, the Government Railway line to the west, and Industrial Drive and the Pacific Highway to the south/south-west.

The main features of the site are shown on the site layout plan (Figure 3.1).

3.2.2 General Site History

The following history of the Steel River Project site has essentially been drawn from the *Environmental Audit Report West of Tourle Street* (CMPS&F 1995) which was based on a

BHP historical investigation and the *Report to BHP Rod and Bar Products Division on Contamination Investigation at West of Tourle Street Site, Newcastle* (Environmental and Earth Sciences Report, 1994). A summary of the recent soil and groundwater investigations undertaken on the site is presented in Appendix C.

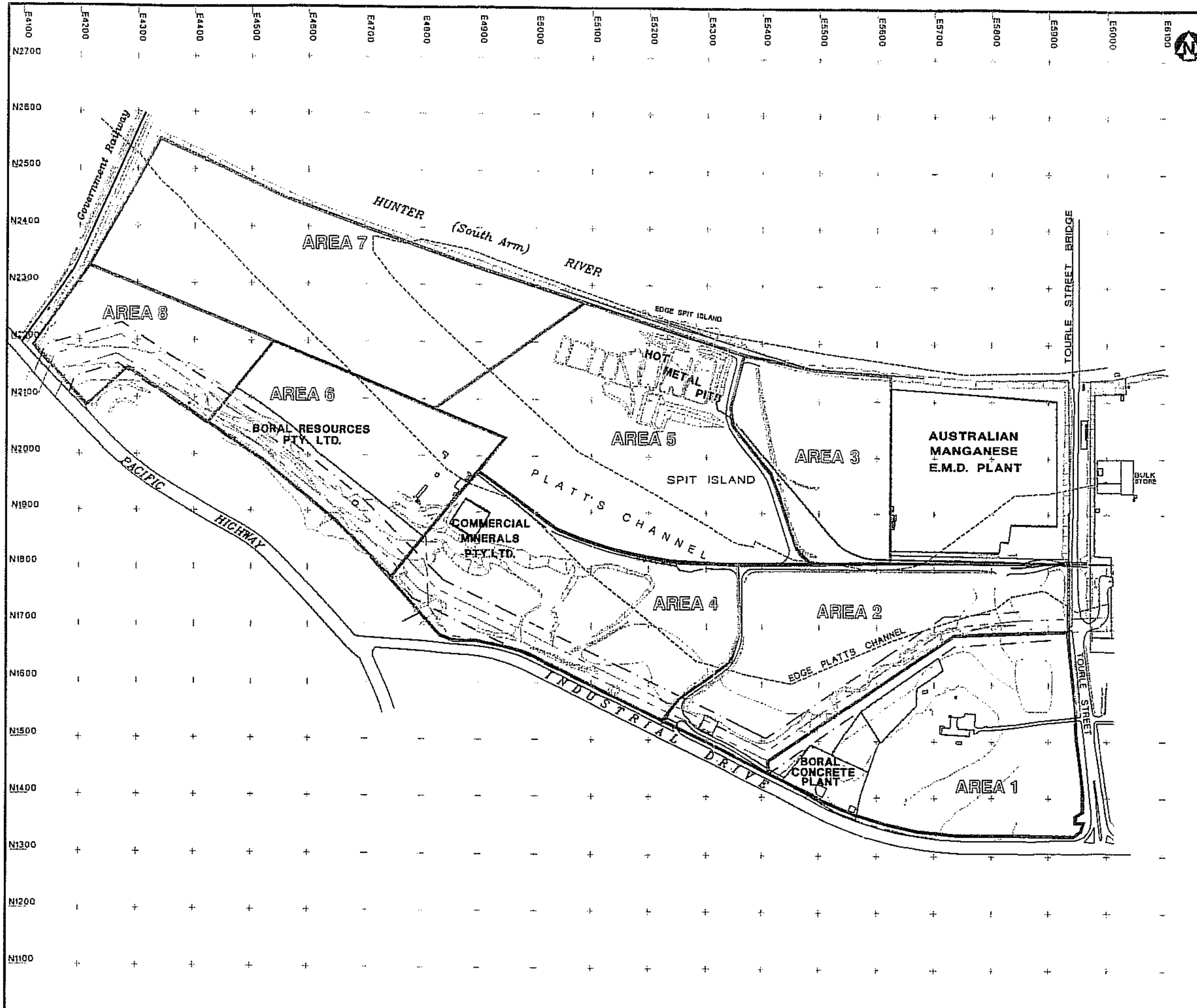
In June 1823 the land currently occupied by BHP was granted to Mr John L. Platt. The 2000 acres granted consisted of pastoral land, wetlands and scrub and was used for residential purposes, the cultivation of maize and wheat, and industrial purposes which included the working of two coal seams.

Between 1823 and 1914 the Australian Agricultural Company took possession of the land. Part of the land in the south-western area of the site (near the Boral site) became the Maritime Services Quarry in 1914. Later from 1935, the land between the present day railway line to Kooragang Island and the Maritime Services Quarry was used as an open hearth and blast furnace slag dump and possibly a site for disposal of waste tar and other works refuse.

With the expansion of BHP in 1935, a portion of land known as "Platt's Estate" was purchased from the Australian Agricultural Company. This land included an area located between the quarry and the present day railway line.

Between 1942 and 1952 further land purchases were conducted by BHP, principally in the area west of Tourle Street.

In the intervening period, the area west of Tourle Street was used extensively by BHP for waste storage and disposal. Sections of this area have also been used as storage areas for waste tar, spent acid from the pickling operations, raw materials and spares. Over the period 1963-1977, major filling occurred at the site, comprising approximately 5 million m^3 of general waste and CWR. The general waste comprised old bricks, ashes, shale, tar, dolomite, lime, spent acid from pickling lines, blast furnace slag, open hearth



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APPROVED: CB
STATUS: FINAL

LEGEND

- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- EASEMENT
- FENCE LINE
- ELECTRICITY LINE
- AREA 5 INVESTIGATION AREA

metres
0 50 150 250
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
SITE LAYOUT PLAN SHOWING INVESTIGATION AREAS

FIGURE
3.1

A3

Woodward-Clyde

slag, basic oxygen steel making slag, fly ash and other waste materials from the steelworks. Sections of the site have been covered with CWR.

Currently the site is used for molten iron dumping pits (Steelstone Pty Ltd) as well as stockpiling (Commercial Minerals Pty Ltd), crushing and screening blast furnace slag (Boral Resources Pty Ltd), and for a concrete batching plant (Boral). Part of the site is also occupied by the Mayfield West Fire Station.

Spit Island

Between 1937 and 1950 BHP purchased the land known as Spit Island which was located adjacent to the BHP site. The land had been previously cleared in parts and used for farming. In 1950, BHP obtained approval by Act of NSW Parliament for reclaiming Platt's Channel (the channel dividing Spit Island and the mainland). These works were completed by the late 1970s.

Platt's Channel

Reclamation of Platt's Channel began in April 1950. Initially a solid embankment of blast furnace slag was constructed from the western end of Platt's Channel to Tourle Street.

3.2.3 Land Use Activities by Site Area:

During the intensive site assessment undertaken by BHP in 1994/1995, the current Steel River Project site was divided into 8 sub-areas in order to facilitate simpler administration of the assessment process.
The following land use activities by area have been described based on information drawn from the Environmental Audit report by CMPS&F (1995). The individual areas are shown in Figure 3.1.

Area 1 in the south-east of the site has a similar topography to that which existed in 1950. No known uses of the land are believed to have contaminated the site. The orphanage building located here was used by BHP Steel Rod and Bar Products Division Refractories Department and until 1997 as the BHP Health and Fitness Centre.

Area 2 is also located in the south-east and consists mostly of reclaimed land from the former Platt's Channel. This area was previously used extensively for storage of steelworks spares.

Area 3 in the north-eastern section forms part of the former Spit Island. The southern end is land reclaimed from Platt's Channel using fill material.

Area 4 located centrally in the Project site. comprises a large area of the reclaimed Platt's Channel. The site is landscaped with trees and grass planted over an added layer of CWR. Prior to this, the area was used for stockpiling of steelworks raw materials and for slag processing and disposal. A small portion of land is currently leased to Commercial Minerals Pty Ltd for stockpiling.

Area 5 lies to the north of Area 4 and partly comprises reclaimed land which was originally Platt's Channel. This section is now covered with CWR and landscaped. Previously it was used for waste processing and disposal, stockpiling of raw materials and a material storage area. This area also contains a CWR covered stockpile of steelmaking furnace flue dust, and a hot metal (molten iron dumping) pit operation.

Area 6 consists of a portion of reclaimed Platt's Channel but is substantially the former mainland. In the past the area was used for raw material and by-product processing and storage. Currently, the area is used by Boral Resources Pty Ltd for crushing and screening blast furnace rock slag.

Area 7 located in the north-western section of the site, mainly comprises land reclaimed from Platt's Channel. This area was subsequently used as a stockpile area for granulated blast furnace slag, a storage area, and an acid and lime sludge dump area and is known to contain areas of coal tar. The acid dump was decommissioned in 1990 and slag removed before a CWR layer was added in 1993. Prior to reclamation the western portion was used for market gardening and Spit Island was used as dairy pasture.

Area 8 is situated in the south-west of the Project site and is essentially part of the former mainland. A layer of CWR was placed over the area in 1993 and sown with grass.

3.3 REMEDIAL APPROACH

3.3.1 Remediation Extent

The extent of remediation required on the Project site was determined by applying risk based remediation criteria for possible future industrial development of the site and by consideration of the requirements of statutory authorities in relation to groundwaters.

Calculation of remediation criteria for industrial development at the site has utilised exposure scenarios descriptive of the potential for adults to be exposed to chemicals present in the soil (Appendix D). The risk assessment concluded that to enable redevelopment of the site for industrial purposes, remediation of particular areas may be required. This would depend on the presence of PAHs and whether the nature of the proposed land use in the area could result in site workers being exposed to excessive PAH concentrations.

The surface soil (or fill) criteria developed for determining whether remediation is required for industrial land use purposes are:

- the presence of free tar;
- total PAH concentrations exceeding 400 mg/kg; and

- benzo[a]pyrene (an individual PAH) concentrations exceeding 15 mg/kg.

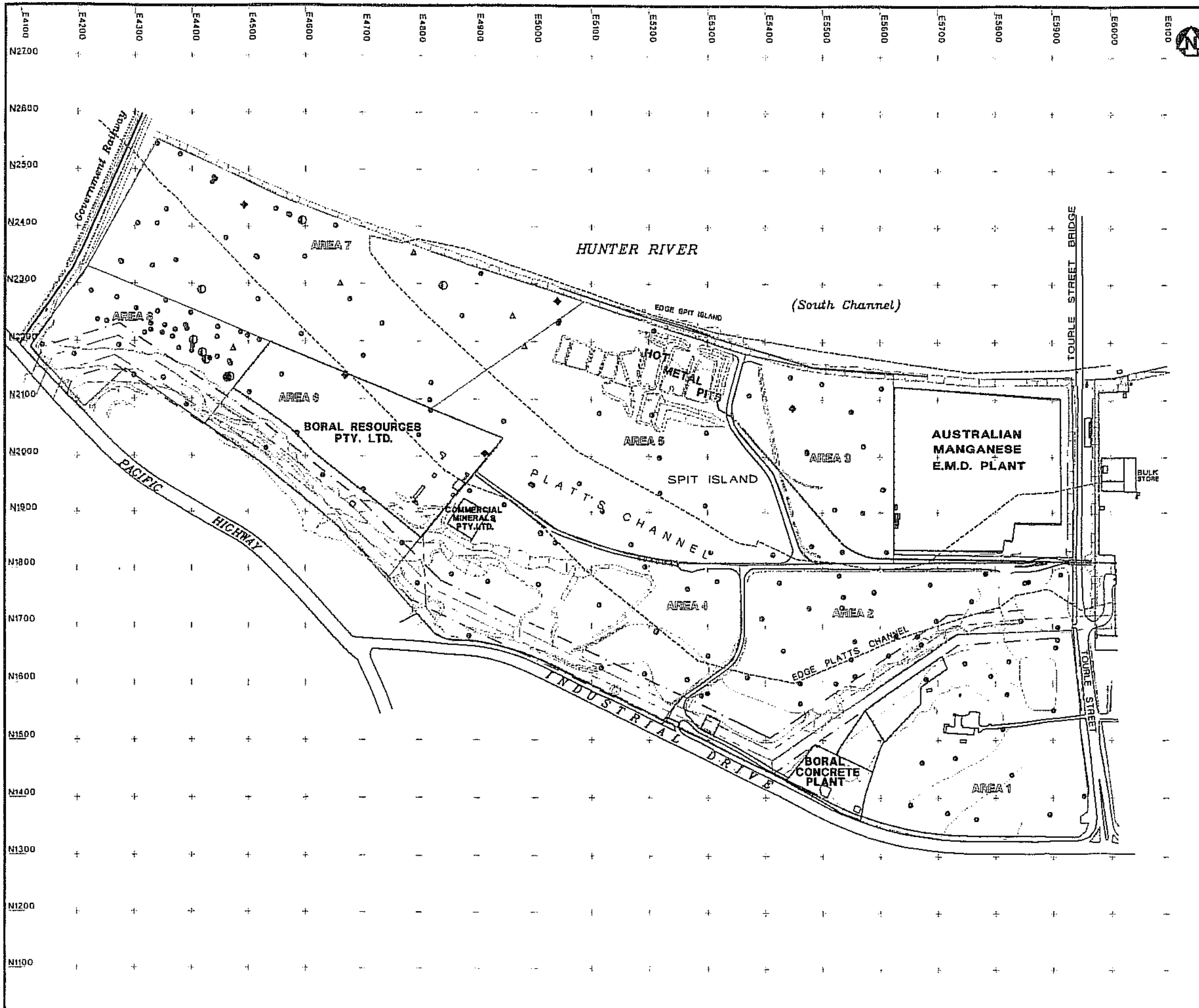
Surface soils (fills) are considered to be those materials in the top 2 m of the site. Disturbance of materials at depths greater than 2 m is considered unlikely for the type of works proposed for the Steel River Project site.

Determination of the extent of contamination present at the site, and consequently the remedial approach, was based on information gathered during site investigations outlined in Appendix C, as well as recent trenching. There are potentially significant uncertainties in the extrapolation of information gathered on the site due to the size of the site and intensity of field investigations. The location of samples that were found to contain concentrations of PAHs above remediation criteria and at a depth of less than two metres are shown on Figure 3.2. Based on these locations, the area in which materials exceeding the remediation criteria at depths of less than two metres are most likely to occur has been identified and is shown on Figure 3.3.

Trenching work undertaken in December 1996 targeted the area indicated on Figure 3.3 (ie within Areas 5, 7 and 8) to enhance the understanding of the distribution of tar affected materials in these areas.

From observations undertaken during trenching, it is likely that where excavation is required within the area of identified shallow contamination, approximately half of the materials encountered would be free of the contaminants of concern and could be handled as clean material. The remaining materials would need to be managed. Smaller areas of land requiring remediation other than those shown on Figure 3.3 may be encountered during development. During the construction of foundations or the installation of services, "pockets" of materials exceeding the remediation criteria would have to be managed.

For the purpose of remediation planning for ongoing industrial use, a best estimate of 200,000 m^3 is a mid-range value for the volume of materials requiring management. Because of the uncertainties related to the occurrence of tar affected materials, the volume of material requiring management could vary in the range of 100 000 m^3 to 280 000 m^3.



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LEGEND

- PIT/BOREHOLE LOCATION
- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- HOT SPOT ABOVE 2m ONLY
- HOT SPOT BELOW 2m ONLY
- HOT SPOT ABOVE AND BELOW 2m

SOIL RESULTS EXCEEDING RISK ASSESSMENT CRITERIA FOR
– VISIBLE TAR
– PAH >400 mg/kg
– BENZO(a)PYRENE >15mg/kg

- EASEMENT
- FENCE LINE
- ELECTRICITY LINE
- AREA 6 INVESTIGATION AREA

metres
0 50 150 250
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

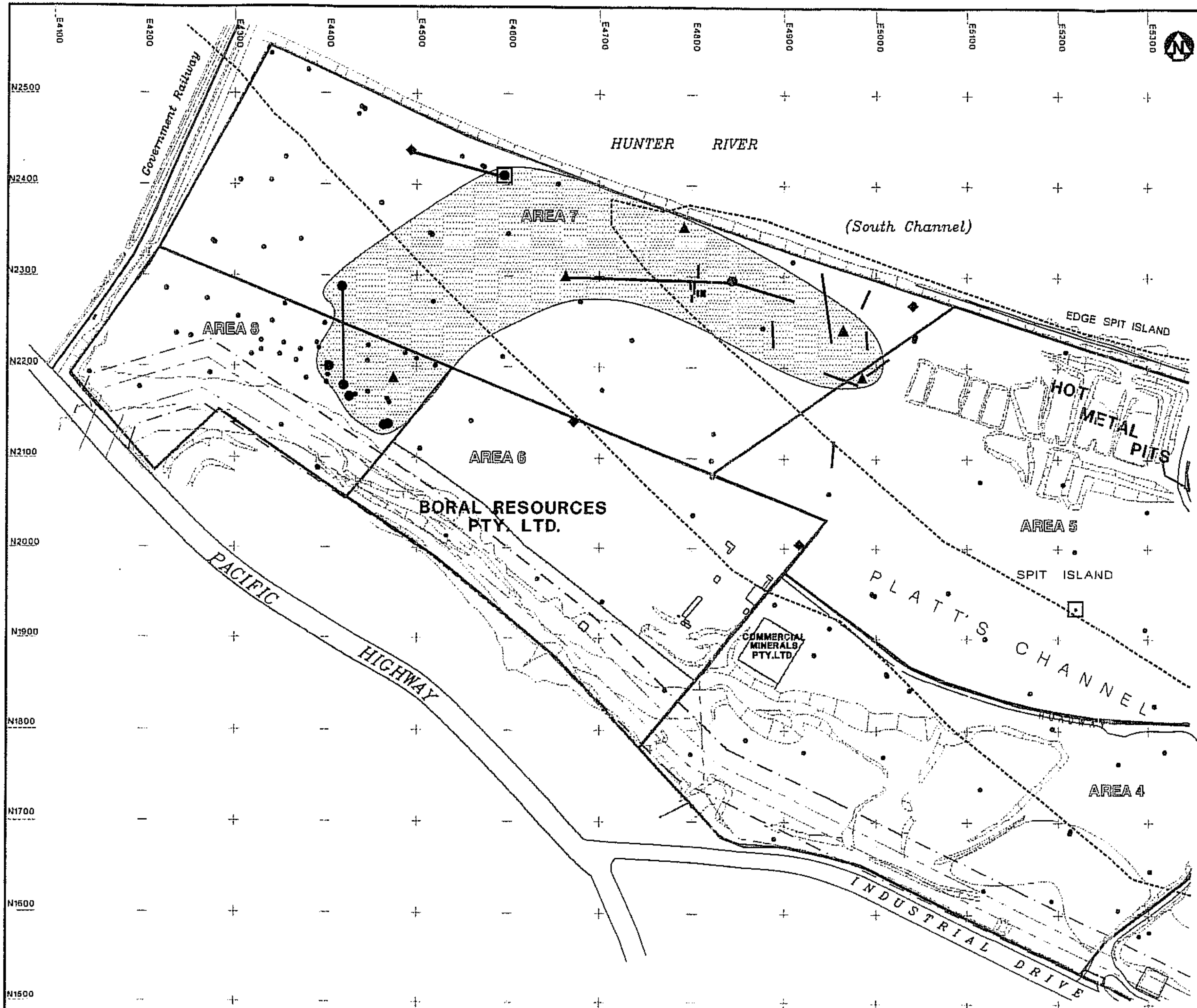
PROJECT
STEEL RIVER PROJECT
REMEDIAL ACTION PLAN EIS

TITLE
RISK CRITERIA EXCEEDENCES

FIGURE
3.2

A3

Woodward-Clyde



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STATUS: FINAL

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
TRENCHING INVESTIGATIONS

FIGURE
3.3

A3

Woodward-Clyde

The options for dealing with tar affected fill materials and groundwaters deriving from the site are outlined in the following section.

3.4 SOIL REMEDIATION OPTIONS

3.4.1 Introduction

Remedial options considered for the site have been focused on techniques suitable for tar affected soils located in the surface two metres of fill across the site.

A number of remediation technologies for tar affected soils are currently being trialled around the world and in Australia. However, in considering feasible remediation alternatives (including consideration of costs, timing, achievement of desired effect and long term liabilities), only a small number of options have been successfully implemented at full scale.

3.4.2 Remediation Alternatives

Appendix E contains a review of soil remediation technologies including:

- Capping/On-site Containment.
- Off-site Disposal.
- Stabilisation.
- Thermal Desorption.
- Bioremediation.
- Soil Washing.
- Alternative Treatments.

The major technical uncertainties in the adoption of the technologies reviewed in Appendix E are:

- the uncertainties in relation to pretreatment (eg excavating and screening large rock and similar within the fill) and handling problems associated with cohesive soils, can be a substantial risk in adopting many treatment options (stabilisation, soil washing, bioremediation, thermal desorption, bioreactor and so on);

- high energy cost for soils with high moisture contents introduces significant economic risk in adopting thermal desorption as a remedial strategy;

- the remediation level obtainable with fixed bed bioremediation (200-500 mg/kg) does not provide certainty that the soils remediation criteria can be met and thus bioremediation is too risky to accept as a remediation option. Landfarming has even a greater degree of uncertainty in the treatment of PAHs, as well as posing time and space constraints;

- soil washing is dependent on the distribution of contaminants in the various soil fractions and for the Project site filling operations have resulted in tarry materials being present in a variety of fill types. This technology is not appropriate for the subject site because of the nature of contamination;

- the long term performance of stabilised soils introduces an uncertainty which may not be acceptable when combined with a relatively high cost of implementation;

- off-site disposal of materials is not in keeping with EPA philosophy of conserving valuable landfill space. Excavated fill may need to be transported long distances due to a lack of acceptable facilities in Newcastle;

- in situ processes, in particular bioremediation, are not applicable due to the cohesive nature of the fill and the potential establishment of preferential pathways through the more permeable areas. As a result this option would not be fully effective in achieving uniform remediation; and

- alternative treatments such as brick or asphalt manufacture and co-burning are considered inappropriate due to the cost, effectiveness, and time frame for the completion of remediation.

3.5 GROUNDWATER CONTROL OPTIONS

3.5.1 Introduction

Alternative methods for the control and prevention of potentially contaminated groundwater from reaching the Hunter River were considered. Such methods involve either the minimisation of the generation of groundwater, the capture and recovery of affected groundwater using extractive pumping methods (imposition of a hydraulic barrier) or the construction of a physical barrier (barrier wall, either chemically reactive or non-reactive).

Physical barrier options were reviewed and were considered to be technically impractical and of a high cost. For these reasons a detailed analysis is not presented here.

3.5.2 Interception Alternatives

Groundwater hydraulic barrier system technologies applicable to the Steel River Project site are as follows:

a) recovery well methods;

b) interception trench methods; and

c) horizontal drains.

A description of each of these options is presented in Appendix F, including the advantages and disadvantages for each.

3.5.3 Control of Groundwater Generation

The groundwater remediation technologies listed above and described in Appendix F are considered subordinate to those methods which involve reducing the source of infiltration to the groundwater for the following reasons:

a) uncertainties within the groundwater system (heterogeneity of fill materials) make predictions of efficiency difficult;
b) duration of operation of the system is not readily predictable and may be open ended;
c) systems are inherently inefficient due to recovery of significant volumes of "clean" river water requiring treatment when mixed with groundwater originating from the fill; and
d) high cost of installation, monitoring and operation.

Remedial options which include the minimisation of infiltration to the fill and, therefore, minimisation of input water to the internal groundwater system are considered more efficient and of lower technical risk since they reduce to low levels the generation of contaminated groundwater and minimise the groundwater mounding within the site. This reduces the groundwater gradients which are the primary driving forces to the migration of contaminant affected groundwaters to off-site locations, in particular, the Hunter River.

3.6 CONSIDERATIONS IN REMEDIATION TECHNOLOGY SELECTION

A number of considerations within the broad study area had a major bearing on the selection of an appropriate treatment technology. These considerations are briefly discussed below:

3.6.1 Nature of Contamination

The nature, concentration and extent of contamination present at the site poses a major constraint in the selection of an appropriate remedial technology.

3.6.2 Environmental Impact

The environmental impact of the alternative remediation technologies is a major factor when choosing a suitable technology for the proposed works. Many of the alternative technologies were considered inappropriate on the basis that they were likely to have adverse impacts on the environment.

3.6.3 Social Concerns

The impact of the alternative remedial technologies on urban development strategies and future land use of the site significantly influences the selection of an appropriate remediation technology and methodology for the proposed works

The preferred remediation technology provides a guarantee that contaminated soils would be managed and would be contained on-site. This process limits the risk of exposure to others, and enables future development to take place on the site.

3.6.4 Economic Feasibility

The capital cost of site remediation using many of the alternative technologies described in Appendix E and F is prohibitive and not economically justifiable, as many of the alternative technologies are unproven at full scale, are capital and labour intensive, and require extended remedial treatment timeframes.

3.6.5 Future Redevelopment of the Site

An appropriate remedial technology must have due regard to the possible future redevelopment of the site for industrial uses where the majority of the site would be covered by structures, hardstands and road pavements. Containment below 2 metres is considered an appropriate remedial option with major services located in a zone which does not present a risk to on-site workers.

3.7 THE PREFERRED REMEDIATION OPTION

3.7.1 Preferred Soil Remediation Option

A capping option would be the most appropriate remediation technique for the Project site. It poses a low technical risk, has a predictive and effective end result, can be readily implemented (in a staged program if necessary), and is of relatively low cost. The process contains the contaminated material, thus limiting the potential for human or environmental exposure and so allowing the land to be developed in the future for possible industrial uses. Those areas where tarry materials have been identified within two metres of the soil surface would be covered in place or excavated and placed on-site in more appropriate areas and covered with a suitable capping material. Any excavation pits where tarry soils have been removed may be back filled with a suitable 'imported' or on-site fill material. An off-site source of fill would be CWR from the Oceanic Coal Washery.

3.7.2 Preferred Groundwater Control Option

The most beneficial option for remediation of the groundwater is to improve site surface drainage to minimise the potential for infiltration. Recontouring the site by importation of suitable fill materials (capping) would improve surface drainage and could be undertaken in a staged manner in accordance with a phased approach to any future industrial development of the site. The establishment of impervious surfaces as part of industrial development (such as buildings, roadways and car parking) would reduce infiltration in these areas to effectively zero and thus the generation of groundwaters would be substantially reduced.

3.8 DO NOTHING ALTERATIVE

This alternative would consist of taking no action with respect to the remediation of the Project site.

The full range of assessments undertaken as part of this EIS have illustrated that the site does not currently have a detrimental effect on the environment. The 'do nothing' alternative therefore does not leave an environmental hazard to the Hunter River. It was concluded that this alternative would have the following consequences:

- Contaminants present in soils and groundwater at the site would not be contained and would not be remediated.
- If no remediation works were undertaken, redevelopment of the whole of the site for industrial purposes would not occur.

4.0 PROJECT DESCRIPTION

4.1 PROJECT OVERVIEW

A series of site assessments and investigations including assessments of soils and groundwater, and an assessment of risk to the environment and human health, were undertaken on the Project site between 1990 and 1996. These investigations identified a number of environmental issues associated with the subsurface soils on the site.

Based on the history of the site and the results of site investigations, potential chemical contaminants present at the Project site were identified and were primarily associated with various fill materials disposed of on-site from the early 1950's during the reclamation of Platt's Channel. Contaminants present in these fill materials include:

- inorganic contaminants (associated with slags and ashes) such as heavy metals; and
- organic contaminants (associated with coal tars and oils) such as PAHs, to a lesser extent phenolic compounds, and again to a lesser extent volatile hydrocarbons including benzene, toluene, ethylbenzene and xylene (BTEX).

It is proposed that remediation of the site be undertaken to enable the site to be used for different purposes to the current land use. The favoured remediation option for the site is the capping option described in Chapter 3 which limits the potential for human or environmental exposure. This option has a low technical risk, can be readily implemented (in a staged program if necessary) and is cost effective.

4.2 REMEDIATION STRATEGY

4.2.1 Site Regrading

Possible future uses of the Project site, following remediation, are likely to be of an industrial nature. To facilitate this use, the site would need to be recontoured to enable surface drainage of rainfall and to provide a more interesting landform in which to site industrial buildings.

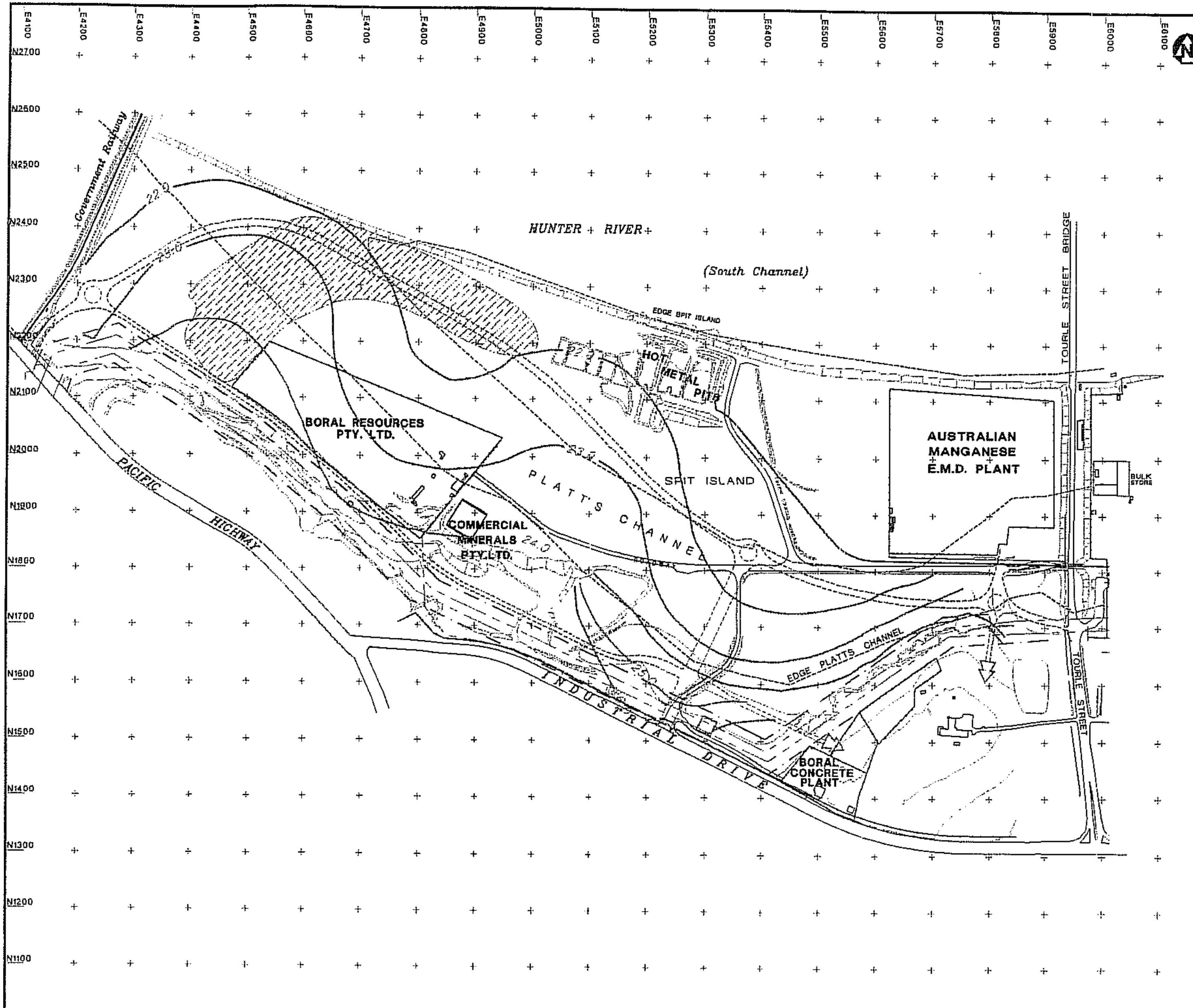
Recontouring would be accomplished by the importation of CWR and placement and compaction of the material to provide a minimum fall across the site of 0.5%, in generally a northerly direction to the Hunter River. The estimated volume of material required to recontour the site is up to some 750 000 m^3 of which some would be won on the site but most would be imported. A contour plan, illustrated in Figure 4.1, provides an indication of the proposed conceptual landform.

The effect of recontouring on the site remediation strategy is two-fold:

1. the importation of material gives an opportunity to cover materials which exceed the remediation criteria in situ (therefore there is no necessity to excavate and relocate the majority of materials); and

2. the surface drainage scheme necessary to allow future redevelopment of the site would enable rainfall falling on the site and further up the catchment to flow towards the Hunter River. This would substantially reduce the potential for infiltration of surface waters to groundwaters.

Remediation of the land would be undertaken in a staged manner which would be linked to the phased redevelopment of the land for industrial purposes.



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DATE: 22/5/97	STATUS: FINAL

LEGEND

- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- REMEDIATION AREA
- EASEMENT
- FENCE LINE
- ELECTRICITY LINE
- PROPOSED ROAD
- 25.0 INDICATIVE SITE REGRADING CONTOURS

NOTE:
EXISTING SURFACE IS APPROXIMATELY RL 21.0m (BHP DATUM)

TO CONVERT BHP DATUM TO AUSTRALIAN HEIGHT DATUM, SUBTRACT 12.51

metres
0 50 150 250
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
REMEDIATION AREA AND SITE RECONTOURING PLAN

FIGURE
4.1

A3

Woodward-Clyde

4.2.2 Site Works

The remediation of the site would involve the filling of the site and the grading of fill material generally to the levels indicated in Figure 4.1. In addition, part of the western portion of the site has been designated as primary, secondary and tertiary containment areas (Figure 4.2) for the emplacement of tar or oil contaminated material that may arise from time to time during excavation of service trenches and foundations.

Primary Containment Area

Incidental contaminated materials would be relocated to the primary containment area.

The depth of filling in the primary containment area would exceed two metres. It would therefore be possible to contain contaminated materials (Figure 4.2) derived from other areas of the site during the redevelopment process (arisings) below two metres of imported fill in this area. Figure 4.3 shows a cross-section through the proposed containment area.

Within this area, and below the upper two metres of fill, is a containment volume of approximately 35 000 m^3. As part of the site preparation works, the upper 0.2 to 0.5 m of the existing CWR cover would be graded into bund walls of a minimum one metre height, thus increasing the containment capacity of the primary containment area by approximately 10 000 m^3 to 45 000 m^3. Any additional existing CWR material would be stockpiled for use as cover material.

Secondary and Tertiary Containment Areas

A further 40 000 m^3 would be contained in the areas identified as secondary and tertiary containment areas. This containment volume is available without excavation below existing surface levels. The total capacity to contain excavated materials on-site would therefore be over 80 000 m^3. This is considered more than adequate to contain "arisings" from redevelopment of the site, as most of the materials identified as exceeding the remediation criteria would be managed by covering in situ.

If the quantity of material requiring management is less than the containment volume available, additional CWR will be imported to achieve desired site contours.

The scraping of the existing CWR and its use for bunding would be undertaken in stages of approximately one hectare, to minimise the area disturbed at any one time and thus allow easier management of the works. The bunding around each of the areas serves a twofold purpose, providing a moderate barrier to intrusion/warning and also controlling stormwater by preventing surface runoff from entering the containment area and preventing potentially contaminated rainfall runoff leaving the area.

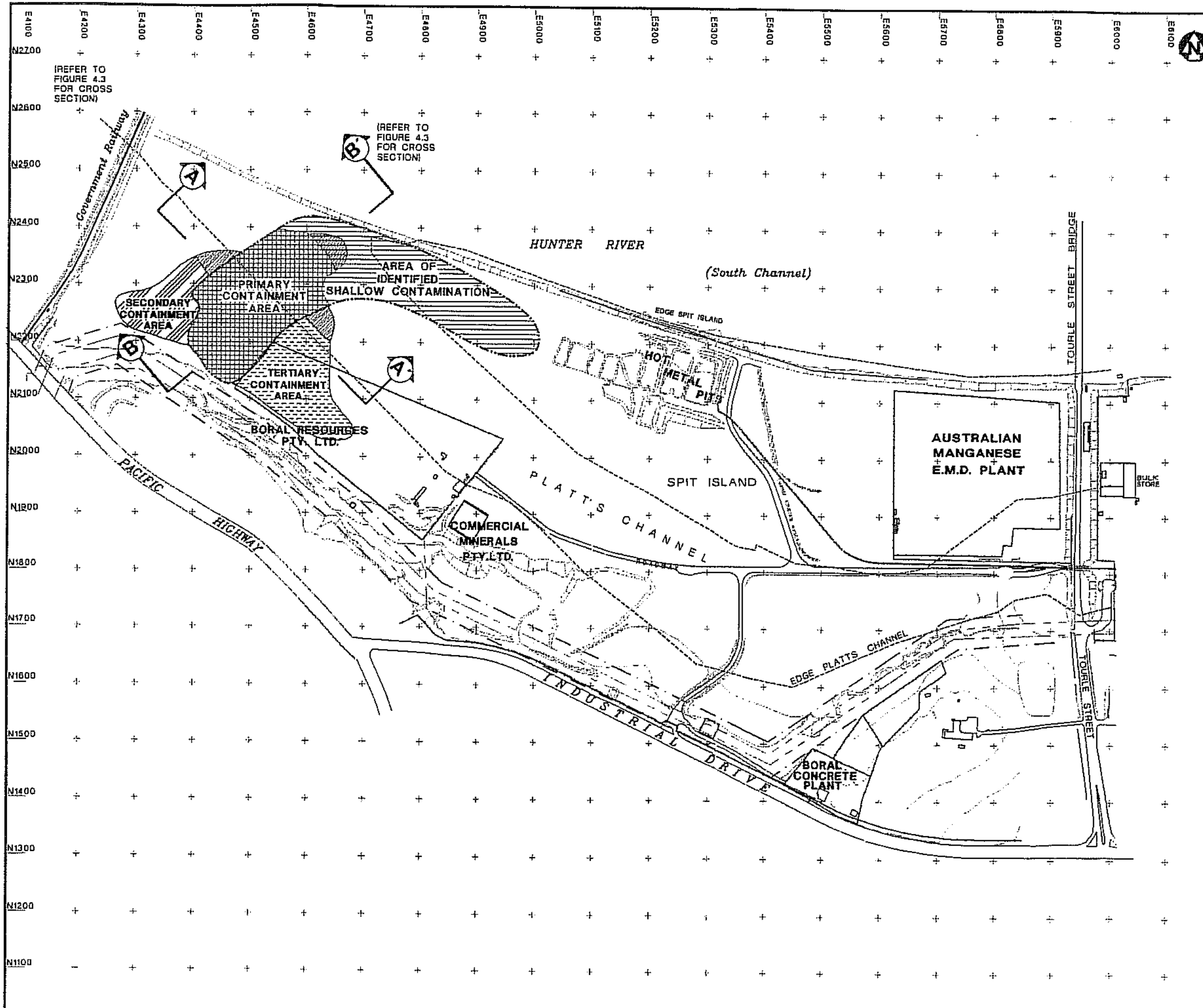
Disposal Areas

In view of the volume available within the containment areas and the predicted volume of contaminated material requiring management, there would be no need for any off-site disposal of contaminated soil. All material would be contained and managed on-site within the designated containment areas.

4.3 IMPORTATION OF FILL

4.3.1 Source and Transport of Material

CWR would be imported by truck from the Macquarie Coal Preparation Plant owned by Oceanic Coal at Teralba, NSW. The Plant which is located at the northern end of Power House Road in Teralba has ready access to a well developed road network which generally avoids built up areas. Safeguards detailed in Chapter 14 include measures to ameliorate the impact of truck movements on both the local and regional traffic environment. These safeguards include haulage restrictions to daylight hours, hazard signage at the entrance to the Project site and Coal Preparation Plant and dust suppression measures for trucks hauling CWR.



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DRAWN: LJE/HC
CHECKED: SKT
APPROVED:
STATUS: FINAL

LEGEND

- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- PROPOSED STORMWATER RETENTION POND LOCATIONS (AS REQUIRED)
- EASEMENT
- FENCE LINE
- ELECTRICITY LINE

CLIENT
BHP STEEL (NEWCASTLE)

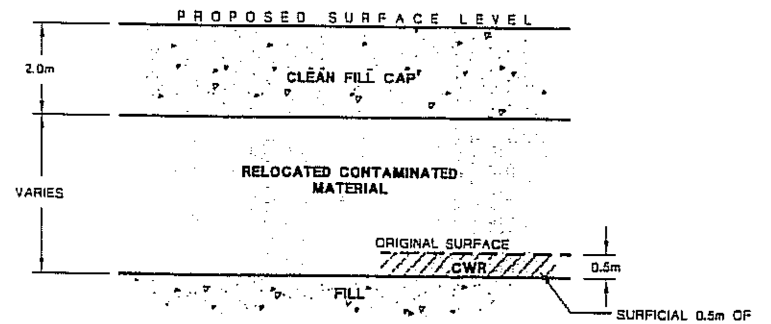
PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
PRIMARY, SECONDARY AND TERTIARY CONTAINMENT AREAS AND AREA OF IDENTIFIED SHALLOW CONTAMINATION

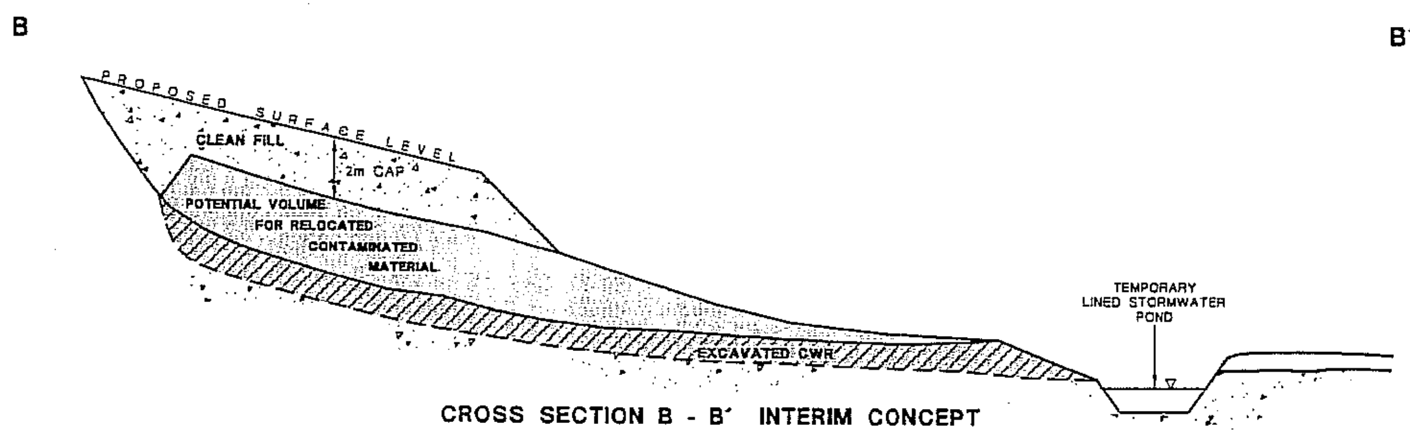
FIGURE
4.2

A3

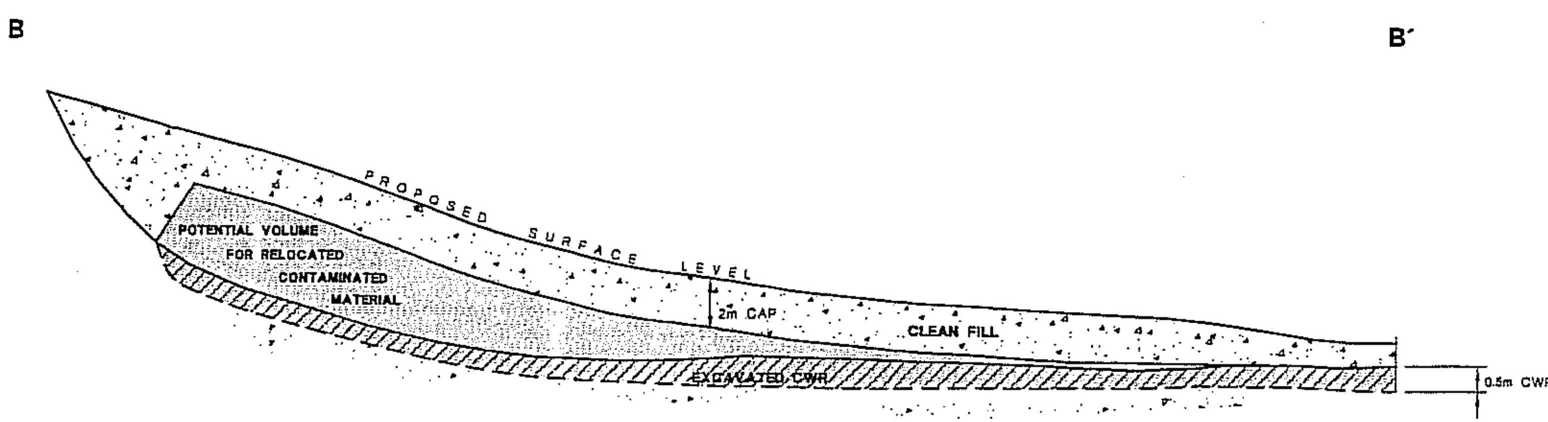
Woodward-Clyde



CROSS SECTION A - A'
(Not to scale)



CROSS SECTION B - B' INTERIM CONCEPT
(Not to scale)



CROSS SECTION B - B' FINISHED CONCEPT
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DATE	21/5/97	STATUS:	FINAL

NOTE:
FOR LOCATION OF CROSS SECTIONS, REFER TO FIGURE 4.2

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
CONCEPT CROSS SECTIONS OF THE PRIMARY CONTAINMENT AREA

FIGURE
4.3

A3

Woodward-Clyde

4.3.2 Material Volumes and Characteristics

The volume of CWR currently available from Oceanic Coal is in the order of 600 000 m^3 per annum. This is well in excess of the project requirements of approximately 110 000 to 150 000 m^3/annum (or approximately 220 000 to 300 000 tonnes/annum) needed over a period of some five years.

The CWR to be imported to the site is comprised of clay, silt, sand, gravel, coal fines, flotation agents and moisture. The material would be predominantly dry, as the bulk of the water (and consequently the flotation agents) would be removed by a dewatering process prior to transportation to the Project site.

As defined in Table 3.1 of the *Draft Hazardous Waste Definition and Draft Environmental Guidelines: Solid Waste Assessment (1996)* the CWR would be considered "clean excavated natural material waste not potentially subject to significant change when removed from its environment" and is therefore classified as inert. Chemical analysis confirms that the CWR from Oceanic Coal would meet guidelines for the assessment of chemical contaminant in waste classification (total and leachable) for inert waste (See Appendix G).

4.3.3 Regulations Relating to the Use and Transportation of CWR

Under the current definitions of waste and land-filling activities, the use of CWR may trigger a number of statutory responsibilities. The Waste Minimisation and Management Act 1995 (WMMA) and the Waste Minimisation and Management Regulation 1996 (WMMR) define these responsibilities.

Clause 5 of the WMMR states that controlled waste facilities include the following:

- *landfill sites that receive over 20,000 tonnes per year of inert waste; and*

- *landfill sites that receive over 20,000 tonnes per year of coal washery rejects or slags.*

Under the provisions of the WMMR the Project site would be defined as a controlled waste facility as volumes of CWR in excess of 20,000 tonnes per year would be imported and used to recontour and cap the surface of the site (refer to Section 4.3.2). Under Section 44 of the WMMA a licence would be required for the importation and recontouring operation. In order to gain a licence a Landfill Environmental Management Plan (LEMP) is required.

Clause 6 of the WMMR requires that transporters of hazardous waste obtain a licence. As the CWR was found to be an inert waste (refer to Section 4.3.2), which is not potentially hazardous or capable of undergoing an environmentally significant transformation, a licence is not required to transport it.

4.4 REMEDIATION PREPARATION

The remediation would commence only after all licences, permits and approvals have been received and a detailed Site Management Plan has been prepared by the nominated remediation contractor. The Site Management Plan would have two key components:

- Environmental Management Plan (EMP, inclusive of a LEMP); and
- Health and Safety Plan (HASP).

A staged work program would be implemented to allow progressive remediation of the site as it is likely that future redevelopment of the land for industrial purposes would occur in a staged manner. Works would be conducted over a period of some five to ten years in conjunction with the future redevelopment of the site. These works would involve remediation of approximately one hectare of land area at a time.

4.4.1 Environmental Management Plan

An EMP would be prepared providing information regarding the methods and safeguards that would be used to remediate the site in a manner which would be protective of workers, the local community and the environment.

The specific objectives of the EMP would be to:

- Ensure that the works would be carried out in accordance with appropriate environmental statutory requirements.
- Ensure that the works would be carried out in accordance with good environmental practice.
- Ensure that the works would be carried out in such a way as to minimise the likelihood of any environmental degradation during the remediation period.
- Ensure that all persons engaged in the works comply with the requirements of the plan.
- Respond to changes in environmental conditions through review of the monitoring and control programmes and consultation with the statutory authorities and the community.
- Ensure that corrective actions would be performed in a timely manner.

Safeguards to be implemented during the site remediation works would be detailed in a number of specific Plans which are key components of the EMP. These plans include:

- Water Management Plan;
- Dust Control Plan; and
- Noise Management Plan.

These plans are described in further detail in Chapter 20 and incorporate the various safeguards outlined in Chapters 7, 9 and 10 respectively.

4.4.2 Health and Safety Plan (HASP)

The HASP, would provide a general description of the chemical and physical hazards associated with the implementation of the remediation works. The primary objective of the HASP would be to establish the health and safety requirements and protection procedures necessary, to minimise the potential for exposures and injuries to field personnel.

4.5 MOBILISATION

Mobilisation would include:

- establishment of monitoring program and equipment;
- installation of personnel and equipment;
- decontamination facilities installation;
- establishment of site amenities;
- site survey;
- safety equipment installation;
- installation of pollution control works;
- area fencing/bunding;
- access road improvements; and
- project signage.

4.6 MANAGEMENT OF WASTES

Waste materials expected to be generated during the proposed remedial activities include some excavated material, domestic and human waste which can not be reused. The preferred methods for the disposal of these wastes are outlined as follows:

- domestic waste and any liquid wastes recovered during excavation would be disposed to a licenced facility; and

- human wastes would be disposed to sewer.

Perched (possibly contaminated) groundwater may be encountered during site remediation activities. Such groundwater would be treated and pumped into retention ponds and used for dust suppression.

4.7 TRUCK TRACKING SYSTEM

A system of tracking trucks importing fill to the site would be implemented to ensure that only approved fill is placed on the site. Any materials not approved would not be admitted to the site.

4.8 MONITORING PLAN

A Monitoring Plan would be prepared by the remediation contractor detailing the environmental controls to be implemented during the works. This plan would be formulated before any site works were commenced, and reviewed as the project progresses.

The plan would detail control and monitoring programs for minimising the impact of stormwater, soil movement, noise, dust, odour and occupational health and safety. The details of the plans would be based on the work method, staging of works and site organisation proposed by the remediation contractor.

4.9 SITE VALIDATION

Upon completion of the proposed remediation works the site would be validated to ensure that contaminated materials have been appropriately contained, and that future redevelopment of the site may be undertaken with minimal risk to human health and the environment. Refer to Section 20.8 for further details relating to site validation.

4.10 HOURS OF OPERATION

It is envisaged that remedial activities would be carried out between the hours of 7.00 am and 6.00 pm from Monday to Friday and from 7.00 am to 1.00 pm on Saturdays. Work would normally not be undertaken on Sundays. Public holidays that occur during the course of the remediation works would normally either be treated as a no-work day or operations would be undertaken between the hours of 7.00 am and 1.00 pm. Where earthworks are required to be undertaken outside the above hours, the work would not take place prior to notification by the remediation contractor to the relevant regulatory authorities.

PART C

CONSULTATION

5.0 CONSULTATION

5.1 FORMAL PROCEDURES

This EIS has been prepared in accordance with Part 4 of the EP&A Act and its Regulation (as amended). Part 4 of the EP&A Act is concerned with environmental planning control and relates to development which is controlled by an Environmental Planning Instrument (EPI). Its purpose is to ensure that the potential environmental effect of a proposal is properly assessed and considered in the decision making process.

In preparing this EIS, the requirements of the Director-General of Urban Affairs and Planning were sought as required by Clause 52 of the Regulation. Each of the matters raised by the Director-General of Urban Affairs and Planning for consideration in the EIS are outlined in Table 5.1 together with the relevant section of the EIS which addresses that matter. An unabridged copy of the Director-General's requirements dated 30 January 1997 can be found in Appendix A.

TABLE 5.1 - DIRECTOR GENERAL OF URBAN AFFAIRS AND PLANNING REQUIREMENTS

MATTER	REFERENCE IN EIS
Description of the Site	Chapter 3
Site History	Chapter 3
Environmental Setting of the Site	Chapter 3
Geologic and Hydrological Conditions	Chapters 6 and 7
Description of Proposal	Chapter 4
Justification for Proposed Remediation Technology	Chapter 3
Consideration of Alternative Remediation Options	Chapter 3
Suitability of any Sites for Disposal of Contaminated Soil	Chapter 4
Description of Fill	Chapter 6
Impact on Aquatic Ecosystem	Chapter 7
Pollution Control Measures	Part D

MATTER	REFERENCE IN EIS
Outline of Remediation Plan	Chapter 4
Risk Assessment	Chapter 18
Water Management during Remediation	Chapter 20
Waste Management	Chapter 4
Visual Impact	Chapter 13
Security Measures	Chapter 18
Outline of Emergency Arrangements	Chapter 18
Outline of Fire Prevention Measures	Chapter 18
Traffic Impact	Chapter 14
Impact from Transportation of Contaminated Sediments	Chapter 4
Statutory Authority Consultation	Chapter 5
Emissions from Proposed Development	Chapter 9

In addition to the above. Clause 51 of the Regulation to the EP&A Act lists the matters which shall be included in the contents of an EIS. These matters together with the relevant sections of the EIS which give consideration to the issues, are summarised in Table 5.2.

TABLE 5.2 - STATUTORY REQUIREMENTS FOR EIS (INCLUDING EP&A REGULATION CLAUSE 51 MATTERS)

MATTER	REFERENCE IN EIS
Summary of EIS	Summary
Objectives of the Proposal	Chapter 2
Alternatives	Chapter 3
Consequences of Not Proceeding	Chapter 22
Justification of Proposal	Chapter 22
Description of Proposal	Chapter 4
Description of Environment	Part D
Analysis of Impacts	Parts D & E
Safeguard Measures	Part D
ESD Principles	Chapter 17
Summary of Safeguards	Chapter 21
Approvals Required	Chapter 1

5.2 CONSULTATION WITH STATUTORY AUTHORITIES

5.2.1 Planning Focus Meeting

A planning focus meeting was held at the Ex-Services Club at Mayfield on 19 December 1996 in order to provide an outline of the project and the EIS. The following authorities attended the meeting:

- NSW Environment Protection Authority
- NSW Department of Health (Public Health Unit);
- Department of Land and Water Conservation
- Department of Urban Affairs and Planning
- Hunter Water Corporation
- Newcastle City Council
- NSW Roads and Traffic Authority

During preparation of the EIS, all relevant statutory authorities were contacted, requesting confirmation of any comments or concerns with regard to the proposed remedial activities. Table 5.3 provides a summary of the comments and/or requirements of each authority.

TABLE 5.3 - STATUTORY AUTHORITY COMMENTS AND REQUIREMENTS

AUTHORITY	COMMENT/REQUIREMENT
NSW Environment Protection Authority	• Confirm and assess environmental requirements under all Acts (Air, Water, Noise). • Groundwater requires a thorough assessment. It is still EPA policy that any off-site migration should not occur. • Consolidation and capping of contaminants is considered a reasonable approach. Will need a good understanding of the hydrology of the area plus sound monitoring program to confirm containment. • Need to consider what allowances should be made for the future if subsequent mobilisation of contaminants occurs. • Should outline the range of end uses for the site and set a range of targets for contaminants for which we can aim. • No formal EPA approval is required for the RAP or EIS. • EIS should address situation of no action on the site.

AUTHORITY	COMMENT/REQUIREMENT
NSW Department of Health (Public Health Unit)	• Noise not a major issue as the site is fairly isolated but should problems arise during remedial activities, public must be able to direct queries to a nominated person. EIS should attempt to outline a process/avenue for community contact. • Examine issue of water seepage/contamination of Hunter River. • Need for ongoing monitoring. EIS should outline a monitoring program and should include an assessment of the movement of groundwaters through and within the site.
Department of Land and Water Conservation	• Need to outline erosion and sediment control measures to be implemented during the works. • Groundwater needs to be addressed. • Queried whether acid sulphate soils would be a problem. • Need to deal with provisions of Rivers and Foreshores Act, 1948, if excavating within 40 m of the river bank. A permit would be required for these works.
Hunter Water Corporation	• Have few requirements as no treated water has been envisaged as going into the sewer. • Future concerns will relate to the installation of deep services into the remediated zone.

AUTHORITY	COMMENT/REQUIREMENT
Newcastle City Council	• Concerns relate to the timing and nature of public consultation. Should precede exhibition of the EIS. • EIS should include discussion regarding future land uses and the standard of remediation achieved. • EIS should provide an outline of the timeframe required for remediation. EIS should also provide a project description and details of activity coordination. • If areas of the site are to be capped Council requires details of the location and types of contaminants present on-site. • If the site is to be subdivided in the future Council needs to be able to identify areas which formerly contained elevated concentrations of contaminants. • Community may be concerned that dust from the site contains levels of contaminants which would be harmful to human health. Measures used to control the generation of dust should be implemented.
NSW Roads and Traffic Authority	• Noted that remediation would occur prior to development. • RTA concerns relate to the accessibility of the site future uses.

AUTHORITY	COMMENT/REQUIREMENT
	• Existing access points for Boral and EMD plant to be retained with no new access points at Tourle Street.
	• Traffic generated during the remediation and future development should not use Werribee Street.

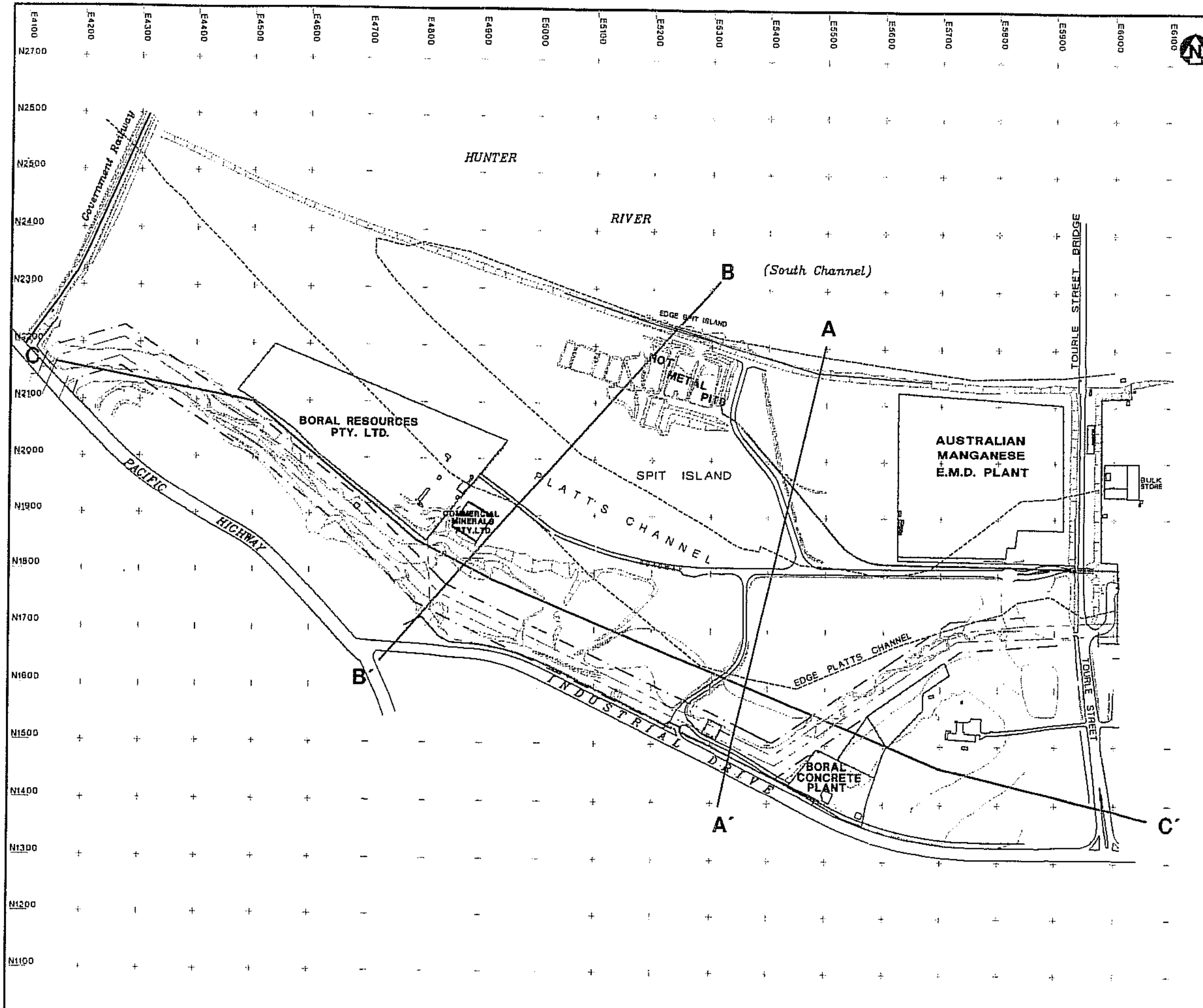
5.3 CONSULTATION WITH THE COMMUNITY

The main avenue of consultation with the community was through the *Newcastle Beyond 2000 Committee Technical Steering Committee*. This group was set up by BHP and relevant statutory authorities to include the community in the examination of potential future uses for the site.

The impact of the proposed works on the local environment and community were among the issues raised by the representative community groups at Steering Committee meetings held on a fortnightly basis. Other issues included future uses of the site and employment opportunities which may arise when the site is redeveloped. These issues are addressed in Part D of this EIS.

PART D

ENVIRONMENTAL ASSESSMENT



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CAD FILE NO: G.037
DATE: 16/5/97
DESIGNED: LB
DRAWN: LJE/HC
CHECKED: SLT
APPROVED: UB
STATUS: FINAL

LEGEND

- A——A´ GEOLOGICAL CROSS-SECTION SCHEMATIC
- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- EASEMENT
- FENCE LINE
- ELECTRICITY LINE

SOURCE: CMPS&F, R.CARR, BHP

metres
0 50 150 250
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
CROSS SECTION LOCATIONS

FIGURE
6.1

A3

Woodward-Clyde

6.0
LANDFORM, GEOLOGY, SOILS AND GEOTECHNICAL

The following description of the topography and geology of the Steel River Project site is based on hydrological investigations undertaken by Robert Carr & Associates in 1995.

6.1 TOPOGRAPHY

The surface of the site is mostly flat with an elevation of approximately 20 to 22 m BHP datum (approximately 7.5 to 9.5 m AHD). The main topographic feature of the site is the natural knoll in the south-eastern corner which rises to about RL 40 m BHP Datum (approximately 27.5 m AHD). There is also a topographic high of similar elevation running along part of the southern portion of the site.

6.2 GEOLOGY AND SOILS

6.2.1 Local Lithologies

The geology underlying the site is described as comprising the following stratigraphic components:

Fill Materials

A layer of variable thickness comprising exotic materials including blast furnace slag, CWR, general builders rubble, some coking plant wastes (tars etc.), brecketts and fly ash. The material was randomly placed as infill materials across the former Platt's Channel and Spit Island areas. The fill layer generally varies between 7 m and 12 m thickness.

Estuarine Muds

The original river deposited sediments and estuarine muds from Platt's Channel and Spit Island were overlaid with man-made filling. These river sediments comprise natural clays with interbedded fine silts and sand layers. A thin layer of residual clay occurs at the base of the sequence and represents materials derived from the underlying bedrock formations (Tomago Coal Measures).

Bedrock Formation

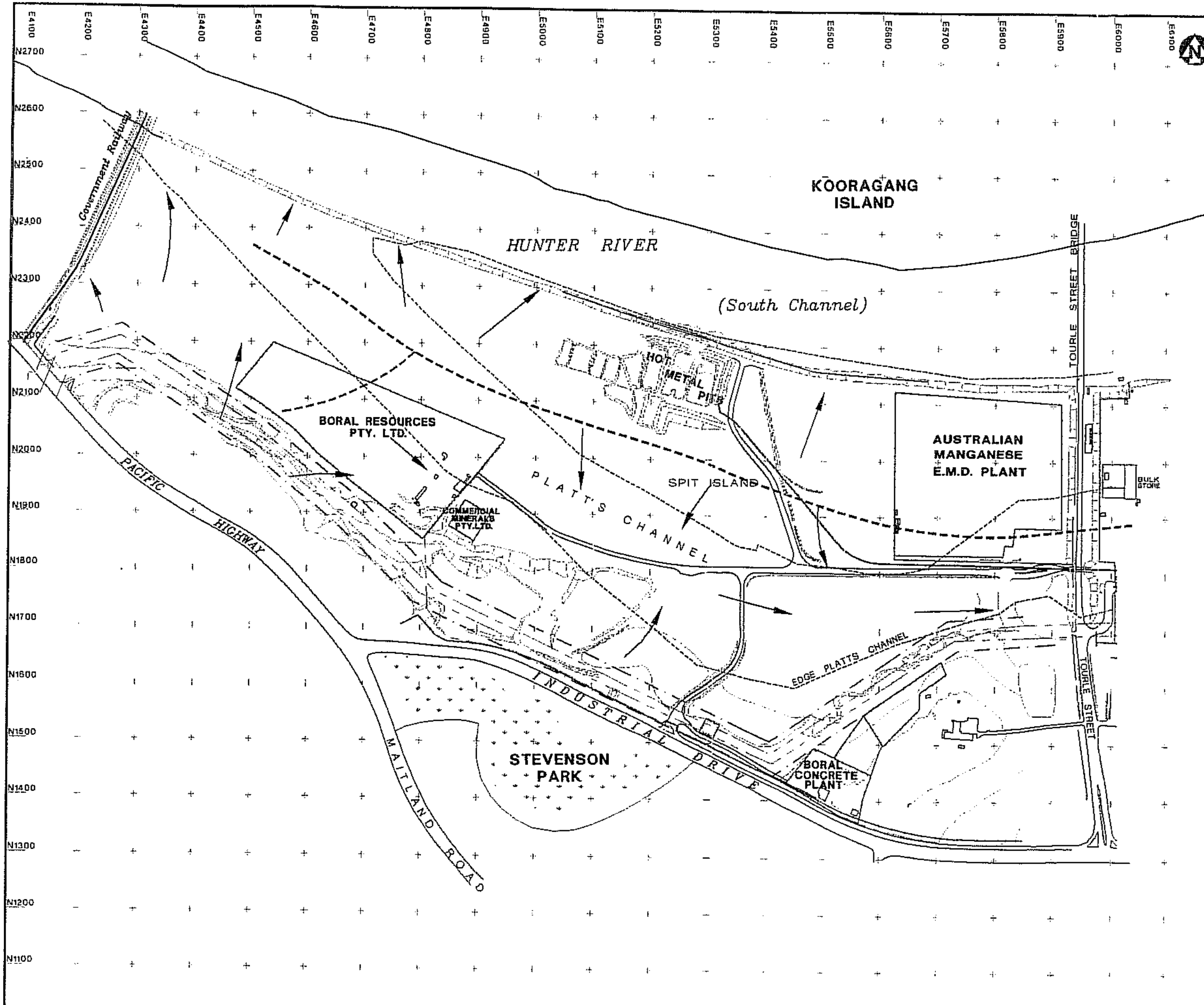
The Tomago Coal Measures bedrock formation which underlies the entire Project site comprises sandstone, siltstones and shales of Permian age.

6.2.2 Buried Topographic Features

Information from the various drilling programs, which defined the geology underlying the site, recorded a moderate topography between the three stratigraphic units. The locations of the geological cross sections of the site are shown in Figure 6.1. The buried topographic features in Figures 6.2 through 6.4 are presented as undulations in the elevation of the different strata (contact) across the site.

The geological contact between the bedrock and unconsolidated estuarine sediments (clayey mud units) varies in elevation up to 40 m across the site. The bedrock contact rises from its lowest elevation in the northern portion of the site (beneath Platt's Channel and the current Hunter River Channel) to its highest elevation along the southern boundary (refer to cross section A-A', B-B', Figures 6.2 and 6.3), where it forms a subcropping ridge (refer to cross section C-C', Figure 6.4) beneath the younger sediments and weathering profile. The estuarine muds (and fill layer) cut out against this bedrock topographic high in the southern portion of the site.

The buried topographic profile recorded for the contact between the estuarine mud and overlying fill materials is more subdued, with differences in contact elevation of 12 m (Figures 6.1 and 6.4).



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DRAWING No:	A66 246/0040	CHECKED:	SLT
CAD FILE NO:	G.038	APPROVED:	CS
DATE:	16/5/97	STATUS:	FINAL

LEGEND

- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- GROUNDWATER DIVIDE IN SHALLOW/FILL AQUIFER
- GROUNDWATER FLOW DIRECTION IN SHALLOW AQUIFER
- EASEMENT
- FENCE LINE
- ELECTRICITY LINE

SOURCE: CMPS&F (1995)

metres
0 50 150 250
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
GENERALISED GROUNDWATER FLOW PATHS

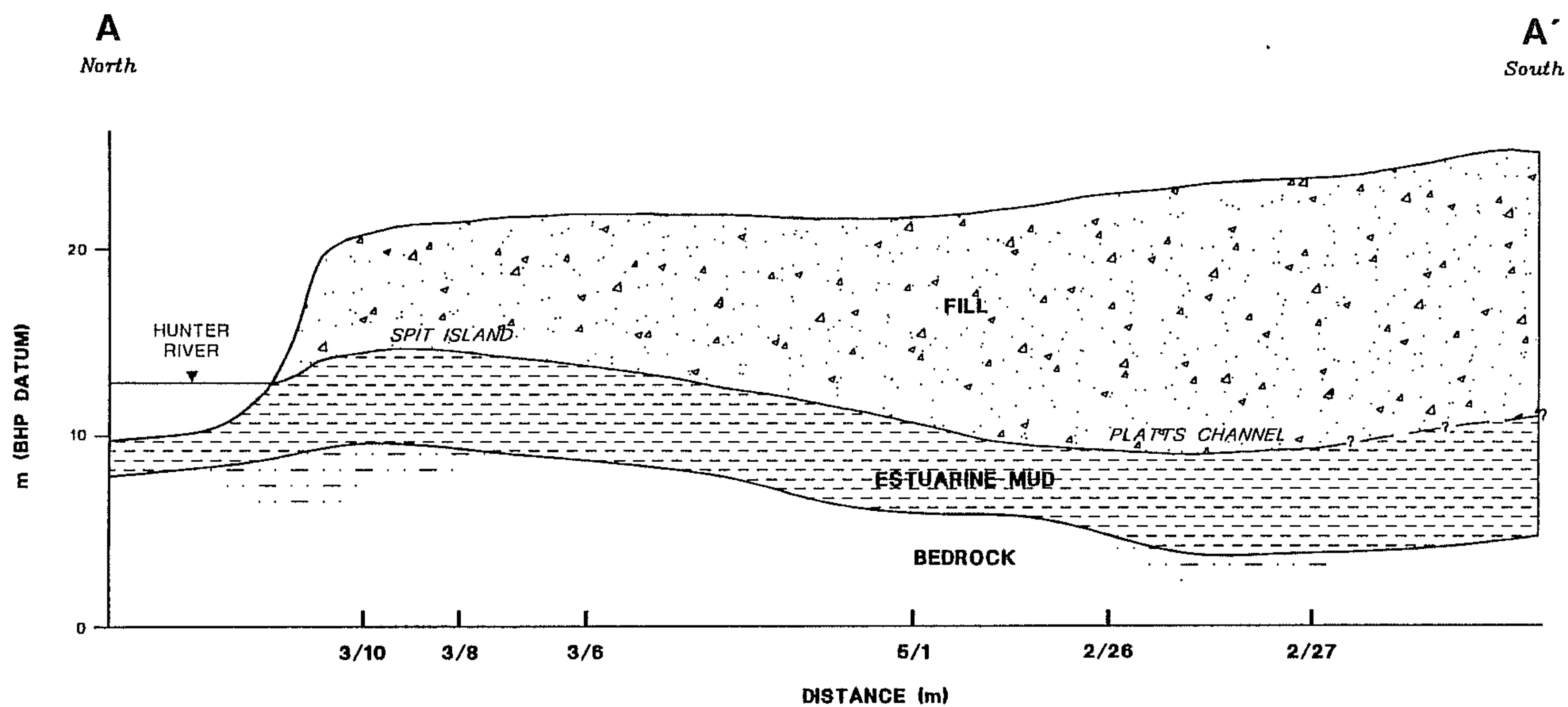
FIGURE
7.1

A3

Woodward-Clyde

NOTE: NO BEDROCK INTERCEPTED ALONG THIS TRANSECT.
ONLY CONTACT BETWEEN ESTUARINE CLAY AND FILL
WERE INTERSECTED.

CROSS-SECTION LOCATION SHOWN ON FIGURE 6.1



DATA

BORE	DEPTH (m)	RL (BHP DATUM)
3/10	15	20.53
3/8	13	21.87 (PIPE)
3/6	13	21.95 (PIPE)
5/1	13	21.94 (PIPE)
2/26	15.5	22.71 (PIPE)
2/27	16.3	22.89 (PIPE)

metres 0 50 100 150
HORIZONTAL SCALE
VERTICAL EXAGGERATION = 10

Woodward-Clyde

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

REVISION: A
SCALE: AS SHOWN
DRAWING No: A80 246/0040
CAD FILE NO: Q.022
DATE: 21/5/97

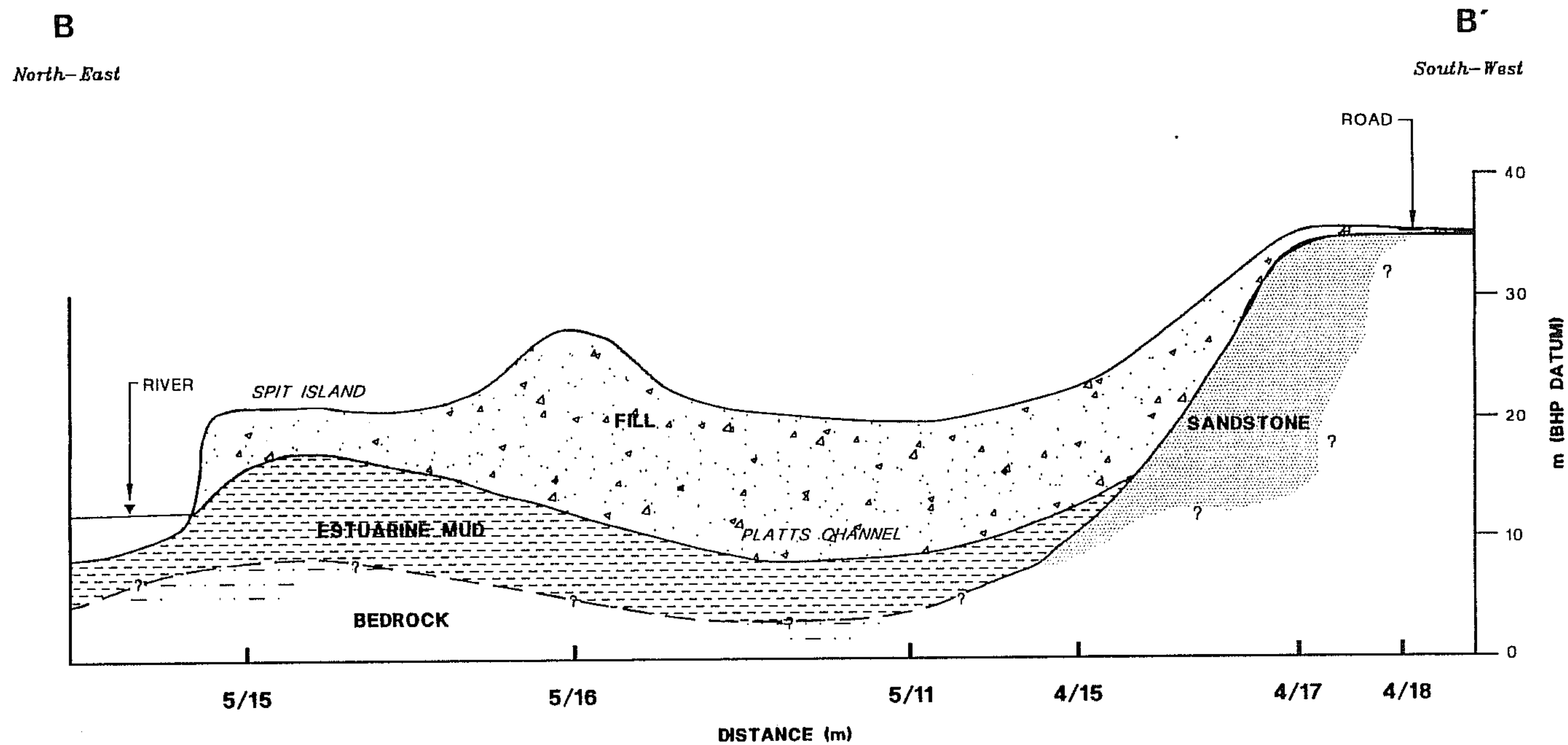
DESIGNED: LB
DRAWN: LJE
CHECKED: SKT
APPROVED: CB
STATUS: FINAL

TITLE
SCHEMATIC GEOLOGICAL CROSS-SECTION A-A´

FIGURE
6.2

A4

NOTE: CROSS-SECTION LOCATION ON FIGURE 6.1



DATA		
BORE	DEPTH (m)	RL (BHP DATUM)
5/15	13	28.47
5/16	17.5	28.95
5/11	16	21.61
4/15	12.7	22.48
4/17	1	36.88
4/18	0.4	36.76

metres 0 25 50 75 100
HORIZONTAL SCALE
VERTICAL EXAGGERATION × 6.5

Woodward-Clyde

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT
REMEDIAL ACTION PLAN EIS

REVISION: A
SCALE: AS SHOWN
DRAWING No: A88 248/0040
CAD FILE NO: G.023
DATE: 21/5/97

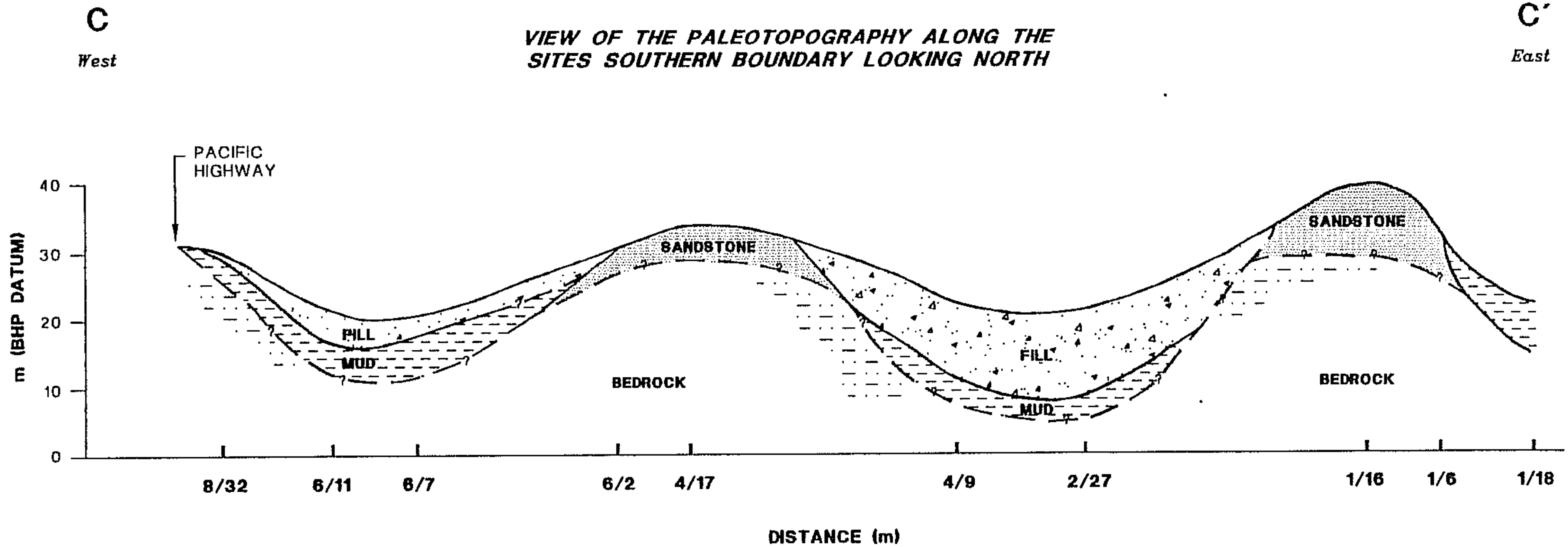
DESIGNED: PDB
DRAWN: LJE
CHECKED: SILT
APPROVED: CB
STATUS: FINAL

TITLE
SCHEMATIC GEOLOGICAL CROSS-SECTION B-B′

FIGURE
6.3

A4

NOTE: CROSS-SECTION LOCATION ON FIGURE 6.1



DATA		
BORE	DEPTH (m)	RL (BHP DATUM)
8/32	6.0	30.28
6/11	7.7	21.34
6/7	6.8	21.68
6/2	3.9	30.34
4/17	1.0	36.88
4/9	16	23.08
2/27	16.3	22.89 (PIPE)
1/16	3.0	37.38
1/6	1.5	30.08
1/18	6.5	23.36

metres
0 50 100 150 200
HORIZONTAL SCALE
VERTICAL EXAGGERATION : 6.5

Woodward-Clyde

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT
REMEDIAL ACTION PLAN EIS

REVISION: A
SCALE: AS SHOWN
DRAWING No: A86 246/0040
CAD FILE NO: 0.024
DATE: 21/5/97

DESIGNED: PDG
DRAWN: LJE
CHECKED: SKT
APPROVED: CS
STATUS: FINAL

TITLE
SCHEMATIC GEOLOGICAL CROSS-SECTION C-C′

FIGURE
6.4

A4

6.3 FILL CHARACTERISTICS

6.3.1 General

The fill used in reclaiming Platt's Channel included:

- blast furnace slag (generally contains oxides of silica, aluminium lime and magnesium, and comes from the removal of impurities from iron in the blast furnace);
- open hearth slag and Basic Oxygen Steelmaking (BOS) slag (from the removal of steel impurities);
- coal washery slurry (fine CWR);
- flue dusts;
- brecketts waste (finely broken BOS slag);
- sinter plant dusts;
- fly ash (light ash component from the coal used to fire the boilers);
- bottom ash (heavy ash component from the coal used to fire the boilers 'clinker');
- shale;
- oil sludges;
- tar wastes;
- general refuse (non-putrescible, including timber, bricks, old gloves etc);
- lime sludge; and
- large volumes of river silt and white beach sand dredged from the remaining South Channel of the Hunter River.

Limited information is available regarding details of the location of the disposal of particular wastes.

6.3.2 Inorganic Chemicals Characterisation

The arithmetic mean concentrations of inorganic parameters analysed for the various fill materials derived from BHP data are summarised in Appendix H.

Based on a comparison with probable background conditions at the site (i.e. those materials classified as fill, clay and clayey sand and sand) the following observations can be made:

- elevated concentrations of manganese appear to be associated with bracketts, BOS/open hearth slags, bottom ash and blast furnace slag; and
- elevated concentrations of chromium appear to be associated with fly ash, bracketts and BOS/open hearth slags.

All of these materials appear to exist on an effectively random basis at various depths across the site. However, the vast majority of the surface of the site does have a covering layer of coal washery refuse. The depth of this layer generally lies in the range of 0.2 - 0.5 m.

6.3.3 Organic Chemicals

The arithmetic mean concentrations of organic parameters analysed for the various fill materials, derived from BHP data, are summarised in Appendix H.

Based on a comparison with probable background conditions at the site (i.e. those materials classified as fill, clay and clayey sand and sand), slightly elevated concentrations of polyaromatic hydrocarbons (PAHs) appear to be associated with all seven classifications of steelworks waste material. Some samples (eg. slags) were found to be contaminated with PAHs, even though the raw material is PAH free. This is due to the slag material being mixed with PAH bearing material in the ground. A comparison of PAH concentrations on a sample by sample basis revealed that the concentration distributions are generally skewed, i.e. there is a high proportion of low concentrations of PAHs with a small number of high concentrations.

Significantly elevated concentrations of BTEX (benzene, toluene, ethyl benzene and xylene), total petroleum hydrocarbons (TPH) and/or phenols were also found to occur in a relatively small number of fill material samples collected.

Based on a review of bore log data contained in the BHP site investigation data reports, it is apparent that the higher concentrations of PAHs are associated with organic substances such as tars and coke oven gas mains condensate. Other organic substances such as oils and possibly diesel may also contribute to the PAH concentrations.

6.4 GEOTECHNICAL ISSUES

The proposed remedial activities would involve surface capping and recontouring to cover areas of soil identified as exceeding the remediation criteria in the top 2 m of fill. Other soils which exceed the remediation criteria and are exposed during redevelopment of the site would be relocated and covered with 2 m of imported fill. As all excavations undertaken as part of the proposed works would be localised and located at some distance from existing structures, the proposed earthworks would not have a significant impact on structures.

Remedial activities would occur behind and to the south of the existing retaining wall along the river bank. The security of the wall would therefore be assured and soils contained.

6.5 IMPACTS OF THE PROPOSAL

The primary impacts associated with the proposed works would occur as a consequence of the importation, spreading and compacting of materials, excavating and transporting material within the site, and temporary stockpiling of material.

6.6 SAFEGUARDS

It would be necessary to control potential sediment transport from the site during the site remediation phase and prior to future redevelopment. Sediment control procedures for the site would be contained in a Water and Sediment Management Plan outlined in Section 20.4 and would contain the safeguards listed below. The Management Plan would be developed in consultation with the Department of Land and Water Conservation (DLWC) prior to commencement of the proposed works. Design standards and methods for erosion control would be based on advice from DLWC's Soil Conservation Service and relevant Government agencies.

The following safeguard measures would be adopted to control sediment transport during the remedial works:

- earth bunds and similar diversion drains would be constructed around the perimeter of any excavations to prevent surface water entering these areas;
- drainage from outside the site would be controlled by diverting surface runoff away from that part of the site;
- stormwater and sediment retention ponds would be constructed adjacent to the containment areas;
- the working face and areas of open excavation would be kept to a minimum;
- stockpiling would be minimised by coordinating importation, spreading and compacting activities;
- water would be applied to active work areas, stockpiles and loads of soil being transported where required:

- silt fences, or similar, and diversion drains would be erected around all soil stockpile areas to prevent the migration of fines;

- compacted haulage roads would be used to transport soil within the site;

- retention ponds would be provided as required to maintain control of surface runoff;

- if excess fugitive dust is observed work would cease or be phased down while the source is being actively investigated and suppression measures implemented; and

- soil adhering to the wheels and undercarriage of trucks would be removed prior to departure from the site.

Upon completion of the remedial activities and prior to site redevelopment, a number of additional safeguard measures would be put in place. These include:

- retaining the access roads currently present on the site; and

- stabilising bare surfaces in areas where surface redevelopment would not occur within a reasonable time period.

6.7 CONCLUSIONS

Based on the assessment of the proposed remedial works and anticipated effects, as outlined in this chapter, it is concluded that:

- there are not expected to be any significant geotechnical issues in relation to the proposed remedial works; and

- there is potential for sediment transport to occur from the site, but with the use of appropriate safeguard measures, potential impacts would be controlled without harm to the environment.

7.0
HYDROLOGY AND WATER QUALITY

7.1 FLOOD LEVELS

The Hunter River drains a catchment of approximately 2 200 km^2. The river divides into two arms as flow passes Kooragang Island, the North Arm and flood plain taking approximately 76% of the peak Hunter River flow in major floods and the South Arm taking approximately 24% of the flow (GHD, 1994). The highest recorded flood event in the Hunter River occurred in 1955.

A flood study conducted by Public Works in 1992 indicated the following flood levels adjacent to the Steel River Project site:

- Extreme Flood - 4.3 m AHD (16.81 m BHP Datum)
- 100 year ARI - 2.0 m AHD (14.51 m BHP Datum)
- 50 year ARI - 1.5 m AHD (14.01 m BHP Datum)
- 20 year ARI - 1.3 m AHD (13.81 m BHP Datum)

The predicted peak flow velocities past the site are:

- 100 year ARI - 2.0 m/s.
- 50 year ARI - 1.5 m/s.
- 20 year ARI - 1.3 m/s.

Ground levels at the site near the bank of the Hunter River typically vary from approximately 7.5 m AHD to around 9.5 m AHD (20.01 to 22.01 m BHP Datum) and as a consequence the site is well above flood levels recorded for all flood events and is therefore not flood affected.

7.2 GROUNDWATER OCCURRENCE AND MOVEMENT

A summary description of the site groundwater characteristics, including a description of the aquifers present beneath the site, groundwater flow patterns, estimates of discharge of groundwater to the Hunter River and water quality, is presented below. A more detailed presentation of the groundwater characterisation is provided in Appendix I.

The hydrological investigations undertaken by Robert Carr & Associates (1995, amended 1997), form the basis for the descriptions of the hydrogeology of the project site. The extent of the investigations, location and density of the sampling points, is shown in Figure 3.1.

7.2.1 Aquifers

The groundwater regime at the site is described as consisting of three aquifers. closely related to the geology beneath the site (Chapter 6):

Shallow Aquifer

A shallow groundwater zone is associated with the fill layer. At the time of the 1994/1995 investigations the water level within the fill layer generally occurred between 4 m and 12 m below the ground surface, however, after rainfall events a number of temporary perched water tables would be expected at more elevated levels within the fill. This is due to the mixed nature of the fill which has a broad range of permeability characteristics. The fill on the eastern half of the site appears to have more permeable materials than the remainder of the fill. There is a vertical flow component of the groundwater from the shallow aquifer into the estuarine aquifer below (Robert Carr & Associates, 1995, amended 1997).

Estuarine Aquifer

An intermediate aquifer of low permeability is associated with the estuarine muds between the fill materials and the bedrock formation. The estuarine aquifer thins out against the bedrock topographic high towards the southern boundary of the site. The mean aquifer thickness intersected was greater than or equal to 3.6 m. The site investigations indicate an interaction between this aquifer and tidal levels in the river.

Bedrock Aquifer

A deep low permeability aquifer occurs within the underlying bedrock (the Tomago Coal Measures). The site investigations indicate that groundwater flow in the bedrock is towards the north. Also the groundwater gradient indicates an upward flow into the overlying aquifers.

7.2.2 Aquifer Permeabilities

The permeability of an aquifer is the physical property which determines the rate at which groundwater may flow though the aquifer. The higher the permeability the higher the potential flow. All three aquifer units have been tested for aquifer characteristics and were noted to be generally of low to very low permeability.

Groundwater flow patterns at the site have been assessed using water level measurements collected from the monitoring well network. The flow pattern defines a groundwater high or divide running approximately east to west through the site (Figure 7.1). Groundwater flows outward from the groundwater divide in a northward direction to the Hunter River, and in a south and eastward direction to a higher permeability zone which correlates to the pre-existing Platt's Channel alignment. The water level information also indicates potential for groundwater from the Stevenson Park area to flow onto the project site.

7.2.3 Estimates of Groundwater Discharge to the Hunter River

Since the various aquifers discharge groundwater (north of the groundwater divide) under known hydraulic gradients to the Hunter River, calculations of the rate of groundwater discharge to the river have been undertaken by Robert Carr & Associates (1995, amended 1997) and independently by Woodward-Clyde. These calculations produced a range of groundwater discharge values, which are provided in Appendix I.

Based on observed seep flows at the site, and the calculations and models run by Robert Carr & Associates (1995, amended 1997) and CMPS&F (1995, amended 1997), and the water balance undertaken by Woodward-Clyde, the groundwater discharge from the site to the Hunter River is estimated to be in the order of 300 m^3/d.

7.2.4 Shoreline Seepage to the Hunter River

Groundwater seeps have been observed entering the Hunter River at different levels across an approximately 2.2 m wide surface zone extending from the low tide level up the fill embankment. Seep points within this zone appear to be governed by the nature (permeability) of the seep face, much of which is impermeable (some being emplaced as molten slag). Seep occurrences are clustered in an area adjacent to the EMD plant (not part of the Steel River Project site) and the western end of Area 7.

Individual seep flows of up to 5 L/sec have been estimated (Robert Carr & Associates 1995, amended 1997). They are seasonal and dry up during extended dry periods.

7.3 EXISTING WATER QUALITY

Surface water, groundwater, shoreline seeps and river water, are the main existing water quality elements discussed below:

7.3.1 Surface Water

Surface water drainage generally occurs as overland flow in a northerly direction towards the South Arm of the Hunter River, as there are no stormwater drainage lines present on the site. Since the majority of the site is flat, surface water tends to pond on the site and that which is not lost to evaporation will gradually infiltrate to groundwater following periods of extended and/or heavy rainfall.

Surface water quality data specific to the site is limited. However, as the land is mostly flat, the site does not favour the generation of surface water runoff. The surface of the site is covered predominantly with CWR which has relatively low levels of contaminants associated with it. Should surface water runoff occur, then there exists potential for suspended sediments to be transported to the river. The extent to which this may take place is limited by the fact that the surface is largely covered by grass. Sediments that may be transported to the river would be expected to have chemical properties similar to those for CWR as described in Section 6 and included in Appendix H.

7.3.2 Groundwater

The groundwater analytical data is reported in the site investigation reports prepared by BHP from 1994 to 1995. In addition, Robert Carr & Associates has also undertaken some assessments of groundwater conditions. This section presents a summary of the key relevant issues.

Inorganic Chemicals

The metal found to be present at highest concentrations in groundwater is manganese. The concentration of manganese in groundwater is dependant on pH, with the highest manganese concentrations occurring with the lower pH values. Notably, the higher manganese concentrations are associated with the bedrock aquifer. Consistent with the influence of pH on manganese concentration, elevated manganese concentrations (i.e. in the parts per million range) are indicated in all areas, including Area 1 which is comprised largely of natural materials. The range of manganese concentrations for the three aquifers intersected beneath the site are summarised below:

- Shallow (fill) aquifer - manganese range 0.01 to 3.2 mg/L, average 0.15 mg/L.
- Estuarine sediments - manganese range 0.01 to 37.0 mg/L. average 3.54 mg/L.
- Bedrock - manganese range 0.01 to 5.8 mg/L, average 2.68 mg/L.

This data indicates that the concentration of manganese in shallow groundwater (i.e associated with the fill), falls within the lower range of background levels for manganese in groundwater which is reported to be in the range of 0.5 mg/L to 4.5 mg/L (Robert Carr & Associates. 1995, amended 1997). Additional evidence that this is the case is provided by data collected by BHP for groundwater bores monitoring the estuarine aquifer on Ash

Island (the western third of Kooragang Island). The monitoring data, which has been collected since 1990, for bores located in undisturbed areas of the island and outside the potential influence of waste disposal activities, show that concentrations of manganese range from 0.01 to 4.7 mg/L with an average of 1.2 mg/L.

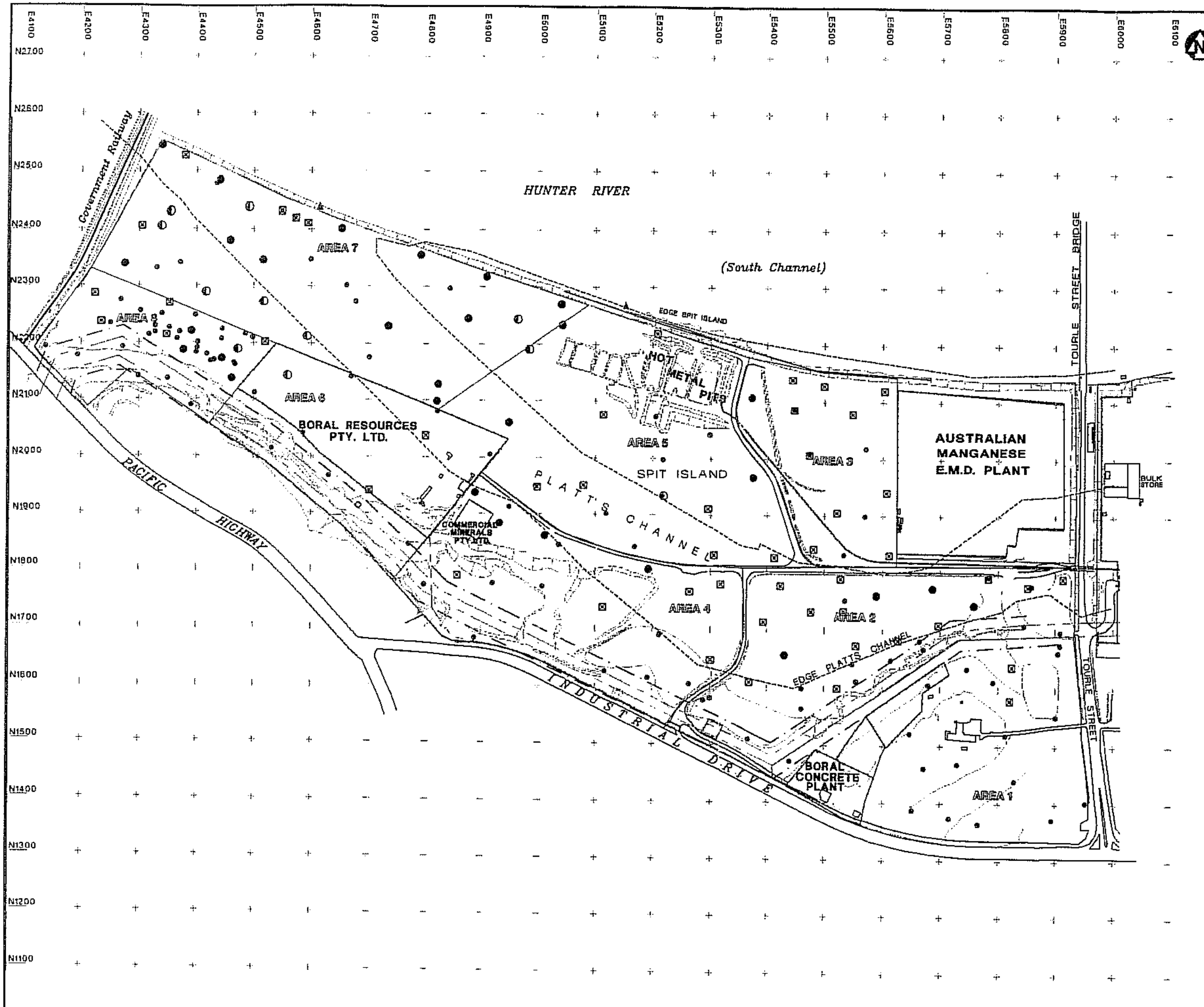
On this basis it can be concluded that any discharge of manganese via groundwater, from the site, should not be different from background discharges to the river.

Organic Chemicals

The following observations of total PAHs and total phenolic compounds concentrations can be made for the site.

- In contrast to the concentration of manganese in groundwater, the concentrations of PAHs and phenolic compounds show an apparent correlation with the presence of fill contaminated with organic materials. The highest concentrations of PAHs are recorded for areas where tar or other hydrocarbon materials have been noted on the bore logs i.e. Areas 5, 6, 7 and 8.
- Elevated concentrations of phenolic compounds are generally coincident with the presence of elevated concentrations of PAHs.
- The PAHs found in groundwater are dominated by naphthalene. On average, naphthalene accounts for 79 % of the total PAH concentration across all bores where PAHs were detected. Figure 7.2 provides an indication of the distribution of PAH across the site.

The concentration of BTEX compounds in groundwater is low, being less than analytical detection limits in all areas with the exception of Area 5 (bore W5/13) and Area 7 (bore W7/17). In these areas, however, the concentration of BTEX compounds was still within acceptable limits. On this basis, widespread occurrence of BTEX compounds in groundwater is not evident. This is consistent with the limited occurrence of elevated concentrations of BTEX compounds in fill materials.



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SCALE:	AS SHOWN	DRAWN:	LJE/HC
DRAWING No:	ASS 246/0040	CHECKED:	SLT
CAD FILE NO:	G.039	APPROVED:	Sm
DATE:	21/5/97	STATUS:	FINAL

LEGEND

- MONITORING WELL LOCATION (NOT SAMPLED)
- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- GROUNDWATER SEEP SAMPLE WITH PAH DETECTION
- GROUNDWATER MONITORING WELL (SAMPLED)
- PAH DETECTED >24.8mg/L (SITE AVERAGE)
- PAH DETECTED >653mg/L (SITE 95% UPPER CONFIDENCE LEVEL)
- EASEMENT
- FENCE LINE
- ELECTRICITY LINE
- AREA 5 INVESTIGATION AREA

SOURCE: CMPS&F, R.CARR, BHP

metres
0 50 150 250
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
PAH DETECTED IN GROUNDWATER

FIGURE
7.2

A3

Woodward-Clyde

7.3.3 Shoreline Seeps

The analytical results for inorganic and organic contaminants contained within the shoreline seeps described in Section 7.2.4 are discussed below.

Inorganic Chemicals

The shoreline seeps were analysed for a range of inorganic parameters. The inorganic parameter results indicated that the seeps have a similar chemistry to the groundwater bores adjacent to the river. On this basis, and consistent with the direction of groundwater flows, the seeps would appear to be associated with the shallow groundwater aquifer and reflect conditions present in the fill material.

The concentration of metals in the seeps is generally close to or below the analytical detection limits with the exception of manganese and to a lesser extent copper, lead and zinc. The concentrations of manganese ranged from 0.02 mg/L to 2.7 mg/L.

Organic Chemicals

The concentrations of PAHs were below the analytical detection limits for the individual PAH compounds tested in the seeps, with the exception of two locations as noted on Figure 7.2. TPH concentrations were above detection limits in all samples, with total concentrations ranging from 0.106 mg/L to 1.920 mg/L.

The concentrations are generally consistent with concentrations found in the adjacent groundwater bores, with the possible exception of TPH, which appears to be higher in the seep samples than observed in the groundwater. It should be noted, however, that the TPH analyses for the bores and the seeps were performed by different laboratories and that this analysis is sensitive to the analytical technique, and in Woodward-Clyde's experience, are often not directly comparable.

In 1995, a hydrocarbon sheen was noticed by Woodward-Clyde at a seep located within the mud flat area adjacent to the hot metal pits. Observations by Woodward-Clyde in 1995 indicated that the sheen was associated with the contaminants in the mud rather than the seeps. A recent survey (April 1997) undertaken by BHP after a prolonged dry spell, observed that the hydrocarbon affected seep was dry and that no sheen could be detected. This would indicate an intermittent occurrence of both the seep and sheen associated with the muds.

7.3.4 River Water

The data available on river water quality is limited to data collected by BHP at irregular intervals since February 1992 and a single sample collected by Robert Carr & Associates, which was analysed for TPH only. The BHP monitoring involved the collection of samples from a point adjacent to the site, some 100 metres west of the Tourle Street Bridge and six other locations including two points in the North Arm of the Hunter River. Samples were collected at both high and low tide for each sample date. There are no sample points upstream of the subject site which might provide an indication of background conditions in the South Arm of the Hunter River.

Sampling results can be summarised as follows:

- The concentration of PAHs in both the South and North Arm of the Hunter River were below the analytical detection limit of 0.002 mg/L for all samples at all locations.

- Similarly the concentration of total phenolic compounds was close to or below the analytical detection limit (i.e. around 0.001 mg/L) adjacent to the Project site. This was also true for all other sample locations, with the exception of samples taken in 1986 and 1989 adjacent to the steel works and in 1990 for locations in the North Arm, where concentrations, ranging from 0.01 to 0.1 mg/L were recorded.

- The concentrations of manganese adjacent to the Project site fell within the range <0.010 mg/L to 0.16 mg/L, with the exception of a single high value of 1.34 mg/L recorded in 1986. Further discussion of these results is provided in Appendix I.

- The salinity of the river adjacent to the Project site is roughly equivalent to sea water.

In summary, the monitoring data does not indicate deterioration of river water quality adjacent to the Project site. The chemical data indicates conditions adjacent to the site to be generally similar to conditions in the North Arm of the Hunter River, with the exception of a single elevated manganese concentration recorded at high tide adjacent to the Project site in 1986.

7.4 ESTIMATED POLLUTANT LOADINGS

Groundwater discharge from the Project site is estimated to fall within the range 287 m^3/d to 450 m^3/d. The contaminant loading using the site mean concentration of total PAH in monitoring wells located adjacent to the Hunter River (river front) of 366 μg/L (0.000366 kg/m^3) over the full length of the site along the South Arm of the Hunter River ranges from 0.11 kg/day to 0.17 kg/day total PAH.

The corresponding upper estimates for river concentrations fall in the range 0.2 μg/L to 0.85 μg/L. This is less than the analytical detection limit of 2 μg/L.

The potential contaminant loading using the average concentration of Total PAH in the seep samples collected along the Hunter River (river front) of 11.7 μg/L (0.0000117 kg/m^3) over the full length of Hunter River frontage is in the range 0.004 to 0.005 kg/day total PAH.

The upper estimates for river concentrations. based on the seep data, fall in the range 0.005 μg/L to 0.025 μg/L.

The upper estimate of PAH concentration in the river is consistent with the river water quality monitoring program (Section 7.3.2), which is that PAHs are found to be consistently less than the analytical detection limit of 2 μg/L.

Details of the calculations of total PAH loading and upper estimated river concentrations are presented in Appendix I.

7.5 IMPACTS OF PROPOSAL

The proposed works would have the following impacts on the hydrology of the site:

- Reducing infiltration, decreasing the generation of contaminated groundwater and minimising groundwater mounding within the site.

- Reducing groundwater discharge and surface seepage to the Hunter River.

The impacts on the hydrology would be localised, and not significant in terms of the regional groundwater regime.

Potential impacts of the proposed works on water quality include:

- Increasing sediment load in surface waters due to localised ground disturbance.
- Decreasing the generation of potentially contaminated groundwater.

Potential adverse impacts of the proposal on surface and groundwater quality would be limited for the following reasons:

- The hydraulic connection between groundwater in the fill material at the site and in the underlying bedrock aquifer is poor, thereby limiting the potential for migration of contaminants into the regional aquifer system.

- The hydraulic connection between groundwater in the fill at the site and the Hunter River is poor, thereby limiting the potential for migration of contaminants from groundwater into the River.

- The remediation technology used to carry out the proposed works does not require large quantities of water for remediation and has the advantage of requiring a shorter time frame compared to many alternative technologies. These features would reduce the impact of the proposed works on water quality.

Safeguard measures as discussed in Section 7.6 would mitigate potential impacts.

7.6 SAFEGUARDS

There are two potential mechanisms which could give rise to the generation of contaminated surface water. These are stormwater which comes in contact with contaminated soil, and perched groundwater within any excavations.

7.6.1 Stormwater Control

The safeguard measures which would be used to prevent a decline in surface water quality during the proposed works include:

- Implementation of a Water and Sediment Management Plan (see Section 20.4) to address areas affected by remedial works.

- Control of drainage from outside the property by diverting outside runoff.

- Control of on-site drainage by intercepting and redirecting runoff in a manner which protects exposed areas from damage. Runoff from the site that does not come in contact with any excavation area would be considered to be uncontaminated and would be diverted away from remedial areas without treatment.

- Rainfall that comes in contact with any excavation area would be considered as potentially contaminated and would be collected in sumps and pumped into retention ponds located as shown on Figure 4.2. It would then be assessed, treated (if necessary) and subsequently used for dust suppression.

- Settling ponds used for wet weather runoff containment would be routinely cleaned of silt to ensure that their capacity is not reduced by more than 10% of volume. These ponds would be regularly inspected for storm damage and where necessary cleaning and/or repairs would be undertaken as soon as practicable.

In addition, any overland and diffuse drainage paths would be addressed by the following controls:

- Earthen bunds and similar diversion drains would be constructed around the perimeter of any excavation areas to prevent surface water entering these areas.
- Silt fences, or similar, and diversion drains would be erected around all soil stockpile areas to prevent the migration of fines from the stockpile areas.

Stormwater and sediment retention ponds would be constructed as required adjacent to containment areas to contain runoff water. The ponds would be designed to meet minimum recognised standards. Preliminary estimates based on *Australian Rainfall and Runoff* and assuming retention of all rain falling on the excavation areas, requires a capacity of 1 700 m^3 for a 1 in 10 year 24 hour duration storm, for each hectare of exposed area.

Disposal of collected surface waters would take the following forms, depending on the condition of these waters:

- Uncontaminated surface waters (e.g. Area 2) collected in stormwater retention basins, seepage pits and excavations would be allowed to evaporate or naturally seep into groundwater provided this does not adversely impact on groundwater quality; and

- Where collected surface water requires more immediate disposal, wastewater from excavation and associated activities may be stored on-site for assessment and treatment (if necessary). Where visible hydrocarbons are present in the collected water, the water would be treated by separation of the free-phase before intermediate storage and subsequent use for dust suppression.

7.6.2 Groundwater Control

If the excavation work which might be undertaken within some parts of Project site encounters or intersects the groundwater table (perched), floating hydrocarbon may be exposed on the water table. In this situation, management of these contaminants is appropriate.

The primary method of recovering the floating hydrocarbons, where quantities make it practicable, would be through total fluids pumpage from the applicable excavation. The fluids could be discharged/pumped:

1. to an on-site treatment facility;

   or

2. be taken to the adjoining steelworks for treatment in existing treatment facilities.

Groundwater extracted and treated in this fashion would be pumped, following treatment, into the retention ponds located as shown on Figure 4.3 where it would be used in dust suppression activities, or would be used at the steelworks.

Where circumstances warrant it, proprietary absorbent materials would be used to entrap floating hydrocarbon. These circumstances would be where the floating product is thinly distributed on ponded water, where extractive pumping is not practical or when the inflow of affected groundwater is temporarily greater than the handling capacity of the pump and treatment system. The resulting absorbent materials would be recovered and disposed of with the contaminated soils removed from the excavation in question.

Following remediation of the groundwater by capping, monitoring of the groundwater regime would be undertaken to evaluate the efficiency of the capping system.

7.7 CONCLUSION

The proposed works would contribute to minor and localised effects on the hydrology in the area of the site where capping is to be undertaken, due to reduced infiltration to this area. The reduced infiltration would result in a reduction in potentially contaminated groundwater discharging from the site to the river.

The proposed works would improve the quality of surface water at the site, provided the water management strategies as discussed in Section 7.6 are implemented.

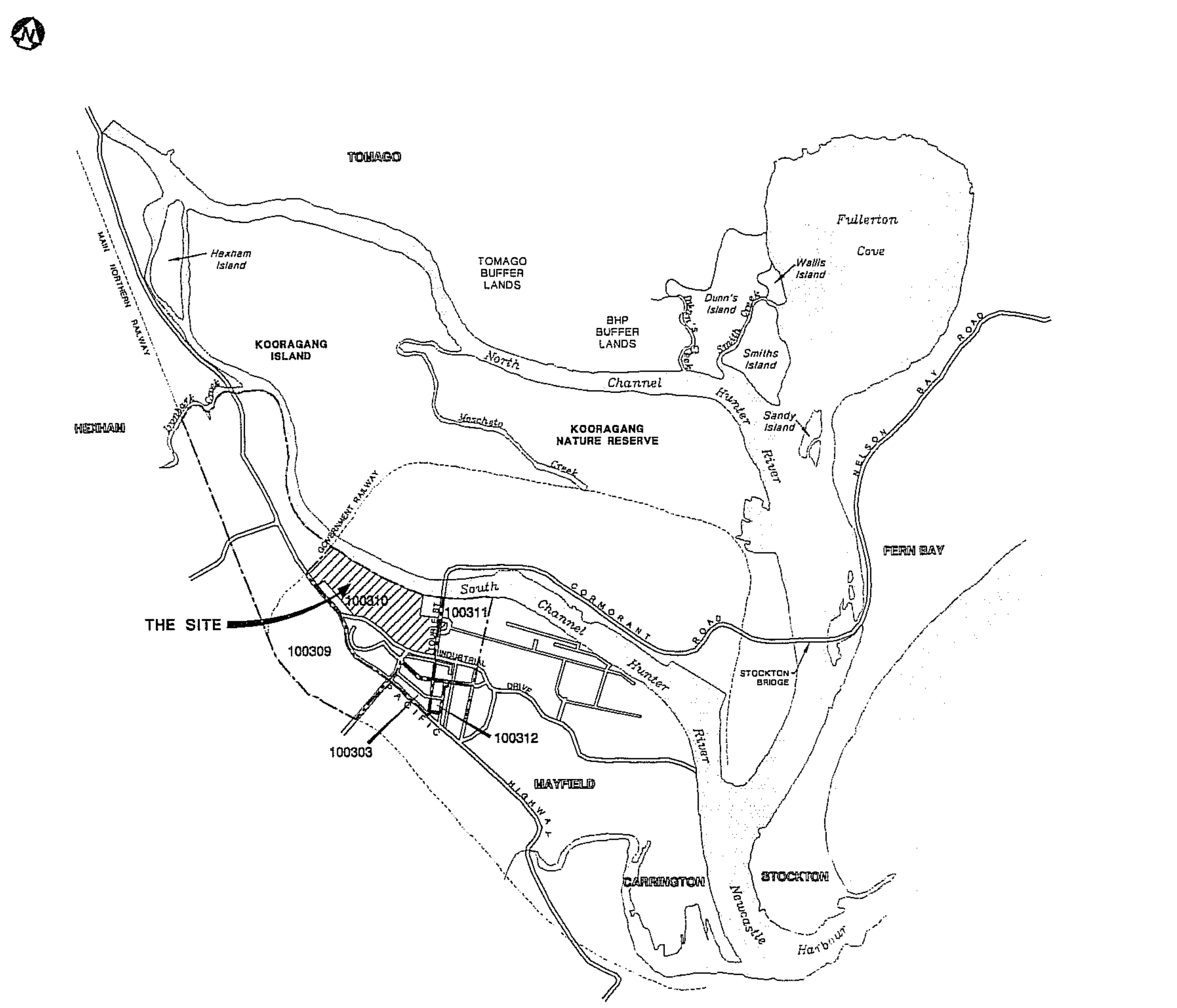
8.0
SOCIO-ECONOMICS

8.1 THE MAYFIELD REGION

The following community profile has been compiled from Australian Bureau of Statistics data from the 1991 Census (ABS, 1996), using the 1991 Census Basic Community Profiles. The community profile for the area of Mayfield surrounding the site was created by aggregating Census Collector Districts 1003003 and 100309 to 100312 (Figure 8.1). For the purposes of this document this area will be referred to as the Mayfield Division.

In 1991, the population of the Mayfield Division was 2944. The age profile of the Mayfield Division is shown in Figure 8.2 and illustrates that the largest proportion of the population is aged between 20 and 39 years representing a similar age profile to that of Newcastle as a whole (see Figure 8.3). Just over half (52%) of the population in the Mayfield division is female and 48% of the population is male. The 20 - 29 year age group is slightly more dominant in the Mayfield Division and wider Newcastle area whereas in NSW a larger proportion of the population is aged between 30 and 39 years (Figure 8.4). The population is also more evenly split between the sexes in NSW with 49.7% of the population being male and 50.3% of the population being female.

The majority of people living in the Mayfield Division, Newcastle and New South Wales were born in Australia. As Figure 8.5 illustrates, the greatest proportion of people born overseas were born in Europe and the former USSR.



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LEGEND

—·— CENSUS BOUNDARY

Kilometres
0 0.5 1 1.5 2 2.5
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
CENSUS STATISTIC AREA

FIGURE
8.1

A3

Woodward-Clyde

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FIGURE 8.2 - POPULATION AGE/SEX PROFILE OF THE MAYFIELD DIVISION

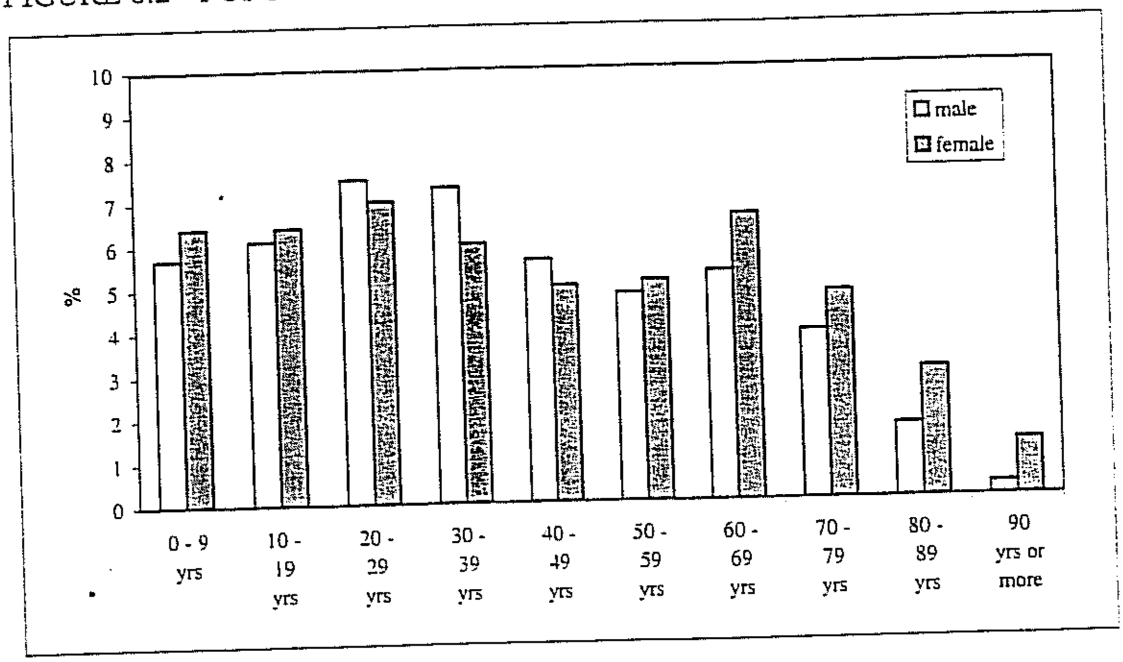


FIGURE 8.3 - POPULATION AGE/SEX PROFILE OF NEWCASTLE

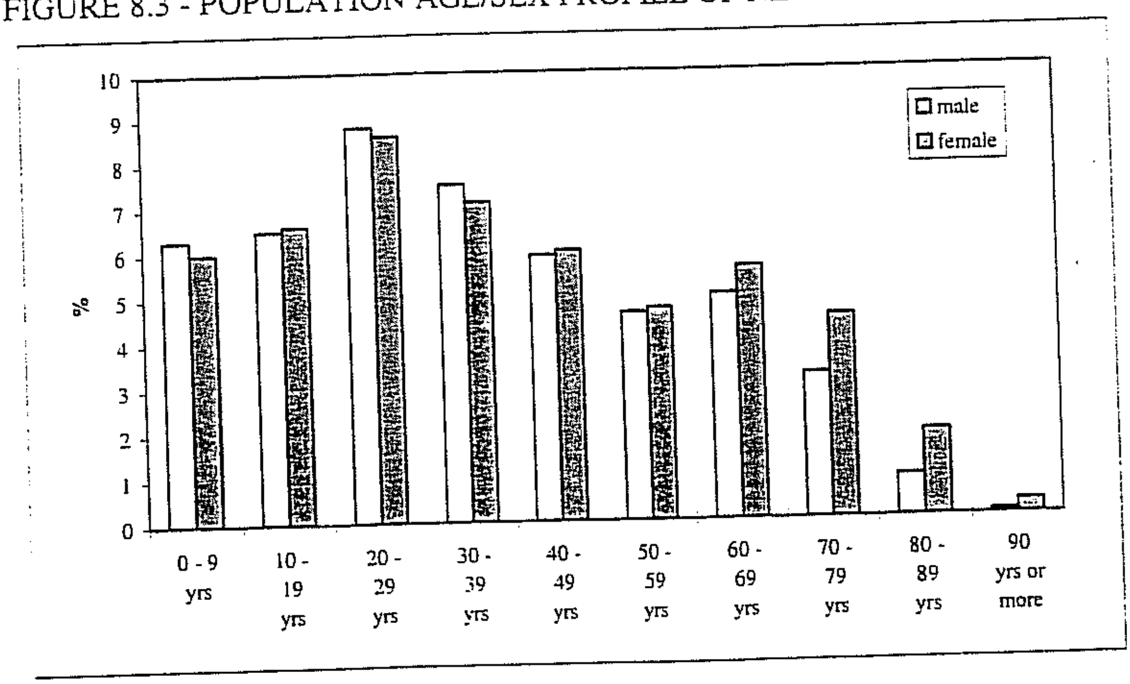


FIGURE 8.4 - POPULATION AGE/SEX PROFILE OF NEW SOUTH WALES

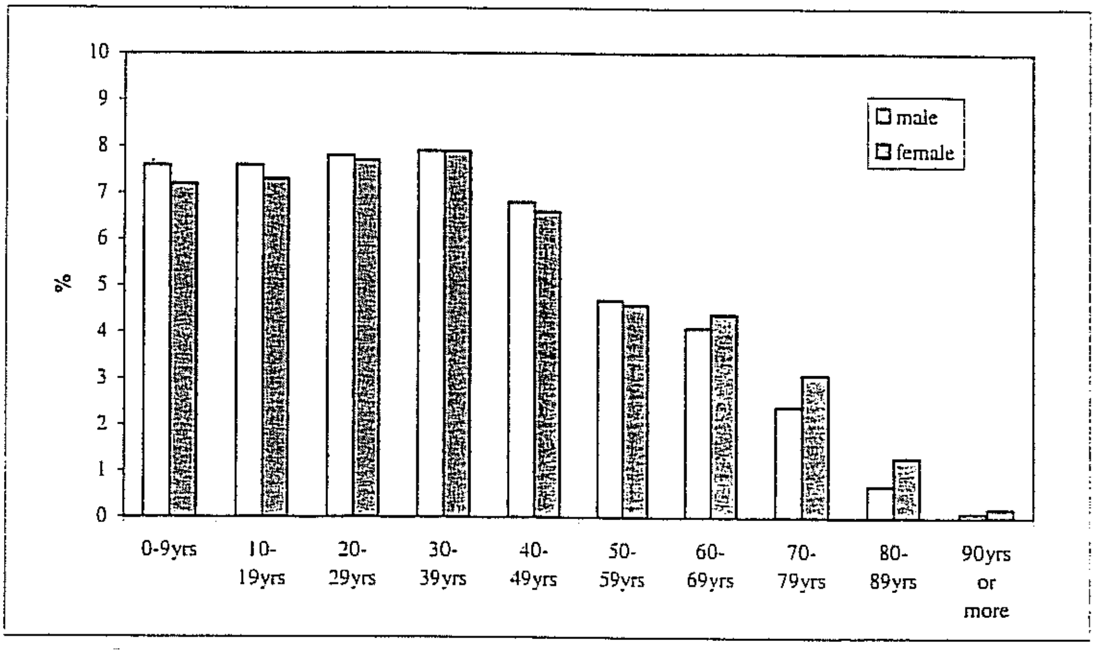
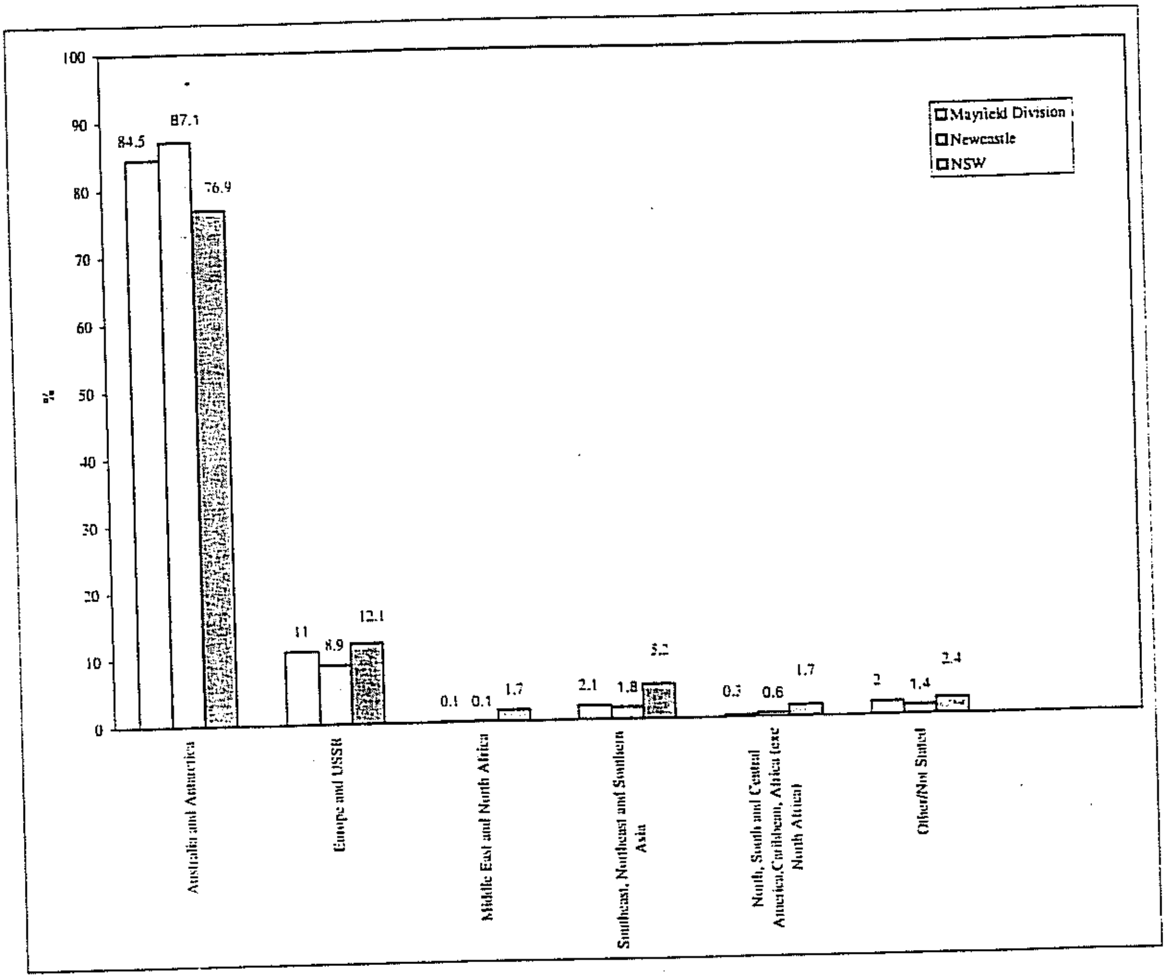


FIGURE 8.5 - POPULATION BIRTHPLACE - MAYFIELD DIVISION, NEWCASTLE AND NEW SOUTH WALES



Within the Mayfield Division 87% of the workforce is employed. Figure 8.6 illustrates that the majority of the workforce is employed in manufacturing (21.0%), wholesale and retail trade (19.2%), community services (15.0%) and construction (8.4%) industries. The employment structure within the Mayfield Division is similar to the employment structure of both Newcastle and NSW as a whole. In Newcastle, the majority of the workforce is employed in community services (21.2%), wholesale and retail trade (19.5%), manufacturing industries (15.6%), and finance, property and business services (10.1%) (Figure 8.7). In NSW the majority of the workforce is also employed in wholesale and retail trade (18.9%), community services (17.0%), manufacturing industries (13.1%), and finance property and business services (12.7%) (Figure 8.8).

Unemployment rates, based on 1991 Census data, are shown in Table 8.1. The table shows that the unemployment rate in the Mayfield Division (12.9%) and in Newcastle (12.6%) is higher than the unemployment rate for NSW as a whole (11.2%).

TABLE 8.1 - THE LABOUR MARKET

	Mayfield Division	Newcastle	NSW
Unemployed*	147	7487	304539
Employed*	993	51930	2407009
Total Labour Force*	1140	59397	2711548
Population Aged 15 or more	82%	82%	78%
Unemployment Rate	12.9%	12.6%	11.2%
Participation Rate	39%	45%	61%

* Applicable to persons 15 years or older

TABLE 8.2 - COMPARISON OF SOCIOECONOMIC PROFILES

	Mayfield Division	Newcastle	NSW
Population aged 15 or more	82%	82%	78%
Australian born	83%	86%	75%
Unemployment rate	12.9%	12.6%	11.2%
Workforce participation rate	39%	45%	61%
Same address 5 years ago	52%	61%	56%
Dwelling owned or being purchased	64%	71%	66%
Annual household income >$25 000	39%	43%	49%

Table 8.2 illustrates that the population in the Mayfield Division has a lower workforce participation rate and household income compared to Newcastle and NSW. The Australian born component of the population is above the NSW average but slightly below the Newcastle average. Just under two thirds of the population in the Mayfield

Division own or are purchasing their home (64%) a pattern similar to the NSW average but below that for the wider Newcastle area.

FIGURE 8.6 - DISTRIBUTION OF THE MAYFIELD DIVISION WORKING POPULATION BY INDUSTRY

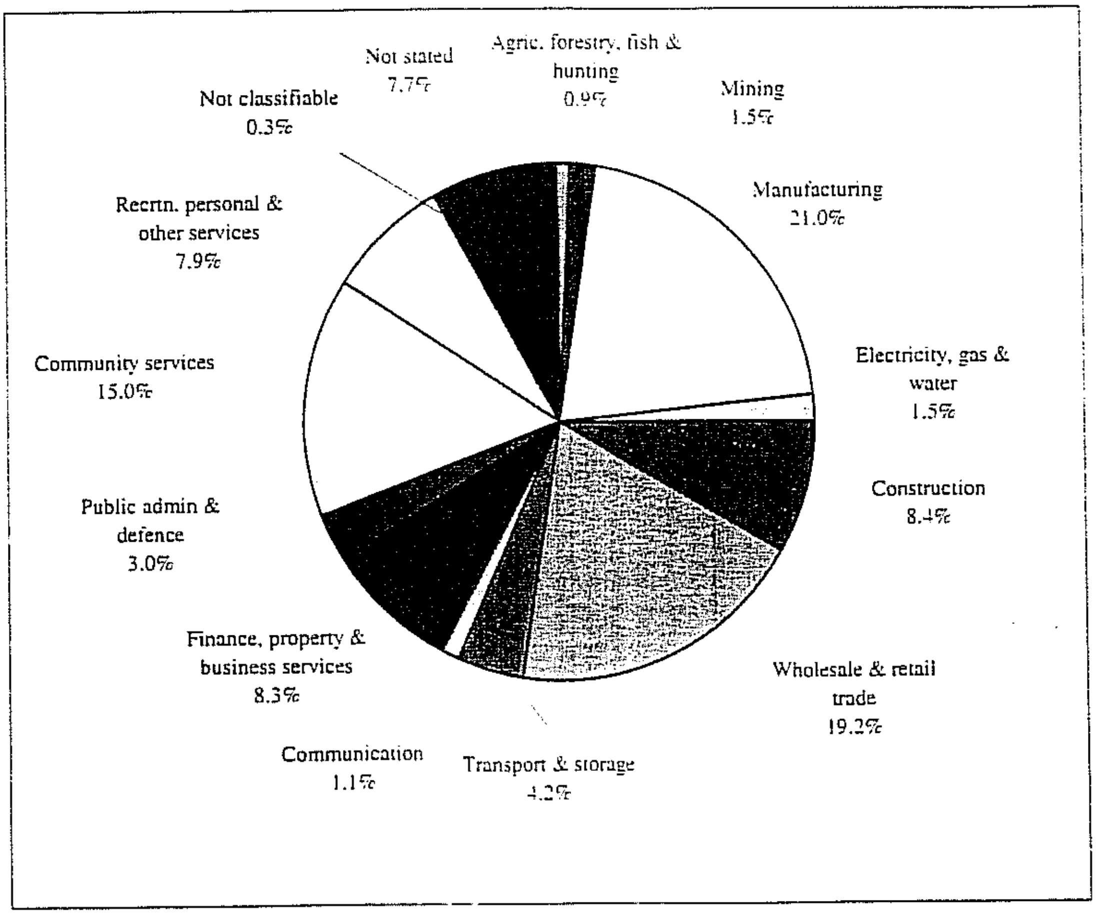


FIGURE 8.7 - DISTRIBUTION OF THE NEWCASTLE WORKING POPULATION BY INDUSTRY

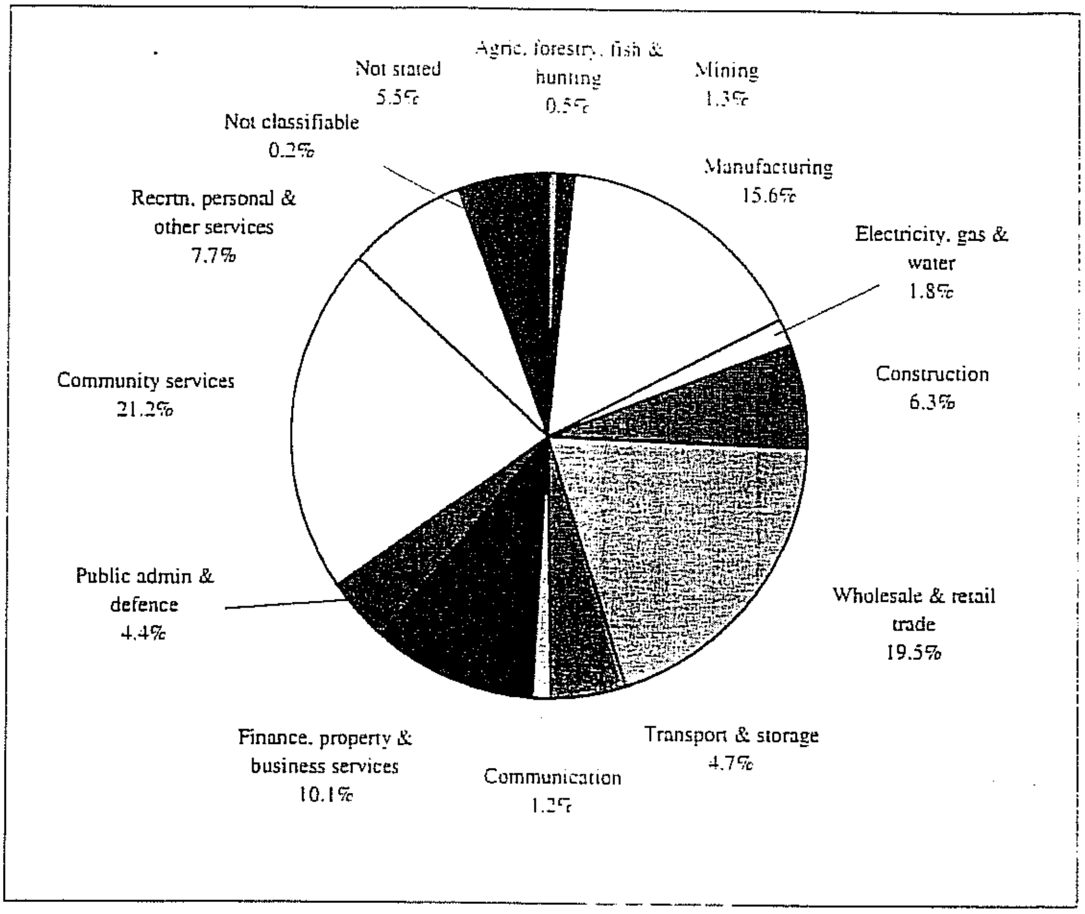
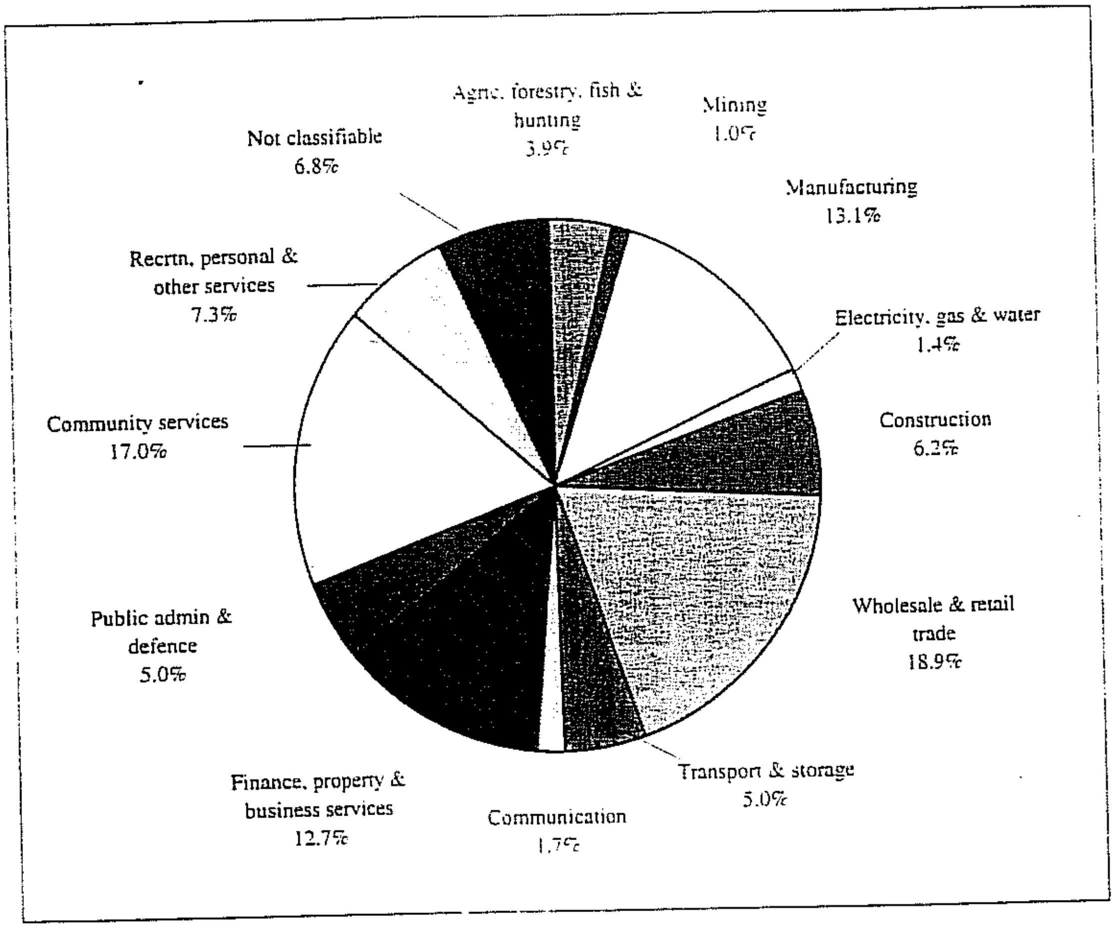


FIGURE 8.8 - DISTRIBUTION OF THE NEW SOUTH WALES WORKING POPULATION BY INDUSTRY



8.2 SOCIAL CONCERNS

8.2.1 Community Issues

Key local community groups were consulted through the *Newcastle Beyond 2000 Committee Technical Steering Committee*. The main social issues raised by these groups related to:

- impact of remediation works on the local environment;
- impact of the proposal on the health of the surrounding community; and

- future redevelopment opportunities for the site and potential employment generation.

These issues have been addressed in this EIS.

8.2.2 Health Issues

The health of the community would not be affected by the proposal for the following reasons:

- dust control measures would be implemented;
- remediation would occur over a relatively short (5-10) year time frame;
- extremely dusty conditions would be required before unacceptable dust concentrations would be generated; and
- the surrounding community is located at some distance from the site.

The findings of the human health risk assessment suggested that risks to the community from inhaling vapours are negligible. More detail on this issue can be found in Chapter 18.

Noise impacts of the project are dealt with in Chapter 10. The implementation of ameliorative measures would ensure that, noise impacts would be reduced to levels which are not harmful to the health of the community.

The air quality impacts of the proposal would be minimised by performing the remedial actions in such a way as to reduce the production of fugitive emissions.

8.3 ECONOMIC IMPACTS

The proposed remedial activities would have a number of economic impacts on the region. The economic impacts are listed as follows:

- The project would enable BHP to utilise the site for the purpose of redevelopment;

- The project would create direct employment opportunities for a crew of up to 20 during the time period required to remediate the site. It is BHP's intent to utilise remediation contractors that use labour sourced from the lower Hunter Region to perform the remedial work. The local economy would therefore benefit from the multiplier spin offs generated from this employment. Unemployment as noted is above the NSW average and is an increasing problem in the Newcastle Region with continued rationalisation of the traditional industrial base. The opportunities offered by the remediation project which would facilitate future redevelopment of the site are seen as positive steps in creating future employment in the area.

8.4 CONCLUSION

Remediation of the Project site would have a number of significant benefits. The containment of contaminated material would have positive benefits for the local community as it would enable the release of valuable industrial land for redevelopment and would generate local employment opportunities.

Use of appropriate remediation technologies would ensure that there would be no health risk to on-site workers. In addition, the implementation of safeguards and an on-site monitoring program would ensure that the environmental impacts which may be generated by the proposal do not affect the health and safety of the surrounding community.

9.0 METEOROLOGY AND AIR QUALITY

9.1 CLIMATE

Climate data for the Newcastle area have been obtained from the Bureau of Meteorology (BoM). The closest BoM monitoring station to the Project site is located at Williamtown, which is some 15 km to the north. The meteorological data (wind speed and direction, temperature, pan evaporation, humidity and rainfall) are monitored daily.

Temperature

Climatic extremes are modified by the influence of the sea-land circulation system. In general, the Newcastle area experiences warm to hot summers and cool to mild winters.

Monthly mean 9 am and 3 pm temperatures for the BoM meteorological station at Williamtown are shown in Table 9.1. The data indicate that the mean annual temperatures are 17.5°C and 21.6°C for 9 am and 3 pm respectively. January is generally the warmest month with mean temperatures of 23.0°C and 26.3°C for 9 am and 3 pm respectively. July experiences the coldest mean temperatures of 9.3°C at 9 am and 16.3°C at 3 pm. The range between morning and afternoon temperatures varies throughout the year, with the winter months having the greatest variation.

Humidity

Mean monthly 9 am and 3 pm humidity data are also provided in Table 9.1. The mean relative humidity values are higher at 9 am than 3 pm. This difference is greater during the late autumn and winter months. The lowest monthly mean 9 am relative humidity value is 63% (October) and the highest is 80% (June). The lowest 3 pm mean value is 49% (September) and the highest is 61% (February).

TABLE 9.1 - METEOROLOGICAL DATA FOR WILLIAMTOWN METEOROLOGICAL STATION

(Station No. 061078 Latitude 32°47'47" S, Longitude 151° 49' 59" E Elevation 9.0 m, Opened In Jan 1942 and still operating)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Temperatures (°C)													
9am	23.0	22.5	21.5	18.2	14.2	11.5	10.3	12.0	15.3	18.7	20.5	22.2	17.5
3pm	26.2	25.9	24.8	22.6	19.3	16.7	16.2	17.5	19.7	21.7	23.7	25.4	21.6
Mean Relative Humidity (%)													
9am	72	76	75	75	79	80	77	71	66	63	64	67	72
3pm	58	61	60	57	59	60	54	50	49	53	52	55	56
Mean Rainfall (mm)													
	107.5	116.4	121.6	96.9	107.2	120.6	69.5	79.0	57.9	77.5	76.8	83.3	1114.2
Mean Daily Pan Evaporation (mm)													
	6.7	6.2	4.8	3.9	2.6	2.5	2.6	3.6	4.6	5.5	6.4	7.4	4.7
Mean Rain days (Number)													
	12.1	11.8	12.8	10.8	12.2	12.5	9.5	10.5	9.7	12.2	11.0	10.9	136.1
Mean Thunder days (Number)													
	3.5	3.1	2.0	1.4	0.8	0.9	0.6	1.2	1.9	3.0	3.9	4.4	29.6

Source: Bureau of Meteorology (1996)

Rainfall and Evaporation

Rainfall data are also included in Table 9.1. Mean annual rainfall is 1 114 mm, with rainfall recorded on a mean of 136 days per year. Pan evaporation is shown as a daily mean of 4.7 mm over the year equating to a total pan evaporation of approximately 1 700 mm per year

Thunder storms are an important influence on precipitation in the region during summer, in that they generally provide intense rainfall for brief periods. The months November to February experience, on average, 3 to 4 thunderstorms a month. The winter months are typically drier and experience fewer storm events.

Wind Direction and Wind Speed

The climate in the Newcastle area is strongly influenced by synoptic weather patterns and to a lesser extent by regional circulations such as local sea breezes, katabatic winds (night time cold air drainage), and land breeze winds. The synoptic weather patterns are mostly caused by high pressure cells and cold fronts which move west to east over Australia.

Easterly breezes are most common during summer. Westerly and northwesterly land breezes and katabatic winds are most likely to occur during the colder winter months and in particular, on cold nights. Prevailing winds measured by the BoM at Williamtown at 9 am and 3 pm, for the years 1942 to 1993, are shown in the wind frequency analyses in Appendix J.

9.2 AIR QUALITY GUIDELINES

9.2.1 Particulate Matter

Particulate matter (mainly in the form of dust emissions) is the air emission of potential concern from the proposed remediation activities. Dust deposition and total suspended particulates (TSP) are a measure of the effects of airborne particulates on amenity.

The dust deposition rate is measured as the amount of dust deposited on a horizontal surface and the units for this parameter are grams per square metre per month (g/m^2/month). The NSW EPA notes, as an objective, an ambient goal of 4 g/m^2/month (annual average) for dust deposition before loss of amenity occurs. To protect against loss of amenity from new developments, the EPA (Air Pollution Control Manual, CASANZ, 1990) has set goals for the maximum acceptable increase of dust fallout levels over existing mean annual levels. These goals are detailed in Table 9.2.

TABLE 9.2 CRITERIA FOR DUST DEPOSITION

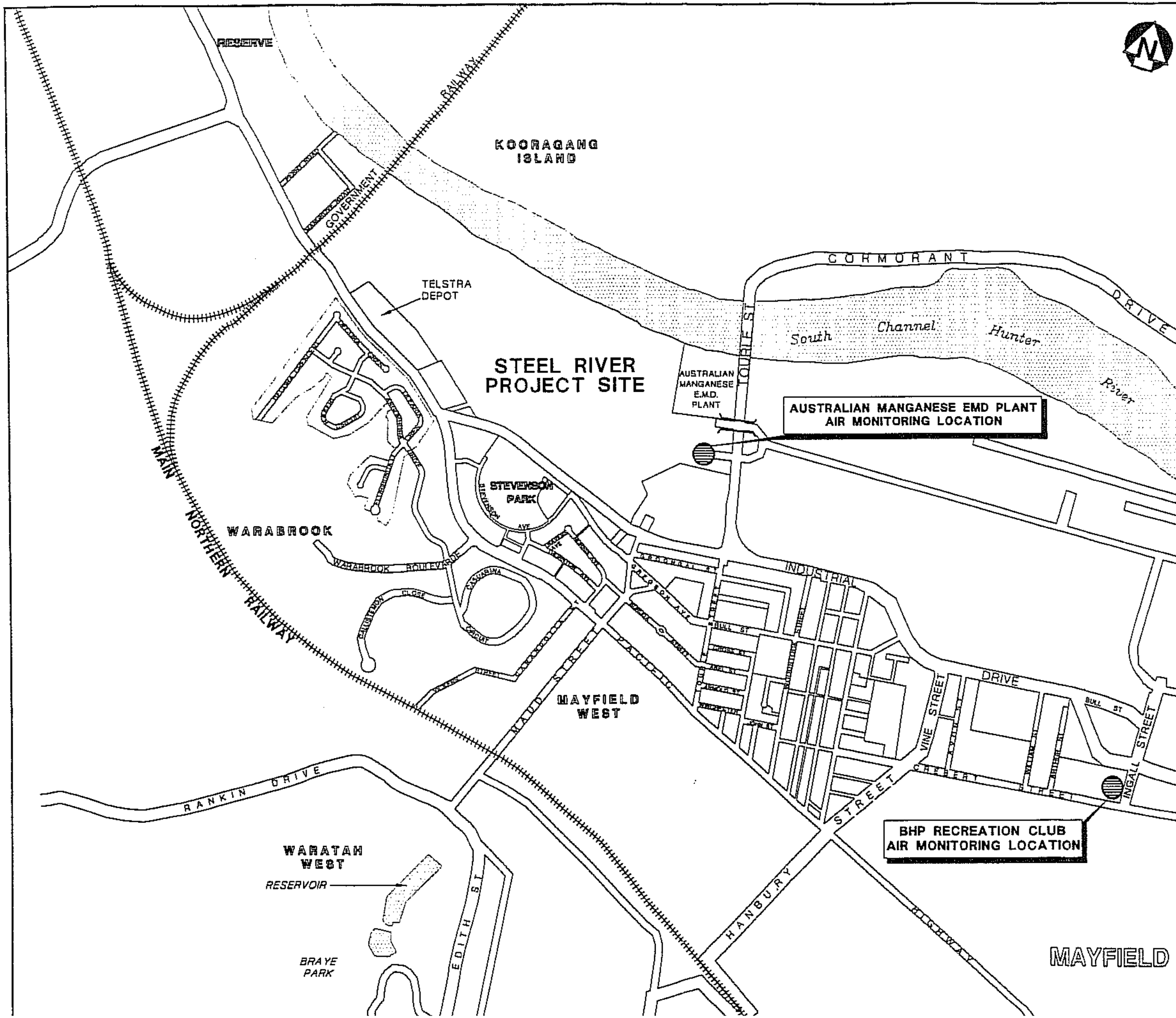
Existing Dust Level (g/m^2/month)	Maximum Acceptable Increase over existing Dust Level (g/m^2/month)	
	Residential Suburban Areas	Commercial and Industrial Areas
2	2	2
3	1	2
4	0	1

Note: If any existing dust level in residential suburban areas is greater than 4 g/m^2/month then no increase in dust fallout is acceptable as a result of any dust emitting works.

Presently the only formally adopted ambient air guidelines in Australia are those adopted by the National Health and Medical Research Council (NHMRC). The standard set by the NHMRC for TSP is 90 $\mu g/m^3$ for an annual arithmetic average. Exposure periods of less than one year are not yet covered by the NHMRC. However, the USEPA recommends a 24-hour maximum criterion of 260 $\mu g/m^3$, not to be exceeded more than once a year. This criterion is noted by the NSW EPA.

9.3 EXISTING AIR QUALITY

The EPA prepares quarterly air quality monitoring reports from an array of air quality monitoring networks around NSW. The network includes a monitoring station near the Steel River Project Site at the BHP Recreation Club, one of the closest monitored areas to the proposed remediation activity (see Figure 9.1).



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DATE: 21/5/97	STATUS: FINAL

NOTES

1. DATA FOR THE BHP RECREATION CLUB WAS OBTAINED FROM NSW EPA QUARTERLY AIR QUALITY MONITORING REPORTS
2. DATA FOR THE EMD PLANT OBTAINED FROM AMCL ENVIRONMENTAL MONITORING DATA REPORTS

CLIENT

BHP STEEL (NEWCASTLE)

PROJECT

STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE

AIR QUALITY MONITORING LOCATIONS

FIGURE

9.1

A3

Woodward-Clyde

Dust deposition rates are monitored at the BHP Recreation Club. The annual average dust deposition rate ranged from 4.8 to 10.6 g/m^2/month for the years 1993 to 1996. The TSP results obtained from the site for the same period indicate that the annual average 24-hour TSP levels ranges from 75 to 107 $\mu g/m^3$. The results are summarised in Table 9.3.

The AMCL plant which processes manganese ore from Groote Eylandt into electrolytic manganese dioxide (EMD), is also required to perform regular atmospheric monitoring for TSP and manganese from their plant.

Air quality monitoring data have been obtained from AMCL (see Figure 9.1) Annual Environmental Reports for the period of August 1994 to August 1996. The reports provide an indication of air quality with respect to TSP at the Project site which lies to the west and south of the EMD plant. Air quality monitoring data obtained from AMCL EMD for TSP indicate that the annual average TSP levels for the period of August 1994 to July 1995 was 83 $\mu g/m^3$, and from August 1995 to July 1996 was 73 $\mu g/m^3$. Manganese annual averages across the year for the same periods were 1.3 $\mu g/m^3$ and 2.3 $\mu g/m^3$ respectively (Table 9.4).

TABLE 9.3 MEAN TOTAL SUSPENDED PARTICULATES AND DUST DEPOSITION RATES AT BHP RECREATIONAL CLUB, CREBERT STREET, MAYFIELD

	1993													
Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Criteria
TSP Monthly Average ($\mu g/m^3$)	113	135	102	80	76	48	57	58	55	78	98	128	86	90
TSP Highest Value ($\mu g/m^3$)	152	213	195	133	134	61	101	98	103	103	188	185	-	-
DDR (g/m^2/month)	9.3	11.1	6.8	6.2	5.4	5.3	5.3	8.3	10.1	14.5	9.1	7.0	8.2	4

INFORMATION SOURCE: NSW EPA Quarterly Air Quality Monitoring Reports

	1994													
Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Criteria
TSP Monthly Average ($\mu g/m^3$)	147	154	84	121	113	60	52	72	88	146	138	114	107	90
TSP Highest Value ($\mu g/m^3$)	288	237	201	202	287	115	105	119	147	224	295	201	-	-
DDR (g/m^2/month)	29.0	16.9	5.2	8.9	5.4	11.6	4.9	5.9	9.8	11.2	9.5	8.5	10.6	4

	1995													
Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Criteria
TSP Monthly Average ($\mu g/m^3$)	105	112	81	101	70	51	56	99	39	85	98	95	83	90
TSP Highest Value ($\mu g/m^3$)	182	209	125	232	160	68	86	159	58	117	185	195	-	-
DDR (g/m^2/month)	10.4	9.7	3.9	7.2	6.5	2.4	2.6	4.7	5.9	*	6.3	9.2	6.3	4

TABLE 9.3 (Cont'd)

INFORMATION SOURCE: BHP Air Quality Monitoring Reports

* - tampering suspected, no result

Parameter	1996 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Criteria
TSP Monthly Average ($\mu g/m^3$)	107	107	105	97	34	34	43	49	74	72	59	123	75	90
TSP Highest Value ($\mu g/m^3$)	247	166	246	165	91	84	79	67	122	80	113	137	-	-
DDR (g/m^2/month)	5.7	5.9	9.7	4.0	2.7	1.5	4.0	3.5	6.0	3.9	5.1	5.7	4.8	4

SOURCE: BHP Air Quality Monitoring Reports

Note: TSP - Total Suspended Particulates

Mn - Manganese

DDR - Dust Deposition Rates

TSP Criteria - NHMRC GOAL

DDR Criteria - NSW EPA amenity based criteria

TABLE 9.4 MEAN TOTAL SUSPENDED PARTICULATES AND MANGANESE PARTICULATES FOR AMCL ANNUAL ENVIRONMENTAL REPORT 8/1994 TO 8/1995 AND LICENCE PERIOD 8/1995-8/1996 AT EMD PLANT

	1994					1995								
Parameter	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Mean	Criteria
TSP Monthly Average (μg/m³)	68	59	81	100	108	112	110	99	102	71	60	51.2	83	90
TSP Highest Value (μg/m³)	109	80	144	136	192	163	176	187	171	112	74	62	-	-
Mn Monthly Average (μg/m³)	2.9	0.7	0.7	0.8	1.6	0.7	0.4	0.6	0.9	1.7	1.9	0.2	1.3	-
Mn Highest Value (μg/m³)	11.1	1.0	2.1	2.3	5.7	1.8	0.7	2.7	2.0	4.0	6.9	0.4	-	-
	1995					1996								
Parameter	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Mean	Criteria
TSP Monthly Average (μg/m³)	76	59	54	90	88	64	68	77	65	83	46	50	73	90
TSP Highest Value (μg/m³)	99	117	88	155	131	122	105	109	85	155	81	67	-	-
Mn Monthly Average (μg/m³)	1.7	2.3	2.7	1.9	3.0	0.8	0.6	1.3	0.5	1.2	2.5	1.4	2.3	-
Mn Highest Value (μg/m³)	3.2	4.1	7.7	5.0	5.0	1.5	1.6	3.3	1.1	4.8	6.4	5.1	-	-

SOURCE: EMD Laboratory Reports
NOTE: Annual means correspond with pollution control licence periods (August - July)
TSP - Total Suspended Particulates
Mn - Manganese
TSP Criteria - NHMRC GOAL

9.4 POTENTIAL SOURCES OF EMISSIONS

During the proposed works, dust would be generated from unloading, spreading, compacting and loading operations at the Project site, and from the loading operations at the Maçquarie Coal Preparation Plant.

9.5 ASSESSMENT OF EMISSIONS

Fugitive dust particulates are presently a major atmospheric pollutant in the Mayfield area. Existing air quality data summarised in Tables 9.3 and 9.4 show that the mean annual TSP level for the year exceeded the NHMRC goal of 90 $\mu g/m^3$ in 1994 at the BHP Recreation Club, and was close to the criteria in all other years.

The mean annual dust deposition rates for the years 1993-1996 at 4.8 to 10.6 g/m^2/month exceeded the NSW EPA amenity based criteria of 4 g/m^2/month.

9.6 IMPACTS OF PROPOSAL

The principal potential air quality impacts of the proposal would be:

- dust associated with trucks importing fill material;
- dumping, stockpiling and movement of fill material; and
- on-site earthworks.

These impacts can be ameliorated by the implementation of safeguards as noted below.

9.7 SAFEGUARDS

Dust control procedures for the site would be contained in a Dust Management Plan which would be prepared prior to the commencement of the proposed works. The Dust Management Plan outlined in Section 20.5 would contain the safeguards listed below. In addition the Monitoring Plan would detail control and monitoring programs for minimising the impact of soil movement, dust and odour and would be prepared by the remediation contractor prior to commencing work, and then implemented.

The safeguard measures which would be used to mitigate dust and suspended particulates occurring during the remediation phase include:

- watering of exposed surfaces and stockpiles where required;
- possible stabilisation of long term stockpiles;
- sealing of the access and haul roads;
- control of vehicle speed along the haul roads;
- control of loading haul vehicles, whereby the load would not exceed the height of the side and tailboards on the vehicles;
- maintenance of the access and haul road's interface with public roads to prevent degradation;
- all loads of soil or contaminated material leaving a work zone would be watered if atmospheric conditions lead to excessive fugitive dust emissions;
- soil adhering to the undercarriage and wheels of trucks would be removed prior to departure from the site;
- there would be no burning of any material on-site;

- water sprays would be used as required across work zones to suppress dust. The water would be applied by water cart across ground surfaces whenever the surface has the potential to generate excessive levels of dust. The water spray equipment would be available for use from initial mobilisation, to a time when remedial works have reached practical completion; and
- the area of contaminated soils exposed at any one time would be minimised wherever possible by a localised staged program.

9.8 CONCLUSION

The proposed works would contribute to minor and localised effects on the air quality in the area of the site where capping is to be undertaken (and at the capping material source) due to loading, unloading and spreading of materials.

These effects would be minimised provided suitable management strategies are implemented.

10.0 NOISE

10.1 NOISE ASSESSMENT PROCEDURES

Assessment guidelines for environmental noise are contained in the *Environmental Noise Control Manual* (NSW EPA, 1994). The Construction Noise Guideline ('the Guideline') contained within the manual presents the most appropriate method of assessment for the proposed remediation activities at the Project site, owing to the nature of the proposed works. The Guideline recommends limits for construction noise based on:

- the construction duration; and
- the existing background noise level.

The recommended noise limits for construction, or in this case the proposed remediation activities, in the Guideline are:

For a construction period of 4 weeks and under:

> *The L_{A10} level measured over a period of not less than 15 minutes when the construction-site is in operation must not exceed the background level by more than 20 dB(A).*

For a construction period greater than 4 weeks and not exceeding 26 weeks:

> *The L_{A10} level measured over a period of not less than 15 minutes when the construction-site is in operation must not exceed the background level by more than 10 dB(A).*

The Guideline also recommends that construction activities be restricted to the following time periods:

- Monday to Friday, 7.00 am to 6.00 pm;
- Saturday, 7.00 am to 1.00 pm if inaudible at residential premises, otherwise: 8.00 am to 1.00 pm; and
- no construction work to take place on Sundays or Public Holidays.

Where construction work is required to be undertaken outside the above hours, the work would not take place prior to notification by the remediation contractor to the relevant regulatory authorities.

The Guideline does not include a recommendation for a construction period exceeding 26 weeks. The following recommended noise limit has been adopted and approved by regulatory authorities on other project sites and is generally regarded as reasonable and adequate for a construction period exceeding 26 weeks:

> *The L_{A10} level measured over a period of not less than 15 minutes when the construction-site is in operation must not exceed the background level by more than 5dB(A).*

The background noise level is commonly taken to be approximated by the noise level exceeded for 90% of a measurement period, abbreviated to $L_{A90.T}$ (Standards Australia, 1989). The L_{A90} noise level measured over consecutive 15 minute measurement periods varies throughout the day and night. It is usual practice for noise impact assessments to adopt as the background level the lower values of measured $L_{A90.\ 15\ minute}$ levels, in order to account for quiet periods when noise from a specific source would be potentially most intrusive. This conforms to the EPA (1994) requirement that the background noise level be measured in the absence of noise from the proposed development, and the absence of noise from extraneous noise sources (i.e., birds, voices, vehicles, aircraft).

The L_{A10} level is the noise level from the proposed development which is exceeded for 10% of a measurement period, specified as 15 minutes in the Guideline. It is commonly taken to be an approximation of the average maximum sound pressure level (Standards Australia, 1989).

10.2 EXISTING NOISE ENVIRONMENT

10.2.1 Measurement Locations

Noise levels were measured at five locations in the vicinity of the Steel River Project Site from the 8 to 14 January, 1997. The locations were selected to include those potentially most affected by noise from the proposed works, for a range of land use zonings specified in the Local Environmental Plan (LEP) for the City of Newcastle, Sheet No. 446. Table 10.1 contains a description of each of the measurement locations. The locations are plotted on Figure 10.1.

TABLE 10.1 - DESCRIPTION OF NOISE MONITORING LOCATIONS

Location No.	Zoning	Predominant Land use[1]	Description
1	5(a) Special Uses (Church)	Residential Area on a busy road and near an industrial area.	Located at the Mayfield West Church, corner of Industrial Drive and Werribi Street, Mayfield.
2	4(a) Industrial	Industrial Area	Industrial estate located west from the subject site, on Ayrshire Crescent. The topography of the area forms a barrier to noise from the site.
3	2(a) Residential	Residential near a busy road and industrial area.	Located within residential dwellings, along Travers Avenue. The dwelling has direct line of sight to the site.
4	2(a) Residential	Residential near a busy road and industrial area.	Located within a residential dwelling, at the corner of Terry Street and Stevenson Avenue. Residential dwelling has direct line of sight across Stevenson Park and Industrial Drive.

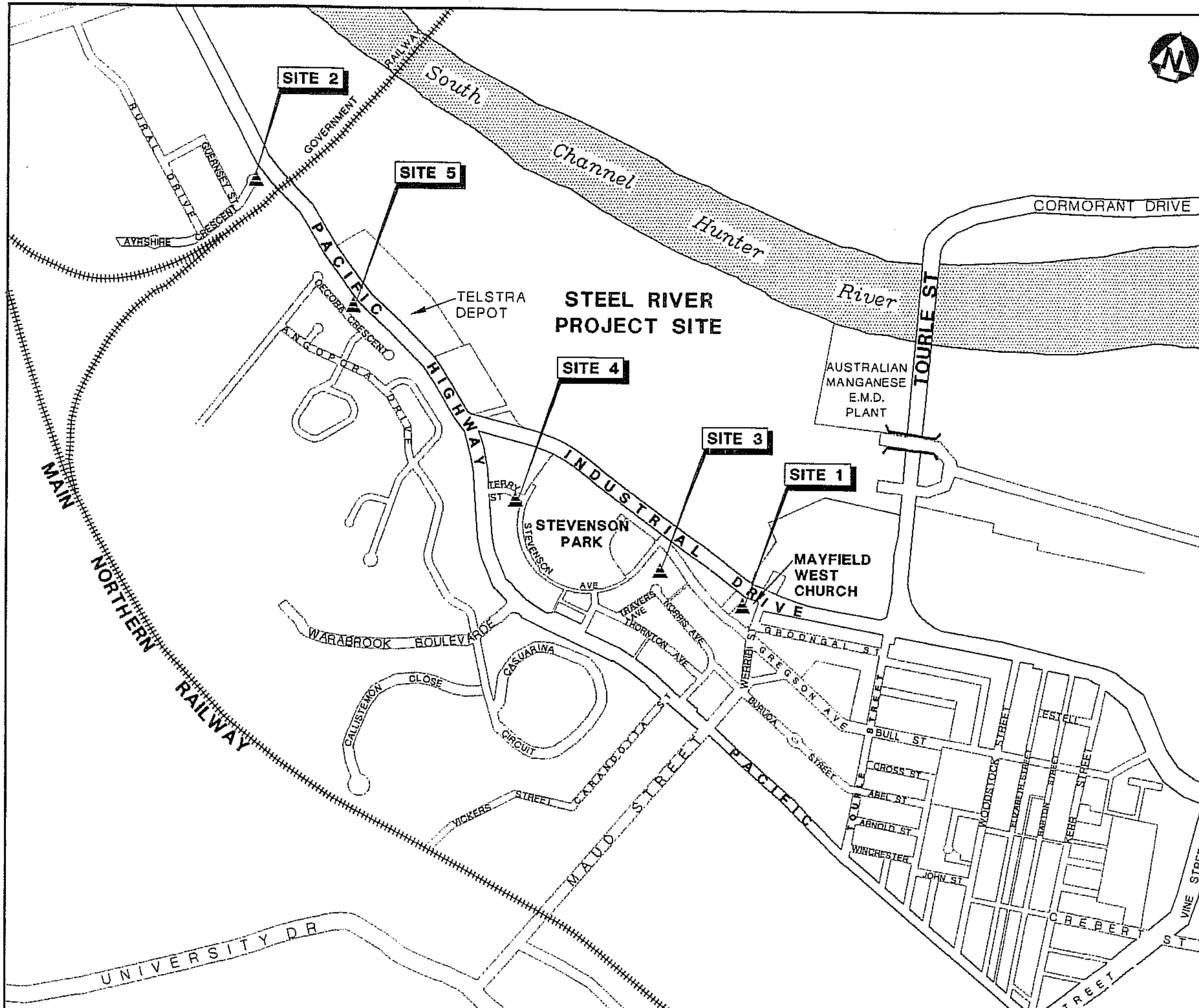
Location No.	Zoning	Predominant Land use[1]	Description
5	2(a) Residential	Residential near a busy road and industrial area.	Located within a residential dwelling along Decora Crescent via Angophora Drive. Topography forms a barrier to noise from the site, with the Telstra Depot directly opposite, and the Pacific Highway adjacent to the backyard of the residential dwelling.

[1] From Chapter 21, EPA (1994)

10.2.2 Measurement Equipment and Methodology

At each location a datalogging sound level meter was left unattended for the measurement period. This was accompanied by attended measurements to verify the unattended data and to make aural assessments of major noise sources in the vicinity. Major noise sources apparent during the attended measurements were road traffic noise from Industrial Drive and the Pacific Highway, and general industrial activities near the site.

Attended measurements were conducted using a Rion NL-14 sound level meter (Type 1). Unattended measurements were conducted using Acoustic Research Laboratory data-logging sound level meters (EL015V20). The sound level meters were field calibrated with a Rion NC-73 calibrator at the commencement of each monitoring period, and confirmed to be within ± 1 dB(A) of calibration at the end of each monitoring period. Table 10.2 lists equipment serial numbers and their most recent dates of laboratory calibration.



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APPROVED: CB
STATUS: FINAL

LEGEND

▲ NOISE MEASUREMENT LOCATIONS

0 200 400 600
metres

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
BACKGROUND NOISE MEASUREMENT LOCATIONS

FIGURE
10.1

A3

Woodward-Clyde

TABLE 10.2 - CALIBRATION RECORDS OF EQUIPMENT USED

Instrument	Serial Number	Date of Last Calibration
Logger - EL015.v20	192444	19 January 1996
Logger - EL015.v20	192424	4 October 1996
Logger - EL015.v20	192445	25 September 1996
Logger - EL015.v20	192446	29 November 1996
Logger - EL015.v20	192443	4 November 1996
Sound Level Meter - NL-14	10262108	December, 1996
Calibrator - NC-73	10334201	2 October, 1996

During both the attended and unattended measurements the sound level meters were programmed to continuously sample sound pressure levels at a rate of between 10 and 12 per second. After every 15 minute interval within the measurement period each meter automatically calculated the statistical distribution of the sound pressure levels, including the L_{A90} and L_{A10}, which were then recorded.

To make allowance for any variation in noise levels likely to occur over different days of a week, the unattended measurement period included a Friday and/or Monday (to allow for differences in noise levels if either of these days were rostered days off), a weekday other than Friday or Monday, and a weekend. This gave an adequate period of unattended measurements from which to calculate background levels. The week of unattended measurements occurred in January, which is a holiday period for many, and therefore should give conservative (lower) background noise levels because of industry, commercial activities, and transportation industry operating at reduced levels, or not at all.

Rainfall and wind speeds greater than 5 metres per second invalidate environmental sound level measurements. Meteorological conditions were noted at the time of each attended measurement survey, and obtained for the duration of the unattended measurement period from the BHP meteorological station, located approximately 2 km east of the Project site.

The meteorological data were used to exclude from the background level determination sound levels measured during rainfall or when winds exceeded 5 metres per second.

10.2.3 Measurement Results

The background noise level, which accounts for quiet periods when noise from the proposed works would be potentially most intrusive, was calculated from the unattended noise measurements, at each location, as follows:

1. The minimum $L_{A90,\ 15\ minute}$ value in each 7.00 am to 6.00 pm period from the 8 to 14 January 1997 was identified.

2. The minimum $L_{A90,\ 15\ minute}$ values were arithmetically averaged to give an "average minimum" background level.

The results are summarised in Table 10.3

TABLE 10.3 - BACKGROUND NOISE LEVELS (7.00 AM TO 6.00 PM - 8 TO 14 JANUARY)

Noise Measurement Location	Zoning	Background Noise Level
1	Special Use "Church"	43[(1)]
2	General Industry	46
3	Residential (Travers Ave)	43
4	Residential (corner of Terry Street)	47
5	Residential (Decora Street)	50

[(1)] Estimated from the results at noise location 3 because of data loss

The EPA (1994) recommend background noise levels in residential and special use areas (i.e. churches) on a busy road or near an industrial or commercial area should not exceed 50 dB(A) daytime (7.00 am to 10.00 pm). The background noise levels in Table 10.3 are less than the EPA recommended limit of 50 dB(A) daytime, indicating that existing background levels are acceptable.

10.3 NOISE PREDICTIONS

The remediation activities are detailed in Chapter 4 and include the importation of fill to the site, the grading of fill material and the excavation and movement of some on-site materials within the site. Figure 4.1 shows the proposed final contours for the site.

Filling, contouring and grading will take place in stages. Approximately 110 000 to 150 000 m^3 of CWR are planned to be placed each year. The estimated maximum number of trucks bringing CWR to the site per day is 96. Allowing 2 tonnes per cubic metre, the required 110 000 to 150 000 m^3/annum of CWR would be brought on to the site in 25 tonne capacity trucks over a period of 5 years.

At this stage the timing of the filling of each area is not confirmed. nor is the scheduling of filling in relation to excavation and replacement of small amounts of contamination. The preliminary assessment of the noise impact has been made by assuming that a bulldozer is used to roughly form CWR which has been unloaded, then a grader follows to smooth the surface, after which a compactor runs over the CWR to achieve adequate compaction. On average one truck per six minutes would bring material to the site. The dozer, grader and compactor would operate continuously on site, but not simultaneously at maximum noise emission levels.

It should be noted that the existing, measured average maximum noise levels ($L_{10,\ 15\ minute}$) for residences along Industrial Drive currently range from 60 to 69 dBA, predominantly from traffic noise.

The average maximum noise level ($L_{10,\ 15\ minutes}$) at residential receivers, attributable to filling activities, can be estimated by assuming that there is at least always one item of plant operating at its maximum noise emission level. Australian Standard AS 2436 (1981) lists estimated sound power level ranges for generic types of industrial equipment. These are summarised in Table 10.4. The potentially most affected residences are 175 metres away across Industrial Drive from the centre of Area 2. For the range of all sound power levels in Table 10.4 (113-124 dBA), the average maximum ($L_{10,\ 15\ minutes}$) sound pressure level at the nearest residences across Industrial Drive. predicted by allowing 6 dB(A) attenuation per doubling of distance and no atmospheric or ground absorption. no topographic barrier effects, and no meteorological effects is 60 to 71 dBA. These levels are +17 to +28 dBA above the measured background of 43 dB(A), and outside the EPA's guidelines limit of background +10 dBA for a project of duration greater than 4 weeks and less than 26 weeks, however, they are the same as existing average maximum ($L_{10,\ 15\ minute}$) levels (60 to 69 dBA), indicating that they would be no more intrusive than existing traffic noise. The impact would be minimised by selecting the quietest available equipment and by planning filling operations appropriately.

Filling would need to be planned to commence at the southern limit of each area and move northwards, downslope to maintain the maximum topographic barrier between operating equipment and residences. It may be necessary to leave initial loads of CWR in a line at the southernmost limit of fill in each area, as unloaded from trucks, to act as a noise barrier while most of the filling and contouring is done, after which the CWR noise barrier would be spread and compacted to complete the area. There is insufficient detail at this stage to realistically further define the requirements. This would be done in the detailed plan for the site.

TABLE 10.4 - REMEDIATION EQUIPMENT

Equipment Item	Typical Sound Power Level Range(dBA) (Standards Australia, 1981)
Bulldozer	113-120
Compactor	117-124
Grader	114-120

10.4 IMPACTS OF PROPOSAL

The principal noise impacts of the proposed remediation works are likely to result from the following activities:

- importation and unloading of fill material;
- placement and grading of fill material; and
- earthworks associated with the excavation and movement of material within the site.

A preliminary assessment of noise levels predicts that they would not conform to the EPA's Guideline without attenuation measures.

10.5 SAFEGUARDS

Remediation works for the Project site would be carried out in a manner which aims to minimise the production of noise emissions from the site. The work would be undertaken such that it conforms with all WorkCover regulations relating to noise emissions. In addition, the remediation works would be performed to ensure compliance with EPA Guidelines for controlling noise emissions from this type of project.

Noise control procedures for the Project site would be those detailed in the Noise Management Plan (refer to Section 20.6) to ensure that the noise impacts from the proposal would be acceptable.

In addition, the Monitoring Plan would be prepared by the remediation contractor and would provide details on the control and monitoring programs to be implemented during the project.

Further safeguards include limiting the hours of operation for the majority of remediation works to between 7.00 am and 6.00 pm from Monday to Friday and 7.00 am to 1.00 pm on Saturdays with no work taking place on Sundays or public holidays. Where remediation works are required to be undertaken outside these hours, the relevant regulatory authorities would be advised of any proposed variations to these hours, prior to any changes being implemented.

10.6 CONCLUSION

Sound levels emitted by the proposed remedial works on the Steel River Project Site are unlikely to comply with level restrictions in the NSW EPA's Construction Noise Guidelines but would not be more intrusive than existing traffic noise. Filling operations would need to be planned to minimise the impact on surrounding land uses.

11.0
FLORA AND FAUNA

11.1 METHODOLOGY

A site walkover was undertaken in January 1997. In addition, a review of 1:25 000 and 1:10 000 orthophoto maps, a review of the flora and fauna assessment of the site conducted by the SWC Wetlands Institute in December 1996 and air photo interpretation were undertaken to identify the vegetation units occurring on-site.

The methodology to assess the nature and extent of flora on-site included:

- Identification of native plant species and vegetation communities on-site and compilation of a plant species list, (Appendix K). Non-native plant species were recorded where dominant.

- A review of existing research including SWC Wetlands Institute (1996), Briggs and Leigh (1996).

- Database searches and discussions with relevant authorities including the NSW National Parks and Wildlife Service (NSW NPWS) to identify any threatened flora species as prescribed in the *Threatened Species Conservation Act 1995* (TSC Act), that are both known to occur in the Newcastle region and that could be expected to occur within the study area.

No fauna surveys were undertaken within the study area. A review of the flora and fauna assessment carried out by SWC Wetlands Institute in December 1996 on the site, and database search results from the Australian Museum, NSW NPWS and the Royal Australasian Ornithologists Union (RAOU) were undertaken. This review was considered adequate to identify fauna (including threatened species) that could be expected to occur on-site, given the habitat that exists.

In summary, the principle components of flora and fauna assessment are as follows:

- describe the plant species, vegetation communities and their state of condition within the study area and surrounding areas;
- identify potential fauna habitats on-site;
- target significant flora and fauna species which are listed as threatened (endangered or vulnerable as prescribed in Briggs and Leigh (1996) and the TSC Act);
- assess the impacts of the proposed development on the flora and fauna habitat identified within the subject site; and
- address the requirements of the TSC Act and Section 5A of the EP&A Act.

11.2 FLORA OF THE SUBJECT SITE

11.2.1 Vegetation Units

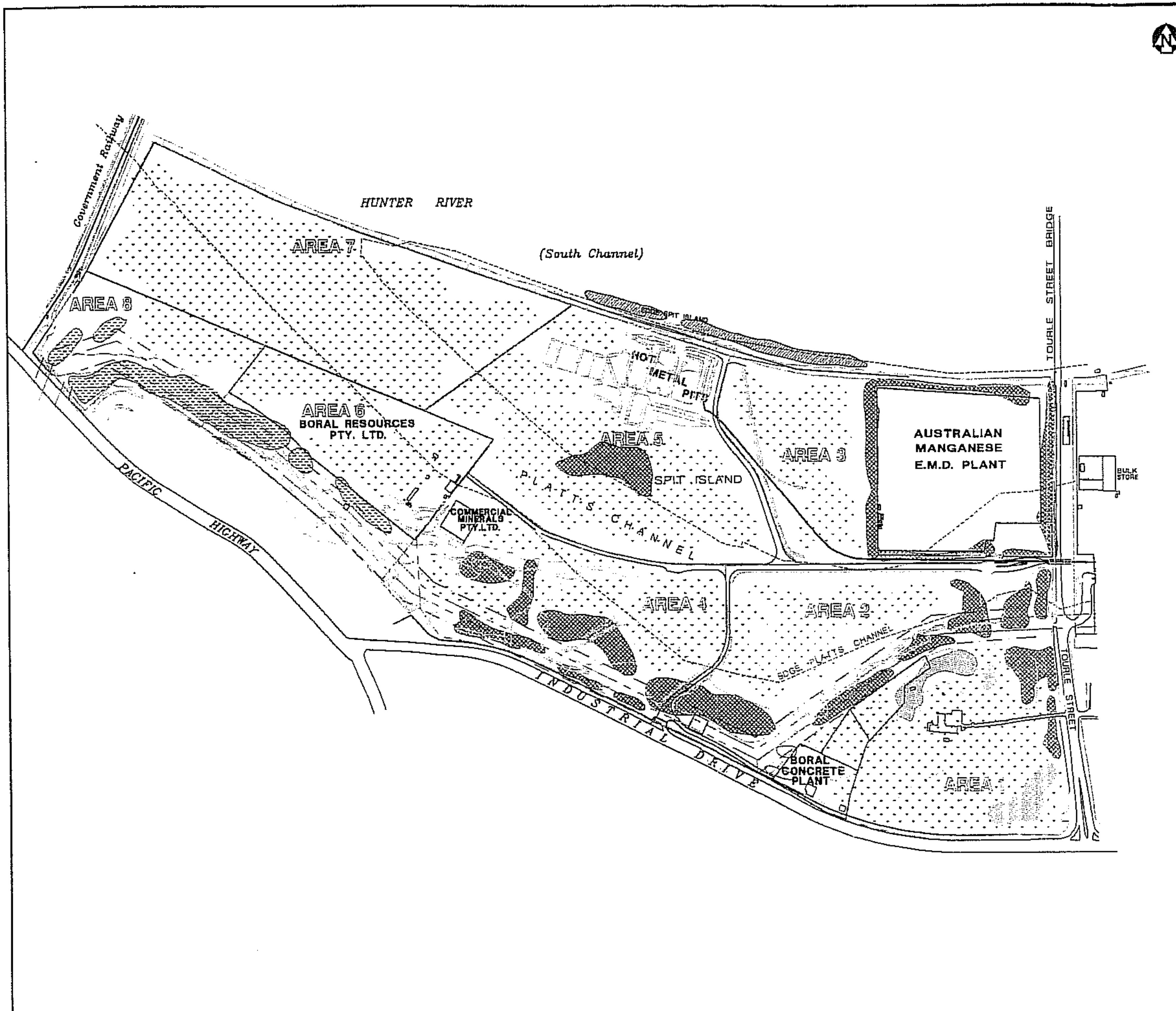
Six vegetation units have been identified on-site and are summarised below. These include:

- remnant stand of *Eucalyptus spp.*;
- narrow fringe of mangrove vegetation (*Avicennia marina*);
- native and non-native grassland;
- native plantings on mounds;
- native plantings along site boundaries and around the EMD plant; and
- non-native plantings (cultural) in the southeastern corner of the site.

The distribution of each of the six units on-site is illustrated in Figure 11.1.

- **Remnant stand of Eucalyptus spp:**

The southwestern corner of the study area contains patches of eucalypts dominated by *Eucalyptus siderophloia* Northern Grey Ironbark, *Eucalyptus punctata* Large-fruited Grey



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LEGEND

- NON-NATIVE CULTURAL PLANTINGS
- SCREEN PLANTINGS
- NATIVE VEGETATION (REMNANT STAND OF EUCALYPTUS sp)
- GREY MANGROVE VEGETATION (Avicennia marina)
- PATCHES OF GRASSLAND
- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- EASEMENT
- FENCE LINE
- ELECTRICITY LINE
- AREA 3 INVESTIGATION AREA

SOURCE: ADAPTED FROM HASSELL PTY LTD

metres
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APPROX SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
VEGETATION DISTRIBUTION

FIGURE
11.1

A3

Woodward-Clyde

Gum and *Eucalyptus maculata* Spotted Gum. These patches of immature trees are considered to be regrowth of the original vegetation occurring on these southern slopes of the site. The shrub understorey is dominated by weeds including *Lantana camara* Pink Lantana, *Chrysanthemoides monilifera* Bitou Bush and *Ligustrum sinense* Small-leaved Privet, although occasional specimens of *Acacia irrorata* Green Wattle, *Acacia longifolia* Sydney Golden Wattle and *Acacia falcata* Sickle-leaf Wattle occur.

- **Narrow band of mangroves (Avicennia marina):**

A narrow band of *Avicennia marina* Grey Mangrove occurs on silt deposited along the Hunter River within the northern boundary of the site. This band of *Avicennia marina* is not considered to be remnant vegetation.

- **Grassland:**

Grassland is the dominant vegetation unit on-site and occurs as low grassland as a result of annual slashing. Most of the grasses identified on-site are non-native and common weeds, although some species of native grass occur, including *Agrostis avenacea* Blown Grass, *Cynodon dactyl* Common Couch, *Danthonia sp.* Wallaby Grass, *Folium sp.* Rye Grass and *Pennisetum alopecuroides* Swamp Foxtail Grass.

- **Native Mound Plantings:**

A number of large mounds on-site have been sown with a range of native plant species approximately two years ago, although few of these native plant species are indigenous to the Mayfield area (SWC Wetlands Institute, 1996). Dominant species identified in this dense unit include *Acacia saligna* Golden-wreath Wattle, a number of Eucalyptus sp. as saplings (species unconfirmed), *Melaleuca quinquenervia* Broad-leafed Paperbark, *Banksia integrifolia* Coastal Banksia, *Acacia filicifolia* Fern-leaf Wattle and *Callistemon viminalis* Weeping Bottlebrush.

- **Native Boundary Plantings:**

A range of native plant species (few of which are indigenous to the area) and a small number of introduced species occur as screen plantings along Industrial Drive and Tourle Street. Common species identified in this unit include *Melaleuca quinquenervia* Broad-leaf Paperbark, *Melaleuca armillaris* Coast Paperbark, *Callistemon viminalis* Weeping Bottlebrush and the widely introduced species *Lophostemon confertus* Brush Box. The widely cultivated weed *Nerium oleander* Oleander commonly occurs in these plantings.

- **Non-Native (Cultural) Plantings:**

Isolated patches of predominantly non-native (introduced) trees and shrubs occur in the southeastern corner of the site and to the immediate north of the Former BHP Health and Fitness Centre. Commonly occurring species in this unit include *Erythrina* x *sykesii* Coral Tree, *Salix babylonica* Weeping Willow, *Olea europea* subsp. *africana* African Olive, *Phyllostchys aurea* Fishpole Bamboo and *Araucaria cunninghamii* Hoop Pine. Weed proliferation (*Lantana camara* Pink Lantana and *Ligustrum sinense* Small-leaved Privet) is evident throughout most of these plantings.

11.2.2 Regional Vegetation

Two large wetlands, Kooragang Nature Reserve and Hexham Swamp Nature Reserve occur within the vicinity of the subject site. General and vegetative descriptions of the two nature reserves are described by NSW NPWS (1996) and are summarised below.

Kooragang Nature Reserve:

Kooragang Nature Reserve, an estuarine wetland, lies adjacent to the subject site to the north. The reserve is approximately 3 000 hectares in area and is the largest single estuarine reserve in NSW (NSW NPWS, 1996). Kooragang Nature Reserve is also mapped as protected wetlands (No's 817 - 823 and 843) under the provisions of State

Environmental Planning Policy (SEPP) No. 14 - Coastal Wetlands. NSW NPWS, 1996 describes the nature reserve as including:

- the bed of Fullerton Cove;
- Kooragang Island with the exception of the western end and industrial areas of the island;
- an area of mangroves on the south bank of the south arm of the river;
- most fringing mangroves and islands; and
- some former farmlands which had been developed on reclaimed lands north of the North Arm of the Hunter River near Tomago.

NSW NPWS (1996) group the fifteen vegetation types mapped on Kooragang Island into the following broad major communities from saline to terrestrial:

- **Mangrove Forests:**

This community is dominated by *Avicennia marina* Grey Mangrove with some *Aegiceras corniculatum* River Mangrove.

- **Saltmarsh:**

This community is dominated by *Sarcocornia* sp. Samphire and *Sporobolus virginicus* Saltwater Couch.

- **Saltwater and Freshwater Pastures:**

This community predominantly comprises pasture grasses including *Cynodon dactylon* Common Couch, sedges and introduced weeds. The estuarine herb, *Zannechellia palustris*, has been recorded adjacent to Kooragang Rail Bridge and is known only from the Newcastle/Lake Macquarie area and along Ironbark Creek.

- **Swamp Forests:**

The swamp forest community consists of limited numbers of *Casuarina glauca* Swamp Oak and *Melaleuca* spp. Paperbarks, which form an intermediate habitat between mangroves and forests in brackish water.

- **Rainforest:**

This community exists in remnants on Kooragang Island. Isolated individual trees including *Ficus* spp. Figs and *Livistona australis* Cabbage Tree Palm remain. The Threatened rainforest vine, *Cynanchum elegans* occurs adjacent to the western boundary of the reserve and is only known from approximately 40 other sites in NSW.

NSW NPWS (1996) also identify two minor vegetation types of conservation interest within the reserve:

- A small area of seagrass, *Ruppia spiralis* was identified in a large tidal pool adjacent to the railway line south of the reserve; and

- *Scirpus* spp., sedges and other aquatic species were identified within brackish swamps and standing open water.

Hexham Swamp Nature Reserve:

Hexham Swamp Nature Reserve, comprising both freshwater and estuarine elements, is some 900 hectares in area and lies approximately 4 km to the west of the subject site. The nature reserve is part of the entire Hexham Swamp which has been recognised as the largest freshwater swamp on the north coast of NSW. The total area of the swamp at 2 500 hectares comprises 45 percent of all the remaining freshwater wetland habitat in the Hunter Valley. The swamp also contains estuarine habitat in its north-eastern corner adjacent to the Hunter River, which forms an ecological link with the western end of Kooragang Nature Reserve. The freshwater swamps of the nature reserve are contiguous with important freshwater wetlands on freehold lands to the west near Minmi, the Shortland Wetlands Centre to the east and in the Newcastle Council's Wetlands Reserve below Newcastle University.

The majority of the swamp including all of the nature reserve is classified as a protected wetland (No. 840) under the provisions contained in SEPP No. 14- Coastal Wetlands.

Hexham Swamp is grouped into four vegetation types, identified by Briggs (1978):

- **Saltmarsh and Mangroves:**

This community occurs in the south-east zone of the swamp and is dominated by *Avicennia marina*, *Sarcocornia quinqueflora* Red Samphire, *Sporobolus virginicus* and *Paspalum vaginatum* Paspalum. On higher ground there occurred isolated stands of *Casuarina glauca* and *Melaleuca quinquenervia*.

- **Reeds:**

This community occurs in the central portion of the swamp and is dominated by *Fimbristylis ferruginea* with small areas containing *Phragmites australis* Common Reed.

- **Freshwater Meadows and Seasonal Freshwater Swamps:**

This community occurs in the upper reaches of the swamp to the south-west dominated by *Typha australis* Cumbungi and many other freshwater species such as *Eichhornia crassipes* Water Hyacinth.

- **Freshwater Grassy Swamps:**

This community occurs in the north-west section of the swamp and consists of submerged aquatic plants, reeds, paspalum, *Eleocharis* spp. and other agricultural fodder.

NSW NPWS (1996) report that more recent studies of the swamp indicate that the swamp is now dominated by a single community, the reed *Phragmites australis*, with a large reduction in the extent of saltmarsh, mangrove, Couch and *Fibrystilis* communities.

11.3 FAUNA

11.3.1 Habitat Units

The methodology for the fauna assessment described earlier in Section 11.1, identified the following habitat types on-site:

- Native eucalypt stand.
- Mangroves.
- Native Boundary Plantings.
- Grassland.
- Mound Plantings.
- Non-native (Cultural) Plantings.

These are given a conservation rating based on the following habitat and management parameters.

1. high conservation value
2. medium conservation value
3. low conservation value.

Criteria for *high conservation values*

- Good vegetative structure.
- Low degradation due to exotic species occurrence.
- Observed or good potential habitat for a diversity of fauna including Endangered fauna.
- Good diversity of habitat types.

- Above 4 hectares in size.
- Is linked or provides links to other areas of significant habitat.
- Functioning as an important corridor for fauna.
- Contains vegetation communities or associations of Regional, State or National significance.

Criteria for medium conservation value

- Degradation due to exotic species occurrence.
- Unlikely to provide significant habitat for Endangered fauna.
- Low diversity of habitat types.
- Up to 4 hectares in size.
- Is linked or provides links to other areas of habitat.
- Functioning as a corridor for fauna.
- Good potential for rehabilitation.
- Contains vegetation communities or associations of Local and in some cases Regional significance.

Criteria for low conservation value

- Poor vegetative structure.
- Highly degraded due to exotic species and grazing and/or logging.
- Very highly unlikely to provide habitat for Endangered fauna.
- Poor or no habitat diversity.
- Less than 1 hectare in size.
- Not functioning as a viable corridor or has low value as a fauna corridor.
- Poor rehabilitation potential.
- Vegetation communities or associations not considered of Local, Regional or National significance.

Descriptions of the six habitat types are summarised below.

- **Native Eucalypt Stand:**

This patch of vegetation occurring in the southwestern corner of the site would provide a limited annual food source for insectivorous birds and a seasonal food source for nectivorous birds. The moderate to dense shrub understorey would provide a habitat for introduced mammals, some reptiles and cryptic, insectivorous birds.

No roosting or nesting hollows were observed during the site walkover, nor would the existing stand of eucalypts provide such a habitat at this time due to their immaturity.

The conservation rating for this stand of vegetation is low.

- **Mangroves:**

The band of *Avicennia marina* occurring on the southern arm of the Hunter River would be expected to provide habitat for a number of insectivorous birds, including the Mangrove Warbler *Gerygone laevigaster*.

The conservation rating for this stand of vegetation is medium.

- **Native Boundary Plantings:**

The sparse understorey and narrow band of vegetation associated with these plantings would be expected to provide only limited, transient habitat value to some insectivorous and nectivorous birds.

The conservation rating for this stand of vegetation is low.

- **Grassland:**

The grassland on-site would be expected to have limited habitat value due to the regular cutting that is carried out to prevent grassland growth and reduce fire hazard.
The conservation rating for this stand of vegetation is low.

- **Mound Plantings:**

These dense plantings would be expected to provide habitat for small, cryptic birds and reptiles. Additionally, these plantings would provide a seasonal food source for nectivorous birds once the plantings reach maturity.

The conservation rating for this stand of vegetation is low.

- **Non-native (Cultural) Plantings:**

The Coral trees found in these plantings would be expected to provide a seasonal food source for nectivorous birds (predominantly Honeyeaters including the Noisy Friarbird *Philemon corniculatus*) whilst the moderate to dense understorey would be expected to provide habitat for smaller, cryptic birds.

The conservation rating for this stand of vegetation is low.

11.3.2 Fauna Likely to Utilise the Site

Tables 11.1 through to 11.4, presented below, list the species of fauna that could be expected to utilise the identified vegetation units within the study area. This list was derived from a desktop review by SWC Wetlands Institute (1996) and NSW NPWS (1996) describing previous fauna studies of the subject site and surrounding Kooragang and Hexham Swamp Nature Reserves. The fauna listings are also based on search results provided to Woodward-Clyde by the NSW NPWS, RAOU and the Australian Museum as well as a habitat assessment conducted during the site walkover.

TABLE 11.1 - LIST OF AVIFAUNA

SPECIES	COMMON NAME
Coturnix australis	Brown Quail
Elanus notatus	Black-shouldered Kite
Falco cenchroides	Australian Kestrel
Charadrius melanops	Black-fronted Plover
Vanellus miles	Masked Lapwing
Columba livia	Feral Pigeon
Ocyphaps lophotes	Crested Pigeon
Streptopelia chinensis	Spotted Turtle-dove
Cacatua galerita	Sulphur-crested Cockatoo
Cacatua roseicapilla	Galah
Cacatua sanguinea	Little Corella
Cacatua tenuirostris	Long-billed Corella
Platycercus eximius	Eastern Rosella
Psephotus haematonotus	Red-rumped Parrot
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo
Chrysococcyx lucidus	Shining Bronze-Cuckoo
Cuculus pallidus	Pallid Cuckoo
Cuculus pyrrhophanus	Fan-tailed Cuckoo
Ninox novaehollandiae	Southern Boobook
Tyto alba	Barn Owl
Dacelo novaeguineae	Laughing Kookaburra
Todiramphus sanctus	Sacred Kingfisher
Malurus cyaneus	Superb Fairy-wren
Malurus lamberti	Variegated Fairy-wren
Stipiturus malachurus	Southern Emu-wren
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
Acanthiza lineata	Striated Thornbill
Acanthiza nana	Yellow Thornbill
Acanthiza pusilla	Brown Thornbill
Acanthiza reguloides	Buff-rumped Thornbill
Gerygone laevigaster	Mangrove Gerygone
Sericornis frontalis	White-browed Scrubwren
Acanthorhynchus tenuirostris	Eastern Spinebill
Anthochaera chyrsoptera	Little Wattlebird
Gymnorhina tibicen	Australian Magpie
Anthochaera carunculata	Red Wattlebird
Lichenostomus chrysops	Yellow-faced Honeyeater
Lichmera indistincta	Brown Honeyeater

SPECIES	COMMON NAME
Manorina melanocephala	Noisy Miner
Myzomela sanguinolenta	Scarlet Honeyeater
Philemon corniculatus	Noisy Friarbird
Phylidonyris nigra	White-cheeked Honeyeater
Grallina cyanoleuca	Magpie-lark
Rhipidura fuliginosa	Grey Fantail
Rhipidura leucophrys	Willie Wagtail
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Artamus leucorhynchus	White-breasted Woodswallow
Cracticus nigrogularis	Pied Butcherbird
Cracticus torguatus	Grey Butcherbird
Gymnorhina tibicen	Australian Magpie
Corvus coronoides	Australian Raven
Anthus novaeseelandiae	Richard's Pipit
Lonchura castaneothorax	Chestnut-breasted Mannikin
Emblema temporalis	Red-browed Finch
Passer domesticus	House Sparrow
Hirundo neoxena	Welcome Swallow
Cisticola exilis	Golden-headed Cisticola
Zosterops lateralis	Silvereye
Acridotheres tristis	Common Myna
Sturnus vulgaris	Common Starling

Source: SWC Wetlands Institute (1996) and NSW NPWS (1996)

TABLE 11.2 - LIST OF MAMMALS

SPECIES	COMMON NAME
Pteropus poliocephalus	Grey-headed Flying Fox
Pteropus scapulatus	Little Red Flying Fox
*Miniopterus schreibersii**	Common Bent-wing Bat
Chalinolobus gouldii	Gould's Wattled Bat
Chalinolobus morio	Chocolate Wattled Bat
Hydromys chrysogaster	Water-rat
*Rattus rattus***	Black Rat
*Rattus norvegicus***	Brown Rat
*Mus domesticus***	House Mouse

SPECIES	COMMON NAME
*Lepus capenis***	Brown Hare
*Vulpes vulpes***	Red Fox
*Felis catus***	Domestic Cat

* = Threatened

** = Introduced

For simplicity, author citations for scientific names are not given, these follow: Strachan (1995)

TABLE 11.3 - LIST OF AMPHIBIANS

SPECIES	COMMON NAME
Litoria tyleri	Tyler's Tree Frog
Litoria dentata	Bleating Tree Frog
Limnodynastes tasmaniensis	Spotted Grass Frog
Limnodynastes peronii	Brown Striped Frog

For simplicity, author citations for scientific names are not given, these follow: Cogger (1992)

TABLE 11.4 - LIST OF REPTILES

SPECIES	COMMON NAME
Cryptoblepharus virgatus	Fence Skink
Ctenotus robustus	Striped Skink
Eulamprus quoyii	Eastern Water Skink
Lampropholis delicata	Garden Skink
Saiphos equalis	Three-toed Skink
Saproscinus mustelinus	Weasel Skink
Tiliqua scincoides	Eastern Blue-Tongued Lizard
Hemiaspis signata	Marsh Snake
Pseudechis porphyriacus	Red-bellied Black Snake

For simplicity, author citations for scientific names are not given, these follow: Cogger (1992)

11.4 CONSERVATION SIGNIFICANCE

11.4.1 Flora

Table 11.5, presented below, lists the three Rare Or Threatened Australian Plants (ROTAP) of conservation significance previously recorded in the Newcastle region and known to occur in the vicinity of the subject site. One of these plant species, *Tetratheca juncea*, could be expected to occur on the subject site given the habitat that exists.

Population(s) of *Tetratheca juncea* could be supported within the moderate to dense shrub understorey on the slopes in the south-western section of the site containing the patches of remnant *Eucalypt* spp. This species is classified as Vulnerable by Briggs and Leigh (1996) and is known to be conserved in at least one protected area in New South Wales. *Tetratheca juncea* is also classified as a Threatened species in Schedule 2 of the TSC Act and as a result, is assessed under provisions contained in Section 5A of the EP&A Act (to determine the impact on the species from the proposed development) in Section 11.6.3 of this EIS. This species was not recorded on-site during Woodward-Clyde's flora survey nor from the flora and fauna assessment carried out by the SWC Wetlands Institute in December 1996.

TABLE 11.5 - LIST OF RARE OR THREATENED AUSTRALIAN PLANTS

SPECIES (FAMILY)	HABITAT/LOCALITY	SIGNIFICANCE
Cynanchum elegans	Adjacent to Kooragang Nature Reserve	3ECi
Zannichellia palustris	Ironbark Creek, Kooragang Nature Reserve	3R+
Tetratheca juncea	Glenrock State Recreation Area	3VCa

Conservation Significance based on Briggs and Leigh (1996)

Conservation Code

The Distribution Category **(can be 1, 2 or 3)**

1 Known by one collection only

2 Geographic range in Australia less than 100 km

3 Geographic range in Australia greater than 100 km

The Conservation Status (can be X, E, V, R or K)

X **Presumed Extinct:** taxon not collected or otherwise verified over the past 50 years despite thorough searching in all known and likely habitats, or of which all known wild populations have been destroyed more recently.

E **Endangered:** taxon in serious risk of disappearing from the wild within 10-20 years if present land use and other threats continue to operate. This category includes taxa with populations possibly too small (usually less than 100 individuals) to ensure survival even if present in proclaimed reserves.

V **Vulnerable:** taxon not presently Endangered, but at risk over a longer period (20-50 years) of disappearing from the wild through continued depletion, or which occurs on land whose future use is likely to change and threaten its survival.

R **Rare:** taxon which is rare in Australia (and hence usually in the world) but which currently does not have any identifiable threat. Such species may be represented by a relatively large population in a very restricted area or by smaller populations spread over a wide range or some intermediate combination of distribution pattern.

K **Poorly Known:** taxon that is suspected, but not definitely known, to belong to one of the above categories. At present, accurate field distribution information is inadequate.

C **Reserved:** indicates taxon has at least one population within a national park, other proclaimed conservation reserve or in any area otherwise dedicated for the protection of flora. The taxon may, or may not be, considered adequately conserved within the reserve(s), as reflected by the conservation status assigned to it. Where applicable, the 'C' symbol immediately follows the conservation status symbol in the written code e.g. 2RC.

Size-class of all reserved populations (options are a, i or -)

a 1000 plants or more are known to occur within a conservation reserve(s),

i less than 1000 plants are known to occur within a conservation reserve(s),

\- reserved population size is not accurately known.

t **Total known population reserved;**

\+ **Overseas occurrence** (included if the taxon has a natural occurrence overseas).

11.4.2 Fauna

Fauna species of particular conservation importance in New South Wales are listed as threatened fauna (vulnerable or endangered) in Schedules 1 and 2 contained in the TSC Act. Fauna species of particular conservation importance in Australia are listed in Schedule 1 of the Commonwealth Endangered Species Protection Act 1992. Additionally, the Japan/China and Australia Migratory Bird Agreements (JAMBA and CAMBA) provide protection for a number of conservationally significant species of migratory waders, that regularly summer in the Hunter estuary (feeding and roosting sites have been recorded at Kooragang Nature Reserve, Hexham Swamp and Fullerton Cove).

Table 11.6, presented below, lists the eighteen Threatened (as prescribed in the TSC Act) fauna species that have been previously recorded in the Newcastle region and are known to occur in the vicinity of the subject site.

TABLE 11.6 - LIST OF THREATENED FAUNA SPECIES

SPECIES	SIGNIFICANCE
Terek Sandpiper	Vulnerable, JAMBA, CAMBA
Broad-billed Sandpiper	Vulnerable, JAMBA, CAMBA
Black-tailed Godwit	Vulnerable, JAMBA, CAMBA
Pied Oystercatcher	Vulnerable
Great Knot	Vulnerable, JAMBA, CAMBA
Painted Snipe	Vulnerable
Little Tern	Endangered, JAMBA, CAMBA
Australasian Bittern	Vulnerable
Black-necked Stork	Vulnerable
Large Sand Plover	Vulnerable, JAMBA, CAMBA
Mongolian Plover	Vulnerable, JAMBA, CAMBA
Wompoo Fruit-Dove	Vulnerable
Rose-crowned Fruit Dove*	Vulnerable
Osprey	Vulnerable
Freckled Duck	Vulnerable
Masked Booby	Vulnerable
Common Bent-wing Bat*	Vulnerable
Green and Golden Bell Frog*	Endangered

* as per the TSC Act
Japan and Australia Migratory Bird Agreement (JAMBA)
China and Australia Migratory Bird Agreement (CAMBA)

Three of the eighteen species, the Green and Golden Bell Frog, the Rose-crowned Fruit Dove and the Common Bent-wing Bat, could possibly occur on the subject site. The Green and Golden Bell Frog would be expected to have limited habitat on-site, that being the plantings around the Former BHP Health and Fitness Centre, the small drain in the south-eastern corner of the site, the small drainage basins and the drainage line to the west of the EMD Plant. No other creeks or wetlands occur on the site. The species was not heard calling during the site walkover nor was it identified during the assessment carried out by the SWC Wetlands Institute in December 1996. The species has been previously recorded (repeatedly) in the vicinity of the subject site on Kooragang Island (pers. comm., NSW NPWS Newcastle). This species is classified as Endangered in Schedule 1 of the TSC Act and is assessed under provisions contained under Section 5A of the EP&A Act in Section 11.6.3 of this EIS.

The Rose-crowned Fruit Dove generally lives in rainforests but occasionally resides in eucalypt woodlands and paperbark forests and stands. This fruit-eating species could be expected to gain a seasonal food source from the patches of eucalypts on-site. This species is classified as Vulnerable in Schedule 2 of the TSC Act and is assessed under provisions contained under Section 5A of the EP&A Act in Section 11.6.3 of this EIS.

The patch of remnant bushland in the southwestern section of the site would provide limited foraging habitat for the Common Bent-wing Bat. The absence of tree hollows in the southwestern section of the site and tree cover in the residual part of the site would strongly limit the use of the site by this insectivorous species. This species is classified as Vulnerable in Schedule 2 of the TSC Act and is assessed under provisions contained under Section 5A of the EP&A Act in Section 11.6.3 of this EIS.

11.5 IMPACTS OF PROPOSAL

11.5.1 Impact on Flora

The proposed remediation works would result in the removal of two areas of grassland and a small area of boundary plantings on the site. The remnant stand of native trees and shrubs in the southwestern section of the site as well as the mound, boundary plantings (with the exception of some Tourle Street plantings) and cultural plantings would not be significantly impacted upon by the proposed works.

The removal of grassland areas is not considered to be significant given the large number of introduced pasture grasses and the absence of ROTAP or Threatened plants on-site. The native pasture grasses that would be removed as a result of the proposed works are common and widespread locally, regionally and statewide.

11.5.2 Impact on Fauna

The impact of the proposed works on the life cycle and survival of the fauna species which could be expected to utilise the habitat within the site is considered negligible. The impact on species of mammal, avifauna, reptiles and amphibians is summarised below.

A small number of ground foraging avifauna including the Masked Lapwing (Plover), Red-rumped Parrot, Galah, Crested Pigeon and Australian Magpie would lose some foraging and roosting habitat as a result of the proposed works. The impact on these species is considered negligible given the small areas of grassland affected on-site and the relatively large and more suitable grassland habitat available within Hexham Swamp and Kooragang Island. Although the open grassland on-site would provide suitable nesting habitat for the Masked Lapwing (Plover), regular cutting of the grassland would significantly reduce the number of available nesting areas on-site.

The dense, non-native (cultural) plantings and the remnant patch of *Eucalypt spp.* provide the only reptile habitat on-site. These habitat areas are not expected to be impacted upon from the proposed works. Similarly, the proposed works are not expected to impact upon habitat areas of amphibians on-site.

Past disturbances to the site have greatly reduced habitat for native terrestrial mammals. The patches of remnant tree cover in the southwestern section of the site could be expected to provide limited foraging habitat value for some species of bat. These patches of bushland, however, are not expected to provide suitable roosting habitat for species of bat, given the absence of tree hollows. The proposed works are not expected to impact upon habitat areas of terrestrial mammals on-site.

11.6 THREATENED SPECIES CONSERVATION ACT

11.6.1 Legislative Requirements

Determination of significant effects on threatened species, populations or ecological communities, or their habitats is required under the TSC Act. This Act was passed by Parliament on 18 December 1995, commenced on 1 January 1996 and effectively replaces the legislative scheme introduced by the *Endangered Fauna (Interim Protection) Act, 1991* (EF Act).

The TSC Act makes substantial amendments to the *National Parks and Wildlife Act* (NPW Act) and the EP&A Act. It also makes a few, largely consequential amendments to a range of other legislation. Section 5A of the EP&A Act is of particular relevance here (Department of Urban Affairs and Planning [DUAP], 1995).

This section sets out the factors to be considered in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats and hence, if a Species Impact Statement is required. Those factors within Section 5A are as follows:

(a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at the risk of extinction;*

(b) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised;*

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed;*

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;*

(e) *Whether critical habitat would be affected;*

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region;*

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process;*

(h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

In addition, Section 37, Part 3, Division 1 of the TSC Act, provides for the identification and declaration of critical habitat, which are yet to be identified by the TSC Act, and consequently point "*(e)*" of Section 5A, cannot be addressed.

Point "*(g)*" of 5A addresses the impacts of recognised threatening processes (Schedule 3 of TSC Act), which are yet to be identified by the TSC Act and hence, cannot be discussed further at this time.

Threatened flora and fauna species previously recorded and known to occur in the Newcastle region are listed in Tables 11.5 and 11.6.

11.6.2 Threatened Flora Species

The species *(Tetratheca juncea)* was not recorded on-site during the site walkover nor from the flora and fauna assessment conducted by the SWC Wetlands Institute in December 1996. The species could be supported within the dense understorey of the remnant stand of *Eucalypt spp.* in the southwestern section of the site. Although the site walkover occurred during the species' flowering period (in the absence of the species' conspicuous flower, the plant is very inconspicuous and is often overlooked during surveys), any deflowered species may have been overlooked. Nevertheless, population(s) of the species on-site would not be expected to be viable and self-sustaining in the long-term. The proposed works are also not expected to impact upon potential habitat areas on-site for this species.

11.6.3 Threatened Fauna Species

The Common Bent-wing Bat, Green and Golden Bell Frog and Rose-crowned Fruit Dove could possibly occur within the subject site.

The Section 5A assessment for the identified Threatened species is provided below.

(a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.*

In order to assess impacts on the life cycle it is necessary to address the primary components of the ecology of the three identified fauna species. These components are breeding, foraging, roosting/nesting and migration/movement.

Breeding:

Green and Golden Bell Frog:

The dense plantings bordering the BHP Health Fitness Centre, the small drain planted with willows in the southeastern section of the site, the two small drainage basins and the drainage line to the west of the EMD Plant are considered possible breeding sites for the species, albeit rather poor. The proposed works are not expected to impact upon these potential habitat areas. Consequently, the proposed works would not represent a loss of potential breeding habitat for the species.

Common Bent-wing Bat:

This species of bat roosts and breeds predominantly in caves, although it can be found in buildings. The proposed works are not expected to impact upon this potential breeding habitat for the species.

Rose-crowned Fruit Dove:

This species typically breeds in rainforests only. There are no recordings of the species breeding in the Newcastle region nor in New South Wales (Blakers, Davies and Reilly, 1984). The subject site is not considered potential breeding habitat for this species.

Foraging:

Green and Golden Bell Frog:

The proposed works may result in a loss of potential foraging habitat for the species, although the foraging habitat on-site is considered very poor and is unlikely to sustain a viable population of this species.

Common Bent-wing Bat:

This species of bat typically forages above the tree canopy for insects. The remnant stand of *Eucalypt* spp. in the southwestern section of the site could provide foraging habitat for this species, albeit limited. The proposed works are not expected to impact upon the potential foraging habitat of this species.

Rose-crowned Fruit Dove:

This species of avifauna typically forages in tall trees for fruit. The remnant stand of *Eucalypt* spp. in the southwestern section of the site could provide foraging habitat for this species, albeit limited. The proposed works are not expected to impact upon the potential foraging habitat of this species.

Roosting:

Green and Golden Bell Frog:

The proposed works are not expected to result in the removal of the potential habitat areas on-site for this species and are thus not expected to result in a loss of potential shelter for the species.

Common Bent-wing Bat:

The proposed works are not expected to impact upon potential roosting habitat of this species.

Rose-crowned Fruit Dove:

The patches of remnant *Eucalypt spp.* on-site could provide potential nesting sites for this species. The proposed works are not expected to impact upon the potential nesting habitat of this species.

Migration/Movements:

Faunal corridors consist of areas between vegetation communities and (in the case of amphibians) ponds/pools which allow the species to move with confidence and safety. The corridor can be either a well vegetated area (containing appropriate water bodies in the case of amphibians) which provides a continuous link with larger habitat areas, or small pockets of vegetation and ground cover closely spaced which fauna can utilise in its distribution or dispersal range.

The site is situated on the south bank of the Hunter River's South Arm. The main habitat connection is considered to be to the west and north, linking the site with the Hunter River and Kooragang Nature Reserve. Unconnected yet proximate significant habitat areas to the south-west and west of the site include the Shortland Wetlands Centre and Hexham Swamp. It is considered unlikely that these connecting and non-connecting areas of presently utilised significant habitat would be isolated as a result of the proposed works. None of the migratory shorebirds that utilise these significant habitats are expected to utilise the habitat on-site, even on a limited, transient basis.

Consequently, based on a review of the habitat requirements of the identified flora and fauna species considered as a possible occurrence within the study area and the nature of the proposed works, it is considered unlikely that the proposal would affect any stage of the life cycle of the species considered, to the extent that it would place a local viable population at risk of extinction.

(b) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disturbed such that the viability of the population is likely to be significantly compromised.*

This item is not applicable as the distribution range of the sole endangered population of Squirrel Glider, identified in Schedule 1, Part 2 of TSC Act, is outside the study area, being located on the Barrenjoey Peninsula.

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

None of the potential areas of habitat for the identified Threatened species are expected to be modified or removed as a result of the proposed works.

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.*

When discussing areas of "known habitat" it is necessary to first define what constitutes habitat for threatened species, populations or ecological communities and hence, the requisites for ensuring interconnectivity between such areas.

The TSC Act defines habitat *as an area or areas occupied, or periodically or occasionally occupied, by a species. population or ecological community and includes any biotic or abiotic component.* Significant areas of habitat exist within the wider Regional context. Development of the subject land does not pose a threat to the habitat links in the Region as the land is only infrequently used by species and it is unlikely that species rely exclusively on this habitat.

(e) *Whether critical habitat will be affected.*

This issue is not applicable as those areas defined as critical habitat have yet to be identified by the TSC Act

(f) *Whether a threatened species, population or ecological community or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region;*

Populations of *Tetratheca juncea* have been recorded at Glenrock State Recreation Area in Highfields, some 14 kms to the south of the subject site (Briggs and Leigh, 1996 and pers. comm., NSW NPWS). The preferred habitat of the Rose-crowned Fruit Dove exists in the rainforest remnants that occur within Kooragang Nature Reserve to the north of the site. The habitat of the Common Bent-wing Bat, typically forest valleys, exists within protected pockets of the Lake Macquarie district and within Heaton and Awaba State Forests, to south-west of the site.

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

Those processes defined as threatening are yet to be defined under the TSC Act.

(h) *Whether any threatened species, population or ecological community is at the limit of its known distribution.*

The Green and Golden Bell Frog and the Common Bent-wing Bat are widely distributed along the entire New South Wales coast and thus are not at their limit of distribution.

The Rose-crowned Fruit Dove is likely at the limit of its eastern distribution in northern New South Wales, although occasional recordings of the species on the Central and mid-north coasts do exist.

Tetratheca juncea, however, does have a restricted distribution, with the species recorded from only the coast and adjacent plateau areas of the Lake Macquarie district.

11.6.4 Impacts on Threatened Species

Following analysis of the provisions relating to Section 5A of the EPA & Act, 1979, it can be concluded that the proposed development is unlikely to have a significant impact on a threatened species, populations or ecological communities within the meaning of the Act. Therefore, it is not considered necessary for a Species Impact Statement to accompany the Development Application for the proposed development.

11.7 COMMONWEALTH LEGISLATION

11.7.1 Endangered Species Protection Act

The *Endangered Species Protection Act 1992* (ESP Act) is the governing Act for protection of significant fauna and flora at a national scale. The primary objectives of this Act are to promote the recovery of species and ecological communities that are endangered in Australia and to prevent other species and ecological communities from becoming nationally endangered.

- **Schedule 1**

Schedule 1 of the ESP Act, lists those species that are considered Endangered (Part 1), Vulnerable (Part 2) and Presumed Extinct (Part 3), in Australia. The subject site is considered potential habitat for the species *Tetratheca juncea* listed in Schedule 1 Part 2 of the Act. The proposed works would not take place on Commonwealth land, and, as a result, provisions in the Act requiring the proponent to seek a licence for the potential "taking" of a listed species are not relevant.

- **Schedule 2**

Schedule 2 of the ESP Act refers to listed ecological communities. Currently there are no entries under this Schedule.

- **Schedule 3**

Schedule 3 of the ESP Act lists key threatening processes. These processes are those that threaten or may threaten the survival, abundance or evolutionary development of a native species or ecological community. The main key process relevant to the development is predation by feral cats (*Felis catus*) and Foxes (*Vulpes vulpes*).

Although it is known that feral cats predate on native mammals, birds and reptiles, their impact on populations of native mammals is yet to be quantified (ANCA 1994). While no domestic and/or feral cats were observed at the subject site at the time of the site walkover, their presence in the general area is highly likely.

The Commonwealth Feral Pests Program has provided for the creation of a Threat Abatement Plan for Feral Cats. All future feral cat management strategies at the subject site would be in accordance with this plan.

The Fox has long been suspected as a significant predator of native wildlife in Australia (ANCA, 1995). Recent scientific studies, mostly in Western Australia, directly implicate the Fox as a major cause of population decline in certain critical weight range species (NSW Agriculture, 1994). Circumstantial evidence based on Fox distribution and faunal abundance, consistently incriminates the Fox as a serious predator of smaller wildlife species (*ibid.*).

Foxes were not observed at the subject site during the site walkover (although Foxes are more likely to be witnessed at night). A Threat Abatement Plan for Foxes (prepared under the auspices of the Commonwealth Feral Pests Program, in accordance with a requirement of the Endangered Species Protection Act), would form the basis for any fox control at the site.

- **Schedule 4**

Schedule 4 - outlines a number of international agreements between Australia and other countries, which relate to the conservation, preservation and protection of important habitat areas and migratory bird species.

The agreements relevant to the proposed works are:

- Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA).

- Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment (CAMBA).

- Convention on the Conservation of Migratory Species of Wild Animals (referred to as Bonn). This data is based on the preliminary views of the Australian and New Zealand Environment and Conservation Council (ANZECC) Working Group on International Agreements Relating to Migratory Birds and Wetlands (March, 1995).

- Convention on Wetlands of International Importance (RAMSAR).

Nearby Kooragang and Hexham Swamp nature reserves serve as seasonal homes to a number of migratory shorebirds listed in the JAMBA and CAMBA agreements. The subject site is not considered potential habitat for any of these protected species and thus the proposed works are not expected to impact upon the habitat requirements or flight patterns of these species.

Kooragang Nature Reserve is listed as a RAMSAR wetland. The proposed works are not expected to impact upon the wetland or the fauna that utilise its habitat.

11.8 SAFEGUARDS

A number of ameliorative measures are proposed to minimise adverse impacts on the vegetation communities and fauna identified within the study area, namely:

- Signs would be erected to prohibit the dumping of rubbish of any kind within the study area.

- Patches of remnant bushland in the southwestern section of the site as well as mound and boundary screen plantings would be retained on-site, where possible, to assist in soil stabilisation and visual amelioration.

11.9 CONCLUSION

- Six vegetation units were identified on-site: Remnant patches of *Eucalypt spp.*, non-remnant *Avicennia marina*, grassland, mound plantings, boundary plantings and non-native cultural plantings.

- A total (native species only) of 9 reptiles, 5 amphibians, 6 mammals and 54 avifauna have been previously recorded within the Newcastle region and could be expected to utilise the study area, given the habitat that exists. The proposed works are not expected to pose significant adverse effects on the fauna habitats of these species.

- The proposed works would not affect any areas of significant habitat, nor would works effect any wildlife corridor.

- Although not found on the site, one flora species and three fauna species of conservation significance were identified that could be supported by the habitat found on-site: *Tetratheca juncea*, Common Bent-wing Bat, the Rose-crowned Fruit Dove and The Green and Golden Bell Frog are listed as Threatened in Schedules 1 and 2 of the TSC Act. The Section 5A assessment carried out for the species concluded that the proposed works would not result in a significant adverse impact upon their life cycles and survival. Consequently, the preparation of a Species Impact Statement for these species is not required.

12.0 ARCHAEOLOGY AND HERITAGE

A cultural heritage assessment of the Project site was based on field surveys conducted by Woodward-Clyde personnel, and a search of the NPWS Register of Aboriginal Sites.

12.1 OBJECTIVES

The objectives of the archaeological and heritage assessment were;

- to inspect areas which may be affected by the proposed development and to identify any previously recorded or unrecorded Aboriginal and historic sites within these areas; and

- to define any constraints imposed by, and provide appropriate management recommendations for, any archaeological or heritage sites which may be adversely impacted by the proposed works.

12.2 METHODOLOGY

12.2.1 Register Search

A search of the NPWS Register of known Aboriginal Sites was conducted for a 10 km radius around the project site. The findings of the database search are discussed in Section 12.3.

12.2.2 Field Survey

A visual field survey of the subject site was carried out on the 23 January 1997 by Woodward-Clyde personnel.

Field survey and its effectiveness is related to surface visibility at the site, which is a measure of the bare ground visible during the survey. The predominant factor affecting surface visibility is the degree of vegetation and ground litter. However, the depth and type of exposure, the extent of recent or secondary deposition, and the level of visual interference from surface gravels, are also important factors.

12.3 FINDINGS OF THE ARCHAEOLOGICAL AND HERITAGE SURVEY

The project site has been used for a mixture of urban uses and farmland for approximately 175 years. As described in detail in Chapter 3, the site has been used for residential, farming, quarrying, waste storage and disposal activities which have caused extensive disturbance to the landscape. In addition, the area of the site which was formally Platt's Channel was reclaimed from the 1950's.

No Aboriginal heritage sites were identified during the field survey. Given that numerous Aboriginal archaeological sites have been found throughout the Newcastle region and that the project site is in close proximity to the South Arm of the Hunter River, it is highly likely that it was once occupied by Aborigines. Had Aboriginal sites such as open campsites, shell middens and artefact scatters once been present at the site, they would have been buried, destroyed or disturbed by past activities.

Search of the NPWS Register of known Aboriginal Sites revealed 92 recorded sites within a 10 km radius of the site of the proposed remedial activities. However, none of these sites were located on the project site.

No historic sites listed by the Australian Heritage Council or the NSW National Trust occur on the Project site.

12.4 IMPACTS OF THE PROPOSAL

Due to the disturbed nature of the site , which has resulted from activities such as farming and waste disposal, and the fact that no Aboriginal or European heritage sites were identified during the field survey, it is not anticipated that the proposal would have an impact on archaeology or heritage.

12.5 SAFEGUARDS

In the absence of any heritage or archaeological sites or relics, no specific safeguards are required.

However, if any Aboriginal archaeological sites or heritage items are discovered during the proposed remedial activities, they would be reported to the zone archaeologist of the NPWS and the Local Aboriginal Land Council. These sites/items would then be assessed for significance and appropriate protection measures would be instituted, if required.

12.6 CONCLUSION

As no Aboriginal sites or heritage items were listed on the NPWS, Australian Heritage Council or the NSW National Trust registers, or identified during the field survey, the proposed works would not impact on any known items or areas of archaeological or heritage significance.

13.0 LANDSCAPE AND VISUAL

13.1 VISUAL CHARACTER OF THE SITE

Three elements are typically used to describe the visual and physical characteristics of a landscape, namely:

- landform;
- vegetation; and
- land use.

Each of these three elements are described below and are used in the following sections to assess potential visual impacts on specific points of interest and on vantage points surrounding the site as a result of the proposed works.

13.1.1 Landform

The surface of the site is currently at about 20 to 22 m BHP datum (approximately 7.5 to 9.5 m AHD) and is mostly flat. The main topographic feature of the site is the natural ridge in the southeast corner which rises to about RL 40 m BHP Datum (approximately 27.5 m AHD). There is also a topographic high of similar elevation running through the southern half of Areas 4, 6 and 8. A topographic analysis of the site is shown in Figure 13.1.

13.1.2 Vegetation

As discussed in detail in Chapter 11 six vegetation units have been identified on-site:

- remnant stand of *Eucalyptus spp.* in the south-western section of the site to 15 m in height;

- narrow band of *Avicennia marina* along the south shore of the South Arm of the Hunter River;
- open grassland;
- native mound plantings;
- native boundary plantings along Industrial Drive and Tourle Street to 3 m in height; and
- non-native cultural plantings around the EMD Plant and in the south-eastern section of the site.

The native mound and boundary plantings provide an effective screening media to surrounding vantage points with views into the site, predominantly from surrounding major roads.

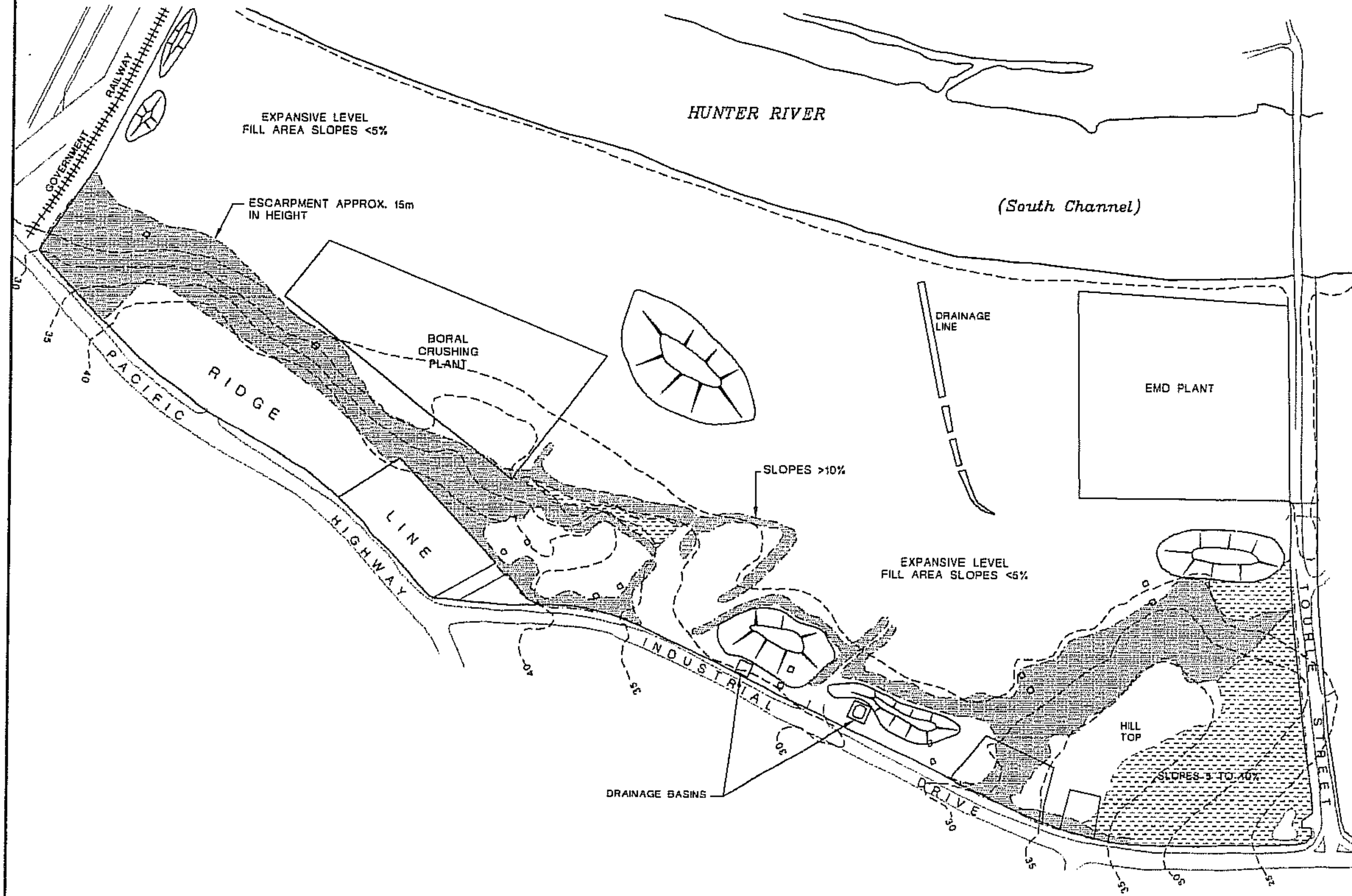
13.1.3 Land use

Current facilities and operations on-site include:

- The transportation (via an internal rail line) of molten iron for emergency disposal in hot metal pits in Area 5.
- The former BHP Health and Fitness Centre.
- Boral processing plant (blast furnace rock slag crushing) in Area 6.
- Boral Concrete Batching Plant.
- Mayfield West Fire Station.
- Commercial Minerals Pty Ltd stockpiling area.

13.2 VISUAL CHARACTER OF SURROUNDING LANDSCAPES

The landform, vegetation and land uses of the surrounding areas are summarised below:



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DATE:	16/5/97	STATUS:	FINAL

LEGEND

- SLOPES <5%
- SLOPE 5 – 10%
- SLOPES >10%
- MOUNDING

SOURCE: HASSELL PTY LTD

metres
0 50 100 150 200 250 300
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
TOPOGRAPHIC ANALYSIS VISUAL ASSESSMENT

FIGURE
13.1

A3

Woodward-Clyde

13.2.1 Landform

Prominent landform features (land/sea units) surrounding the project site include:

- South Arm of the Hunter River and the low-lying Kooragang Island to the north of the site.

- The relatively flat BHP Iron and Steel Works to the east of the site with a maximum elevation of approximately 10 m AHD.

- Residential suburb of Mayfield with a maximum elevation of approximately 40 m AHD along a ridgeline that follows Bull Street, Mayfield, sloping moderately downwards to the north at Industrial Drive (at approximately 10 m AHD).

- Residential suburb of Mayfield West with a maximum elevation of approximately 40 m AHD sloping moderately downwards to the project site (at approximately 10 m AHD).

- Industrial properties along Pacific Highway to the west, south-west of the site, with maximum elevation of approximately 15 to 20 m AHD, sloping downwards steeply to the site.

13.2.2 Vegetation

Significant areas of vegetation surrounding the site include Kooragang Nature Reserve to the north across the Hunter River and Hexham Swamp to the west of the Shortland residential suburb. The vegetation communities that comprise these two areas are described by NSW NPWS (1996) and are detailed in Chapter 11 of this EIS.

These areas of vegetation do not serve as prominent screening media to vantage points surrounding the site.

13.2.3 Land uses

Land uses which surround the Project site are listed below:

- BHP Iron and Steel Works to the east of the site.
- Kooragang Island Industrial Area to the north-east of the site.
- Government Railway line forming the western boundary of the site.
- Kooragang Nature Reserve to the north-west and north of the site
- Industrial facilities along Pacific Highway to the south-west of the site.
- Stevenson Park, to the south, across Industrial Drive.
- The residential suburbs of Mayfield and Mayfield West to the south-east and south of the site.
- EMD Plant to the north-east.

The landform, vegetation and land uses of the site and areas surrounding the site combine to make up two homogeneous land units within the locality namely the riverfront industrial and urban land units.

Riverfront Industrial Complex:

This land unit dominates the riverfront landscape to the east, west and in part, to the north of the site. A range of industrial facilities dominated by the BHP Iron and Steel Works site to the east of the project site, characterise this predominantly flat landscape. Form is the dominant feature of this landunit.

Urban:

This landunit dominates the landscape to the south and is characterised by both long-standing and relatively new, moderately-sloping residential suburbs of Mayfield, Mayfield East and Mayfield West. Form and line are the dominant features of this landunit.

13.3 VIEWS INTO THE SITE (EXISTING VISIBILITY)

An observation study was undertaken on 23 January 1997 to assess the existing visibility of the project site from seventeen vantage points in the surrounding areas. Table 13.1, lists the seventeen vantage points visited during the observation study, describes the views into the project site and proposed remediation areas from each and notes the corresponding selected number of photographic plates. Figure 13.2 shows the locations of the nominated vantage points studied, the direction of views into the site and the site's visual catchment.

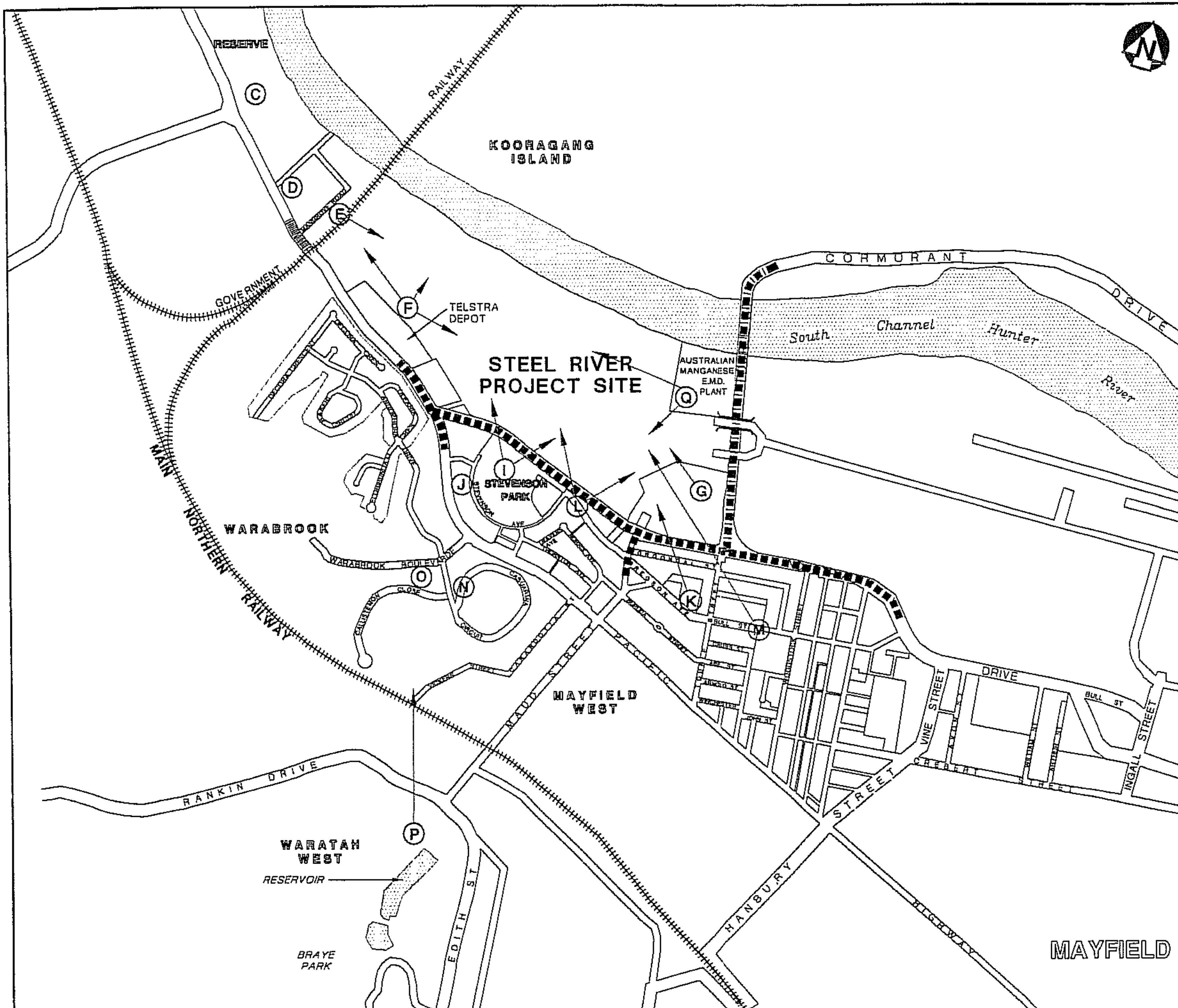
TABLE 13.1 EXISTING VIEWS INTO THE SITE

	VANTAGE POINT	VIEWS INTO THE SITE
A	Pacific Highway/Maitland Road/ Industrial Drive	Unrestricted, prominent views into site and proposed remediation areas.
B	Industrial property along Pacific Highway to the rear of Telstra Depot[1]	Unrestricted, prominent views into site and proposed remediation areas.
C	Southern limit of Kooragang Nature Reserve at Ferry Road	No views into the site.
D	Ferry Road residence	No views into site.
E	Ferry Road Industrial Property	Partially-restricted views into site and proposed remediation areas.
F	Telstra Depot on Pacific Highway	Unrestricted, prominent views into site and proposed remediation areas.
G	Former BHP Health and Fitness Centre[2]	Unrestricted, prominent views into site and proposed remediation areas.
H	Tourle Street/Cormorant Road	Partially-restricted long views into site and proposed remediation areas.
I	View looking north from east of Stevenson Park[3]	Partially-restricted views into site and proposed remediation areas.
J	Stevenson Avenue residence	No views into the site. Vegetation serves as the main screening medium.

	VANTAGE POINT	VIEWS INTO THE SITE
K	Mayfield West Public School	Partially-restricted views into site and proposed remediation areas. Wide-sweeping views of the riverfront industrial landscape.
L	Gregson Avenue residence	Partially-restricted views into site and proposed remediation areas. Wide-sweeping views of the riverfront industrial landscape.
M	Bull Street residence (at Tourle St. Park)[4]	Partially-restricted views into site and proposed remediation areas. Wide-sweeping views of the riverfront industrial landscape.
N	Casuarina Drive, Warabrook	No views into site
O	Warabrook Blvd, Warabrook	No views into site
P	Braye Park, Waratah West	Partially-restricted, long views into site and proposed remediation areas.
Q	Australian Manganese E.M.D Plant	Unrestricted, prominent views into site and proposed remediation areas.

Note:
1. Plate 13.1
2. Plate 13.2
3. Plate 13.3
4. Plate 13.4

Results of the observation study confirmed that none of the five vantage points (A, B, F, G and Q) which yielded prominent, unrestricted views into the site and proposed remediation areas could be considered sensitive receptor areas (i.e. residential, schools, hospitals). Four of the vantage points operate within the context of heavily industrialised areas which dominate the riverfront landscape whilst the fifth vantage point, G, (former BHP Health and Fitness Centre) is an abandoned facility surrounded by industry.



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DATE:	16/5/97	STATUS:	FINAL

LEGEND

- VANTAGE POINT A
- VANTAGE POINT B
- VANTAGE POINT H
- (D) VANTAGE POINTS STUDIED
- EXTERNAL VIEWS OF SITE

0 200 400 600 800
metres

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
VISUAL ASSESSMENT

FIGURE
13.2

A3

Woodward-Clyde

Of the seven vantage points which yielded partially-restricted views into the site and proposed remediation areas (E, H, I, K, L, M, P), two vantage points, E (Ferry Road industrial property) and H (Tourle St/Cormorant Road) are considered non-sensitive receptors operating within an industrial surround whilst vantage points M (Bull Street residence) and P (Braye Park, Waratah West) possess subtle and long views (between 2 and 3 km) to the site, respectively.

Five of the vantage points studied, C (Kooragang Nature Reserve at Ferry Road), D (Ferry Road Residence), J (Stevenson Avenue residence), N (Casuarina Drive, Warabrook) and O (Warabrook Blvd, Warabrook) do not yield views into the site.

13.4 IMPACTS OF PROPOSAL

Prominent visual features associated with the proposed works relate to the heavy machinery required for soil handling, and truck transport of soil around the site to proposed containment areas.

The proposed works are not expected to significantly contribute to any loss of overall visual amenity from the seventeen vantage points identified, given:

- The visually insignificant nature of the proposed works (i.e. small number of heavy machinery required, the minimal height proposed for soil stockpiling and ameliorative measures proposed to minimise fugitive dust emissions).

- The mound and boundary vegetative screening that exists on-site which will act to effectively shield visually prominent areas of the site (including the proposed excavation areas) from short distance views into the site that exist along Industrial Drive and Tourle Street.

- The proposed works would not be out of context with the industrial land use that dominates the South Arm river frontage.

Additionally, a number of mitigation measures are proposed in Section 13.5 to reduce the loss of visual amenity of the vantage points identified as a result of the proposed works.

13.5 SAFEGUARDS

The following environmental safeguards are recommended to minimise any adverse effects on the visual amenity of the local environment resulting from the proposed works:

- The removal of mound and boundary screen plantings would be minimised, where possible.
- Proposed safeguards to control and minimise fugitive dust emissions would be strictly enforced.
- Bare work faces on-site would be minimised at any one time.

13.6 CONCLUSION

The following conclusions can be made concerning the impact on the visual amenity of the local environment resulting from the proposed works:

- An observation study undertaken at seventeen vantage points surrounding the site indicated that no sensitive vantage points possess prominent, unrestricted views into the site and proposed remediation area. The sensitive vantage points identified yielded partially-restricted views into the site and proposed remediation areas.
- The impact on the visual amenity of the local environment as a result of the proposed works would be negligible.

- A number of mitigation measures are proposed which would minimise adverse effects on the visual amenity of the local environment.

14.0 TRAFFIC AND TRANSPORTATION

14.1 EXISTING TRANSPORT NETWORK

14.1.1 Road

The Project site is accessed from both Industrial Drive and Tourle Street. Industrial Drive is a four to six lane arterial road on the regional road network, providing a direct link between the City of Newcastle and the Port. At either end of Industrial Drive there are either direct or indirect connections with the Pacific and New England Highways and the Sydney-Newcastle Freeway (F3), thereby linking the Port of Newcastle with the Hunter Region and other areas in NSW. Tourle Street and the Tourle Street Bridge form part of Main Road (MR) 108, which is the only road on Kooragang Island which connects Industrial Drive to Stockton and Port Stephens.

During the proposed works, trucks would be required to transport CWR from the Macquarie Coal Preparation Plant, located at the northern end of Power House Road in Teralba, to the site. The roads proposed to be used for the transportation of CWR to the site are listed as follows:

- Rhondda Road.
- Wakefield Road.
- Northville Drive.
- George Booth Drive.
- Cameron Park Drive.
- Minmi Road.
- Sydney - Newcastle Freeway (F3).
- New England Highway (State Highway No. 15).
- Pacific Highway (State Highway No. 1).
- Industrial Drive.

The road network to be used in the transportation of CWR to the site is shown in Figure 14.1 and was selected on the basis that it would have minimal impact on traffic flow and built up areas. In addition, this route has been used on past occasions to transport coal from the Macquarie Coal Preparation Plant to the Port Waratah Coal Terminal, when rail transport has not been possible.

14.1.2 Rail

The Main Northern Railway also services the area, however, it would not be utilised as part of the proposal. A railway siding feeds into the site from BHP Steelworks to the east of Tourle Street.

14.2 EXISTING TRAFFIC AND ROAD CONDITIONS

14.2.1 Traffic Conditions

Traffic survey results for roads near the project site and roads to be used in the transportation of CWR to the site were obtained from the Roads and Traffic Authority (RTA). Traffic survey results are shown in Table 14.1.

TABLE 14.1 TRAFFIC SURVEY DATA

Location	Projected Year	AADT[1]	Source
Tourle St Bridge	1995	23, 400	RTA
Industrial Drive			
- West of Werribi Street	1995	22,950	RTA
- West of Woodstock Street	1995	29,750	RTA
Maud Street	1995	21,870	RTA
Hannel Street	1995	18,970	RTA
Pacific Highway (SH1)			
- South of Wallsend Road	1992	42,950	RTA
New England Highway (SH15)			
- North of Pacific Highway (SH1)	1992	34,520	RTA

Location	Projected Year	AADT[1]	Source
George Booth Drive	1992	8,060	RTA
Sydney-Newcastle Freeway (F3) as it joins John Renshaw Drive	1996	19,000	RTA

Note: 1. AADT - Average Annual Daily Traffic (axle pairs)

In order to obtain an estimate of traffic flows for 1997, a 1% annual growth rate (based on a projected population growth rate of approximately 1%, *NSW Department of Planning, 1994*) was adopted. The revised figures are presented in Table 14.2.

TABLE 14.2 PROJECTED TRAFFIC FLOWS

Location	Projected Year	AADT[1]
Tourle St Bridge	1997	23, 870
Industrial Drive		
- West of Werribi Street	1997	23,410
- West of Woodstock Street	1997	30,350
Maud Street	1997	22,310
Hannel Street	1997	19,350
Pacific Highway (SH1)		
- South of Wallsend Road	1997	45,100
New England Highway (SH15)		
- North of Pacific Highway (SH1)	1997	36,250
George Booth Drive	1997	8,460
Sydney-Newcastle Freeway (F3) as it joins John Renshaw Drive	1997	19,190

Notes: 1. AADT - Average Annual Daily Traffic (axle pairs)

14.2.2 Road Conditions

The roads surrounding the site are generally in good repair with sealed carriageways. Not all the roads have kerbs and gutters. Parts of Industrial Drive and Tourle Street have kerb and gutter, and other sections have a gravel shoulder and grassed verges.

Access to Industrial Drive and Tourle Street is generally good, via the Pacific Highway/Industrial Drive and Industrial Drive/Tourle Street signalised intersections.

14.3 TRAFFIC GENERATED BY THE PROPOSAL

Access to the site for vehicles undertaking remediation works and importing fill would be via the existing access points, with fill vehicles being excluded from use of the Tourle Street entrance/exit.

The proposed works would be undertaken over a period of approximately 5 years. For the duration of the works there would be vehicle movements to and from the site associated with:

- Personnel commuting to and from the site;
- Mobilisation and demobilisation of heavy equipment;
- Possible off-site removal of contaminated groundwater; and
- Importation of CWR from the Macquarie Coal Preparation Plant.

The volume of traffic likely to be generated by these activities is discussed in the following subsections.

14.3.1 Site Personnel

It is estimated that an average of 8 site personnel would commute to and from the site on a regular basis. However, depending on the activities being undertaken, a maximum of 20 site personnel may be expected to commute to and from the site.

14.3.2 Heavy Equipment

Apart from the trucks used to transport CWR from the Macquarie Coal Preparation Plant to the site, approximately 5 to 15 items of heavy equipment would be used to recontour the site. It is anticipated that heavy equipment used for these activities would remain on-site for the duration of the works.

14.3.3 Possible Off-Site Transport of Contaminated Groundwater

Off-site transport of contaminated groundwater would be required in the event that hydrocarbons are recovered from the site. It is not expected that significant volumes of hydrocarbons would be recovered, therefore, the volume of traffic generated by this activity is likely to be negligible.

14.3.4 Importation of CWR

As discussed in Section 14.1.1, CWR would be obtained from the Macquarie Coal Preparation Plant in Teralba and transported to the site via the route shown in Figure 14.1. Additional traffic generated as a result of these truck movements would be a maximum of some 96 vehicle movements per day or some 10 vehicle movements per hour, for a duration of 5 years. This is based on the worst case scenario of importing all fill material.

14.4 POTENTIAL IMPACTS OF THE PROPOSAL

The road network shown in Figure 14.1 was selected on the basis that it avoided built up areas and would have minimal impact on traffic flows. Comparison of the predicted AADT's (Table 14.2) for the roads selected indicated that the impact of 90 additional daily truck movements on the AADT of Industrial Drive, Pacific Highway and the New England Highway would be less than 0.5%. This increase is considered negligible.

The impact on smaller roads with lower traffic volumes such as George Booth Drive, Northville Drive, Wakefield Road and Rhondda Road are expected to be more significant, as these roads have a lower vehicle capacity. The increase in AADT for George Booth

Drive based on 1997 projected traffic flows was approximately 1%. This low volume of additional traffic would have minimal impact on existing local traffic. Similarly traffic generated from on-site workers would have an insignificant impact on traffic volumes on surrounding streets.

The potential impacts of increased traffic volumes on the condition of site access roads and traffic flow are as follows:

- *Degradation of site access roads* - As heavy vehicles would use Industrial Drive, the Pacific and New England Highways, the Sydney-Newcastle Freeway, and other roads within the area, there is some potential for the roads to degrade. Potholes and loosened gravel may result, which in turn could create a hazard to local traffic.

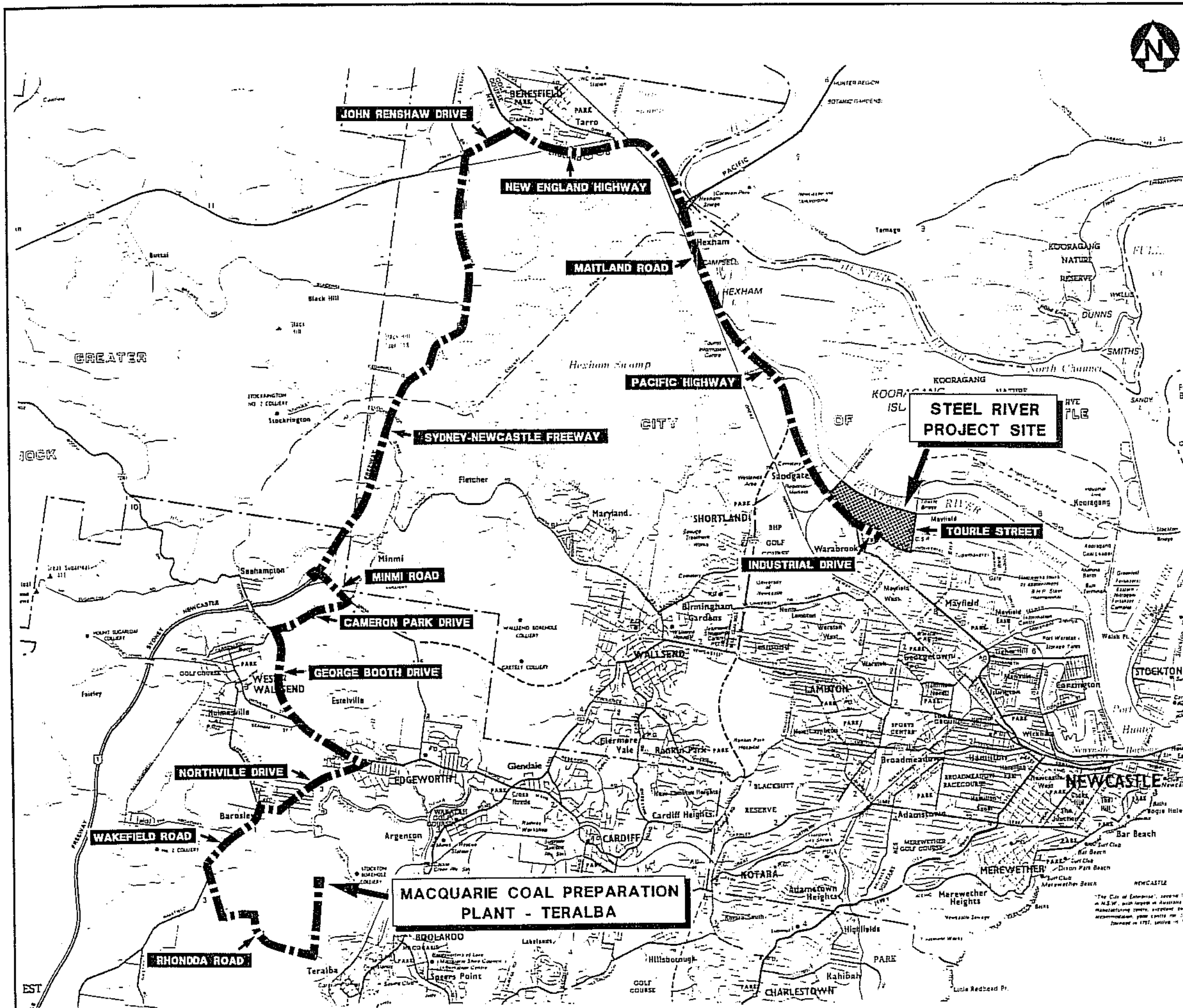
- *Traffic entering the site* - A potential hazard exists where vehicles are required to turn across on-coming traffic lanes when entering and leaving the site.

- *Safety risk* - there is a potential minor risk associated with the transportation of hydrocarbon material from the site in the event that this material needs to be moved off-site.

14.5 SAFEGUARDS

Although only small volumes of traffic would be generated by the proposed works the following safeguards have been incorporated into the proposal to alleviate any impacts of additional traffic volumes:

- *Transport route selection* - the transport route selected would have the least impact on built up areas and traffic flows.



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DATE:	16/5/97	STATUS:	FINAL

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
TRANSPORT ROUTE

FIGURE
14.1

A3

Woodward-Clyde

- *Signage* - to ensure a smooth merging of site traffic and existing traffic on Industrial Drive, the entrance and exit to the site access road would be appropriately signposted to indicate:

    - to traffic on Industrial Drive and Rhondda Road that there is an intersection road; and

    - to traffic leaving the site to give way to traffic on Industrial Drive, and traffic leaving the Macquarie Coal Preparation Plant to give way to traffic on Rhondda Road.

- *Haulage restrictions* - transportation of CWR would be restricted to daylight hours.

- *Retain equipment on-site* - heavy equipment involved in active remediation would be retained on-site, for the duration of that phase of remediation work for which it is required.

- *Covered loads* - all trucks hauling CWR would be covered, thus preventing spillage of material onto the roads and minimising dust emissions.

- *Licensed contractor to transport hydrocarbons* - in the event that concentrated hydrocarbons are recovered from the site, a licensed contractor, experienced in the transportation of hydrocarbon wastes would be used. The contractor would transport the waste along a route approved by the local traffic authority.

14.6 CONCLUSION

During the proposed works, small volumes of vehicle movements would result from personnel commuting to and from the site, trucks hauling CWR and mobilisation and demobilisation of heavy equipment. However, upon completion of the remedial activities traffic volumes would return to normal. By implementing the safeguards discussed in Section 14.5 the impact of the proposed works on the existing traffic and road conditions would be minimised.

15.0 LAND USE AND PROPERTY

15.1 EXISTING LAND USE

Mayfield is an established area of Newcastle City and is located to the north west of Newcastle CBD. The Port is an important focus for the Hunter Region's transport and economy and has traditionally provided an industrial employment base for Newcastle. Industrial activities centre on manufacturing, coal resource related industries and steel.

Mayfield West lies in the area to the west of BHP Steelworks. Residential areas are concentrated to the south of Industrial Drive and are generally well established. The area is well served by land uses ancillary to residential development and typical of more established housing areas. These include the Mayfield West Public School and Mayfield West Pre School along Bull Avenue, the Mayfield Church of Christ on Werribi Street, the Mayfield West Fire Station on Industrial Drive and the Mayfield Scout Group along Gregson Street. Figure 15.1 shows the location of these land uses.

There are also several areas of open space which are used for recreational activities by joggers and walkers. Local parks on Bull Street and Werribi Street East provide passive recreational opportunities. The larger Stevenson Park has a cricket oval and Boomerang Field - a baseball diamond, providing active recreational opportunities, and other amenities for more low key recreational pursuits. The North and South Arm of the Hunter River are used for boating and fishing.

Industrial uses located to the north of Industrial Drive include the BHP Steelworks (east of Tourle Street), the EMD Plant to the north-east of the subject land and Amcor Fibre Packaging at the junction of Industrial Drive and the Pacific Highway. An Industrial Estate located further to the west along the highway is almost fully occupied, with occupants including GB Electrical Contractors, NHP Industrial Switchgear, Teresaki, IWR Lighting, Sprecher and Schick and Tool Specialists.

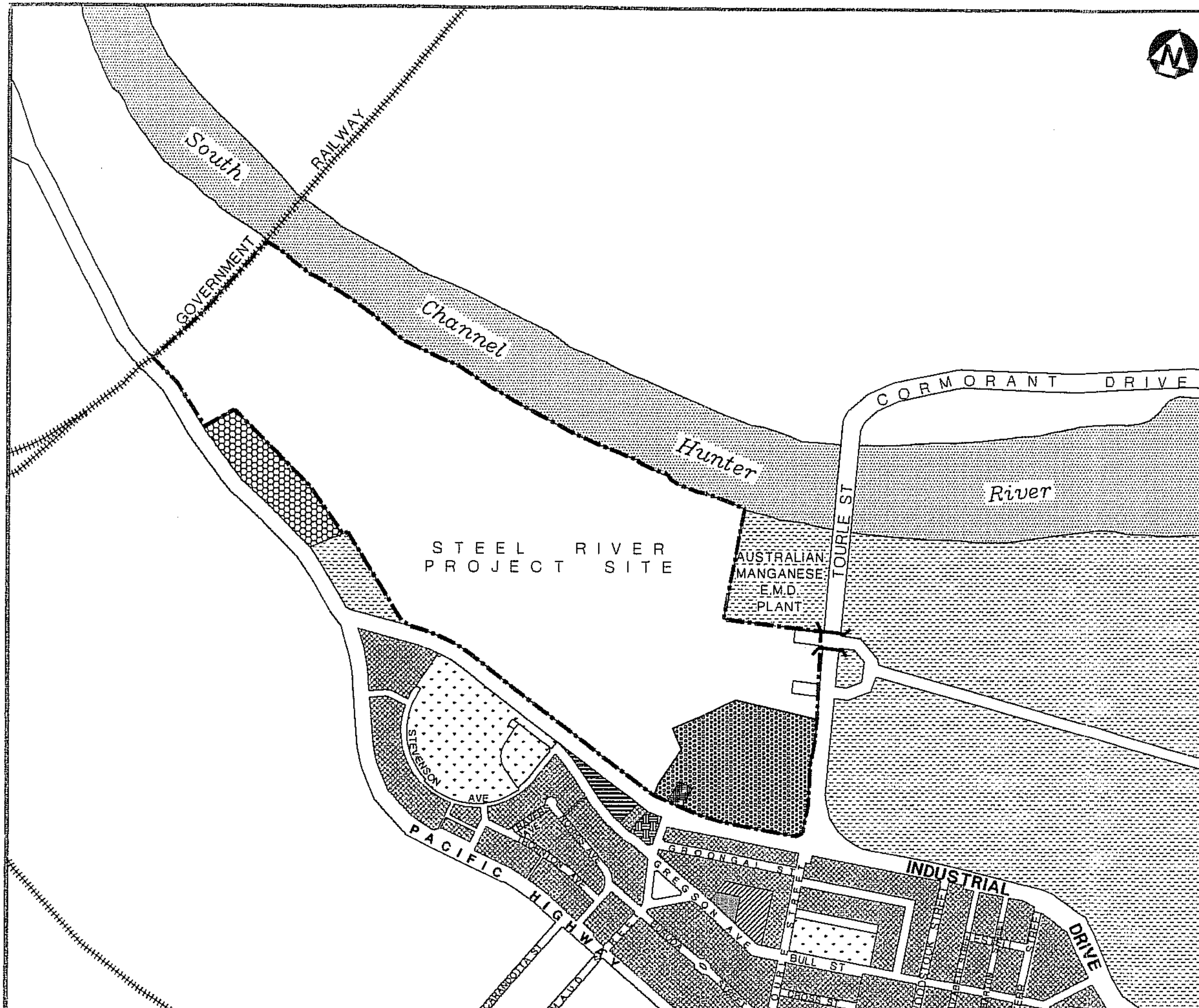
Other land uses in the immediate vicinity of the Project site include a Telstra Depot on the Pacific Highway and the Government Railway to Kooragang Island which forms the west/north west boundary to the Project site.

Land uses on the project site include the Boral Concrete Plant and Mayfield West Fire Station which are located in the south-eastern corner of the site. A transmission line easement runs along the west/north western boundary of the site. Commercial Minerals Pty Ltd currently lease land in the area of the site near the Industrial Drive/Pacific Highway junction for stockpiling. Further to the west, the Boral Resources Pty Ltd plant is used for crushing and screening blast furnace slag. Hot metal pits in the north-eastern position of the site are currently used for the cooling down and then removal of molten metal. These pits are security fenced for safety reasons and are accessed from Industrial Drive via a haulage road and by a railway siding from the industrial railway serving the BHP Steelworks.

15.2 FUTURE LAND USES

The Newcastle Beyond 2000 Committee Technical Steering Committee is currently investigating possible future industrial land uses for the subject land including an Industrial Estate in a park like setting.

It is proposed that the Steel River Project site would be redeveloped for industrial purposes on completion of the remedial works.



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APPROVED: CS
STATUS: FINAL

LEGEND

- SITE BOUNDARY
- MAYFIELD WEST PUBLIC SCHOOL
- MAYFIELD WEST PRE-SCHOOL
- RESIDENTIAL
- MAYFIELD CHURCH OF CHRIST
- MAYFIELD WEST FIRE STATION
- MAYFIELD SCOUT GROUP
- OPEN SPACE
- INDUSTRIAL
- BHP HEALTH AND FITNESS CENTRE
- TELSTRA DEPOT

CLIENT
BHP STEEL (NEWCASTLE)

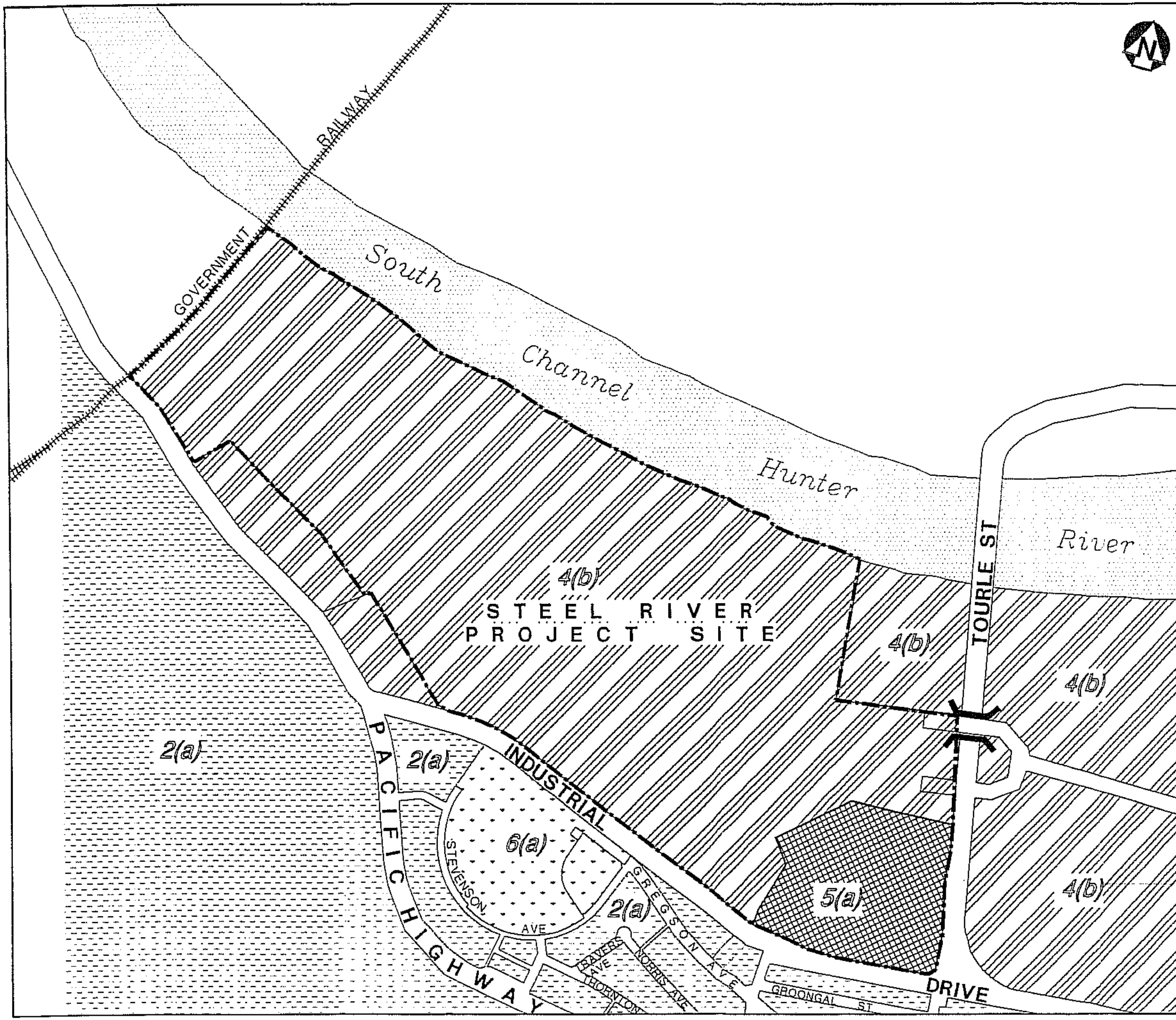
PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
LAND USE

FIGURE
15.1

A3

Woodward-Clyde



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DATE:	16/5/97	STATUS:	FINAL

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
ZONING PLAN

FIGURE
16.1

A3

Woodward-Clyde

15.3 IMPACTS OF THE PROPOSAL

15.3.1 Impacts on Local Planning

Newcastle Local Environmental Plant (LEP) 1987 zones the land for general industrial purposes. Remediation of the land to allow future industrial development would be consistent with the objectives of the LEP and would be consistent with strategic planning for the locality and the wider Region outlined in Hunter Regional Environmental Plan (REP) 1989 (and its Amendments).

15.3.2 Impacts on Land use

The proposed works would have little impact on existing land uses on-site as the land is generally vacant. The Boral slag crushing quarry would continue to operate and stockpiling of materials by Commercial Minerals Pty Ltd would continue until such time as current leases expire or remedial activities, (necessary to facilitate future industrial development) which will be staged over the whole site, reach this area. The hot metal pits would also be retained for some time. Safeguards which would be implemented during the remediation phase would ensure the proposed works would not impact on these land uses or indeed the health and safety of workers on-site.

15.4 SAFEGUARDS

Safeguards relate to the rehabilitation of the land and restoration of the site upon cessation of the proposed works.

In order to minimise the potential adverse impacts of the proposed works on existing land uses on-site and in the immediate vicinity, the safeguard measures detailed in Chapter 21 would be adopted. These safeguards relate to matters such as traffic management measures during the proposed works, monitoring of noise levels, minimisation of fugitive dust emissions and the implementation of a Water and Sediment Management Plan to control erosion and on-site drainage.

15.5 CONCLUSION

The proposed works would enable development for industrial land uses and in doing so satisfy strategic planning land use outcomes for the area. Remediation would be carried out in a phased manner which would allow continuation of current land uses on-site in the short to medium term. Safeguard measures would be implemented to ensure that the proposed works would have minimal impacts on surrounding land uses and the riverine environment.

16.0 STATUTORY PLANNING CONTROLS

16.1 LOCAL PLANNING AND REQUIREMENTS

The Steel River Project site is located within Newcastle City and is governed by the provisions of Newcastle LEP 1987.

The subject land is zoned 4(b) General Industrial pursuant to the provisions of Newcastle LEP 1987 with the exception of the land currently occupied by the former BHP Health and Fitness Centre which is zoned 5(a) Ecclesiastical, in recognition of its original use as the Murray Dwyer Catholic Orphanage (Figure 16.1).

Part 2 of the Newcastle LEP 1987 presents the development control objectives and land use tables which outline the types of development which are either permissible without development consent, permissible only with development consent, or are prohibited.

The Development Control Table has the following objectives for the 4(b) General Industrial Zone.

(a) to facilitate the development of large scale industrial, service and storage activities which by nature of their operations should be isolated from residential areas; and

(b) to allow commercial, retail or other development only where it is:

  (i) ancillary to the use of land within this zone for industrial, service and storage purposes;
  (ii) primarily intended to provide personal services to persons occupied or employed in activities otherwise permitted in this zone;
  (iii) associated with an industrial environment;

(iv) unlikely to prejudice the viability of existing commercial centres; and

(v) will not prejudice the intent of objective (a).

All uses require development consent. Development will be permitted in this zone for:

> *"Any purpose (which in the opinion of the Council, is consistent with the objectives of the zone) other than a purpose included in Item 4 of the matter relating to the zone."*

Item 4 contains the uses which are prohibited in the 4(b) zone including advertising structures; caravan parks; dwellings (other than those used in conjunction with industry and situated on the same land as the industry); educational establishments; hospitals; institutions; mines; motels; residential flat buildings; roadside stalls and tourist facilities.

The 5(a) Ecclesiastical Zone has as its single objective:

> *"to cater for the provision of community and public facilities and services".*

Development which serves the local community or the wider public is permissible in this zone. All other forms of development are prohibited.

None of the special provisions in Part 3 of the Newcastle LEP 1987 apply to the subject land.

16.2 REGIONAL PLANNING POLICIES

Hunter REP 1989 and its Amendments apply to the Hunter Region, which includes the City of Newcastle. It aims to promote the balanced development of the region, the improvement of its urban and rural environments, and the orderly and economic development and optimum use of its land and other resources.

The Hunter REP 1989 must be considered by a consent authority in carrying out its function under the EP&A Act or under the relevant environmental planning instrument.

Clause 17 of Amendment 1 of the Hunter REP stipulates a number of matters to be taken into consideration by Council. Of relevance to the subject land is the requirement that Council should:

> *"ensure that an adequate supply of zoned and serviced industrial land is available in appropriate locations to meet needs, taking into account the extensive nature of modern industrial and quasi-industrial development".*

16.3 STATE PLANNING POLICIES

SEPP No. 11 - Traffic Generating Development applies to this project. This Policy requires Newcastle City Council to forward a copy of the development application to the Roads and Traffic Authority within seven days of receipt of the application.

As the RTA is one of the regulatory authorities consulted during the preparation of this EIS, the Authority is well aware of all issues relating to the proposal and to the potential future use of the site. Additionally, as one of the statutory authorities nominated in the Director General's requirements for the EIS, Newcastle City Council will seek the Authority's comment's on the EIS, thereby satisfying the requirements of SEPP11.

16.4 CONCLUSION

The subject land was zoned in 1987 to permit industrial development and in the south-eastern section, community purposes. The rehabilitation of the land and its future potential use for industrial purposes is permissible with development consent.

SEPP11 - Traffic Generating Development is the only State Environmental Planning Policy applicable to the subject land.

Regionally, the rehabilitation of the subject land to facilitate industrial development is consistent with the provisions of Hunter REP 1989 (as Amended) and consultation has been carried out with all relevant government departments identified by DUAP and Newcastle City Council.

PART E

OTHER ENVIRONMENTAL MATTERS

17.0
CURRENT ECOLOGICAL ISSUES

17.1 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

The Commonwealth Government in its document *'Ecologically Sustainable Development: A Commonwealth Discussion Paper'* 1990 defined ESD as: *'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future can be increased'*. Generally, ESD aims to address the wise use or reuse of resources.

In NSW, the concept of ESD has been given legal definition by *the Protection of the Environment Administration Act* 1991 (NSW) which set up the EPA. Section 6(1)(a) of the above Act provided that the EPA in protecting, restoring and enhancing the quality of the environment in NSW should have *'regard to the need to maintain ecologically sustainable development'*. This would require *'the effective integration of economic and environmental considerations in decision making processes'*. The principles which would assist in the achievement of ESD have been clearly set out in Schedule 2 of the Environmental Planning and Assessment Regulation 1994. These principles include:

(a) *The precautionary principle* - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

(b) *Inter-generational equity* - namely, that the present generation should ensure that the healthy diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

(c) *Conservation of biological diversity and ecological integrity* - namely, that while prices for natural resources should be set to recover the full social and environmental costs for their use and extraction, many environmental values cannot be priced in monetary terms.

(d) *Improved valuation and pricing of environmental resources.*

The four principles are interrelated. For instance intergenerational equity can only be achieved in many instances if biodiversity is conserved for the use and enrichment of future generations. The linkage of the four principles means that they must be considered individually and collectively when assessing whether a proposed project will contribute to economically sustainable development in Australia (Department of Urban Affairs and Planning, 1995).

Current ecological issues which have been considered in light of this proposal and are discussed below include:

- climate change and greenhouse effect;
- biological diversity and ecological integrity;
- inter-generational equity;
- precautionary principle; and
- valuation and pricing of environmental resources.

The World Bank (1994) summarised ESD as:

> *'The concept of sustainable development implies balancing environmental protection with the generation of increased opportunities for employment and improved livelihoods'.*

17.2 CLIMATE CHANGE AND GREENHOUSE EFFECT

The Greenhouse Effect is the phenomenon whereby certain gases, known as greenhouse gases, capture heat radiated from the earth and re-radiate it back to the earth. This mechanism maintains the thermal balance that controls the earth's climate. It is now well established by a consensus of scientists that the thermal balance may be disturbed by steadily increasing concentrations of certain greenhouse gases, principally carbon dioxide (CO_2). This change is known as the enhanced greenhouse effect and it is predicted that it may change global climate patterns.

CO_2 is the main greenhouse gas of concern. It is the inevitable product of the combustion of fossil fuels and accounts for approximately half of the total enhanced greenhouse effect. The other main greenhouse gases are methane, nitrous oxide (NO_x) and Chloro-Fluorocarbons (CFC's). The emissions of these other gases are much less than CO_2 but their effect in the atmosphere is significant because they are more effective as greenhouse gases.

Due to growing concern regarding the enhanced Greenhouse Effect, the Commonwealth Government, as part of its National Greenhouse Response Strategy, announced in October 1990 that it had adopted a planning target to reduce greenhouse gas emissions by 20% by the year 2005 (Energy Production Working Group, 1991).

The proposed remedial works would not emit greenhouse gases, apart from those emitted by vehicles and machinery used during excavation and earth moving activities. Therefore the project is unlikely to have a significant impact on the enhanced Greenhouse effect.

17.3 BIOLOGICAL DIVERSITY AND ECOLOGICAL INTEGRITY

Preserving biological diversity and ecological integrity requires that ecosystems, species and genetic diversity within species be maintained.

Environmental safeguards and monitoring programs would be implemented so as to maintain the biological diversity and ecological integrity of the region. Erosion and sediment control techniques would be used to minimise adverse impacts on the soil and water resources, and revegetation of excavated soils and screen planting would control soil erosion and contribute to the visual amenity of the area.

As discussed in detail in Chapter 11, it is not anticipated that the project will pose a significant threat to terrestrial flora or fauna, since the site has been substantially disturbed in the past, contains very little vegetation, and is unlikely to provide habitat for any threatened fauna species.

A detailed review of the environmental safeguards and monitoring programs which should be implemented for the proposed project are provided in Chapters 20 and 21, respectively.

17.4 INTER-GENERATIONAL EQUITY

Inter-generational equity has been defined by Leiss (1990) as a concept which states that humans *'hold the natural and cultural environment of the earth in common both with other members of the present generation and with other generations, past and future'*. In other words the present generation has inherited the Earth from its forbearers and should ensure the diversity and productivity of the environment is maintained or enhanced and passed on in a condition which has a positive benefit for future generations. The most significant aspect of this concept is that future generations should not inherit a degraded environment.

Environmental investigations of the site identified several areas which contain contaminated soils and groundwaters. The purpose of the proposed remedial activities is to prevent contaminated soils and groundwaters impacting on the surrounding environment by capping the site, and to return the site to a condition suitable for industrial use by existing and future generations.

17.5 PRECAUTIONARY PRINCIPLE

The Intergovernmental Agreement on the Environment (IGAE) prepared in 1992 and signed by Commonwealth, State, Territory and Local Government, provides a definition of the precautionary principle. The precautionary principle is defined as follows;

Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

In the application of the precautionary principle, public and private decisions should be guided by:

i) *careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and*

(ii) *an assessment of the risk-weighted consequences of various options.*

The IGAE states that the precautionary principle is to be a guiding principle for informed 'policy making and program implementation' by all levels of government in Australia. In this manner, it is to guide both the public and private sector in its decision making and assessment of different options, particularly when decisions are being made in the face of uncertainty. In doing so, it requires avoidance of serious or irreversible damage to the environment whenever practicable.

This project has taken on board the 'precautionary principle' by ensuring that potential environmental risks associated with the project have been considered from the outset and that environmental management practices and safeguards are used to minimise environmental impacts.

Studies undertaken during the preparation of this EIS in relation to flora and fauna, archaeology and heritage, visual amenity, hydrology, soil and water quality, and socioeconomic impacts have not indicated threats of serious or irreversible environmental damage. However, where risk of potential environmental degradation has been identified, safeguards have been developed to ensure that significant adverse environmental impacts do not occur.

In addition, visual site inspections would be conducted during the remediation process so as to reduce the uncertainties surrounding the possible long-term impacts of the development and to enable an assessment of the adequacy of the precautions and safeguards used to minimise environmental impacts. This would ensure any shortcomings of the operation are identified before environmental degradation reaches a significant level.

17.6 VALUATION AND PRICING OF ENVIRONMENTAL RESOURCES

The IGAE and the Protection of the Environment Administration Act both call for improved valuation, pricing and incentive mechanisms which should form an element of policy making and program implementation. In other words, environmental factors should be included in the valuation of assets and services.

The integration of environmental and economic goals is one of the key principles of ESD set out by the Commonwealth Government and is a feature of the IGAE.

Cost-benefit analysis can be applied to assist in deciding which way to proceed towards sustainable development. It is a means of helping decisions to be made in an objective and rational manner by allowing the costs of proceeding with a project to be measured against the benefits arising from the project in like and numeric terms.

It is difficult to assign a monetary value to the environment of the proposed site, given the lack of precedence and guidelines in the valuation of environmental resources not considered for commercial use, the site's relatively disturbed nature and its size. However, by identifying appropriate safeguards to mitigate against adverse environmental effects and including the cost of implementing these safeguards in the total project cost, the value and price of environmental resources is more accurately reflected.

The IGAE also refers to the polluter pays principle. The environmental safeguards and monitoring aspects of the proposal set out in Chapters 20 and 21 of this EIS ensure that any potential environmental impacts of the proposal are minimised.

17.7 CONCLUSION

The Steel River Project site remediation is directed at a combination of environmental and economic objectives which collectively summarise the principles of ESD.

Remediation of the Project site would allow redevelopment of the site for industrial land use which would leave significant economic benefits for the Region. While achieving this economic benefit the proposed works would have positive environmental impacts given that they would prevent the movement of contaminants off-site and numerous environmental safeguards and monitoring programs would be implemented to minimise the spread of contaminants during remediation.

18.0
HAZARDS AND RISKS

18.1 INTRODUCTION

A risk assessment of the Steel River Project site was undertaken by Woodward-Clyde in 1995. The findings of the risk assessment are based on conservative screening levels and are reported in the document "*Human Health and Environmental Risk Assessment, West of Tourle Street Site, Newcastle* (August 1995)".

Human health and ecological risk assessment is the process by which scientific data are analysed to describe the likelihood of harm to humans or the environment.

A hazard is defined as a physical situation with potential for human injury, damage to property, damage to the environment or some combination of these.

Risks are determined by the following factors:

- the potential for human or environmental exposure to the hazards given the existing and proposed site land use; and
- the presence of significant ecological receptors.

Risk assessment is a problem identification, analysis and evaluation process, used to facilitate the management of risk.

The following assessment of the hazards and risks which may arise as a consequence of the proposed remedial activities are based on the findings of the risk assessment of the Project site and the HASP prepared for the environmental investigation of the site and other remedial works.

18.2 HAZARD AND RISK TO ENVIRONMENT

The site is located within a heavily industrialised and urbanised area. Significant ecological features (eg remnant woodlands, wetlands, habitats for endangered species) were not identified within the site boundaries. The Hunter River environment was considered as a potential ecological receptor.

The prime hazards were considered to be off-site migration of contaminated groundwater and surface waters to the Hunter River System.

Potential risks considered were:

- effects on flora and fauna in contact with contaminated water and sediments;
- uptake of contaminants in flora or fauna in contact with or feeding in contaminated water or sediments; and
- magnification of contaminants in fauna feeding on affected flora or fauna.

In considering the risks it was found that:

- the site condition does not favour the generation of surface water runoff;
- the site surface has a relatively low level of contamination associated with it, with the possible exception of manganese;
- the prime contaminants present in groundwater with the potential to discharge to the river are manganese and PAHs;
- the mean concentration of manganese in groundwater in the fill was lower than has been consistently measured for background levels (Robert Carr & Associates, 1997);
- there was limited potential for the shoreline seepages to adversely affect river quality;
- the river sediments show no evidence of the accumulation of manganese or PAHs that could be directly attributed to contaminant discharges from the site; and

- there was some accumulation of manganese and PAHs in shoreline sediments over a relatively small area.

Given the above considerations, the qualitative risk assessment of potential risks to the environment indicated a low potential for the site to have adverse effect on the Hunter River ecosystem.

18.3 HAZARD AND RISK TO OFF-SITE POPULATIONS

Potential hazard and risk to off-site populations as a consequence of the remedial activities relates primarily to the presence of elevated concentrations of contaminants in the site. The human health risk assessment identified several exposure pathways by which off-site populations may come in contact with contaminants present at the site. Those pathways relevant to the proposed works are vapour and dust inhalation.

The risk assessment recognised that the inhalation of contaminated dusts by off-site residents may occur as a result of wind erosion of fill material or generation of dusts during excavation activities. In this instance however, the inhalation of contaminated dusts originating from the site during the proposed works was not considered to be a significant exposure pathway for off-site populations for the following reasons:

- dust suppression measures would be implemented;
- remediation would occur over a relatively short time frame;
- extremely dusty conditions would be required before unacceptable dust concentrations at the site boundary would be considered possible; and
- off-site populations are located a significant distance from the site.

The risks associated with the inhalation of vapours originating from contaminated soil and groundwater at specific areas of the site were examined in the human health risk assessment. The findings of the risk assessment in relation to on-site workers indicated a low potential for unacceptable risks, provided appropriate health and safety precautions are taken. On this basis the potential risks to off-site populations were assessed as being negligible.

18.4 HAZARD AND RISKS TO ON-SITE POPULATIONS

On-site populations who potentially may be at risk from the proposed works comprise site workers and visitors.

The categories of hazards which are likely to affect on-site populations during the proposed remedial activities are:

- chemical hazards;
- biological hazards;
- flammable hazards;
- safety hazards;
- electrical hazards;
- noise; and
- heat stress.

The specific nature of these hazards, as they relate to the proposed works, are examined in detail in the following sections.

18.4.1 Chemical Hazards

The risk assessment for on-site workers indicated a low potential for unacceptable risks to result from exposure to chemicals present at the site. The major findings of the risk assessment are listed as follows:

- In some areas of the site, concentrations of PAHs in surface materials are elevated due to the presence of tar. Ingestion of, and dermal contact with, fill material visibly affected by tar presents low level unacceptable health risks.

- Unacceptable health risks are not anticipated to result from the ingestion of, or dermal contact with fill material having elevated concentrations of metals. The average concentrations of metals would need to be at least 10 times higher than those used in the risk assessment calculations, in order to be associated with potentially unacceptable risks.

- Exposures to chemicals via dust inhalation is unlikely to be of concern because their estimated concentrations, despite the conservative assumptions, are low.

- It is unlikely that concentrations of volatile organic chemicals originating from the fill material or groundwater at the site would be associated with unacceptable risks to on-site workers due to the inhalation of vapours. As a safeguard, temporary buildings would be located away from areas containing elevated concentrations of volatile organic compounds.

The potential for unacceptable health risks to result from exposure to chemicals would be reduced by implementing safeguard measures such as dust suppression and, if required, ensuring on-site workers wear personal protective equipment (PPE). The appropriateness of the safeguards and PPE would be assessed based on the results of the environmental monitoring program.

18.4.2 Biological Hazards

The main biological hazard at the Steel River Project site is likely to be the risk of infection and tetanus from cuts and abrasions. Other biological hazards that may be present at the site include poisonous insects, spiders and snakes.

18.4.3 Flammable Hazards

During the proposed remedial works explosions and fires may result from activities, such as introducing an ignition source (ie a spark from equipment) into an explosive or flammable environment. Explosions and fires not only pose the obvious hazards of intense heat, open flame, smoke inhalation, and flying objects, but may also cause the release of toxic chemicals into the environment.

18.4.4 Safety Hazards

The Steel River Project site is likely to contain numerous safety hazards such as;

- holes or ditches;
- precariously positioned objects, such as drums or boards that may fall;
- sharp objects, such as nails, metal shards, and broken glass;
- slippery surfaces;
- uneven terrain; and
- unstable surfaces.

Conducting the remedial activities would also create additional safety hazards. Heavy equipment (eg. excavators) used for remediation, creates safety hazards for workers in the vicinity of the operating equipment. PPE worn by workers may limit manual dexterity, hearing, visibility and may increase the difficulty of performing some tasks and place additional strain on the wearer when performing work that requires physical activity.

18.4.5 Electrical Hazards

Overhead power lines and electrical equipment used on-site all pose a danger of shock or electrocution if workers contact or sever them during the remedial activities.

18.4.6 Noise

The effects of noise from large equipment used on-site, on workers, could possibly include the following:

- workers being startled, annoyed, or distracted;
- physical damage to the ear, pain, and temporary and/or permanent hearing loss;

- communication interference that may increase potential hazards due to the inability to warn of danger and the proper safety precautions to be taken.

18.4.7 Heat Stress

Heat stress is a major hazard, especially for workers wearing protective clothing although excessive PPE would not be required by all workers involved in the proposed works at all times. PPE can create a hazardous condition as they add weight and bulk, severely reduce the body's access to normal heat exchange mechanisms and increase energy expenditure (NIOSH/OSHA/USCG/EPA, 1985). Depending on the environmental conditions, the individual characteristics of the worker and the nature of work being performed, heat stress can occur very rapidly - within as little as 15 minutes.

In its early stages, heat stress can cause rashes, cramps, discomfort and drowsiness, resulting in impaired functional ability that threatens the safety of both the individual and co-workers. Continued heat stress can lead to heat stroke and death.

18.5 HAZARD CONTROLS

A site specific HASP, which establishes policies and procedures to protect workers and the public from the potential hazards posed by the proposed remedial activities, would be developed before remediation proceeds.

The '*Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*' 1984 recommends that at a minimum a HASP should;

- name key personnel and alternatives responsible for site safety;
- describe the risks associated with each operation conducted;
- confirm that personnel are adequately trained to perform their job responsibilities and to handle the specific hazardous situations they may encounter;

- describe the protective clothing and equipment to be worn by personnel during various site operations;
- describe any site-specific medical surveillance requirements;
- describe the program for periodic air monitoring, personnel monitoring, and environmental sampling if required;
- describe the actions to be taken to mitigate existing hazards to make the work environment less hazardous;
- define site control measures and include a site map;
- establish decontamination procedures for personnel and equipment;
- set forth the site's standard operating procedures; and
- set forth a contingency plan for safe and effective response to emergencies.

The types of control measures that would be used to make the work environment less hazardous are described in the following subsections.

18.5.1 Control of Exposure to Chemical Hazards

Work would be performed in a manner that minimises exposure (of persons both on-site and off-site) to contaminants through inhalation, ingestion or dermal contact. Work practices to reduce risk of chemical exposure would include:

- periodic air monitoring at the work zone, site boundaries and nearby residential area;

- monitoring of any excavation areas for volatile compounds should this be considered necessary;

- employment of dust suppression measures to minimise potential for migration of chemical hazards both within the site and off-site;

- implementation of water management controls (see Section 20.4);

- where wind speeds are such that the effectiveness of dust control measures are hindered work would cease until corrective action can be taken;

- WorkCover approved PPE (eg safety glasses, hard hats, safety boots, gloves and respirators where required) would be worn by all site personnel;

- eating, drinking and smoking would be prohibited in active areas of the work site. All workers would be required to wash their hands and face upon leaving the remediation area. This would control the ingestion of chemicals;

- washing with soap and water any body area which comes in contact with contaminated materials; and

- decontaminating equipment and personnel so as to limit the migration of contaminants off-site and to further minimise the risk of exposure to contaminants through skin and eye contact.

18.5.2 Control of Exposure to Biological Hazards

The risk of injury resulting from biological hazards can be reduced by wearing appropriate PPE and by ensuring that all site personnel have had current tetanus inoculations.

18.5.3 Control of Flammable Hazards

Work practices that would be employed to reduce the risk of injury resulting from flammable hazards include:

- regular maintenance of on-site equipment to a level in compliance with relevant WorkCover requirements. Unsafe equipment would be identified by the equipment operator and either made safe or removed from the site;

- a requirement that heavy machinery operators have access to a fire extinguisher at all times and that hose reels or fire water are easily accessible; and

- prohibiting smoking in active remediation areas and other areas which may be affected by flammable hazards.

18.5.4 Control of Safety Hazards

The risk of injury resulting from safety hazards would be reduced by;

- making site personnel aware of potential safety hazards on-site;

- ensuring all equipment brought on-site is adequately maintained and complies with relevant WorkCover requirements. Unsafe equipment would be identified by the equipment operator and either made safe or removed from site;

- ensuring site personnel are aware of the position of large machinery at all times;

- ensuring that site personnel are aware that PPE limits manual dexterity, hearing, visibility and may increase the difficulty of performing some tasks;

- being conscious of wind directions and coordinating field activities and petroleum powered equipment, so that exhaust fumes are located downwind (where possible) from work areas;

- ensuring that site personnel apply suitable sunscreen to the head and neck areas; and

- removing wastes and other materials from areas where site personnel are likely to trip over them.

18.5.5 Control of Electrical Hazards

The risk of injury resulting from electrical hazards can be reduced by ensuring that machinery is located at least 6 m from power lines and by avoiding work during electrical storms. Excavation clearances would be obtained prior to any ground disturbance should disturbance be necessary during remediation.

18.5.6 Control of Risks Caused by Excessive Noise

The risk of injury caused by excessive noise from heavy machinery can be reduced by wearing ear muffs or plugs and by standing as far away from the noise source as possible.

18.5.7 Control of Risks Caused by Heat

Avoiding over protection, careful training and frequent monitoring of site personnel who wear PPE, sensible scheduling of work and rest periods, and frequent replacement of fluids can protect against the hazard of heat stress.

18.5.8 Other Hazard Controls

Other hazard controls which would reduce the risk of injury to site personnel include;

- ensuring that site personnel and visitors to the site have read and understand the requirements of the HASP;
- limiting site access to personnel working on the site, project management and approved visitors who have undergone visitor clearance;
- developing site emergency warning systems and an emergency response plan;
- ensuring that at least one person trained (St Johns Ambulance or Red Cross) in basic first aid and cardiopulmonary resuscitation would be available; and
- identify key personnel responsible for site safety and emergency procedures.

18.6 CONCLUSION

The Risk Assessment Study found that the potential risks to nearby residents from the proposed works would be negligible. On-site workers would be protected from unacceptable risks from exposure to chemical, biological, flammable, electrical, noise and health hazards by implementation of a HASP, which would contain policies and procedures to protect workers and the public from potential hazards. This HASP would be put in place before the start of the proposed works.

19.0
CUMULATIVE IMPACTS

Cumulative impacts can result from a number of different elements within a project as well as from a number of different projects with interacting impacts in the same locality. The cumulative impact of a project is a combination of each elemental impact of the project. The impact of individual projects, such as this one, when considered in light of other projects within a locality also needs to be assessed.

This chapter discusses both forms of cumulative impact by summarising impacts as identified in Part D of this EIS in total. This total impact of the proposed works is then considered in conjunction with other known projects in the area.

19.1 TOTAL CUMULATIVE IMPACT OF PROJECT

The cumulative impact of all factors of the remediation project is shown in Table 19.1.

TABLE 19.1 CUMULATIVE IMPACT OF PROJECT

FACTOR	IMPACT
Landform, geology, soils and geotechnical	Erosion potential ameliorated by stormwater control measures. Some vegetation clearance required initially.
Hydrology and Water Quality	Surface water management and drainage controls resulting in minimal impact on South Arm of Hunter River. Potential improvement in groundwater quality.
Air Quality	Best work practices to minimise emissions from site. Negligible impact on regional air quality.
Noise and Vibration	Acceptable noise levels from remediation activities at adjacent sites.
Socio-economic	Project allows site to be developed as an Industrial Park with consequent employment generation.

FACTOR	IMPACT
Archaeology and Heritage	No known archaeological site or relic located within the study area.
Landscape and Visual	Remediation area predominantly hidden from view. Some partial views possible.
Flora and Fauna	No rare or threatened flora or fauna species identified at the site. No significant impact on observed or possibly occurring flora or fauna species. Vegetation on site not significant habitat for several threatened species of birds and mammals.
Services and Utilities	Minimal demand placed on water and power services.
Traffic and Transportation	Additional traffic, particularly during remediation. Minimal impact during the daytime. No impact is expected from operational traffic.

Table 19.1 indicates that the cumulative impact of the project would be at most minimal. Most of the impact would be during the proposed works which would be phased, be of a limited duration at any one time, and would be carried out in the short term.

19.2 CUMULATIVE IMPACT WITH OTHER PROJECTS

Discussions with Newcastle City Council have indicated that there are no projects, other than the remediation works, proposed for the local area. Any projects of significance in the wider area are largely confined to Kooragang Island.

The cumulative impacts of these proposals with the remediation would be confined, predominantly, to the remediation period and are therefore only considered to be short term. The most significant cumulative impact of the Kooragang Island proposals would relate to additional traffic on Tourle Street. As the proposed works would be carried out in a phased manner in the short term, the cumulative impact with other projects is considered to be minimal.

19.3 CONCLUSION

As the proposed works would take place over a five year timeframe and the impact of the individual factors is negligible, no significant cumulative impact is anticipated from the project. The cumulative impact of works with other known projects proposed for the wider area as described above, is also considered to be insignificant.

PART F

ENVIRONMENTAL MANAGEMENT

20.0 MANAGEMENT AND MONITORING

20.1 ENVIRONMENTAL MANAGEMENT AND MONITORING PRINCIPLES

A number of environmental management and monitoring tools have been identified in the preparation of this EIS. If the project proceeds, implementation of these measures would be necessary to ensure that the project has minimal impact on the physical, social and economic environments of the local area and wider region.

The proposed works on the subject site would be a significant undertaking. Without appropriate environmental management measures being incorporated into the detailed design of the project and the contractual arrangements associated with the proposed works, potential would exist for adverse impacts on the environment to occur. Adoption of an appropriate Environmental Management Plan (EMP), inclusive of an Landfill Environmental Management plan (LEMP), and monitoring program would therefore be an important component of the proposal and underlines the commitment of BHP to the safeguard measures outlined in this EIS.

20.2 ENVIRONMENTAL MANAGEMENT PLAN

An EMP is a procedural document which outlines the environmental goals of the project, the safeguard measures to be implemented, the timing of the implementation in relation to the progress of the project, responsibilities for implementation and management, and a review process.

In general the EMP addresses the pre-remediation, remediation and post-remediation phases of the project and is prepared following assessment of the project. It would provide a working tool to be used during the detailed design of the proposal and would form the basis for environmental specifications in any contractual arrangements between the proponents and those parties conducting the remedial activities.

The EMP would include:

- establishment of environmental goals and objectives;
- conditions of project approval;
- list of actions, timing and responsibilities;
- supervision protocols fully identifying areas of responsibility for environmental management of the project;
- statutory requirements (licences and approvals required);
- a structured reporting system detailing all relevant matters on a regular basis;
- procedures and forms for documentation and reporting of issues;
- standard specifications incorporating environmental safeguards;
- training of personnel (proponent and contractor) in environmental awareness and Best Practice Environmental Management Systems;
- guidelines for emergencies, contact names and corrective actions for non-conformance and notifications to appropriate authorities and affected parties;
- calibration and measuring of testing equipment;

- process surveillance and auditing procedures;
- review procedures and protocols for modification of the EMP;
- complaint handling procedure;
- site management and control procedures;
- monitoring procedures; and
- quality assurance procedures.

The EMP would be made available to the EPA, Newcastle City Council, government departments, statutory authorities, the community and all other interested organisations and individuals.

Key components of the EMP are the:

- General Site Management Plan;
- Water and Sediment Management Plan;
- Dust Management Plan;
- Noise Management Plan; and
- Landfill Environmental Management Plan.

The safeguards and environmental controls for each of these key components have been detailed previously in the text, however, the monitoring and management requirements associated with these environmental controls will be detailed in the following sections.

As a guide to establishing an EMP, the general structure would be similar to that shown below:

ITEM	DESCRIPTION
Introduction and purpose	Details the objectives of the Plan.
Statutory requirements and integration with other plans	Details the statutory requirements, if any, and other obligations required to be met as part of the licensing approval.
Environmental management procedures	Describes the operational procedures for preventing environmental impacts, nominates responsibility to individuals, establishes reporting protocols and procedures, nominates corrective and preventative action procedures.
Monitoring requirements	Details the monitoring program for checking environmental performance of the project, nominates responsibilities to individuals, establishes reporting protocols and procedures, nominates corrective and preventative action procedures.
Emergency response	Contains emergency response plans.

Issues to be considered in the monitoring program include:

- background data;
- sampling procedures;
- reporting and data interpretation;
- recommendations;
- laboratory procedures; and

- statutory limits.

Monitoring requires an on-going commitment and continual maintenance of records, both prior to project commencement (baseline) and during site works. Should routine monitoring and/or external parties identify a potential issue relating to the site works, the EMP would have provision for the potential issues to be logged, validated and where required rectified. If necessary the scope of monitoring would be increased in order to address the potential issues as they arise. Figure 20.1 provides an outline of an issues response procedure which could be adopted.

20.3 GENERAL SITE MANAGEMENT PLAN

The objectives of the General Site Management Plan are as follows:

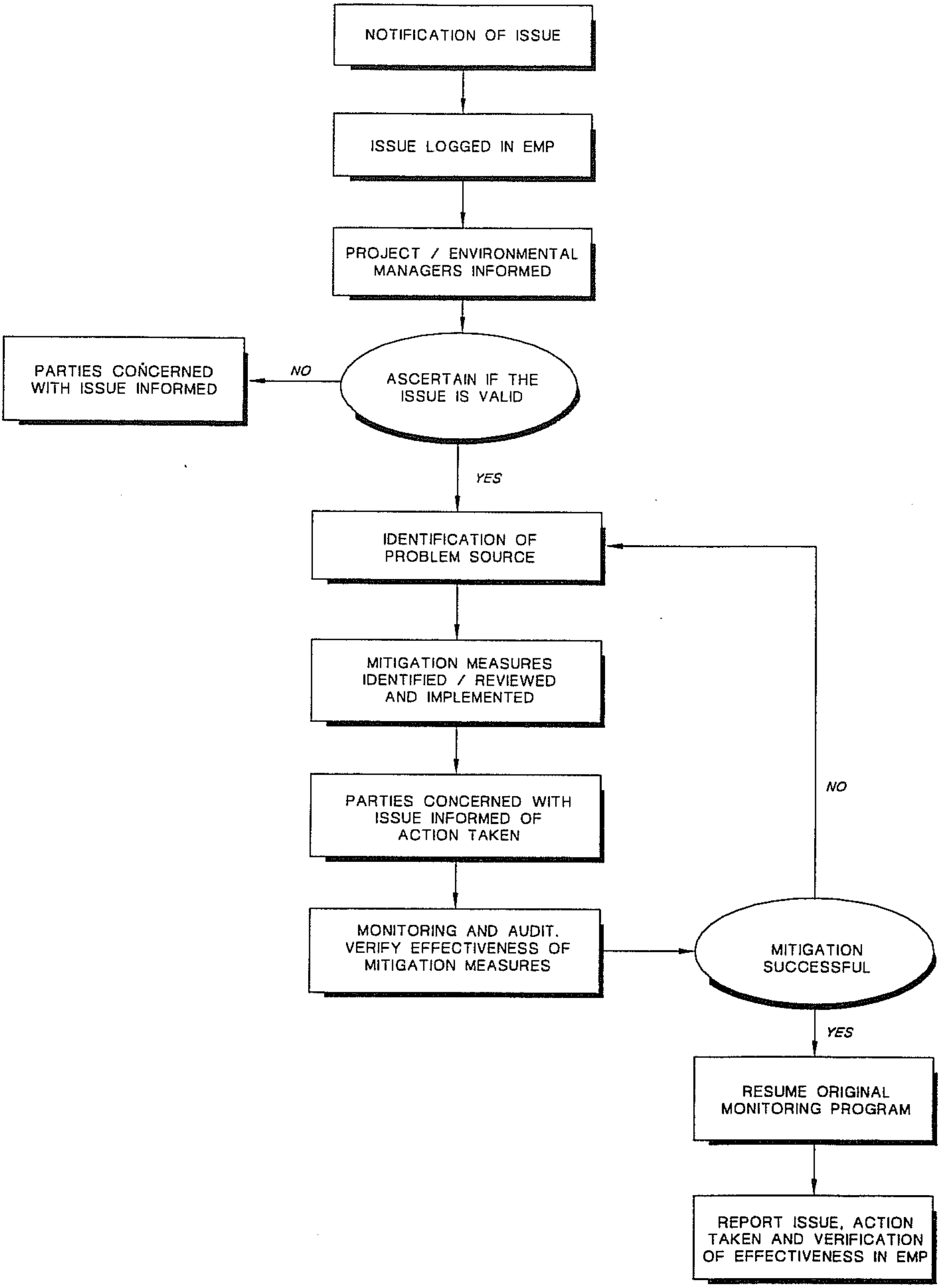
- where possible, control the visual impact of the site works;
- prevent unauthorised entry and minimise risk of injury;
- institute a site health and safety plan to protect site workers and site visitors;
- minimise risk of transport of contaminants off-site by workers or equipment; and
- control traffic impacts of the project.

20.3.1 Site Screening

The site is naturally screened from the public along much of its road frontage by the landform of the site and vegetation. In addition, buildings located between the site and the Pacific Highway provide further screening from the general public.

20.3.2 Site Security and Access

Site security is an important component of an EMP. Implementation of appropriate security measures prevents exposure of any potentially contaminated fill to unauthorised



Woodward-Clyde	CLIENT **BHP STEEL (NEWCASTLE)** PROJECT **STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS**	REVISION: A SCALE: N/A DRAWING No: A86 248/0040 CAD FILE NO: Q.064 DATE: 21/5/97	DESIGNED: ST DRAWN: HC CHECKED: SKT APPROVED: CB STATUS: FINAL	TITLE **ISSUES RESPONSE PROCEDURE** FIGURE **20.1** A4

people and prevents theft or vandalism of any environmental control and monitoring structures.

The following site access and security measures would be adopted:

- the existing fence surrounding the site would be inspected by the Site Supervisor on a regular basis and repairs would be made promptly where required;
- signs would be erected at all potential access points, warning the public of the dangers of entering the site;
- the trucks used for hauling materials to the site would be inspected after unloading, and before leaving the site, to ensure that soil adhering to the wheels or undercarriage is minimised. Any accumulation of soil would be removed prior to departure from the site;
- all truck drivers carting fill materials to the site would be given a safety instruction brief. The brief would be concise and would detail the procedures to be followed by the truck driver should the following occur:
    - vehicle accident;
    - mechanical breakdown; and
    - payload (or other) loss.
- Operating practices that prevent spillage from occurring, such as checking that trucks are not overloaded, adhering to speed limits, covering truck bins, and carefully loading and unloading materials, would be used.

20.3.3 Site Health and Safety Plan

The Health and Safety Plan (HASP), would provide a general description of the chemical and physical hazards associated with the field work to be undertaken as part of the site works. The primary objective of the HASP would be to establish the health and safety requirements and protection procedures necessary, to minimise the potential for exposures and injuries to field personnel.

The HASP would describe the procedures to be followed and the protective equipment to be used by personnel working on-site. All activities carried out would also comply with all BHP or future site owners requirements for contractors and site health/safety clearance procedures.

Site Health And Safety Inductions

All personnel involved in remediation, recontouring, monitoring and validation activities would attend a health and safety briefing to be presented by the site owners prior to work on the site. During the briefing session, an overview of the project would be presented including:

- scheduled remediation activities and personnel responsibilities;
- site control procedures;
- contaminants and hazard identifications and precautions;
- exposure risk;
- warning symptoms from exposure to contaminants;
- protective equipment usage;
- decontamination facility and procedures;
- prohibitions; and
- emergency response.

The health and safety briefing would be repeated to new personnel as they arrive at the site by the site owner's representative. In addition, on-site safety meetings would periodically review safety requirements and discuss modifications to the Health and Safety Plan. Site personnel and visitors would be required to sign in and out of the site office daily with identification cards displaying which areas of the site they are allowed to be present in. Upon the discovery of any arisings requiring relocation, temporary barricading would be erected to restrict access to those workers with the correct clearance and the area would be designated as an active remediation area.

Compliance Agreements

All personnel involved in the remediation activities would be required to read a copy of the HASP, be assessed for understanding and sign a compliance agreement prior to commencing site work.

Decontamination Procedures

The HASP would outline the procedure for decontamination of personnel leaving any active remediation area prior to breaking for eating, drinking, smoking or using the toilet, and before leaving the site.

All tools, vehicles or equipment which have been in contact with contaminated materials would be decontaminated after leaving the active remediation area.

20.3.4 Traffic Management

The traffic impacts of the project are considered to be minimal on both the surrounding streets and on the arterial road network. The following operational protocols have been incorporated. Details are available in Section 14.5.

- haulage trucks would observe the nominated haulage routes;
- signage would be implemented to ensure smooth merging of traffic on Industrial Drive;
- heavy equipment would be retained on-site;

- CWR would only be transported during daylight hours; and
- in the event that concentrated fluid hydrocarbons are recovered on-site, a licensed contractor would be used to transport the waste along a route approved by the local traffic authority.

20.4 WATER AND SEDIMENT MANAGEMENT PLAN

Contaminated water and sediment may be generated by stormwater which comes into contact with contaminated fill, and perched groundwater within the excavations. A Water and Sediment Management Plan would be used to mitigate these effects by:

- minimising and controlling sediment released as a result of site excavations and the importation of materials;
- preventing surface run off from becoming contaminated as a result of soil disturbance or contact with contaminants;
- controlling and treating potentially contaminated run off in water quality control ponds or treatment systems before reuse or discharge from the site;
- treating any floating organics on groundwater encountered during the proposed works; and
- protecting stormwater systems from site sediments and organic contaminants.

Where any result from monitoring exceeds a threshold agreed with the EPA, the source of contamination would be investigated, and appropriate remedial actions taken.

20.4.1 Stormwater and Sediment Management

The management of the stormwater would rely on preventing contamination of water and on containment, assessment, treatment and disposal of water which becomes contaminated.

There is currently no management of stormwater on the site. Any water falling on the site either ponds on the surface before eventually evaporating, or infiltrates into the substrata.

In order to ensure appropriate environmental management of surface waters including those coming into contact with remediation areas, a range of actions to meet these objectives would be implemented. The controls and safeguards were detailed previously in Sections 6.6 and 7.6 and would be implemented from the outset to control erosion and potential sediment transport from the site, and to prevent a decline in surface water quality.

The monitoring of water pollution control works would include:

- A pollution control approval and licence would be obtained for water pollution control works proposed for the site prior to commencing works on the site. The requirements of the approval and licence would be incorporated into the site EMP and responsibility for meeting statutory requirements delegated to appropriate project personnel.

- A series of plans indicating the staging of the works would be formulated and the necessary safeguards identified for each stage. At the commencement of each stage an audit of control measures would be undertaken and the implementation of control measures verified. The staging plans would be reviewed 6 monthly and implementation of control measures revised as necessary. Stabilisation of completed areas would be undertaken progressively and immediately final surface levels are reached.

- Weekly inspection of water control measures, including sediment control ponds and filter fences would be undertaken. The control measures would also be inspected within 24 hours of significant rainfall events which cause runoff. After rainfall an assessment of the reuse potential of contained stormwater would be undertaken and site operations amended to maximise the reuse of water on site.

- If control measures do not meet the objectives of the plan, corrective action would be instituted. A follow up inspection would be undertaken to verify the outcome of the corrective action.
- Water pollution control monitoring would include monthly measurements of non-filtrable residue (NFR), oil and grease, pH and other chemicals of concern as agreed with the EPA, from the discharge of all sediment control ponds. Monitoring would also be undertaken after significant rainfall events.

- A monthly report of inspections, monitoring and corrective action would be maintained and provided to relevant authorities for licencing purposes.

20.4.2 Perched Groundwater

It is possible that excavation work to be undertaken during the proposed works may encounter/intersect the perched groundwater table. The Water and Sediment Management Plan for the Project site would address the recovery, handling and disposal of the floating hydrocarbon fluids in those circumstances where the occurrence (quantities) presents an occupational health and safety hazard during soils handling. Section 7.6.2 provides the controls and safeguards which would be implemented to manage recovery of contaminants.

Management and monitoring would include weekly review of excavation activities to identify issues related to floating hydrocarbon recovery and disposal, as well as the performance of the groundwater treatment system. Monitoring of the treatment system would include NFR, oil & grease, pH and other chemicals of concern as agreed with the EPA.

It is not anticipated that the quality of groundwater within the fill would be significantly affected by the proposed works. However, the reduction of infiltration to groundwater would cause the groundwater level to lower and thus decrease the contact between potentially contaminated fill and groundwater. The monitoring of groundwater would therefore include the periodic measurement of groundwater level to track the fall in levels, as well as field parameters of pH and turbidity to identify changes in the basic chemistry of the groundwaters encountered in the fill.

20.5 DUST MANAGEMENT PLAN

The overall objective of the Dust Management Plan would be to control the amount of dust generated from the proposed works, and to ensure minimal impact on the air quality of the local area, and the health of on-site workers and the general community. Controls and safeguards which would be implemented to achieve this objective are detailed in Sections 6.6 and 9.7.

These procedures would ensure that the works are performed in such a way as to minimise the production of fugitive emissions emanating from the site. The work would be undertaken in a manner which conforms with all WorkCover regulations for the handling of dust to ensure emissions are minimised and within regulations. All due care would be taken to ensure that dust is not evident outside the site boundaries.

The requirements of the air licence for the site would be incorporated into the site EMP and responsibility for meeting statutory requirements delegated to appropriate project personnel.

Dust monitoring would be undertaken prior to, during and following the proposed works. The likely location(s) of monitors would be based on the wind speed and wind direction information available for the Newcastle region. Exact location(s) would be subject to physical and logistic operational requirements.

Methods employed for monitoring include:

- high volume air sampling (HVS), based on a 24 hour sampling period every sixth day from a commencement date prior to the start of the site works. Sampling would be carried out for total suspended particulates (TSP) which provides a measure of mean suspended dust concentrations over time. This monitoring would be performed in accordance with Australian Standard 2724.3-1984;

- dust deposition monitors, used to measure the routine deposition of air borne particles over extended periods (typically monthly). This work would be performed in accordance with Australian Standard AS 3580.10.1-1991, which provides a measure of mass deposition rate assessment of deposited insoluble solids;

- one real-time portable PM10 dust monitor to monitor dust generating activities and identify episodes of high dust levels as they occur so actions can be taken to minimise the dust emissions. The real time information would supplement the HVS data, and in conjunction with wind data would provide information on the likely sources of dust; and

- one automatic wind recorder should be installed on-site to provide real time information on prevailing wind conditions. The recorder can be fitted with an arm to indicate when winds exceed a speed (to be determined in consultation with the EPA) for a certain period, so that dust generating activities on-site could cease until wind speeds decrease.

The above methods of monitoring would be supplemented by the use of observational techniques and comprehensive daily logs of site activities which are standard practice for large earthworks programs.

20.6 NOISE MANAGEMENT PLAN

The main objective of the Noise Management Plan is to ensure that the proposed works would be carried out in a manner which would have least impact on the noise environment of the locality and conform to EPA guidelines. This would be achieved by ensuring:

- that best practice techniques are used to minimise unnecessary noise; and

- the regulatory limits for noise emissions are strictly adhered to.

The controls and safeguards outlined in Section 10.5 would be incorporated into the Noise Management Plan to ensure that noise impacts are within EPA guidelines.

Regulatory limits for noise would be met by applying the following management and monitoring procedures:

- all equipment would be selected on the basis of its noise performance;
- all equipment would comply with regulatory standards for noise generation, including the EPA's Environmental Noise Control Manual;
- operations on the site would be routinely monitored to ensure that noise emissions from site activities do not exceed the guidelines specified in the NSW EPA Environmental Noise Control Manual;
- all equipment would be operated in a correct manner which includes proper maintenance;
- testing of equipment for compliance with manufacturers specifications would be undertaken;
- stockpile areas would be positioned to take advantage of their acoustic barrier properties, but equally taking into consideration the noise generated during stockpile access;
- hours of operation would be observed including prevention of noise occurring from the early arrival of equipment to the site prior to agreed operating hours; and

- all practical measures would be used to silence excavation and/or construction equipment. All noise control equipment would be maintained in good order and used properly at all times.

Monitoring for noise would be undertaken on days randomly selected and at a frequency of 1 day per month throughout the site works program to ensure that operational targets are not exceeded.

20.7 LANDFILL ENVIRONMENTAL MANAGEMENT PLAN

The recontouring of the site involves the importation of CWR over a period of approximately five years, to provide the necessary grading to encourage stormwater runoff. The site is currently quite flat. Due to the substantial quantities of CWR to be imported, the Waste Minimisation and Management Act, 1995 and Regulation, 1996, requires that the site be classified as a Class II inert waste landfill and as such requires licensing as a controlled waste facility. Part of the licensing requirements is the submission of a LEMP, with an outline to be provided at the initial EIS stage. Appendix L contains a table of contents for the intended final LEMP.

The purpose of the LEMP is to identify key environmental management issues and detail the site specific strategic approach that the landfill occupier will put in place to meet the Environmental Goals for the landfill's operation as identified in the Environmental Guidelines: Solid Waste Landfills (Landfill Guidelines), EPA, 1996. The LEMP applies specifically to the importation of CWR and the recontouring of the site.

Due to the nature of the project, being largely civil earthworks and bulk transport (inert waste), some items pertaining to putrescible landfills, as well as solid waste landfills, do not apply in this case.

As identified in the table of contents in Appendix L, all major issues addressed in an LEMP have been included within this EIS. The relevant sections of this EIS would be compiled into a comprehensive format to submit with a licence application to the EPA.

Outlined below are the key environmental management issues that apply to this project and the Sections where their control and management is considered.

20.7.1 Air Quality and Noise

CWR is an inert non-putrescible material that is intrinsically a natural soil/weathered rock that does not readily decompose. As such, no landfill gas would be generated from CWR and therefore no landfill gas controls or monitoring would be required.

Controls and monitoring procedures would be put in place to ensure levels of noise and dust comply with the relevant regulations (see Sections 9, 20.5 and 10, 20.6 respectively). Air quality issues would be similar to those at any large earthworks type project.

20.7.2 Leachate

Leachate as defined in the Landfill Guidelines, is a "liquid released by, or water that has percolated through, waste and which contains dissolved and/or suspended liquids and/or solids and/or gases."

CWR, like any other soil or rock, can be subject to leaching with the movement of a liquid through its matrix. CWR is a naturally occurring material with a low leaching potential and thus generation of leachate from the site would not be significant and no leachate monitoring would be required.

Appendix G contains laboratory data that quantified the leachate formed from CWR when subjected to deionised water as well as more aggressive media (acidic/alkaline). The results showed that the CWR could be classified as inert, according to the guidelines outlined by the EPA in the Draft Hazardous Waste Definition and Draft Environmental Guidelines: Solid Waste Assessment.

20.7.3 Surface Water and Sediment

As is typical for any large construction projects, strict surface water runoff controls, collection and monitoring would be required (see Sections 7 and 20.4).

20.8 SITE VALIDATION

The proposed works involve covering areas identified as exceeding the remediation criteria in the upper two metres of fill, to provide a physical separation between these materials and workers who would use the site after future redevelopment. In addition, materials which exceed the criteria in the top two metres and are exposed during redevelopment within the site, would be relocated to areas of the site which are subsequently covered by two metres of imported fill. The documentation of the site contamination status after these works are undertaken is as follows:

- the existing site surface would be subject to a detailed survey to define the surface of the existing fill and natural materials;
- the area identified on Figure 4.3 as potentially having materials which exceed the remediation criteria in the upper two metres of fill would be defined by survey co-ordinates (eastings, northings and AHD);
- the location of containment areas where contaminated materials have been placed after exposure during redevelopment would be defined by survey co-ordinates (eastings, northings and AHD);
- the receipt of CWR materials from the Macquarie Coal Preparation Plant would be tracked to ensure no other materials are imported to the site unless assessed as suitable;
- the recontoured site surface would be subject to a detailed survey to define the final surface levels before redevelopment construction activity; and

- monitoring of standing water levels, as well as basic water quality parameters, from nominated boreholes to validate that the water table mound currently existing on site is subsiding.

A final report following the validation stage of the work would be prepared. This report would be issued to the EPA and Council for information. This report would be prepared in compliance with the EPA's guidelines and would be suitable for third party audit, if required. The final report would contain the following major sections:

- site identification;
- scope of works;
- sampling results and methodology (data summary);
- field QA/QC;
- laboratory QA/QC;
- QA/QC data validation;
- validation and monitoring assessment; and
- conclusions.

20.9 QUALITY ASSURANCE/QUALITY CONTROL PLAN

A site specific Quality Assurance/Quality Control Plan (QA/QC) plan would be prepared prior to the commencement of the proposed works. A copy of the QA/QC plan would be available on-site at all times with copies forwarded to the following regulatory bodies; Newcastle City Council, Environment Protection Authority (EPA) and WorkCover.

The plan would cover the following aspects of work.

- Project Organisation and Responsibility;
- Calibration Procedures;
- Surveying;
- Decontamination;
- Documentation of Field Activities;

- Validation;
- Laboratory Analysis Program; and
- Nonconformance.

20.10 POST REMEDIATION MANAGEMENT PLAN

A Post Remediation Management Plan would be prepared to ensure that future activities on the Project site do not create unacceptable risk to human health or the environment.

Any intrusive works conducted on-site would be required to be in compliance with a Health and Safety Plan designed specifically for post remediation activities and with BHP or future site owner requirements for contractors.

Any contracting personnel involved in the intrusive works (eg drillers, plumbers etc) would be required to attend an induction briefing presented by a representative of the site owner and obtain a permit prior to the commencement of any works on-site. Issues which would be included in the briefing are:

- health and safety requirements for intrusive work;
- the identification of hazards;
- the appropriate action on identifying a hazard, including health and safety procedures, the site owners contact person and measures to protect the immediate environment;
- contamination assessment and delineation procedures;
- appropriate remedial actions based on the contamination assessment;
- the documenting of actions and location of contaminated materials (arisings); and
- the notification of relevant statutory authorities.

As a principle, where possible, contaminated material (arisings) would be handled within the relocation areas. The location of materials exceeding remediation criteria would be documented by survey and copies of the documentation provided to the EPA and Council.

The landscape mediums imported onto the site for use in public open spaces where existing fill materials have the potential to exceed the remediation criteria, would be the type of material suitable for use in parks, recreational open space and playing fields.

21.0
SUMMARY OF SAFEGUARD MEASURES

A number of environmental safeguards/mitigation measures to reduce any potential environmental impacts which may be generated by the proposed works have been detailed in the various subject chapters.

These measures would be implemented throughout the duration of the project. Table 21.1 summarises these safeguard measures, sets up priorities for implementation, and lists the authorities responsible for ensuring that these safeguard procedures are carried out. This is the first step in the preparation of an EMP which forms the link between environmental assessment and construction operations. The EMP would include a general environmental management component, designation of environmental responsibilities and general environmental procedures with respect to reporting, complaint investigation, operator training, engineering response procedures and so on.

TABLE 21.1 SAFEGUARD MEASURES

ISSUE	SAFEGUARDS	IMPLEMENTATION PHASE [1]	RESPONSIBILITY
Environmental Management Environmental management & monitoring.	• Prepare and implement an EMP.	1	BHP
(1) Implementation	1 Preremediation	2 Remediation	3 Post Remediation

TABLE 21.1 SAFEGUARD MEASURES

Geotechnical and Soils			
Sediment Transport	• Implement a Water and Sediment Management Plan to address areas affected by remedial works.	1, 2	BHP/contractor
	• Construct earthen bunds and similar diversion drains around the perimeter of any excavation zones.	1, 2	BHP/contractor
	• Divert surface runoff from outside the site, away from the site.	1, 2	BHP/contractor
	• Construct stormwater and sediment retention ponds adjacent to the containment areas.	1, 2	BHP/contractor
	• Keep the working face and areas of open excavation to a minimum.	2	BHP/contractor
	• Minimise the need for stockpiling.	2	BHP/contractor
	• Apply water to active work areas, stockpiles and loads of soil being transported, if necessary.	2	BHP/contactor
	• Restrict traffic movements to compacted haulage roads where possible.	1, 2, 3	BHP/contractor

(1) Implementation 1 Preremediation 2 Remediation 3 Post Remediation

TABLE 21.1 SAFEGUARD MEASURES

Geotechnical and Soils (Cont'd)	• Construct silt fences and diversion drains around stockpile areas.	2	BHP/contractor
	• Use retention ponds as required to maintain control of surface runoff.	1, 2	BHP/contractor
	• Should excess fugitive dust be observed, work would cease or be phased down while the source is being investigated and suppression measures implemented.	2	BHP/contractor
	• Soil adhering to the undercarriage or wheels of trucks would be removed prior to departure from the site.	2	BHP/contractor
	• Retention ponds would be provided as required to control surface runoff.	1, 2	BHP/contractor
	• Stabilise bare surfaces.	3	BHP/contractor
(1) Implementation	1 Preremediation	2 Remediation	3 Post Remediation

TABLE 21.1 SAFEGUARD MEASURES

Water Quality and Hydrology			
Sediment Transport	• Implement a Water and Sediment Management Plan to address areas affected by remedial works.	1	BHP
	• Divert outside runoff away from the site.	2	BHP/contractor
	• Redirect on-site runoff away from remedial areas.	2	BHP/contractor
	• Construct stormwater and sediment retention ponds adjacent to the containment areas.	1, 2	BHP/contractor
	• Rainfall that comes in contact with contaminated areas would be collected in sumps and pumped into the retention ponds located beside the containment areas.	1, 2	BHP/contractor
	• Construct earthen bunds and similar diversion drains around the perimeter of any excavation zones.	2	BHP/contractor
	• Construct silt fences and diversion drains around stockpile areas.	1, 2	BHP/contractor

(1) Implementation 1 Preremediation 2 Remediation 3 Post Remediation

TABLE 21.1 SAFEGUARD MEASURES

Water Quality and Hydrology (Cont'd)	•		
Contamination of surface water	• Redirect surface runoff away from remedial areas.	1, 2	BHP/contractor
	• Collect, store and treat (if necessary) surface water which comes in contact with contaminated soil.	2	BHP/contractor
Groundwater Control	• Develop a Water and Sediment Management Plan which addresses the recovery, handling and disposal of floating hydrocarbons.	1, 2, 3	BHP
	• Use absorbent materials (if necessary) to recover floating hydrocarbons.	2	BHP/Contractor

(1) Implementation 1 Preremediation 2 Remediation 3 Post Remediation

TABLE 21.1 SAFEGUARD MEASURES

Air Quality			
Generation of dust and suspended particulates	• Prepare a Dust Management Plan detailing control and monitoring programs for minimising the impact of soil movement, dust and odour.	1	BHP
	• Water exposed surfaces and stockpiles as required.	2	BHP/contractor
	• Stabilise long term stockpiles where possible.	2,3	BHP/contractor
	• Seal access and haul roads.	3	BHP/contractor
	• Control vehicle speed along haul roads.	1,2,3	BHP/contractor
	• Ensure loads of soil in haul vehicles do not exceed the heights of the side and tailboards.	2	BHP/contractor
	• Maintain access and haul roads interface with public roads to prevent degradation.	1,2,3	BHP/contractor
	• Water loads of material being transported by trucks if atmospheric conditions lead to excessive fugitive dust emission.	2	BHP/contractor

(1) Implementation 1 Preremediation 2 Remediation 3 Post Remediation

TABLE 21.1 SAFEGUARD MEASURES

Air Quality (Cont'd)	• No material to be burnt on-site.	2	BHP/contractor
	• Water sprays would be used as required across work zones to suppress dust.	2	BHP/contractor
	• Exposed areas would be minimised by staged programming.	2	BHP/contractor
	• Soil adhering to the undercarriage or wheels of trucks would be removed prior to departure from the site.	2	BHP/contractor
Landscape and Visual			
Impact on visual amenity	• Minimise the removal of mound and boundary screen plantings.	2	BHP/contractor
	• Enforce dust minimisation safeguards.	2	BHP/contractor
	• Bare work faces on-site would be minimised.	2	BHP/contractor
(1) Implementation	1 Preremediation	2 Remediation	3 Post Remediation

TABLE 21.1 SAFEGUARD MEASURES

Noise			
Noise emissions	• Preparation of Noise Management Plan.	1	BHP
	• Most remediation to take place during designated hours of 7 am - 6 pm Monday-Friday and 7 am - 1 pm on Saturday.	2	BHP/contractor
	• Work outside designated hours not to be undertaken prior to notification to regulatory authorities.	2	BHP/contractor
	• Noise level monitoring.	2	BHP/contractor
Flora and Fauna			
Potential for adverse effects on habitats of native species of flora and fauna	• Erect signs to prohibit the dumping of rubbish of any kind within the site.	1	BHP/contractor
	• Retain patches of remnant bushland in the southwestern section of the site as well as mound and boundary screen plantings where possible.	1,2,3	BHP/contractor
Traffic and Transportation			
Traffic hazards and congestion.	• Select a transport route which would have the least impact on built up areas and traffic flow.	1	BHP

(1) Implementation 1 Preremediation 2 Remediation 3 Post Remediation

TABLE 21.1 SAFEGUARD MEASURES

Traffic and Transportation (Cont'd)	• Erect signs to ensure site traffic and existing traffic merge smoothly.	1,2	BHP/Contractor
	Enforce haulage restrictions on trucks transporting CWR.	1,2	BHP/Contractor
	• Retain equipment on-site for the duration of that phase of work for which it is required.	2	BHP/Contractor
	• Cover loads of CWR.	2	BHP/Contractor
	Use a licenced contractor to transport hydrocarbons if this task is required.	2	BHP/Contractor
	•		
Hazards and Risk	• Develop a Health and Safety Plan for the works being undertaken.	1	BHP/Contractor
	• Use measures to control exposure to chemical, biological, flammable, safety, electrical and other hazards.	1,2	BHP/Contractor
Land Use and Property Impact on surrounding land uses	• Implement the safeguards detailed above to control erosion, dust emissions, noise levels and to allow revegetation.	1,2,3	BHP/Contractor

(1) Implementation 1 Preremediation 2 Remediation 3 Post Remediation

TABLE 21.1 SAFEGUARD MEASURES

Site Management	• Ensure activities on the site incorporate adequate management practices for the careful treatment of rubbish and waste materials, and domestic waste water, and limit soil disturbance and erosion.	2, 3	BHP/Contractor
Archaeology and Heritage			
	• No specific safeguards required.	-	-
	If Aboriginal archaeological sites are discovered during the works they would be reported to the NPWS and Local Aboriginal Land Council.	2	BHP/Contractor
(1) Implementation	1 Preremediation	2 Remediation	3 Post Remediation

PART G

FINDINGS

22.0
CONCLUDING STATEMENT

This EIS has been prepared by AGC Woodward-Clyde Pty Ltd on behalf of BHP to assess the potential environmental impacts of the proposed remediation works. The proposed works, located at Mayfield West, Newcastle, would rehabilitate the site in a manner that would enable its future use for industrial purposes.

22.1 NEED FOR PROPOSAL

Remediation of the site is required to contain contaminants at the site in order to enable the release of valuable industrial land for redevelopment. The main features of the proposal include:

- management of contaminants in situ;
- importation of CWR and movement of some on site material for the purposes of capping and recontouring the site;
- reduction of surface water inflow and hence lowering of the water table to reduce off-site discharge; and
- creation of a site which is usable for other purposes.

Rehabilitation of the subject site is necessary to enable future industrial redevelopment to occur on the site. The main features of the proposal are:

- ensuring that contaminated soil and groundwater are contained on-site without affecting the local environment;
- ensuring that future industrial redevelopment of the site can be undertaken with minimal risk to the health of on-site workers or the surrounding community; and
- the establishment of industry in the area which would benefit the local community and Newcastle region by generating government revenue, creating employment opportunities and stimulating the local economy.

22.2 IMPACT ASSESSMENT

This EIS has been prepared in accordance with Part 4 of the EP&A Act and the Environmental Planning and Assessment Regulation, 1994. Part 4 deals with environmental planning control and relates to development which is controlled by an existing planning instrument.

An assessment of the environmental impacts of the proposal was carried out which included the effects on soils and landform. water quality, the noise environment. flora and fauna, local traffic and transportation and the socio-economic environment.

The assessment of the possible effects of the proposed development on the environment indicates that there is potential for minimal adverse impacts. These impacts, although minimal can be ameliorated by the safeguards recommended in this EIS.

22.3 CONSEQUENCES OF NO ACTION OR DEFERRAL

If the proposal did not proceed or was deferred. contaminants present at the site would not be contained and redevelopment of the site for industrial purposes would not be possible. As a consequence, the numerous benefits such as the generation of local employment opportunities, the protection of the environment, the protection of the health of on-site workers and the protection of the health of the surrounding community which would result from the remediation of the site, would not be attained. There would be no detrimental environmental consequence of not undertaking the project.

22.4 JUSTIFICATION OF THE PROPOSAL

Remediation of the Project site is well justified. This justification is based on the conclusions reached within each of the Chapters in this EIS.

The proposed works would enable the site to be redeveloped for industrial purposes.

22.5 CONCLUSION

In summary:

- Remediation of the site would allow future, redevelopment of the site for industrial purposes.
- The works would provide a positive incentive for industry looking to relocate or establish itself in the Mayfield area, thereby creating employment opportunities, generating government revenue and stimulating the local economy.
- The investigation has shown that by re-contouring the site the proposed works would alter the landform and hydrology of the area.
- No flora and fauna species identified as having conservation significance would be adversely affected by the proposal.
- The proposed works would have minimal impact on surrounding land uses and the riverine environment.
- The impact on the visual amenity of the local environment as a result of the proposed works would be negligible.
- The remediation works would lower the groundwater table at the site.
- Minor and localised effects on air quality would result from the excavation, loading, unloading and spreading of materials. These effects would be minimised by implementing safeguard measures.
- Sound levels emitted by the proposed remedial activities are unlikely to comply with level restrictions in the NSW EPA's construction Noise Guidelines but would not be more intrusive than existing traffic noise.

- The remediation works would not pose a threat to the health of on-site workers or the local community.

The assessment of the possible effects of the proposal on the environment indicates that there would be no major adverse physical, biological or social impacts and that there would be beneficial environmental impacts from the proposal.

Remediation of the site would also allow future redevelopment for industrial purposes which would have a number of economic and social benefits.

23.0 BIBLIOGRAPHY

1:25 000 Topographic Map - Beresfield 9232-3-N, 1990.

1:25 000 Topographic Map - Newcastle 9232-2-S, 1990.

1:25 000 Topographic Map - Wallsend 9232-3-S, 1990.

1:25 000 Topographic Map - Williamtown 9232-2-N, 1990.

A3 Topographical Analysis extract prepared by APT Peddle Thorp, November 1996.

AGC Woodward-Clyde Pty Ltd, (August 1995), Human Health and Environmental Risk Assessment, West of Tourle Street Site, Newcastle, NSW. Prepared for BHP Steel, Road and Bar Products Division.

ANCA (1994), Feral Cats - A National Approach: Towards a Threat Abatement Plan. Australian Nature Conservation Agency, Canberra.

ANCA (1995), Species Sheet for European Red Fox. Australian Nature Conservation Agency, Canberra.

ANZECC (1992), Australian Water Quality Guidelines for Fresh and Marine Waters.

ANZECC/NHMRC (1992), Guidelines for the Assessment and Management of Contaminated Sites.

Australian Bureau of Statistics (1996). Census Statistics - Basic Community Profile.

Australian Manganese Company Pty Ltd (1995), Environmental Monitoring Data for EPA Licence Period 18 August 1995 to 18 August 1996.

Australian Manganese Company Pty Ltd (1996), Environmental Monitoring Data for EPA Licence Period 18 August 1995 to 18 August 1996.

BHP Environment and Site Services Department, Newcastle Steelworks, 1995a. West of Tourle Street Area 1 Site Assessment Data Report. March.

BHP Environment and Site Services Department, Newcastle Steelworks, 1995b. Site Assessment Area 2 West of Tourle Street. March.

BHP Environment and Site Services Department, Newcastle Steelworks, 1995c. West of Tourle Street Area 3 Site Assessment Data Report. April.

BHP Environment and Site Services Department, Newcastle Steelworks, 1995d. West of Tourle Street Site Assessment Data Report Area 4. May.

BHP Environment and Site Services Department, Newcastle Steelworks, 1995e. West of Tourle Street Site Assessment Data Report Area 5. May.

BHP Environment and Site Services Department, Newcastle Steelworks, 1995f. West of Tourle Street Site Assessment Report Area 6 Data. May.

BHP Environment and Site Services Department, Newcastle Steelworks, 1995g. West of Tourle Street Site Assessment Report Area 7 Data. May.

BHP Environment and Site Services Department, Newcastle Steelworks, 1995h. West of Tourle Street Site Assessment Data Report Area 8. May.

BHP Environmental and Site Services Department, Newcastle Steelworks, 1995I, Material Characterisation Report for West of Tourle Street. May.

Blakers, M., Davies, S.J.J.F., and Reilly, P.N., (1985), The Atlas of Australian Birds. Melbourne University Press, Carlton, Victoria.

Briggs, J.D. and Leigh J.H. (1996), Rare or Threatened Australian Plants. CSIRO Publishing. Collingwood, Victoria.

Brooker, M.I.H. and Kleinig, D.A. (1990), Field Guide To Eucalypts - Volume 1. Inkata Press, NSW.

Bureau of Meteorology (1996), Meteorological Data from Williamtown.

Clean Air Society of Australia and New Zealand (CASANZ, 1990), Air Pollution Control Manual. Second Edition.

CMPS & F (1995, amended 1997), Environmental Audit Report West of Tourle Street. Prepared for BHP Steel, Rod and Bar Products Division.

Cogger, H.S. (1994), Reptiles and Amphibians of Australia. Reed, Sydney.

Commonwealth of Australia (1990), Ecologically Sustainable Development - A Commonwealth Discussion Paper.

Commonwealth of Australia (1991), Ecologically Sustainable Development Working Groups, Final Report - Energy Production.

Environmental & Earth Services (1991) - Report to BHP Road and Bar Products Division on preliminary assessment of Groundwater Characteristics for West of Tourle Street, Newcastle NSW - Report No. 9027B.

Environmental and Earth Sciences Pty Ltd (1994), Report to BHP Rod and Bar Products Division on Contamination Investigation at West of Tourle Street Site, Newcastle, NSW (Report No. 9364). July.

Environmental Earth Services (1991) - Report to BHP Rod and Bar Products Division on Installation of Monitoring Network West of Tourle Street, Newcastle NSW - Report No. 9027A.

EPA (1989), Environmental Guidelines - Landfill Disposal of Industrial Wastes.

EPA (1994), Environmental Noise Control Manual. NSW Environment Protection Authority. EPA 94/31. ISBNO 7310 1230 5.

EPA (1996), Draft Hazardous Waste Definition and Draft Environmental Guidelines: Solid Waste Assessment.

Garnett, Stephen. (1992), Threatened And Extinct Birds Of Australia. Royal Australasian Ornithologists Union and the Australian National Parks and Wildlife Service, Victoria.

Gutteridge Haskins & Davey Pty Ltd (1994), Expansion of Electrolytic Manganese Dioxide Plant, Statement of Environmental Effects.

Lamp, G. & Collet. F. (1993), Field Guide to Weeds in Australia. Intata Press, Sydney.

Morris, Alan, K.. McGill, A.R. and Holmes, Glen. (1981), Handlist of Birds in New South Wales. NSW Field Ornithologist Club, Sydney.

National Environmental Health Forum (1996), Exposure Scenarios and Exposure Settings.

National Environmental Health Forum (1996), Exposure Scenarios and Exposure Settings.

National Environmental Health Forum (1996), Health - Based Soil Investigation Level 5.

National Environmental Health Forum (1996), Health-Based Soil Investigation Level 5.

National Parks and Wildlife Service (1997), Aboriginal Sites Register Database 256.

New South Wales (1995), Threatened Species Conservation Act 1995 No. 101. Government Printer, Sydney.

Newcastle Local Environmental Plan and Map No. 446, 5 June 1987.

NIOSH/OSHA/USCG/EPA (1985), Occupational Safety and Health guidance manual for Hazardous Waste Site Activities.

NSW Agriculture (1995), Managing Vertebrate Pests: Foxes. Report prepared by Glen Saunders, Brian Coman, Jack Kinnear and Mike Braysher. The Australian Government Publishing Service. Canberra.

NSW Department of Planning (1994), Population Projections - Non-metropolitan Local Government Areas in NSW 1991-2021.

NSW National Parks and Wildlife Service (1996), Kooragang Nature Reserve & Hexham Swamp Nature Reserve - Draft Plan of Management.

Robert Carr and Associates (1995), Geochemical Assessment South Arm, Hunter River. May 1995

Robert Carr and Associates (1995, amended 1997), Hydrogeological Investigation West of Tourle Street Site Newcastle, NSW, Report Number 137A.

Robinson, Les. (1991), Field Guide to the Native Plants Of Sydney. Kangaroo Press, Kenthurst, NSW.

South Australian Health Commission (1991, 1993, 1996). Proceeding of the First, Second and Third National Workshops on the Health Risk Assessment and Management of Contaminated Sites.

Shortland Wetlands Centre Ltd. (1995), Ecology of migratory shorebirds in the Hunter River estuary. Report prepared by D.J. Geering for the Kooragang Wetland Rehabilitation Project.

Standards Australia 1981. Guide to Noise Control on Construction, Maintenance and Demolition Sites AS2436-1981. ISBN 0 7262 2177 5.

Standards Australia 1989. Acoustics-Description and Measurement of Environmental Noise Part 1: Environmental Procedures. AS 1055.1-1989. ISBN 07262 58512.

Strahan, R. (ed), (1995), The Mammals of Australia. Australian Museum/Reed Books, Sydney.

SWC Wetlands Institute (1996), Draft Flora & Fauna Assessment Of BHP Land West Of Tourle Street, Mayfield. Unpublished report prepared for APT Peddle Thorp.

Tame, Terry (1992), Acacias Of Southeast Australia. Kangaroo Press, Kenthurst, NSW.

The Institution of Engineers (1987), Australian Rainfall and Runoff: A Guide to Flood Estimate Vol. 1 and 2.

Tindale, M. And Carolin, R. (1993), Flora of the Sydney Region. Reed Publishing, Chatswood, NSW.

Tonin 1985. Estimating Noise Levels from Petrochemical Plants, Mines and Industrial Complexes. Acoustics Australia Vol. 13 No. 2-59.

USEPA (United States Environment Protection Agency) 1992. Franework for Ecological Risk Assessment. Washington D.C. Risk Assessment Forum. US Enviroemntal Protection Agency EPA/630/R-92/001.

Wheeler, D.J.B., Jacobs S.W.L., and Norton B.E. (1984), Grasses of New South Wales. University of New England, Armidale, Australia.

PLATES

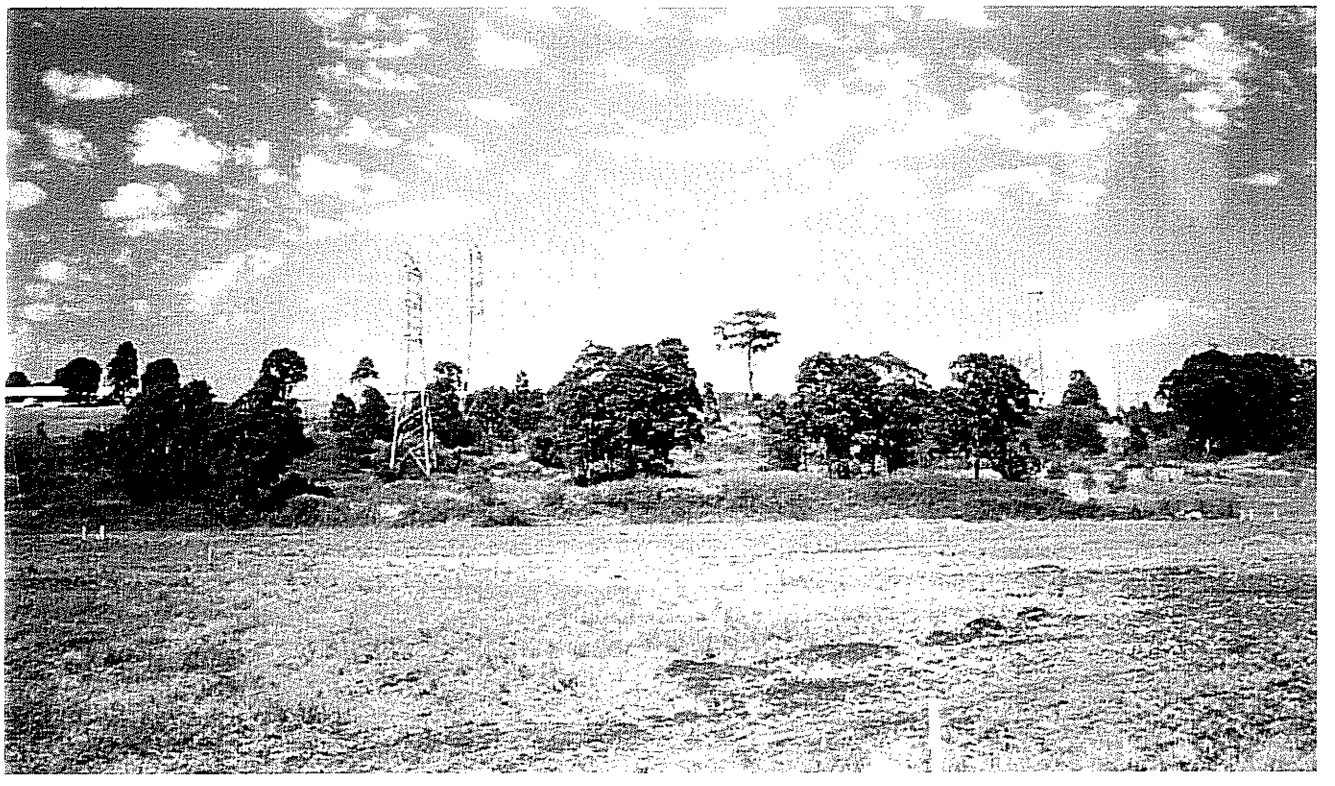


Plate 11.1 : Remnant patch of Eucalyptus sp. in the south-western section of the site.

Plate 11.2 : Narrow band of Avicennia marina along the south arm of the Hunter River, adjacent to site.

Woodward-Clyde

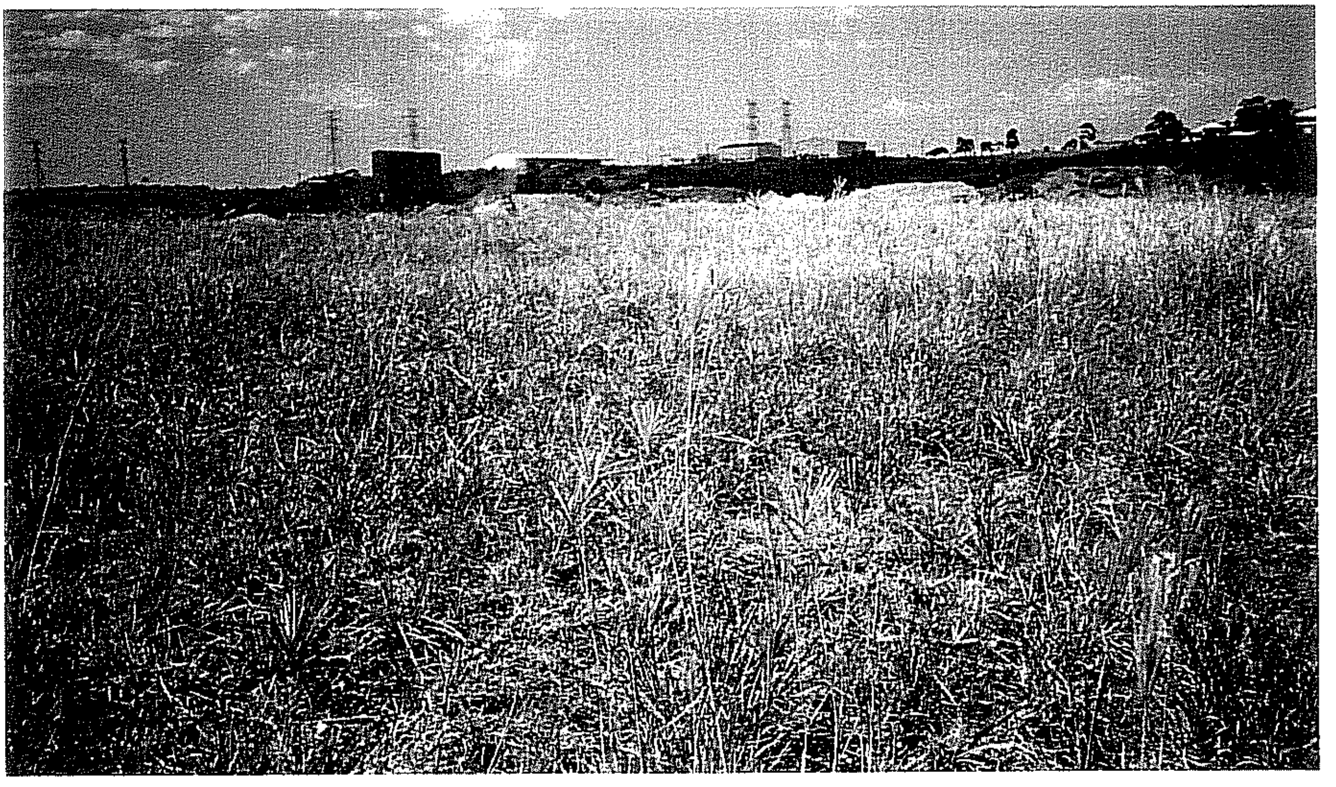


Plate 11.3 : Regularly cut area of open grassland comprising predominantly introduced pasture grasses.

Plate 11.4 : Recently sown, native screen boundary plantings along Industrial Drive.

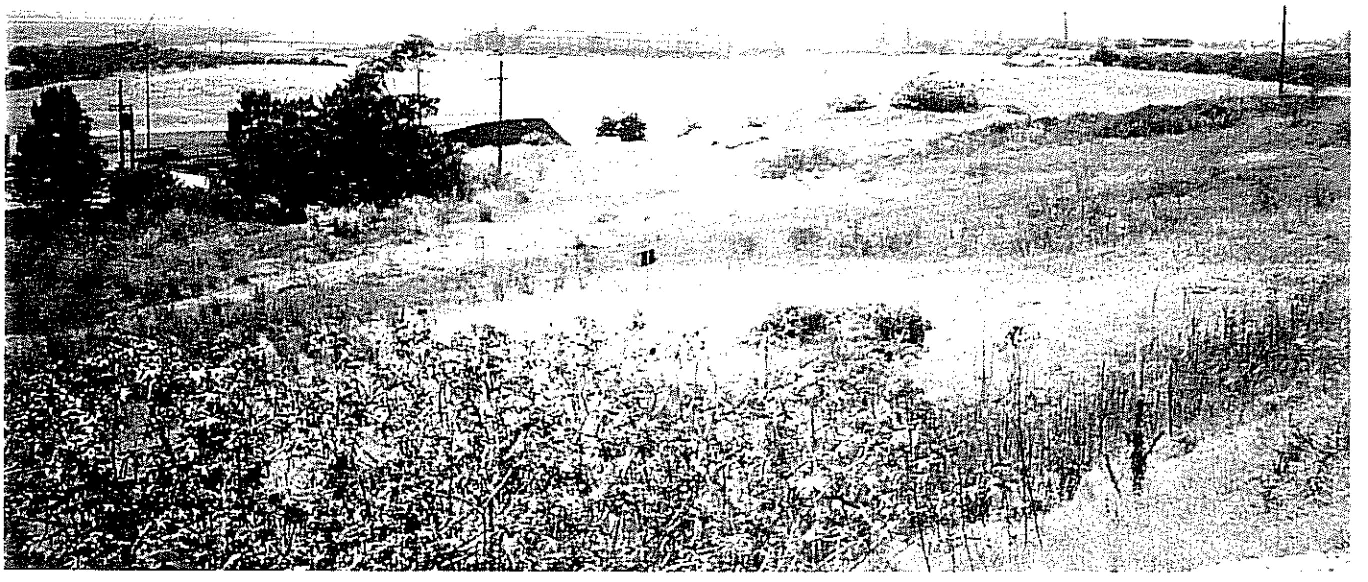


Plate 13.1 : View looking east from industrial property along Pacific Highway (near rear of Telstra Depot) to site. Unrestricted and prominent views into site and proposed remediation areas exist.

Plate 13.2 : View looking west to site from former BHP Health and Fitness Centre. Unrestricted, prominent views into site and proposed remediation areas are evident.

Woodward-Clyde

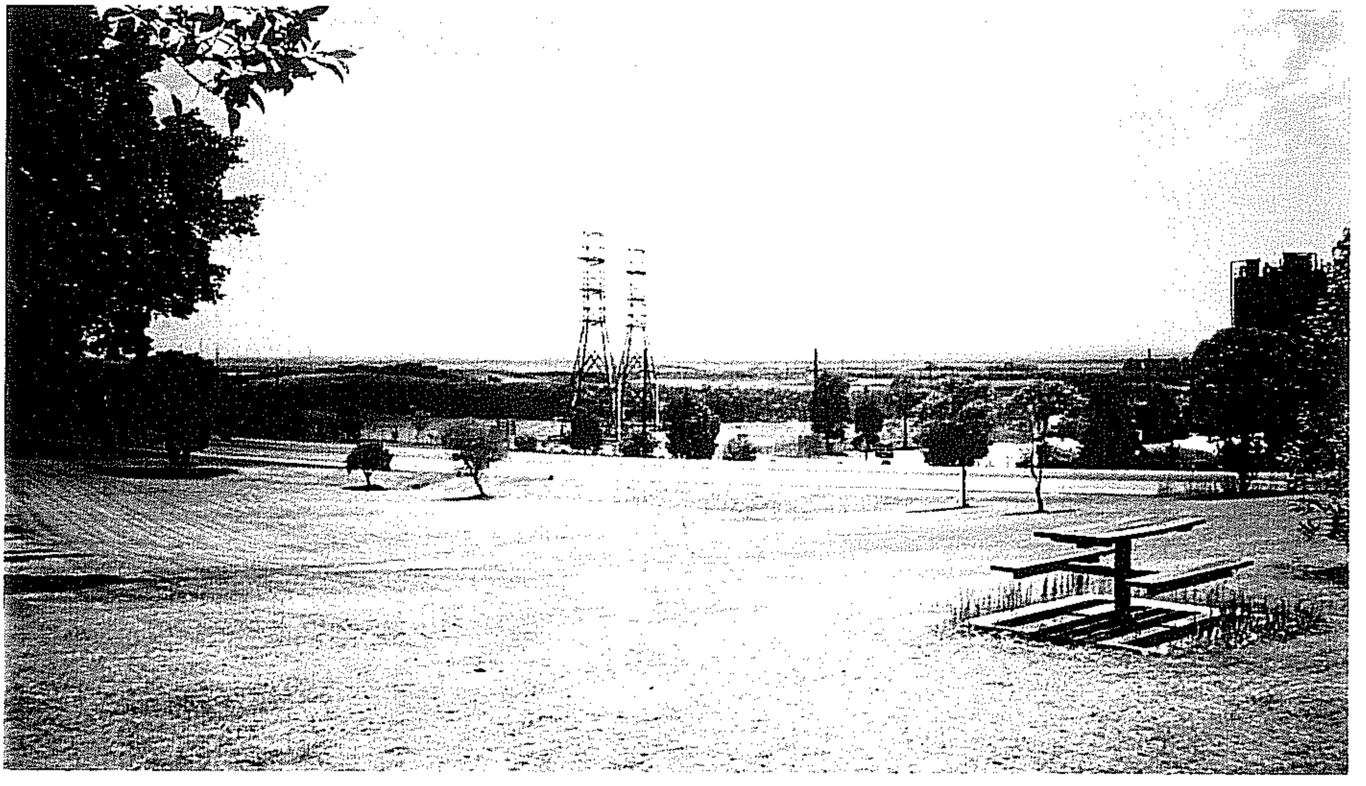


Plate 13.3 : View looking north from east of Stevenson Park to site.
Partially restricted views into site and proposed remediation areas exist.

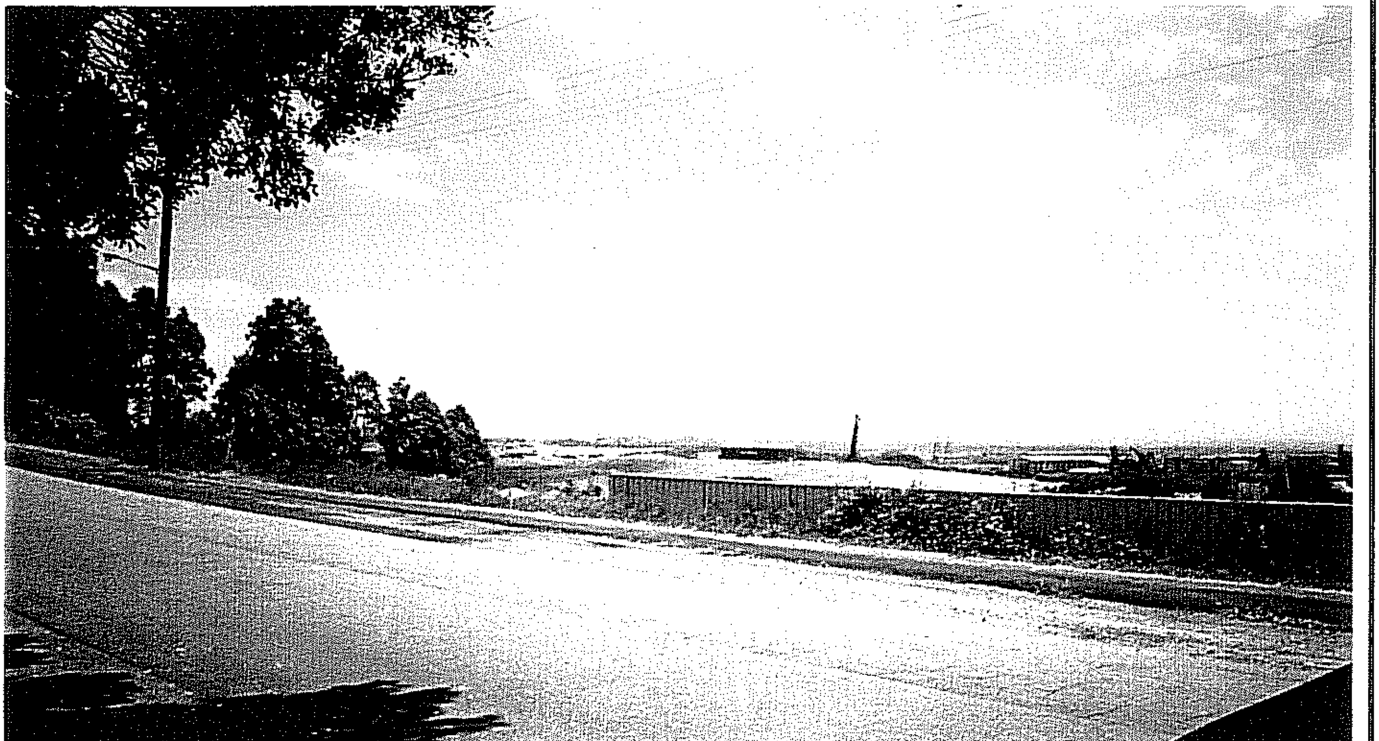


Plate 13.4 : View looking north-west to site from Bull Street residence (at Tourle Street Park).
Partially restricted, long views into site and proposed remediation areas exist.

APPENDIX A

DIRECTOR-GENERAL'S REQUIREMENTS

Mr Michael England
Principal Environmental Planning
AGC Woodward-Clyde Pty Ltd
Level 6, 486-494 Pacific Highway
St Leonards NSW 2065

Contact: A. Maltz

Our Reference: N96/0198/Z01

Your Reference:

DATE RECEIVED 4/2 ... MAIL/COURIER
PROJECT No
DOCUMENT No
DISTRIBUTION ME

Dear Mr England,

BHP Mayfield Project, Newcastle - Site Remediation

Thank you for your letter of 5 December 1996, seeking consultation with the Director-General for the preparation of an environmental impact statement (EIS) for the above development.

Attachment No. 1 outlines the statutory requirements for the form and content of an EIS to be prepared under Part 4 of the *Environmental Planning and Assessment Act 1979*.

Attachment No. 2 lists the matters that the Director-General, pursuant to clause 52 of the *Environmental Planning and Assessment Regulation 1994*, requires be specifically addressed in the EIS. In listing these matters, consideration has been given to the issues that have been raised at the Planning Focus Meeting (19 December 1996).

Should you have any further enquiries regarding this matter, please contact Avi Maltz on phone (02) 391 2083.

Yours sincerely,

30/1/97

Neville Osborne
Acting Manager
Major Assessments and Hazards Branch

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1 Farrer Place, Sydney 2000
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DEPARTMENT OF URBAN AFFAIRS AND PLANNING

Attachment No. 1

STATUTORY REQUIREMENTS FOR THE PREPARATION AND EXHIBITION OF AN ENVIRONMENTAL IMPACT STATEMENT UNDER PART 4 OF THE ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

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

Content of EIS

Pursuant to Schedule 2 and clause 51 of the *Environmental Planning and Assessment Regulation 1994* (the Regulation), an EIS must include:

1. A summary of the environmental impact statement.
2. A statement of the objectives of the development or activity.
3. An analysis of any feasible alternatives to the carrying out of the development or activity, having regard to its objectives, including:
   (a) the consequences of not carrying out the development or activity; and
   (b) the reasons justifying the carrying out of the development or activity.
4. An analysis of the development or activity, including:
   (a) a full description of the development or activity; and
   (b) a general description of the environment likely to be affected by the development or activity, together with a detailed description of those aspects of the environment that are likely to be significantly affected; and
   (c) the likely impact on the environment of the development or activity, having regard to:
      (i) the nature and extent of the development or activity; and
      (ii) the nature and extent of any building or work associated with the development or activity; and
      (iii) the way in which any such building or work is to be designed, constructed and operated; and
      (iv) any rehabilitation measures to be undertaken in connection with the development or activity; and
   (d) a full description of the measures proposed to mitigate any adverse effects of the development or activity on the environment.
5. The reasons justifying the carrying out of the development or activity in the manner proposed, having regard to biophysical, economic and social considerations and the principles of ecologically sustainable development.
6. A compilation, (in a single section of the environmental impact statement) of the measures referred to in item 4(d).
7. A list of any approvals that must be obtained under any other Act or law before the development or activity may lawfully be carried out.
8. For the purposes of Schedule 2, the principles of **ecologically sustainable development** are as follows:
   (a) The precautionary principle - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
   (b) Inter-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
   (c) Conservation of biological diversity and ecological integrity.
   (d) Improved valuation and pricing of environmental resources.

<u>Note</u>

The matters to be included in item (4)(c) might include such of the following as are relevant to the development or activity:

(a) the likelihood of soil contamination arising from the development or activity;
(b) the impact of the development or activity on flora and fauna;

(c) the likelihood of air, noise or water pollution arising from the development or activity;
(d) the impact of the development or activity on the health of people in the neighbourhood of the development or activity;
(e) any hazards arising from the development or activity;
(f) the impact of the development or activity on traffic in the neighbourhood of the development or activity;
(g) the effect of the development or activity on local climate;
(h) the social and economic impact of the development or activity;
(i) the visual impact of the development or activity on the scenic quality of land in the neighbourhood of the development or activity;
(j) the effect of the development or activity on soil erosion and the silting up of rivers or lakes;
(k) the effect of the development or activity on the cultural and heritage significance of the land.

An environmental impact statement referred to in Section 77(3)(d) of the Act shall be prepared in written form and shall be accompanied by a copy of Form 2 of the Regulation signed by the person who has prepared it.

Procedures for public exhibition of the EIS are set down in clauses 55 to 57 of the Regulation.

Attention is also drawn to clause 115 of the Regulation regarding false or misleading statements in EISs.

A copy of the Director-General's Requirements should be included as an appendix to the EIS, as well as table indicating the location within the document where the requirements have been addressed.

Public Exhibition

When the EIS has been completed, four (4) copies should be forwarded to the Secretary (Attention: Manager, Major Assessments and Hazards Branch) together with details of the exhibition period and public display locations.

It is requested that a copy of the text of the EIS also be supplied on a 1.44 MB floppy disk. This should be in a format readable by MS Word for Windows® Version 6 or as plain text (ASCII). Inclusion of files of supporting maps and diagrams is optional.

Procedures for public exhibition of the EIS are set down in clauses 55 to 57 of the Regulation.

Note

Should the development application to which the EIS relates not be made within 2 years from the date of issue of the Director-General's requirements, under clause 52(5) of the Regulation the proponent is required to reconsult with the Director-General.

Submissions

Any submissions made in response to public exhibition of the EIS should, as soon as practicable, be forwarded to the Secretary in accordance with Section 87 of the Act.

– ◇ –

Department of Planning

ATTACHMENT NO 2

DIRECTOR-GENERAL'S REQUIREMENTS
BHP Mayfield Project, Newcastle - Site Remediation

Key Issues

- a description of the site, including past, present and future patterns of land use, historical and current use of chemicals on the site, materials and waste management practices, and a chronology of events leading to the discovery and documentation of soil and ground water contamination. In this regard reference should be made to *Contaminated Land - Planning Guidelines for Contaminated Land*, produced by the Department of Urban Affairs and Planning;
- environmental setting of the site, including patterns of precipitation and evaporation, surface topography, nearby surface waters that might influence the ground water at the site, types of vegetation and predominant soil types and their distributions;
- site specific geologic and water hydrology conditions, including identification of preferred pathways for ground water and low permeability strata, identification of recharge and discharge areas and relationship of contaminated zones to any uncontaminated zones in terms of any possible interaction between them;
- comprehensive description of proposed operations including staging, identification of the type of pollutants and concentrations in soil (e.g. heavy metals, organics such as PAHs and organo-metals), water resources, nearby water bodies and adjacent sites (as a result from possible off site movement of contaminants), distribution of contaminant burden, remediation technology and recovery systems to be used (i.e. in situ and ex situ treatment), type and amount of soil to be treated, all material and inventory to be stored during operation including material and quantities to be transferred, truck loading and unloading operations;
- justification for the proposed technology used and discussion of other alternative remediation options. Any capping, bunding, burying, or filling of land needs to be described in detail;
- any staged remediation, including timeframe, is to be described and details on measures to prevent cross contamination are to be provided (e.g. surface runoffs, segregation, validation areas not to be used as stockpile areas etc);
- discussion of the suitability of any sites available for the disposal of contaminated soil. EPA guidelines on waste assessment and the Waste Minimisation and Management Act and Regulation must be considered in this regard;
- sources and types of imported fill to be identified and testing procedures for the fill, to be addressed where replacement or capping of the contaminated soil is considered;
- impact of remediation on the environment in terms of:
  - any disturbance to nearby aquatic ecosystem (e.g. Hunter River - South Arm) and potential impact to the food chain:
  - impact on river banks and sedimentary processes:

- light penetration and aquatic plant colonisation;

- measures to prevent pollution resulting from stockpile and disposal of spoil;
- outline of remediation plan (Chapter 5 in *Planning Guidelines for Contaminated Land*) including:
  - description of proposed processes;
  - quality control applied and post remediation validation;
  - reduction of comulative environmental impact such as from noise, vibration and odours (including discussion of hours of operation);
  - emissions such as volatile organics and measures to mitigate any such impact. In this regard the types, chemical and physical characteristics and toxicity of any surfactants to be used is to be discussed;
  - measures to reduce any possible exposure of residents and in particular, on-site workers to contaminants in air, soil and water. In this regard, practices to control dust and limit the actual surface area of activity at one time should be discussed.
  - post remediation management of the site, including monitoring practices. In this regard, dust control measures following completion of remedial activities (until such time as the proposed redevelopment is undertaken) should be discussed;
- remediation levels to be clearly stated and justified (e.g. in terms of risk assessment or any other relevant standards). EPA new soil criteria must be considered in this regard;
- water management during remediation is to be discussed. This should include information on:
  i. surface water controls - prevention of run-on and interception of run-off (e.g dikes, diversion channels, floodwalls, grading and revegetation), prevention of infiltration (e.g capping, grading), control of erosion, ;

  ii. storm water outlets and sewage pipes, any dewatering operation, proposed effluent treatment and water quality monitoring and control measures;

  iii. flood impact consideration
- waste management (generation, collection and treatment) including types and quantities of wastes expected to be generated by this development,. Discuss the treatment of these wastes and proposed disposal arrangements;
- timeframe for improvement of visual quality of the remediated site should be discussed;
- security measures to be applied on and adjacent to the site;
- outline of emergency arrangements and fire prevention measures during the remediation operations:

- traffic implications of the proposal. Identify expected traffic volumes and type of trucks to be used and also proposed routes, local and regional (including access routes) and any impact on local transportation network and proposed measures to mitigate this impact. In this regard, the possible interruption to traffic flow on Industrial Drive and the Pacific Highway may need to be considered.
- impact from transportation of contaminated sediments and measures to mitigate it;
- results of consultation with:
  - Environment Protection Authority;
  - Department of Land and Water Conservation
  - NSW Health/Public Health Unit
  - Roads and Traffic Authority
  - Hunter Water Corporation
  - Newcastle City Council

Other Specific Issues

- emissions from proposed development;
- fire prevention measures;

It should be noted that the onus is on the proponent to identify all parties with an interest in the proposal.

APPENDIX B

STUDY TEAM MEMBERS

STUDY TEAM

This Environmental Impact Statement was prepared for BHP Steel Long Products Division by the study team listed below.

BHP:

Mr Brian Butler
Mr Paul Noonan
Ms Ruth Garvin
Ms Angela Clark
Mr Steve Berry
Mr Alan Norton
Mr Greg Cameron

Woodward-Clyde:

Mr Michael England
Ms Catherine Brady
Ms Sarah Townsend
Mr Seth Molinari
Mr Martin Howell
Mr Larry Clark
Mr Bryan Beudeker
Mr Isaac Mamott
Mr Ray Hatley
Mr Scott Porman
Mr Stuart Hodgson
Ms Leanne Bassett
Ms Helen Campbell
Ms Lisa Elliott

APPENDIX C

ENVIRONMENTAL INVESTIGATIONS

C1.0
PREVIOUS INVESTIGATIONS

C1.1 ENVIRONMENTAL INVESTIGATIONS

The data available for the preparation of the EIS is contained within a range of reports prepared by various consultants and by BHP. This section presents a summary of the available information. These reports provide the prime source of data available.

C1.1.1 Environmental and Earth Sciences

A series of environmental site assessments were undertaken by Environmental and Earth Sciences between April 1990 and July 1994 (Environmental and Earth Sciences, 1991a, 1991b and 1994a). These investigations involved the installation of temporary and permanent groundwater monitoring wells, the measurement of standing water levels (SWLs) and the sampling and analysis of fill and groundwater samples.

The data collected as part of these investigations, including bore logs, have been consolidated into the individual site assessment data reports prepared by BHP for Areas 1 to 8 (Section 3.2.3).

C1.1.2 BHP

Environmental site assessments were undertaken by BHP on the eight designated areas of the site (i.e. Areas 1 to 8, as indicated on Figure 3.1), between August 1994 and May 1995. BHP have produced a data report for each area.

The site assessments undertaken by BHP included:

- The collection and analysis of samples of fill material at depths ranging from 0 m to 16 m, from a number of sampling locations across the site. The most common practice being trenching to up to 7m depth and installation of a piezometer into a borehole drilled adjacent to or within the trench.

- The measurement of SWLs and the collection of groundwater samples from a total of 120 permanent groundwater monitoring bores. Gauged and sampled groundwater monitoring bores included those installed by both Environmental and Earth Sciences and BHP.
- BHP's soil/fill sampling approach generally targeted soils which were visually contaminated and visually clean soils/fills were not sampled as often.
- The collection and analysis of two surface samples within each of Areas 1 to 8 respectively.
- The collection of additional samples at depth from each area and analysis for a range of rare metals, volatiles and semi-volatile organic compounds (screening samples). Generally, two 'screening' boreholes were installed per area.
- The compilation of all bore logs, soil and groundwater data available for each area. At the time of preparation of this report, all data had been compiled into the site investigation reports.

Using the data presented in the site assessment reports, BHP prepared a summary report describing the chemical properties of the range of fill materials sampled during the site investigation. This report is titled "Material Characterisation Report" (BHP, 1995) and includes the relevant analytical data for each of the material types as they exist today. In some instances, cross contamination of materials has occurred through being in intimate contact and this may lead to confusion in interpretation of chemical results.

In addition to the site assessment data, BHP has undertaken a soil gas survey across the site. The survey was designed to identify if elevated concentrations of organic vapours in the soil gas, including methane occurred on-site.

C1.1.3 Robert Carr & Associates

Robert Carr & Associates has prepared two environmental assessment reports, namely:

- Hydrogeological Investigation West of Tourle Street Site, Newcastle, NSW.
- Report on Geochemical Assessment South Arm Hunter River.

The hydrogeological report provides an assessment of groundwater conditions using the information contained within the BHP site investigation reports and additional data collected by Robert Carr & Associates.

The geochemical assessment report includes the following:

- A compilation of existing and relevant sediment chemical data for the South Arm and North Arm of the Hunter River and Newcastle Harbour.
- Results of the additional river sediment sampling and analysis program undertaken by Robert Carr & Associates to provide data adjacent to and upstream of the Steel River Project site.
- Results of sampling of shoreline sediments along the site's river frontage.
- Results of sampling of shoreline seepages along the site's river frontage.

C1.1.4 AGC Woodward-Clyde

A risk assessment was carried out by AGC Woodward-Clyde to identify whether the presence of chemical contaminants at the site in both soils, fill and groundwater pose an unacceptable risk to human health and the environment. In the event that unacceptable risks were found, site-specific remediation goals or criteria were to be developed based on the use of the site for industrial purposes.

The Woodward-Clyde assessment included a detailed review of the contamination associated with the site, a qualitative and quantitative human health risk assessment and a qualitative environmental risk assessment.

C1.1.5 CMPS&F

CMPS&F undertook an audit of investigations, including the risk assessment, and this was reported in 'Environmental Audit - West of Tourle Street (August 1995)'.

APPENDIX D

RISK ASSESSMENT

D1.0
RISK ASSESSMENT

D1.1 GENERAL

Human health and ecological risk assessment is the process by which scientific data (i.e. soil, surface water, groundwater, sediment quality) are analysed to describe the likelihood of harm to humans or the environment. Risk assessment is a problem identification, analysis and evaluation process used to facilitate the management of risk.

The risk assessment for the Steel River Project site provides an assessment of risks to human health and the environment at and nearby the Steel River Project site, assuming current land uses and zonings. The risks are developed on the basis of the current site condition (no remediation) and with several levels of remedial action. The majority of the Steel River Project site is currently zoned for industrial purposes, with the south eastern hill area zoned ecclesiastical and containing the former BHP fitness centre and a fire station.

The overall goal of this risk assessment process is to assess if (and where) there is unacceptable risk to human health or the environment and what, if any, remedial action is necessary.

The risk assessment for the Steel River Project site was reported by Woodward-Clyde in the document "Human Health and Environmental Risk Assessment, West of Tourle Street Site, Newcastle (OD014.DOC, August 1995)." The following is a summary, including conclusions and recommendations from the risk assessment.

D1.2 APPROACH TO RISK ASSESSMENT

D1.2.1 Human Health Risk Assessment Approach

The approach taken to the assessment of human health risks is generally in accordance with the protocols/guidelines recommended by Australian and New Zealand Environment and Conservation Council (ANZECC) and the National Health and Medical Research Council (NHMRC) and detailed in the document "The Health Risk Assessment and

Management of Contaminated Sites" (SAHC, 1991, 1993, 1996) and ANZECC/NHMRC (1992). Since completion of the risk assessment in 1995, additional guidance in the setting of health based investigation guidelines for soils for Australian conditions has been provided in the following documents:

- National Environmental Health Forum Soil Series No. 1 - Health Based Soil Investigation Levels (1996a); and
- National Environmental Health Forum Soil Series No. 2 - Exposure Scenarios and Exposure Settings (1996b).

These documents have been developed from the Proceedings of the First, Second and Third National Workshops on the Health Risk Assessment and Management of Contaminated Sites (1991, 1993 and 1996) and published under the endorsement of State, Territorial and Commonwealth health departments.

Human health risk assessment can be divided into the following four stages.

1. **Problem Formulation**. This task involves the collection of representative samples from the site and the evaluation of the available data with respect to the nature and extent of contamination with the aim of identifying chemicals and media of concern. Relevant site history and data have been collected as part of previous site investigations detailed in Section 2.1. Endpoints (or goals) for the risk assessment are developed in line with societal objectives and land use.

2. **Exposure Assessment**. An exposure assessment identifies the human populations which may be exposed to the chemicals of concern, outlines the mechanisms (pathways) by which these populations may be exposed and provides a quantitative estimate of exposure and intake of the main receptor groups.

3. **Toxicity Assessment**. This identifies the most appropriate toxicity values for the chemicals of concern which can be used to provide quantitative estimates of risks to human health.

4. **Risk Characterisation**. This uses the toxicity values and quantitative estimates of chemical intake to provide a quantitative estimate of the potential health risks associated with exposure to the chemicals of concern (COC).

ANZECC/NHMRC (1992), and related documents, provide general guidance for the completion of these tasks and, as such, the more detailed protocols and guidelines developed by the US EPA (1989a) have been used as supplementary guidance for the risk assessment process.

The US EPA (1989a) risk assessment procedures differ from ANZECC/NHMRC (1992) protocols in the toxicity assessment stage, with the US EPA relying on the application of different toxicity values for the assessment of carcinogenic and noncarcinogenic effects. ANZECC/NHMRC have adopted the WHO/FAO acceptable daily intakes (ADIs) and provisional tolerable weekly intakes (PTWIs) for chemicals in the derivation of human health based soil quality guidelines and this has been the approach followed in this risk assessment. This is the same approach used by ANZECC in the derivation of health based drinking water guidelines (ANZECC/ARMCANZ 1996).

D1.2.2 Ecological Risk Assessment Approach

Currently, there are no Australian guidelines for the assessment of ecological risks, therefore the ecological risk assessment has been undertaken following the guidance provided by the USEPA (USEPA, 1992). The approach taken involves four stages, listed below, which are similar to the Human Health Risk Assessment process.

1. **Problem Formulation,** including:
   - Data evaluation and identification of chemicals of potential concern;
   - Characterisation of the exposure setting;
   - Endpoint selection; and
   - Development of a Conceptual Model for Exposure Pathways.

2. **Exposure Assessment**

3. **Ecotoxicity Assessment**

4. **Ecological Risk Characterisation,** including uncertainty assessment.

D1.3 EXPOSURE PATHWAYS

A range of potential pathways by which on-site and off-site populations might be exposed to contaminants deriving from the site have been identified. The primary pathways of concern with respect to the evaluation of human health risks for the Steel River Project site are:

- . the direct contact with fill material (incidental ingestion and dermal contact); and
- the diffusion of volatile organic compounds from contaminated fill and/or groundwater and, their subsequent entry into buildings.

In both cases the most sensitive receptors are assessed as being on-site workers.

The prime ecological receptor of significance for the Steel River Project site is the Hunter River. The potential for site derived contaminants to adversely impact the ecology of the river is directly related to the potential for contaminants to migrate from the site. Potential pathways for off site migration are:

- surface water run off transporting suspended sediment; and
- groundwater discharge transporting dissolved constituents.

D1.4 CHARACTERISATION OF RISKS

D1.4.1 Human Health Risk

A human health risk assessment was undertaken using a "screening level" approach, i.e. a number of highly conservative assumptions have been made in order to deliberately over-estimate the actual risks posed by the presence of site chemicals of concern. This approach has been used in order to clearly identify site-specific issues that have the greatest potential to cause unacceptable human health risk.

The screening level risk assessment for on site workers indicated a low potential for unacceptable risks. The risk assessment did, however, indicate potentially unacceptable conditions which may occur under the following circumstances:

- the concentration of PAHs in surface materials is elevated at the surface due to the presence of tar; and
- buildings were to be constructed over areas affected by elevated concentrations of BTEX compounds.

Based on the current usage of the site, the risks to human health are assessed as being negligible. However, any development of the site would require further consideration of the above circumstances.

The screening level risk assessment has been conducted for the most sensitive receptors and pathways. On this basis the potential risks to other receptors groups, including off-site receptors, such as residential areas to the south east and boating on the river, are assessed as being negligible.

D1.4.2 Environmental Risk

In undertaking a qualitative characterisation of risks to the environment associated with the contaminants present in fill at the Steel River Project site, the following points have been considered:

i) The Steel River Project site is located within a heavily industrialised and urbanised area and the surface consists almost entirely of fill (predominantly coal washery refuse - CWR). On this basis it is not expected that the site contains any significant ecological receptors within the site boundaries. Consideration of potential risks to the environment should be limited to the potential for contaminants to impact on the ecology of the Hunter River.

ii) The pathways by which contaminants may migrate beyond the site boundaries include surface water runoff and groundwater discharge to the river.

iii) The condition of the site does not favour the generation of surface water runoff. The surface of the site is covered predominantly with CWR which is a natural material having a low level of associated contamination. The CWR does, however, have manganese concentrations which are potentially higher than occurring in background surface soils in the area (i.e soils and clays). In the event that surface water runoff were to take place, then the prime contaminant of concern would be manganese, should it be liberated from the CWR.

iv) There is no evidence that the concentration of manganese in shallow groundwater is elevated relative to background concentrations.

v) The best estimates of the discharge of PAHs to the Hunter river indicate the resulting mean river concentrations to be less than the ANZECC water quality guideline for the protection of marine ecosystems. This is consistent with the river monitoring data.

vi) The potential for shoreline seepages to adversely affect the quality of the river is limited. This is a consequence of the moderate concentrations within the seeps and the extent of mixing that can be expected within the river. Again this is consistent with the river water quality monitoring data.

vii) The river sediments show no evidence of the accumulation of manganese or PAHs that could be directly attributed to contaminant discharges from the Steel River Project site either by groundwater or surface water.

viii) The concentration of manganese and PAHs in the shoreline sediments indicate some evidence of accumulation, which may be attributed to discharges from the Steel River Project site. These sediments are relatively small in area and accumulation is not evident in the nearby river sediments. The potential for the shoreline sediments to have an adverse effect on the ecology of the Hunter River is therefore limited.

Based on the above, it is assessed that the potential for the Steel River Project site to be associated with adverse widespread effects on the ecology of the Hunter River is limited. This is consistent with the available data for river water and sediment quality, which extends to areas well removed from the Steel River Project site.

D1.5 CONCLUSIONS

D1.5.1 Human Health

Screening level health risk estimation calculations have been undertaken in order to assess the potential significance of human health risks associated with the presence of site-chemicals These results indicated that, for the majority of the Steel River Project site, no unacceptable carcinogenic or non-carcinogenic risks should exist if the site were to be developed for industrial purposes.

There does, however, exist some uncertainty with respect to the potential for elevated PAH concentrations to be present at the surface in some areas of the site. As a consequence, it is possible that risk calculations may provide an underestimate of the risks posed by the presence of PAHs in surface fill materials at specific locations across the Steel River Project site. This is more likely to occur in those areas where tars were noted close to the surface of the site (i.e. Areas 7 and 8). As a consequence, site-specific remediation goals have been derived for PAHs which can be used in the validation of the site prior to and/or following any development.

The risk assessment did not identify any requirement to derive remediation criteria for metals.

The assessment of the potential for the emission of vapours to adversely effect air quality within buildings located on the site after development, indicated potentially unacceptable conditions may be associated with the higher concentrations of BTEX compounds measured. The investigation data indicates that the area of the site potentially affected by volatile contaminants is limited, however, confirmation of this fact would be warranted for a specific development.

D1.5.2 Environmental

The assessment of risks to the environment indicated limited potential for widespread effects on the ecology of the Hunter River and, on this basis, no specific remediation would be warranted to control releases of contaminants to the Hunter River. Any remediation that might be undertaken to influence the shoreline seepages, would be of an aesthetic nature only and would not be expected to result in measurable changes in the quality of river water or river sediments.

D1.6 RISK BASED REMEDIATION CRITERIA

The National Environmental Health Forum (NEHF) have developed Health Based Soil Investigation Guidelines (NEHF 1996a and 1996b) for a range of land use scenarios. The NEHF soil investigation guidelines for commercial industrial land use have been developed using a default exposure ratio which relates the land use to the standard residential setting. The default exposure ratio for commercial industrial has been set at 0.2. In relation to the default exposure ratio, the NEHF (1996b) states the following in the footnote on Table 5:

> *"These default exposure ratios should be seen as purely guideline values for the development of soil investigation criteria rather than for derivation of soil response criteria."*

The default exposure ratios are stated to be arbitrary values based on judgement and that soil guideline values may be adjusted with site specific assessment.

Accordingly, the calculation of remediation criteria for industrial development at the Steel River Project site has utilised exposure scenarios descriptive of the potential for adults to be exposed to chemicals present in the soil. The risk assessment concludes that for the development of the Steel River Project site for industrial purposes:

- there are no requirements for widespread remediation of the Steel River Project site;

- remediation of particular areas may be required. This will depend on the presence of contamination by polyaromatic hydrocarbons (PAHs) and whether the nature of the proposed land use in the area could result in site workers being exposed to excessive concentrations of PAHs.

- The criteria for determining whether remediation is required for industrial land use purposes on the BHP Steel River Project site are:

  - the presence of visible tar;
  - Total PAH concentrations exceeding 400 mg/kg; and
  - benzo[a]pyrene (an individual PAH) concentrations exceeding 15 mg/kg.

These criteria refer to the 95 % upper confidence limit of the mean concentration over an area where on-site worker exposure is likely to occur over a long period of time. The risk based remediation criteria have been developed using the screening level exposure scenarios used in the health risk assessment.

Consistent with the NEHF (1996b) document, this approach results in soil remediation criteria which are higher than the investigation guidelines calculated using the default exposure ratio. It should be noted that the exposure scenarios used in the risk assessment incorporate conservative assumptions that have the effect of overestimating the likely exposure. For example, it has been assumed that a worker spends every working day at the site for thirty years and that the whole working day is spent in direct contact with affected soil. This does not allow for the fact that the majority of the work day would more likely be spent either indoors or in open areas covered by hard pavement. As a consequence, the calculated NEHF remediation criteria are lower than would be calculated using more site specific assumptions.

The risk based remediation criteria are applicable to the surface of the site after development. Workers who may have to undertake excavations during or after development, may be exposed to materials located beneath the surface, however, as the duration and frequency of exposure is lower, the acceptable concentrations would be higher. As a conservative approach to the management of the site, it is proposed that the risk based remediation criteria, applicable for the surface, be adopted for the top 2 m of areas where it is desirable to allow unrestricted industrial use (including the installation of foundations and major services such as stormwater, sewer, and power). This approach, whilst being over protective of workers undertaking excavations, allows for greater flexibility in the long term management of the site both during and after development.

In areas designated for use as public open space, it is proposed that, as a minimum, the top 0.5 m of the area should be covered by a layer of clean material. This depth is consistent with recreational activities being non-intrusive into the underlying soils and has been the basis of remediation undertaken on other sites. In this context of public open space, clean capping materials will be defined on the basis that it does not constitute a risk to the health of members of the general public who may frequent the area, and be able to support an appropriate standard of landscaping.

APPENDIX E

SOIL REMEDIATION TECHNOLOGIES

E1.0
SOIL REMEDIATION TECHNOLOGIES

E1.1 INTRODUCTION

Remedial options for the Steel River Project site are focused on techniques suitable for tar affected soils located in the surface two metres of fill across the site.

In assessing any remediation or treatment option, management technology or strategy for a site, consideration must be given to the extent and nature of the contamination. In some instances, the technical constraints associated with the nature and depth of the contamination, and the matrix in which the contamination occurs, will render some remediation options not feasible.

For each of the technologies reviewed the following is represented:

- A brief description of the technology;
- The broad advantages and disadvantages; and
- The suitability of each remedial technique with respect to the BHP Steel River Project site remediation, including any limitations.

Options considered include:

- Capping/On-site Containment
- Off-site Disposal
- Stabilisation
- Thermal Desorption
- Bioremediation
- Soil Washing
- Alternative Treatments

E1.2 CAPPING/ON-SITE CONTAINMENT

On-site containment of contaminated materials can range from simply capping the materials to excavation and placement in an engineered cell. Capping is the process of covering contaminated materials to prevent direct contact with receptors and to control the infiltration of surface water. In areas to be grassed or otherwise vegetated the cover typically comprises a base of compacted clayey material 500 to 1 000 mm thick (dependent on proposed land use and the requirements for the installation of services), overlain by an approved general fill and a topsoil layer (for contouring and landscaping purposes).

An engineered cell also involves a final cap, however, materials are placed in a cell which has been engineered to minimise the infiltration and subsequent migration of any contaminants out of the cell. This may involve the lining of the base and sides of the cell with compacted clay or HDPE and collection and treatment of any leachate.

Advantages

- Relatively short timeframe for implementation;
- Capping alone avoids excavation of contaminated soil;
- Odour emissions minimised where capping contaminants in place;
- Fill readily available (if from existing coal washery reject material spread over the site); and
- Contaminant areas can be incorporated into final landscape design of the property development.

Disadvantages

- Does not provide a reduction in contaminant levels, but isolation from receptors;
- Capping alone does not control mobile contaminants and long term monitoring and maintenance may be required;
- To maintain the integrity of the cap, restrictions may be required on the overlying development of the site;
- May involve double handling of materials where excavation of materials is in advance of preparation of disposal areas;

- Statutory authorities may place a notice on the land title identifying the presence of contamination on the property thus "stigmatising" the land; and
- Final cap level must be integrated into the future development of the site.

E1.3 OFF-SITE DISPOSAL

In New South Wales the disposal of contaminated soils to landfill is described in the Environment Protection Authority's "Environmental Guideline - Landfill Disposal of Industrial Wastes" published in 1989. This was updated in 1991 and 1993 and most recently in December 1996 as the "Draft Hazardous Waste Definition and Draft Environmental Guidelines: Solid Waste Assessment". These documents assert the suitability of contaminated soils for landfill disposal based on the specific contaminant concentration, and leachability of the contaminants assessed using the US EPA Toxicity Characteristic Leaching Procedure (TCLP) test.

Advantages

- Removes the near surface contamination from site;
- Relatively short timeframe for implementation;
- Risk of future on-site odour emissions minimised/eliminated;
- Soils found to exceed TCLP concentrations may be acceptable to landfill without pretreatment (e.g. stabilisation) if sent to a leachate controlled landfill and/or disposed within a monofill.

Disadvantages

- Provides containment (although off-site) and restricts availability to the environment, not a reduction in contaminant levels;
- Requires replacement of excavated materials and compaction of these imported soils and/or site materials;
- Not in keeping with EPA philosophy of preserving valuable landfill space by excluding contaminated soil; and
- Soil may need to be transported long distances due to a lack of suitable facilities in Newcastle.

E1.4 STABILISATION

Stabilisation is a form of microencapsulation for soils with potential leachable concentrations.

The process involves the conversion of hazardous liquid, sludge or solid waste into a solid, structurally sound material that can be used for land reclamation or other purposes. The solid produced must not only bond the waste in a solid matrix of low permeability, but also chemically fix the hazardous substances so that they are immobilised. This may involve chemical precipitation, chemical adsorption or physical encapsulation, and can include in situ processing.

Where stabilisation is seen as being appropriate, and in situ techniques beneficial, shallow soil mixing (SSM) could be utilised for the Steel River Project site. The SSM method utilises a crane or excavator mounted mixing system that mixes the contaminated soil or sludges with dry or fluid treatment chemicals to produce a stabilised end product. An example of where SSM has been successfully used is the remediation of a former gasworks, Columbus Georgia. The site which was located adjacent the Chattahoochee River was to be converted into a city park and contained tar affected soils on the site with PAH concentrations in the range of 1 500 mg/kg to 26 000 mg/kg. SSM technology was seen to be the most suitable remedial treatment technology for this site location and soil type as it could provide a uniform mix of the affected soils and have provisions for the control of organic vapours and dust.

Advantages

- Short time frame required for treatment;
- In situ process controls the release of organic vapours and dust;
- Provides a method of preventing migration of contaminants; and
- Provides encapsulation for contaminated soil unsuitable for direct disposal to landfill due to leachate concentrations exceeding guidelines.

Disadvantages

- The volume of contaminated soil is increased with a general requirement of between 3 to 20% by weight addition of cement or other additive. Therefore the volume of material requiring disposal or recompaction is also proportionately increased;
- Laboratory and/or bench scale testing is required to determine optimum reagent addition and water ratios;
- To prevent the leaching of organics, special additives may be required;
- Provides microcontainment, not a reduction in contaminant levels;
- The longterm performance of stabilised soils especially for high organic contents has been questioned, including the suitability of current physical and chemical tests to predict the integrity of the treated soils over time; and
- The existence of large boulders and debris within the fill will interfere with thorough in situ soil treatment. Pockets of high concentrations of tarry material may not be immobilised.

E1.5 THERMAL DESORPTION

Thermal desorption of soils is effective for a wide variety of organic contaminants and has been used successfully on selected sites within Australia. The process of thermal desorption for larger scale remediation projects (such as the Steel River Project site) involves a rotary dryer for the volatilisation of organic compounds combined with flue gas treatment (for acidic components, volatile metals and particulate matter) and a secondary combustion chamber for oxidising organic contaminants contained in the offgas. A particulate collection system is used to collect the fine ash generated in the combustion process.

Advantages

- Desorbs from the soil (natural or fill) matrix both volatile and semivolatile components using a roasting process;
- More certainty of success and control of treatment timeframe relative to biological treatment; and
- Provides treatment of organic contaminants as opposed to containment only.

Disadvantages

- Capital intensive;
- To determine whether the process is applicable, specific testing on a bench and/or pilot scale is required prior to implementation;
- Soils can require extensive pretreatment if heterogeneous e.g. where there are large rocks;
- Significant materials handling problems are associated with fine grained soils (in particular clays or cohesive high organic content materials).
- Blending of feed critical to performance of this technology. Needs a lot of space;
- High energy cost for soils with high moisture contents;
- Requires disposal of fines from the particulate collection system; and
- Typical treatment rates are quite low (may range from 20 to 50 tonnes/hour).

E1.6 BIOREMEDIATION

The different forms of bioremediation rely upon the bacteriological breakdown of hydrocarbons. This process can be aided by the maintenance of treatment conditions, eg moisture levels, and by the addition of nutrients to stimulate bacteriological growth. Recent studies both in the laboratory and on field trials suggest that organic amendments (addition of greenwaste/compost) in engineered beds can increase the rate and extent of PAH degradation.

Landfarming

Landfarming relies on the bacteriological breakdown and volatilisation of hydrocarbons during tilling or reworking of the contaminated soils spread to a shallow depth over the ground. This method also helps to disperse the contamination evenly, enabling good contact between the soil organisms and the contaminants. Biodegradation is maximised by regular soil tilling, the addition of nutrients and soil moisture control, however landfarming has limited success with heavy end organics, including PAHs.

Advantages

- Aggregates of contamination become dispersed and evenly distributed through the soil volume with good contact between soil organisms and the contaminants;
- The process minimises time required for remediation of volatile contaminants;
- Provides good aeration due to regular tilling and shallow treatment depth; and
- The process requires low capital expenditure reducing total costs of remediation.

Disadvantages

- A number of projects have shown landfarming not to be consistently effective for selected heavy end hydrocarbons and PAHs with greater than 4 benzene rings;
- Requires large treatment areas underlain with an impermeable base to prevent contamination from contacting and impacting soil or groundwater;
- Does not normally provide control of volatile emissions (emissions may be controlled using an enclosure similar to a greenhouse);
- Requires regular tilling/earthworks to ensure aeration of soil; and
- The process requires leachate control as treated soil is generally not covered.

Fixed Bed Bioremediation

An alternative to landfarming are engineered beds. This form of bioremediation is commonly used for sites where space is limited. This process often uses a liner between the soil identified as clean and the contaminated soil that is placed in the fixed bed (or biopiles). To allow aeration without tillage of the soil, a series of agricultural pipes are installed within the contaminated soil to ensure that there are sufficient oxygen levels within the beds to stimulate the aerobic bioremediation of the contaminants. The air is supplied by a mechanical air blower.

Advantages

- The mechanical air blower can be placed on vacuum mode. This allows controlled release of any volatile contaminants from the beds to air pollution control equipment;

- A treated geotextile fabric cover over the biobed to limit rainfall infiltration readily ensures hydrocarbons are not leached into the surrounding soil through stormwater runoff;
- Requires less treatment area than landfarming;
- More effective than land farming for heavy end hydrocarbon contaminants, however, to optimise results it requires organic amendment; and
- Aeration piping allows periodic monitoring of volatile concentrations to assist in the assessment of the progress of the remediation.

Disadvantages

- The process requires double handling of contaminated soil;
- PAH bioremediation may be potentially time limiting;
- Contaminant concentration after treatment can generally be 200 - 500 mg/kg PAH, which would not allow the materials to be defined as "clean";
- The process is more capital intensive than land farming;
- To facilitate a suitable level of permeability, hence good aeration and degradation rates, the material may require screening prior to placement in fixed beds. In clayey and carbonaceous soils, the soil's structure can severely limit bioavailability and without organic amendment limit the practical remediation level; and
- Detailed laboratory/pilot testing would be required to determine whether cleanup criteria could be met. Due to the soil's structure limiting the bioavailability of the PAH contaminants the risk of failing to meet the criteria is considered high.

Bioreactor Bioremediation

Contaminated material is excavated, screened and pulverised and slurried with water containing elevated populations of acclimatised cultured bacteria. The slurry is then pumped into a biotreatment digester. Agitation and aeration maintain suspension of solids and dissolved oxygen levels.

Following bioremediation the slurry is pumped into a dewatering system of a hydrocyclone, vibrating filter belt and conveyor. Water containing the biomass is recycled via an incubator to build up bacterial populations.

The system can be operated either in batch, semicontinuous or continuous mode, with a number of reactors running simultaneously.

Advantages

- Designed for low permeability materials, such as clays, that are not amenable to in situ processes; and
- The process can be designed for volatile emission control.

Disadvantages

- The process requires both comprehensive bench and pilot scale testing. Achievement of the cleanup criteria with high tar concentrations in a coal washery refuse matrix has not been previously demonstrated;
- The process requires a large number of reactors to treat significant volumes of soil within a suitable timeframe;
- Reactors incur significant costs for establishment and operation in the field, thus resulting in a high unit cost rate;
- There are often severe adverse effects on soil structure; and
- Process effluents often need to be treated and disposed.

Bioremediation - In situ

In situ bioremediation of subsurface materials, involves stimulating the indigenous subsurface microflora by the addition of oxygen and nutrients to degrade the contaminants in place, although in some cases micro-organisms with specialised metabolic capabilities can be added. The addition of oxygen and essential nutrients such as nitrogen, phosphorous, and trace elements is usually via groundwater. The rate of bioremediation in the subsurface is usually limited by the amount of oxygen that can be transported to the organisms in the zone of contamination. Several methods can be used to supply oxygen to the subsurface, including the addition of air, pure oxygen, or hydrogen peroxide (H_2O_2).

Advantages

- Allows treatment of the soil without excavation or handling requirements;
- Achieves simultaneous remediation of the soil immediately adjacent to the groundwater level and the groundwater;
- Odour emissions are not an issue; and
- Provides viable remedial alternative for ongoing operational sites.

Disadvantages

- Not suited for heterogeneous fill materials;
- The fill materials across the sites are not likely to have sufficient permeability to allow infiltration with a solution of oxygen and nutrients;
- The fill soil matrix would be expected to have preferential pathways, therefore not all areas would be successfully treated in situ; and
- Requires extended remedial treatment timeframe.

E1.7 SOIL WASHING

Soil washing is a process by which excavated soils are washed to remove contaminated material. Soil washing is an aqueous based technology that typically uses chemicals and mechanical separation to concentrate contaminants removed from soils. These processes utilise water alone or water augmented with leaching agents, solvents, surfactants and/or chelating agents to remove organics or heavy metals.

The technology does not destroy contaminants, but rather separates them from the soil. The resulting contaminant rich medium requires further treatment for recovery, destruction or disposal of the wastes. Process developers report that soil washing may be cost effective for soils with up to 40% fines, although the technique is most applicable to soils with up to 20% fines.

Advantages

- Reduces the volume of material requiring ultimate treatment and/or disposal as a contaminated soil; and
- The majority of the feedstock is reusable as clean fill.

Disadvantages

- Capital intensive;
- Soil washing systems are dependent on favourable contaminant distribution and thus to determine whether the process is applicable to a site, comprehensive testing on a laboratory scale and pilot scale is required prior to implementation;
- If the soil is homogeneously contaminated over the various soil fractions and composition then soil washing is unlikely to be effective;
- As the process requires both laboratory, pilot scale testing and then has treatment rates of typically 20 to 50 tonnes/hour the remedial timeframes are significantly extended;
- The process typically reduces the contaminant volume to between 20% to 30% of the original feedstock volume, which in relation to PAH rich material, may require disposal to a secure landfill (stabilisation treatment is unlikely to be applicable to the PAH enriched fraction); and
- Replacement fill required.

E1.8 ALTERNATIVE TREATMENTS

Potential alternative treatment technologies for tarry organic contaminated soils include the following:

Brick Manufacture

The manufacture of bricks requires shale, clay and water which are combined to form a plasticised mixture which is then extruded and moulded into 'green' bricks. These green bricks are then dried in a drying room where hot air is circulated. The dried bricks are then preheated to approximately 540°C in the front of a tunnel kiln and then fired at approximately 815°C for 12 hours. In theory the brick making process could blend some contaminated soils with the shale and clay and the soils become a brick ingredient. The organic contaminants within the soil are volatilised and destroyed.

Co-Burning in Power Station Boilers

A number of power stations in the United States have been co-burning contaminated materials at their power generating stations in recent years. The contaminated materials have included tar affected soils which have been burned at these facilities. Power station boilers that generate steam using cyclone, pulverised coal and/or stoker boilers have the potential to co-burn tar affected soils. The tar affected soils are co-burned in these units by blending them with the feed coal in the ratios of 100:1 to 20:1. The tar affected soils must be ground to less than 20 mm prior to mixing with the coal in the case of cyclone or pulverised coal units.

Cold-Mix Asphalt

Soils contaminated with hydrocarbons can be used to produce cold mix asphalt. Contaminated soils are pre-processed by crushing and screening to produce a uniform size material free of debris. After pre processing, the soil is conveyed to a mixing chamber where liquid emulsion is added at a predetermined rate. The mixture of asphalt and soil thus formed is allowed to cure for 72 hours.

Hot-Mix Asphalt

Contaminated soils have been used as a component of hot-mix asphalt. Hot mix asphalt plants typically consist of a kiln with a multi-hopper soil/aggregate feed system. Soil and aggregate are metered into the rotary kiln. The soil aggregate mixture is heated to approximately 310°C in the rotary kiln. At this temperature most of the organics are volatilised. Liquid asphalt is injected into the centre of the rotary kiln where it is mixed with the soils and aggregates to form a bituminous concrete. Several gas manufacturing sites in the US have used tar affected soils processed into hot-mix asphalt for use as pavement on their property.

Assessment of Alternative Technologies

These alternatives are regarded as unsuitable as remedial techniques for the Steel River Project site due to lack of appropriate local facilities which could incorporate the materials into their normal manufacturing process, the lengthy development program required and the unknown regulatory need for controls and monitoring of the facilities.

APPENDIX F

GROUNDWATER CONTROL OPTIONS

F1.0
GROUNDWATER CONTROL OPTIONS

F1.1 INTERCEPTION ALTERNATIVES

This appendix briefly presents the technologies for hydraulic barrier options for the control and prevention of off-site migration of affected groundwater from the Steel River Project site. The primary purpose of hydraulic control systems is to establish a hydraulic barrier (as opposed to a physical barrier, such as a clay-grout wall) and *not* a system for the extraction of contaminated groundwater. Such systems may capture contaminated groundwater but this is incidental (secondary) to their role as a barrier to the migration of a contaminated water.

Groundwater hydraulic barrier system technologies applicable to the Steel River Project site are as follows:

a) recovery well methods;

b) interception trench methods; and

c) horizontal drains.

A description of each of these options is presented below. The advantages and disadvantages for each are provided.

F1.2 Recovery Well Methods

Recovery wells could be constructed to impose an inward groundwater flow gradient at (or adjacent to) the Steel River Project site river frontage. The wells would be spaced to create a hydraulic barrier condition along the full length of the river frontage. The hydraulic barrier prevents affected groundwater from reaching the river.

The contaminated groundwater is extracted from a series of recovery wells (a continuous line or appropriately sited wells) and is pumped into a balance tank. A feed pump then directs the water into an appropriately designed water treatment plant (WTP). The effluent is then to be treated using one of a number of available primary and secondary treatment options in order to degrade the organic components. The treated groundwater would be discharged to the sewer or the river under an applicable discharge license.

Advantages

- Some contaminant load is recovered, extracted (through treatment) and removed off site;
- The creation of an inward hydraulic gradient which will limit the migration of the organic contaminants and protect the Hunter River; and
- It would be seen as a positive action to manage the problem by the authorities and the community.

Disadvantages

- Uncertainty that a continuous hydraulic barrier has been implemented, without an extensive and costly monitoring well network;
- High cost of installation, maintenance and monitoring;
- Inefficient due to the inherent need to pump and treat significant volumes (~50%) of clean water drawn in from the Hunter River side of the capture zone;
- Requires an effective and costly treatment method/s to treat the effluent for discharge outside the site;
- Effective only while pumping is being carried out; if pumps should fail for any length of time contaminant release to the river could result;
- Sample collection and laboratory analyses required at regular intervals until completion and, possibly, for a monitoring period to be established;
- Compressor and pumps require ongoing power and maintenance; and
- Extraction rate is limited by aquifer permeability.

F1.3 INTERCEPTOR TRENCH

An interception trench could be constructed to impose an inward groundwater flow gradient along (or adjacent to) the Steel River Project site river frontage. When pumped, the trench would create a drawdown condition in the area surrounding the trench. This condition induces an inward flow gradient effect in the vicinity of the trench. The inward gradient creates a continuous hydraulic barrier which would prevent affected groundwater from reaching the river.

The trench would be most effective if constructed at (or close to) the toe of the landfill-river edge bank. Here the optimum trench depth would be 2 m to 3 m. However, this location is considered technically impractical, has regulatory difficulties associated with it (encroachment into the river) and would be high cost. A trench location at the top of the embankment would achieve the same objective but would need to be considerably deeper (10 m to 12 m deep) and more expansive and is therefore more costly.

The contaminated groundwater is extracted from an interception trench (trench drain) and is pumped into a balance tank. The process operation following recovery from the trench is the same as for the recovery wellfield option.

Advantages

- Contamination removed off site.
- Low supervision and maintenance requirements.
- Technology has been tried and tested.
- The certainty of the creation of a continuous inward hydraulic gradient which would limit the migration of the organic contaminants and protect the Hunter River.
- It would be seen as a positive action to manage the problem by the authorities and the community.
- Fewer pumps and other infrastructure than a wellfield recovery system.

Disadvantages

- Technical feasibility and effectiveness of installation and operation in heterogeneous fill aquifer is uncertain. In particular, for a toe of slope trench there is a need to establish an engineered platform into the river to allow equipment access or, alternatively move the current embankment back 6 m to 10 m into the site to provide equipment access followed by a reconstruction of the embankment;

- Excavation in fill materials may be problematic, particularly where excavation depths of 10 m to 12 m are probable (the top of embankment level would have to be lowered by up to 4 m to allow these depths to be reached, this in turn would require considerable potentially contaminated material double handling) and where slag materials may be present;

- Inefficient due to the inherent need to pump and treat significant volumes ($\geq$50%) of clean water drawn in from the Hunter River side of the capture zone (only a liner on the river side of the trench would reduce the capture of clean river water);

- Effective only while pumping is being carried out; if pumps should fail for any length of time contaminant release to the river could result;

- Requires effective treatment method to treat the effluent for discharge outside the site;

- Sample collection and laboratory analyses required at regular intervals until completion and, possibly, for a monitoring period yet to be established;

- Compressor and pumps require power and maintenance;

- Extraction rate is limited by aquifer permeability, from the size of the treatment plant and from the rate of treatment; and

- High cost of installation.

F1.4 HORIZONTAL RECOVERY WELL/DRAIN

A horizontal well alignment could be installed along (or adjacent to) the Steel River Project site river frontage to impose an inward groundwater flow gradient (hydraulic barrier). The advantage over an alignment of recovery wells is that of increased certainty of the effectiveness of the continuity of the hydraulic barrier.

The horizontal well/s would be installed at (or close to) the toe of the landfill-river edge bank to create a hydraulic barrier condition along the full length of the river frontage. Through extractive pumpage from a collection sump/s on the horizontal well alignment, the well induces drainage of groundwater (some contaminated) to the well alignment and, in doing so, creates a continuous hydraulic barrier condition. This hydraulic barrier created when the trench is pumped would prevent affected groundwater from reaching the river.

The contaminated groundwater is extracted as necessary from the horizontal well (up to 1300 m long) and is pumped into a balance tank. The process operation following recovery from the horizontal well/s is the same as for the recovery wellfield option.

Advantages

- Some contaminant load is recovered, extracted (through treatment) and removed off site;
- The creation of an inward hydraulic gradient which will limit (and potentially reverse) the migration of the plume;
- Lower supervision and maintenance requirements than recovery wells due to fewer pump installations;
- Horizontal drilling technology has been tested, albeit not in this environment (heterogeneous fill); encountering significant coarse materials could make this a disadvantage. In the case of the Steel River Project site the alluvial deposits would be considered the target aquifer unit;
- Majority of works is under ground;
- Lower operating costs (single pump, simple plumbing).

Disadvantages

- Uncertainty that a continuous hydraulic barrier (due to aquifer permeability contrasts and low media hydraulic conductivity) has been implemented, without an extensive and costly monitoring well network (installation and monitoring);
- Technical difficulties during installation are uncertain and are likely to be substantial (aquifer inhomogeneity, equipment access, need to build a drilling rig platform into the river bank or into the river channel);
- Airlift pumping type system untested under these conditions; electrical pumping systems require complex and costly level control systems;
- Requires an effective and costly treatment method/s to treat the effluent for discharge outside the site;
- Effective only while pumping is being carried out; if pumps should fail for any length of time contaminant release to the river could result;
- High capital costs; and
- Risk of inability of completing the well/drain if loose collapsible ground is encountered.

APPENDIX G

CHEMICAL ANALYSIS OF CWR

Table G-1
Chemical Analysis of Coal Washery Refuse

Analyte	Sample 1[1]	Sample 2[1]	Sample 1[2]	Sample 2[2]
Cyanide	3.0	1.5	NA	NA
Cyanide - Amenable to Chlorination	0.5	<0.5	NA	NA
Fluorine	395	410	NA	NA
Copper	19	20	22	22
Lead	17	22	14	14
Zinc	54	56	48	48
Cadmium	<2	<2	<1	<1
Chromium	52	43	9	9
Nickel	20	17	18	15
Manganese	220	260	210	230
Aluminium	61900	62400	7100	8300
Barium	396	358	210	180
Beryllium	2.6	2.4	1.8	1.7
Molybdenum	<10	<10	<10	<10
Boron	29	28	25	27
Mercury	0.1	0.1	NA	NA
Arsenic	4.8	3.3	NA	NA
Silver	NA	NA	<1	<1
Selenium	0.36	0.4	NA	NA
Napthalene	0.2	0.3	NA	NA
Acenaphthylene	<0.2	ND	NA	NA
Acenaphthene	<0.2	ND	NA	NA
Fluorene	<0.2	ND	NA	NA
Phenanthrene	0.4	0.5	NA	NA
Anthracene	<0.2	<0.2	NA	NA
Fluoranthene	<0.2	<0.2	NA	NA
Pyrene	<0.2	<0.2	NA	NA
Benz{a}anthracene	<0.2	<0.2	NA	NA
Chrysene	<0.2	<0.2	NA	NA
Benzo{b}fluoranthene	<0.2	<0.2	NA	NA
Benzo{k}fluoranthene	<0.2	<0.2	NA	NA
Benzo{a}pyrene	<0.2	<0.2	NA	NA
Indeno{1.2.3-cd}pyrene	<0.2	<0.2	NA	NA
Dibenzo{ah}anthracene	<0.2	<0.2	NA	NA
Benzo{ghi}perylene	<0.2	<0.2	NA	NA

Notes:
Units are in mg/kg
[1] By fusion method - total metal concentration
[2] By USEPA Method 3050A - acid digestable metal concentration
NA - Not analysed

Prepared by: SKT.
Checked by: [illegible]

Table G-2
TCLP and Water Extraction Results for Coal Washery Refuse

Analyte	Units	Sample 1 (1)	Sample 2 (1)	Sample 1 (2)	Sample 2 (2)
pH		5.0	4.9	9.9	9.9
Fluoride	mg/L	0.17	<0.10	0.31	0.55
Copper - total	mg/L	0.02	0.02	0.02	<0.01
Lead - total	mg/L	<0.05	<0.05	<0.05	<0.05
Zinc - total	mg/L	0.15	0.22	0.11	0.05
Cadmium - total	mg/L	<0.01	<0.01	<0.01	<0.01
Chromium - total	mg/L	<0.01	<0.01	0.01	<0.01
Nickel - total	mg/L	<0.10	<0.10	<0.10	<0.10
Manganese - total	mg/L	0.28	0.27	<0.01	0.01
Aluminium - total	mg/L	0.21	0.19	11.00	3.80
Barium - total	mg/L	1.8	1.7	0.9	1.1
Beryllium - total	mg/L	<0.01	<0.01	<0.01	<0.01
Molybdenum - total	mg/L	<0.01	<0.01	<0.01	<0.01
Boron - total	mg/L	0.05	0.04	0.10	0.12
Mercury - total	mg/L	0.03	0.03	0.30	0.05
Arsenic - total	mg/L	0.002	<0.002	0.008	0.007
Silver - total	mg/L	<0.01	<0.01	<0.01	<0.01
Selenium - total	mg/L	0.002	<0.002	0.003	0.003
Napthalene	ug/L	<0.2	<0.2	<0.2	<0.2
Acenaphthylene	ug/L	<0.2	<0.2	<0.2	<0.2
Acenaphthene	ug/L	<0.2	<0.2	<0.2	<0.2
Fluorene	ug/L	<0.2	<0.2	<0.2	<0.2
Phenanthrene	ug/L	<0.2	<0.2	<0.2	<0.2
Anthracene	ug/L	<0.2	<0.2	<0.2	<0.2
Fluoranthene	ug/L	<0.2	<0.2	<0.2	<0.2
Pyrene	ug/L	<0.2	<0.2	<0.2	<0.2
Benz{a}anthracene	ug/L	<0.2	<0.2	<0.2	<0.2
Chrysene	ug/L	<0.2	<0.2	<0.2	<0.2
Benzo{b}fluoranthene	ug/L	<0.2	<0.2	<0.2	<0.2
Benzo{k}fluoranthene	ug/L	<0.2	<0.2	<0.2	<0.2
Benzo{a}pyrene	ug/L	<0.2	<0.2	<0.2	<0.2
Indeno{1.2.3-cd}pyrene	ug/L	<0.2	<0.2	<0.2	<0.2
Dibenzo{ah}anthracene	ug/L	<0.2	<0.2	<0.2	<0.2
Benzo{ghi}perylene	ug/L	<0.2	<0.2	<0.2	<0.2

Notes:
(1) TCLP extraction
(2) Demineralised water extraction

Prepared by: SKT.
Checked by: JW.

APPENDIX H

CHEMICAL CHARACTERISATION OF FILL

H1.0
CHEMICAL CHARACTERISATION OF FILL

H1.1 GENERAL

The fill used in reclaiming Platt's Channel included:

- blast furnace slag (generally contains oxides of silica, aluminium, lime and magnesium, and comes from the removal of impurities from iron in the blast furnace);
- open hearth slag and Basic Oxygen Steelmaking (BOS) slag (from the removal of steel impurities);
- coal washery slurry (fine CWR);
- flue dusts;
- brecketts waste (finely broken BOS slag);
- sinter plant dusts;
- fly ash (light ash component from the coal used to fire the boilers);
- bottom ash (heavy ash component from the coal used to fire the boilers 'clinker');
- shale;
- oil sludges;
- tar wastes;
- general refuse (non-putrescible, including timber, bricks, old gloves etc);
- lime sludge; and
- large volumes of river silt and white beach sand dredged from the remaining South Channel of the Hunter River.

Limited information is available regarding details of the location of the disposal of particular wastes.

During the course of the investigations undertaken by BHP at the Project site, the concentration of a range of inorganic and organic constituents of the fill materials has been collected. This data has enabled a broad chemical characterisation of the fill to be undertaken. The following sections present a summary of the data collected by BHP.

H1.2 INORGANIC CHEMICALS

The arithmetic mean concentrations of inorganic parameters analysed for the various fill materials derived from BHP data are listed in Table H-1.

Based on a comparison with probable background conditions at the site (i.e. those materials classified as soil, clay and clayey sand and sand) the following observations can be made:

- elevated concentrations of manganese appear to be associated with brecketts, BOS/open hearth slags, bottom ash and blast furnace slag; and
- elevated concentrations of chromium appear to be associated with fly ash, brecketts and BOS/open hearth slags.

All of these materials appear to exist on an effectively random basis at various depths across the site. However, the vast majority of the surface of the site has a covering layer of coal washery refuse. The depth of this layer generally lies in the range of 0.2 - 0.5m.

H1.3 ORGANIC CHEMICALS

The arithmetic mean concentrations of organic parameters analysed for the various fill materials, derived from BHP data, are summarised in Table H-2. Also included in Table H-2 are the arithmetic mean concentrations for soil, clay and clayey sand/sand, intersected during the investigations.

Based on a comparison with probable background conditions at the Project site (i.e. those materials classified as soil, clay and clayey sand and sand), slightly elevated concentrations of polyaromatic hydrocarbons (PAHs) appear to be associated with all seven classifications of steelworks waste material. Some samples (eg. slags) were found to be contaminated with PAHs, even though the raw material is PAH free. This is due to the slag material being mixed with PAH bearing material in the ground. A comparison of PAH concentrations on a sample by sample basis revealed that the concentration distributions are generally skewed, i.e. there is a high proportion of low concentrations of PAHs with a small number of high concentrations.

Significantly elevated concentrations of BTEX (benzene, toluene, ethyl benzene and xylene), total petroleum hydrocarbons (TPH) and/or phenols were also found to occur in a relatively small number of fill material samples collected.

Based on a review of bore log data contained in the BHP site investigation data reports, it is apparent that the higher concentrations of PAHs are associated with organic substances such as tars and coke oven gas mains condensate. Other organic substances such as oils and possibly diesel may also contribute to the PAH concentrations. Specific samples of fill materials having higher concentrations of PAH, BTEX, TPH and phenol and the respective bore log descriptions are provided as Table H-3.

Table H-1

Arithmetic Mean Concentrations of Inorganic Chemicals in Fill Material

	Units	Coal Washery Refuse	CWR & Fly Ash	Brecketts	Fly Ash	Bottom Ash	Blast Furnace Slag	BOS/Open Hearth Slags	Clay	Soil	Clayey Sand and Sand
Arsenic	mg/kg	11.5	9.2	9.5	8.8	5.4	5.3	8.9	11.5	8.0	9.0
Cadmium	mg/kg	2.0	2.0	2.1	2.0	2.0	2.0	2.0	2.3	2.0	2.0
Chromium	mg/kg	265	164	1271	839	347	413	2970	111	110	109
Copper	mg/kg	20.8	20.8	54.8	44.6	41.0	27.2	32.4	17.8	18.9	313
Lead	mg/kg	44.0	28.0	75.3	45.1	33.5	43.2	46.8	39.0	47.8	52.4
Manganese	mg/kg	3431	3462	27502	4790	10183	22250	25248	498	1108	1098
Mercury	mg/kg	0.12	0.07	0.11	0.09	0.05	0.03	0.21	0.03	0.03	0.10
Nickel	mg/kg	35.0	28.8	93.9	55.0	131	33.4	61.6	48.8	43.9	32.6
Tin	mg/kg	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.8	22.1	41.4
Zinc	mg/kg	151	90.4	319	144	107	185	546	155	102	252
Cyanide	mg/kg	1.8	2.2	5.1	2.4	1.8	11.6	8.4	1.8	1.3	1.8
Iron	mg/kg	52539	55150	207936	63429	69750	74004	144000	32930	28567	28338
Aluminium	mg/kg	63082	51230	33099	69386	57313	62440	40700	72667	63767	40306

NOTES:

Concentrations are indicative of materials as found in fill materials and may not be indicative of concentrations in source materials

Prepared by: MS
Checked by: [illegible]

Table H-2
Arithmetic Mean Concentrations of Organic Chemicals in Fill Material

	Units	Soil	Clay	Clayey Sand and Sand	Fly Ash	Coal Washery Refuse	Brecketts	CWR & Fly Ash	BOS/Open Hearth Slags	Bottom Ash	Blast Furnace Slag
PAHs											
Naphthalene	mg/kg	1	1.4	1.2	1.6	8.1	2.1	11.8	1.4	1	1.2
Acenaphthylene	mg/kg	1	1	1	1	1.4	1	1	1.4	1	1.2
Acenaphthene	mg/kg	1.1	1.1	1	1	1.2	1	1	1.4	1.6	1.4
Fluorene	mg/kg	1	1	1.1	1	1.2	1	1	1.4	1.8	1.3
Phenanthrene	mg/kg	1.1	1.2	1.5	1.6	1.5	2.7	1.4	3	6.9	5.5
Anthracene	mg/kg	1	1	1.1	1	1.2	1.1	1	1.4	1.8	1.9
Fluoranthrene	mg/kg	1	1	1.4	1.7	1.6	4.2	2	5.5	8.8	9.3
Pyrene	mg/kg	1	1	1.4	1.6	1.6	3.6	2.2	5.4	7.5	8.4
Benz[a]anthracene	mg/kg	1	1	1.1	1	1.3	1.7	1.4	2.3	3	4.8
Chrysene	mg/kg	1	1	1.1	1	1.2	1.9	1.4	2.6	2.5	4.1
Benzo[b]fluoranthene	mg/kg	1	1	1	1	1	1	1		1	1
Benzo[k]fluoranthene	mg/kg	1	1	1	1	1	1	1		1	1
Benzo[b]&[k]fluoranthene	mg/kg	1	1	1.2	1.4	1.5	3.9	2.4	5.6	5.8	10.7
Benzo[a]pyrene	mg/kg	1	1	1.1	1.1	1.4	2.2	1.8	2.9	3.6	5.8
Indeno[1,2,3-cd]pyrene	mg/kg	1	1	1	1	1.3	1.7	1.4	2.4	2.6	4.7
Dibenzo[ah]anthracene	mg/kg	1	1	1	1	1.1	1.1	1	1.4	1	1.8
Benzo[ghi]perylene	mg/kg	1	1	1	1	1.3	1.8	1.6	2.7	2.8	4.8
Total PAHs	mg/kg	**17.2**	**17.7**	**19.2**	**20**	**28.9**	**33**	**34.4**	**40.8**	**53.7**	**68.9**
BTEX											
Benzene	mg/kg	1	5.7	10.2	1.1	2.1	1.1	1	1.4	1	1.2
Toluene	mg/kg	1	1.2	1	1	1.8	1	1	1.4	1	1.2
Ethylbenzene	mg/kg	1	1	1	1	1.3	1	1	1.5	1	1.25
Xylenes	mg/kg	1	1	1	1	1.2	1	1	1.5	1	1.25
Ethylbenzene & Xylenes	mg/kg	1.1	1	1	1	7.7	1	1	1	1	1
TPH Data											
TPH C6-C9	mg/kg	10	14	10	10	22	10	10	14	10	12
TPH C10-C14	mg/kg	10	21	15	10	66	13	31	48	10	12
TPH C15-C28	mg/kg	31	92	44	46	161	347	104	202	120	90
TPH C29-C36	mg/kg	30	90	35	38	42	207	42	48	95	63
Phenols	mg/kg	1.9	2.1	2.8	2.5	3.0	2.5	1.8	2.1	1.7	2.7

NOTES:
Concentrations are indicative of materials as found in fill material and may not be indicative of concentrations in source materials
PAH = Polyaromatic Hydrocarbons
BTEX = Benzene, Toluene, Ethylbenzene and Xylenes
TPH = Total Petroleum Hydrocarbons

Prepared by: MS
Checked by: [signature]

Table H-3
Summary of Data for Fill Material Samples Having Elevated Concentrations of Organic Chemicals

Borehole Location	Sample Depth (m)	Concentration (mg/kg)								Borelog Description
		Total PAHs	Benzene	Toluene	Ethylbenzene	Xylenes	Ethylbenzene and Xylenes	TPH (C_6 - C_{36})	Phenols	
Area 2	2.5	846	<1	<1	<1	1	-	940	11	brecketts, general refuse
Area 2	12.8	287	<1	<1	<1	<1	-	4030	1.8	sandy clay, green clay
Area 3	5	729	2	1	1.5	<1	-	12050	-	general refuse
Area 5	6.5	305	44	28	-	-	159	2140	27	coal washery
Area 5	1.4	1504	<20	<20	<20	<20	-	29700	6.6	seal pot liquor (coke plant waste) mixed with brecketts
Area 5	4.9	12173	1600	53	-	-	73	63800	98	coal washery refuse (old cables)
Area 5	5.5	19330	840	200	-	-	240	125900	1000	fine black/brown clay (coal washery). Covered in yellow liquid (probably gas mains condensate).
Area 7	1.5	4253	20	<10	-	-	<10	20700	17	shalely clayey tar
Area 7	7	300	2	<1	-	-	<1	16850	-	coal washery, some BF slag, coke oven gas main condensate abundant
Area 7	6.7	285.5	2.5	4.5	-	-	13	2907	2.6	clay (odours detected)
Area 8	0.8	85030	<10	25	-	-	47	116700	-	tar

NOTES:
PAH = Polyaromatic Hydrocarbons
BTEX = Benzene, Toluene, Ethylbenzene and Xylenes
TPH = Total Petroleum Hydrocarbons
Area locations are shown on Figure 3.1

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APPENDIX I

HYDROGEOLOGY AND WATER QUALITY

I1.0
HYDROGEOLOGY AND WATER QUALITY

I1.1 INTRODUCTION

The intent of this appendix is to provide the reader with technical detail pertaining to the summary information on site geology and hydrogeology provided in the main text (Chapters 6 and 7).

I1.2 SITE GEOLOGICAL AND HYDROGEOLOGICAL INVESTIGATIONS

Subsurface investigations undertaken by Robert Carr & Associates (1995, 1996a and 1997) form the basis for the description of the geology and hydrogeology of the subject site which follows. The extent of the investigations, location and density of the sampling points, is shown in Figure I-1.

Groundwater discharge and associated contaminant load estimates have been compiled from the studies undertaken by:

a) Robert Carr & Associates (1995, amended 1997);

b) CMPS&F (1995, amended 1997); and

c) Woodward-Clyde (1997).

I1.3 SITE GEOLOGY

I1.3.1 Local Lithologies

Robert Carr & Associates (Robert Carr Associates) has described the geology underlying the site as comprising the following stratigraphic components:

Fill Materials:	A layer of variable thickness comprising exotic materials including blast furnace slag, coal washery refuse (fines), general builders rubble, some coking plant wastes (tars etc.), brecketts (a steel making slag) and fly ash. The material was randomly placed as infill materials across the former Platts Channel and Spit Island areas. The fill layer generally varies between 7 m and 12 m thickness;
Estuarine Muds:	The estuarine muds are the original river deposited sediments on which the filling was undertaken. These sediments comprise natural clays with interbedded fine silt and sand layers. The sediments formed the original topography of the former Platts Channel and Spit Island features which preceded the filling. A thin layer of residual clays occurs at the base of the sequence and represents materials derived from the underlying bedrock formations (Tomago Coal Measures); and
Bedrock Formation:	The bedrock formations which underlie the entire area encompassing the Steel River Project site include the Tomago Coal Measures. These coal measures comprise sandstone, siltstones and shales of Permian age.

I1.3.2 Paleotopography

Information from the various drilling programs undertaken by Robert Carr Associates, which have defined the geology underlying the site, have recorded a moderate topography between the three stratigraphic units. The buried topographic features (paleotopography) are illustrated in the geological cross sections presented in Figures I-2 to I-4 as undulations in the elevation of the contact across the site. The location of the respective sections are shown on Figure I-1.

The geological contact between the bedrock and unconsolidated estuarine sediments (clayey mud units) varies in elevation up to 40 m across the site. The bedrock contact rises from its lowest elevation in the northern portion of the site (beneath Platts channel and the current Hunter River channel) to its highest elevation along the southern boundary (refer to cross section A-A', B-B', Figures I-2 and I-3), where it forms a subcropping ridge (refer to cross section C-C', Figure I-4) beneath the younger sediments and weathering profile. The estuarine muds (and fill layer) cut out against this bedrock topographic high in the southern portion of the site. The bedrock outcrops on the south west corner of the site (Area 8 in Figure 3.1), where it reaches its highest elevation.

The buried topographic profile recorded for the contact between the estuarine mud and overlying fill materials is flatter, with differences in contact elevation of 12 m (Figures I-2 and I-3)..This reflects the topography of the pre-existing Platts Channel and Spit Island (2.5 m difference in elevation between the base of the Platts Channel to top of Spit Island).

I1.4 HYDROGEOLOGY

I1.4.1 Aquifers

The site groundwater regime has been described by Robert Carr Associates as consisting of three aquifers based closely on the geology beneath the site (Section I.3):

Shallow Aquifer: A shallow groundwater zone associated with the fill layer. The water level within the fill layer generally occurs between 4 m and 12 m below the ground surface at the time of the 1994/1995 assessments, however, after rainfall events a number of temporary perched water tables develop at more elevated levels within the fill. This is due to the mixed nature of the fill which has a broad range of permeability characteristics. The fill on the eastern half of the site appears to have more permeable materials than the remainder of the fill;

Estuarine Aquitard: An intermediate aquifer of low permeability associated with the estuarine muds between the fill materials and the bedrock formation. The estuarine aquifer appears to thin and cuts out (the fill lies in contact with the bedrock residual clay zone) against the bedrock topographic high towards the southern boundary of the site (refer to the geological cross sections, Figures I-2 to I-4). The mean aquifer thickness intersected was ≥3.6 m. Piezometric levels within the near river embankment piezometers were 0.91 m to -0.07 m AHD, and up to 4.5 m AHD towards the interior of the site. The piezometric levels indicate interaction between the tidal effects and flow in the river and the aquifer groundwater flows: and

Bedrock Aquitard: A deep, low permeability aquifer zone associated with the secondary porosity (structural defects like fracture, fault and joint zones) within the Tomago Coal Measures. Piezometric levels within the bedrock aquifer range from 8.7 m AHD in the south and 2.3 m AHD in Area 2, implying flow toward the north. Piezometer pairs indicate a general upward flow gradient from the bedrock into the overlying aquifer unit/s, probably due to the bedrock high along the south side of the site.

I1.4.2 Aquifer Permeabilities

All three aquifer units have been permeability tested and are noted to be generally of low to very low permeability. Table I-1 presents the range of hydraulic conductivities which have been measured for the various aquifer types (Robert Carr Associates, 1995):

TABLE I-1 MEASURED AQUIFER HYDRAULIC CONDUCTIVITIES

Aquifer Unit		Minimum Hydraulic Conductivity, m/sec	Maximum Hydraulic Conductivity, m/sec	Average Hydraulic Conductivity (geometric mean), m/sec	Permeability
Shallow Aquifer		2.2×10^{-6}	1.2×10^{-4}	1.2×10^{-5}	medium
Estuarine Aquitard:	*clays*	3.2×10^{-8}	2.2×10^{-5}	1.2×10^{-6}	low
	sands	2.2×10^{-6}	1.7×10^{-4}	1.3×10^{-5}	medium
Bedrock Aquitard		7.2×10^{-9}	7.5×10^{-5}	1.2×10^{-6}	very low

Horizontal Groundwater Flow Paths

The groundwater flow pattern has been reported in detail in Robert Carr Associates report (1995). Water level measurements collected from the monitoring well network define a groundwater divide running through the site (Figure I-5). From this divide groundwater flows northward to the Hunter River and southward and eastward along a higher permeability zone which correlates to the pre-existing Platt's Channel alignment. The limited water level information available from the southernmost boundary area of the site indicates a potential northward component of groundwater flow originating from the off-site Stevenson Park area south of Maitland Road and Industrial Drive (see Section I1.4.5).

A topographic high (ridge) within the underlying bedrock aquitard occurs along the southern boundary area of the site. Whilst this subcropping ridge is essentially a low permeability barrier, it does have a number of depressions in its profile (see cross section C-C', Figure I-4). These depressions represent pre-existing valleys or more correctly, saddles, now buried by subsequent sedimentation and filling activities. They provide potential flow paths for groundwater originating from the area to the south, including Stevensons Park, to move onto the Steel River Project site. The implications of this issue on groundwater entering the site from the south are considered in more detail in Section I.4.5.

Vertical Groundwater Flow Paths

Groundwater level monitoring indicate that vertical hydraulic gradients exist within and between the aquifer layers. These include:

a) vertically downward flow components from within the shallow fill aquifer unit (generally towards and into the underlying Estuarine Aquitard); and

b) slight vertically upward flow components from within the bedrock aquifer (toward the overlying Estuarine Aquitard);

These characteristics imply the occurrence of numerous perched water tables and narrow conduit zones (lenses of high permeability material) which short circuit the surrounding low permeability zones within the shallow aquifer, and limited horizontal flow within the Estuarine Aquitard.

I1.4.3 Estimates of Groundwater Discharge to the Hunter River

The methodologies used to estimate the groundwater discharge and associated contaminant loading of the groundwater flowing to the Hunter River have been compiled from the studies undertaken by:

a) Robert Carr & Associates (1995, amended 1997);

b) CMPS&F (1995, amended 1997); and

c) Woodward-Clyde (1997).

The initial study undertaken by Robert Carr Associates calculated a range of groundwater discharge rates, using Darcy's Law, and associated contaminant loading based on hydrogeological and hydrogeochemical parameters for the aquifers, averaged for the entire site and the dimensions of the full length of the Hunter River. CMPS&F (1995, amended 1997) estimates were also based on Darcy's Law calculations, but in order to make more specific estimates of likely contaminant loading from known areas of higher PAH concentration, averaged parameter data from the 3 river front areas (Area 3, Area 5 and Area 7, see Figure 3.1) were used. Woodward-Clyde (1997) employed a simple water balance model methodology to provide a more precise estimate of groundwater discharge. Both of these approaches to evaluating the likely discharge rates and contaminant loading from the site to the Hunter River are discussed in more detail in the sections which follow.

Darcy's Law Method

Since the various aquifers discharge groundwater (north of the groundwater divide) under known hydraulic gradients to the Hunter River, calculations of the rate of groundwater discharge to the river have been undertaken using standard Darcy's Law methods (Robert Carr Associates, 1995, amended 1997), in which the defining parameters controlling the predicted discharge, Q, are:

- Hydraulic Gradient, i, acting at the seepage interface
- Hydraulic Conductivity, K, of the aquifer unit; and
- Area of seepage interface, A.

Darcy's Law defines the discharges as $Q = KiA$ (refer to Attachment I-A).

Thus Darcy's Law calculations of flow rates provide results based on observed and measured parameters of hydraulic conductivity, hydraulic gradient, a known length of river frontage and an estimate of the width of the flow zone (seep zone width along the river frontage).

The hydraulic gradients within the aquifer units (particularly the shallow fill aquifer) are variable and dependent on the highly variable permeability (hydraulic conductivity) of the aquifer materials. The hydraulic conductivity values, measured using slug test methods, range from 2.2×10^{-6} m/s to 1.2×10^{-4} m/s for the shallow fill aquifer, the primary aquifer zone (Robert Carr Associates, 1995, amended 1997). This broad range of K values, almost 2 orders of magnitude, gives rise to an even broader range of discharge values when substituted in the Darcy's Law equation, when conservatively high values of flow zone area (that is, flow zone width, or saturated thickness, of ≤ 4.2 m) are used. For example, the discharge values determined for the shallow aquifer ranged from 20 m^3/day to 3500 m^3/day. When used to calculate contaminant loading, these discharge values produced an equally broad range of PAH flux, namely 0.0005 kg/day to 17.5 kg/day from the 1 650 m of river frontage.

The results of the Robert Carr Associates (1995, amended 1997) calculations are provided in the following summary tabulation:

TABLE I-2 ESTIMATES OF GROUNDWATER DISCHARGE FROM SITE (ROBERT CARR ASSOCIATES, 1995, AMENDED 1997).

	Shallow Aquifer*	Estuarine Aquifer	Bedrock Aquifer
Maximum Estimated Discharge	3 500 m^3/d	230 m^3/d	not significant
Minimum Estimated Discharge	20 m^3/d	10 m^3/d	not significant
Best Estimate	210 m^3/d	75 m^3/d	not significant

* Layer of fill materials.

Discharge flows to the Hunter River from the bedrock aquifer are regarded as insignificant due to the low permeability of the aquifer and the indicated upward hydraulic gradient within this aquitard layer.

The work of CMPS&F (1995, amended 1997) provided a more precise estimation of groundwater flow which fell within the range calculated by Robert Carr Associates.

The broad range in outcomes determined from basic Darcy's Law calculations of discharge necessitated that an alternative method be employed to provide a more precise estimate of groundwater discharge. The predicted discharges were evaluated using a simple analytical water balance model (Attachment I-A).

Water Balance Model

A water balance model assesses a given hydrogeological system as if it were a box or tank (Attachment I-A). Inputs (water inflows) and outputs (water outflows) are summed and evaluated and, since they must, by definition, be equal, an alternative estimate of flow rates can be obtained. In the case of the Steel River Project site a water balance model was considered an appropriate alternative method for assessing likely groundwater flow rates to the Hunter River.

The domain for the water balance model (tank) prepared for the Steel River Project site, was defined as the volume of ground underlying the site as defined by its boundary fence. The base (depth) of the model is defined by the low permeability bedrock formation (Tomago Coal Measures).

In terms of the hydrologic cycle for a particular groundwater model, a natural balance must exist between the quantity of water supplied to (entering) the basin and the amount leaving the basin. The equation of hydrologic equilibrium provides a quantitative statement of this balance. In its most general form it may be expressed as in the following equation (Todd 1980):

$$\begin{bmatrix} \text{Surface Inflow} \\ + \\ \text{Subsurface Inflow} \\ + \\ \text{Precipitation} \\ + \\ \text{Imported Water} \\ + \\ \text{Decrease in Surface} \\ \text{Storage} \\ + \\ \text{Decrease in} \\ \text{Groundwater Storage} \end{bmatrix} = \begin{bmatrix} \text{Surface Outflow} \\ + \\ \text{Subsurface Outflow} \\ + \\ \text{Consumptive Use} \\ + \\ \text{Exported Water} \\ + \\ \text{Increase in Surface} \\ \text{Storage} \\ + \\ \text{Increase in Groundwater} \\ \text{Storage} \end{bmatrix}$$

In this form the equation includes all waters, surface and subsurface, entering and leaving the model domain (the 'domain' in this case will be the subsurface beneath the site). There are many situations in which it is possible to eliminate certain items from the equation because they are negligible or because they do not affect the solution.

Each item of the equation represents a discharge, a volume of water per unit of time. Any consistent units of volume (usually cubic metres) and time can be adopted (a period of a year is usual).

In the case of the Steel River Project site, inputs are primarily precipitation infiltration. Minor amounts of groundwater inflow to the model area from the south, however, these do not make their way to the Hunter River due to the presence of the groundwater divide. The amount of precipitation infiltration, itself, is governed by the balance of rainfall over evaporation, surface runoff and the soil's capacity to facilitate infiltration.

The model parameters, model assumptions and calculation of discharge and contaminant loadings are provided in Attachment I-A.

From information contained in the Robert Carr Associates Report (1995, amended 1997), and the known site geology, the outflow of groundwater from the fill layer is predominantly seep flow at the northern edge of the site, that is, along the embankment at the river's edge, with minimal groundwater flow to the river (through river bed sediments). The seep discharges occur primarily at or just above the contact of the fill materials and the underlying estuarine mud layer, due to the low permeability characteristics of this layer.

The results of the water balance model provide an estimate of seep discharge flow to the Hunter River from 287 m^3/d to 450 m^3/d (3.3 L/sec to 5.2 L/sec). The range of values arises from some uncertainties related to applicable infiltration rates for the site (see Attachment I-A). Based on observed seep flows at the site, realistic mean flow rates are likely to be at the low end of this range. This range of values is very much in agreement with the Robert Carr Associates Report, (1995, amended 1997), best estimate value of 210 m^3/d of discharge to the Hunter River (based on Darcy's Law estimates). A value of 300 m^3/d (3.5 L/sec) is considered a reasonable estimate for design purposes.

I1.4.4 Shoreline Seepage to the Hunter River

Groundwater seeps have been observed entering the Hunter River at different levels across an approximately 2.2 m wide surface zone extending from the low tide level up the fill embankment. Seep points (here defined as discrete points of outflow of groundwater to the surface) within this 2.2 m wide zone are governed by the nature (permeability) of the seep face, much of which is impermeable (some being implaced as molten slag) and associated conduit zone immediately behind the embankment face. Seep occurrences are clustered in an area adjacent to the Australian Manganese Company Limited (AMCL) EMD plant (not part of the Steel River Project Site) mangrove wooded mud flats area, and the western end of Area 7 (Figure 3.1).

Individual seeps, having estimated flows of up to 5 L/sec. have been reported in places (Robert Carr Associates). They are seasonal and can dry up during extended dry periods. An accurate estimate of total background flow rates has not been possible.

Shoreline seeps were identified by Robert Carr Associates to occur at locations along the length of the Steel River Project site foreshore. Based on field observations undertaken by Robert Carr Associates, BHP and Woodward-Clyde, the seeps can be categorised into three types as follows:

- High flow seeps adjacent to the EMD plant. These seeps can have flow rates estimated by Robert Carr Associates to be as high as 5 L/sec. Many of the seeps are characterised by a white calcium carbonate deposit. These seeps are evident at both high tide and low tide and were observed to take place through the voids between the large slag boulders used in the construction of the shoreline.

- Mud flat seeps adjacent to Areas 3, 5 and 7. These seeps appear to coincide with the edge of Spit Island and occur at lower flow rates (maximum approximately 1 L/sec). A hydrocarbon sheen was also noted with some of these discharges. A surface crust of calcium carbonate was noted across sections of the mud flats affected by the seeps. A stand of mangroves occurs with the mud flats. These seeps were evident at both high tide and low tide.

- Seeps adjacent to Area 7 in the vicinity of the former Platts Channel. These seeps were observed to have flow rates comparable to the mud flat seeps. These seeps were not evident at high tide.

The reason for the high flow seep adjacent to the EMD plant is not clear (potentially arising from sources unrelated to natural groundwater recharge processes), however, it is outside the area of interest for the Steel River Project. It is apparent, however, that the seepages are taking place via preferred pathways for groundwater flow and are not necessarily representative of the shallow aquifer conditions as a whole.

I1.4.5 Implication of the Adjacent Landfill Site on the Steel River Project Site

A pre-existing domestic waste landfill site, now redeveloped as parkland (Stevenson Park), is located south of the Steel River Project site. It is situated immediately south of Industrial Drive and opposite Area 4 (Figure 3.1). The northern boundary of this old landfill (bordering on the Steel River Project site) is characterised by a low in the bedrock topographical ridge (near monitoring well W4/8) which dominates the geology of the southern portion of the Steel River Project site (refer to Section I.4.2 for a detailed discussion). The buried bedrock topography is well illustrated in the geological cross section presented in Figures I-2 to I-4. The topographic low represents a buried creek channel (paleochannel) and therefore may present a conduit for leakage of leachate/s generated by the landfill to migrate onto the Steel River Project Site (Robert Carr Associates, 1995, amended 1997).

Groundwater flow patterns, derived from a limited data set of water level measurement along the southern boundary area, imply limited groundwater flow onto the Steel River Project Site from off-site locations to the south. This may include groundwaters originating from the Stevenson Park site.

Groundwater originating from the south and flowing northward onto the Steel River Project site would supplement the groundwater regime south of the groundwater divide as discussed in Section I.4.2 (refer to Figure I-5). This component of groundwater flow would join the site groundwater flow pattern (along the Platt's Channel conduit), flowing eastward toward the eastern site boundary (Tourle Street), where it would exit the site. Any contaminant (potential landfill leachates) carried on-site from the south would flow the same flowpath as the groundwater, eventually migrating eastward off-site at the Tourle Street boundary and then off-site into the main steelworks site.

Robert Carr Associates (1995, amended 1997) investigations have reported that the hydrogeochemical characteristics of the groundwater immediately north of the conduit alignment (monitoring wells 2/21, 2/22, 2/26, 2/27, 4/4, 4/6 and 4/7, Figure I-1) do support the possibility that mildly leachate-contaminated groundwater is entering the site from the Stevenson Park area.

I1.5 EXISTING WATER QUALITY

The quality of surface water, groundwater, shoreline seeps and river water, are discussed below:

I1.5.1 Surface Water

Surface water drainage generally occurs as overland flow in a northerly direction towards the South Arm of the Hunter River, as there are no stormwater drainage lines present on the site. However, since the majority of the site is flat, surface water tends to pond on the site and gradually evaporate or infiltrate to groundwater following periods of extended and/or heavy rainfall.

Surface water quality data specific to the site is limited. However, as the land is mostly flat, the site does not favour the generation of surface water runoff. The surface of the site is covered predominantly with CWR which has a relatively low level of contamination associated with it, with the possible exception of manganese. Should surface water runoff occur, the prime contaminant of concern would be manganese. This metal is in a form that allows it to be mobilised by rainwater and then to be transported as runoff to the Hunter River or infiltrate to the groundwater system beneath the site.

I1.5.2 Groundwater

The groundwater analytical data is reported in the site investigation reports prepared by BHP from 1994 to 1995. In addition, Robert Carr Associates has also undertaken some assessments of groundwater conditions. This section presents a summary of the key relevant issues.

Inorganic Chemicals

The review of groundwater hydrochemistry was limited to those monitoring wells adjacent to the river embankment. The prime purpose of the review was to enable comparison with the hydrochemistry of the shoreline seeps. The following features of the hydrochemistry of the near shoreline wells in Areas 3, 5 and 7 (Figure 3.1) are apparent:

- High alkalinity.
- Generally moderate salinity (estimated TDS generally in the range 1,000 to 10,000 mg/L).
- Salinity dominated by sodium which comprises generally in excess of 60% of the total cation concentration on a charge basis.

- The relative proportion of anions contributing to the salinity is variable, with shallower groundwaters showing higher dominance of sulphate and carbonate/bicarbonate and deeper groundwaters being dominated by chloride.

These features are generally consistent with the hydrochemistry of the shoreline seeps sampled as part of the geochemistry investigation undertaken by Robert Carr Associates.

The prime metal found to be present in groundwater at highest concentrations is manganese. The concentration of manganese in groundwater is dependant on pH, with the highest manganese concentrations occurring with the lower pH values. Notably, the higher manganese concentrations are associated equally with the estuarine and bedrock aquifers as well as the shallow (fill) aquifer. Consistent with the influence of pH on manganese concentration, elevated manganese concentrations (i.e. in the parts per million range) are indicated in all areas, including Area 1 which is comprised largely of natural materials. The range of manganese concentrations for the three aquifers intersected beneath the site are summarised below:

- Shallow aquifer - manganese range 0.01 to 3.2 mg/L, average 0.15 mg/L.
- Estuarine sediments - manganese range 0.01 to 37.0 mg/L, average 3.54 mg/L.
- Bedrock - manganese range 0.01 to 5.8 mg/L, average 2.68 mg/L.

This data indicates that the concentration of manganese in shallow groundwater (i.e associated with the fill), falls within the lower range of background levels for manganese in groundwater typically found in the vicinity, namely, 0.02 - 4.5 mg/L (Robert Carr Associates, 1997). Additional evidence that this is the case is provided by data collected by BHP for groundwater wells monitoring the estuarine aquifer on Ash Island (the western third of Kooragang Island). The monitoring data, which has been collected since 1990, for wells located in undisturbed areas of the island and outside the potential influence of waste disposal activities, show that concentrations of manganese range from 0.01 to 4.7 mg/L with an average of 1.2 mg/L.

These concentrations are similar to those recorded for the Steel River Project site, with a higher average concentration than that recorded for the shallow fill aquifer. On this basis it can be concluded that any discharge of manganese via groundwater, from the Steel River Project site, should not be different from background discharges to the river.

Organic Chemicals

The geochemistry investigation observed the following concentrations of total PAHs and total phenolic compounds in all groundwater wells for all of the site areas:

- In contrast to the concentration of manganese in groundwater, the concentrations of PAHs and phenolic compounds show an apparent correlation with the presence of fill contaminated with organic materials. The highest concentrations of PAHs are recorded for areas where tar or other hydrocarbon materials have been noted on the bore logs i.e. Areas 5, 6, 7 and 8 (Figure I-1).
- Elevated concentrations of phenolic compounds are generally coincident with the presence of elevated concentrations of PAHs.
- The PAHs found in groundwater are dominated by naphthalene. On average, naphthalene accounts for 79 % of the total PAH concentration across all wells where PAHs were detected. Figure 7.2 provides an indication of the distribution of PAH across the site.

The concentration of BTEX compounds in groundwater is low, being less than analytical detection limits in all areas with the exception of Area 5 (well W5/13) and Area 7 (well W7/17). In these areas, however, the concentration of BTEX compounds was still within acceptable limits. On this basis, widespread occurrence of BTEX compounds in groundwater is not evident. This is consistent with the limited occurrence of elevated concentrations of BTEX compounds in fill materials.

I1.5.3 Shoreline Seeps

Groundwater seeps enter the Hunter River along a discharge zone which extends from the low tide level up the fill embankment to a height of 2.2 m (refer to Section I.4.4). The analytical results for inorganic and organic contaminants contained within the seeps are discussed below.

Inorganic Chemicals

The shoreline seeps were sampled and analysed for a range of inorganic parameters. The results of inorganic parameter analyses indicated that the seeps have a similar hydrochemistry to the groundwater wells adjacent to the river. The salinity and pH of the seeps falls generally within the range observed for the shallow groundwater. As with the groundwater, the composition of the salinity is variable, ranging from sodium chloride type waters to waters richer in sulphate and carbonate/bicarbonate. On this basis, and consistent with the direction of groundwater flows, the seeps would appear to be associated with the shallow groundwater aquifer and reflect conditions present in the fill material.

The concentration of metals in the seeps is generally close to or below the analytical detection limits with the exception of manganese and to a lesser extent copper, lead and zinc. The concentrations of manganese ranged from 0.02 mg/L to 2.7 mg/L. In contrast to the groundwater, the concentration of manganese in the seepage samples does not appear to be related to the pH of the water. This may be a consequence of the presence of colloidal, rather than dissolved material. As the samples were filtered, however, the colloids would be relatively small, i.e. < 0.45 μm in diameter.

The concentrations of metals in the seeps show no apparent relationship with locations of the seeps, i.e. mud flat seep versus high flow seep.

Organic Chemicals

The concentrations of PAHs were below the analytical detection limits for the individual PAH compounds tested in the seeps, with the exception of two locations as noted on Figure 7.2. TPH concentrations were above detection limits in all samples, with total concentrations ranging from 0.106 mg/L to 1.920 mg/L.

The concentrations are generally consistent with concentrations found in the adjacent groundwater wells, with the possible exception of TPH, which appears to be higher in the seep samples than observed in the groundwater. It should be noted, however, that the TPH analyses were performed by different laboratories and that this analysis is sensitive to the analytical technique used and in Woodward-Clyde's experience are often not directly comparable.

In 1995, a hydrocarbon sheen was noticed by Woodward-Clyde at a seep located within the mud flat area adjacent to the hot metal pits. Observations by Woodward-Clyde in 1995 indicated that the sheen was associated with the contaminants in the mud rather than the seeps. A recent survey (April 1997) undertaken by BHP after a prolonged dry spell, observed that the hydrocarbon affected seep was dry and that no sheen could be detected. This would indicate an intermittent occurrence of both the seep and sheen associated with the muds.

I1.5.4 River Water

The data available on river water quality is limited to data collected by BHP at irregular intervals since February 1992 and a single sample collected by Robert Carr Associates, which was analysed for TPH only. The BHP monitoring involved the collection of samples from a point adjacent to the Steel River Project site, some 100 metres west of the Tourle Street Bridge and six other locations including two points in the North Arm of the Hunter River. Samples were collected at both high and low tide for each sample date. There are no sample points upstream of the subject site which might provide an indication of background conditions in the South Arm of the Hunter River.

Sampling results can be summarised as follows:

- The concentration of PAHs in both the South and North Arm of the Hunter River were below the analytical detection limit of 0.2 µg/L for all samples at all locations.

- Similarly the concentration of total phenolic compounds was close to or below the analytical detection limit (i.e. around 0.001 mg/L) adjacent to the Project site. This was also true for all other sample locations, with the exception of samples taken in 1986 and 1989 adjacent to the steel works and in 1990 for locations in the North Arm, where concentrations, ranging from 0.01 to 0.1 mg/L were recorded.

- The concentrations of manganese adjacent to the Project site fell within the range <0.010 mg/L to 0.16 mg/L, with the exception of a single high value of 1.34 mg/L recorded in 1986. The higher manganese concentration of 0.16 mg/L was also coincident with higher values of manganese at all locations at that time, including a concentration of 0.19 mg/L for a sample taken from the North Arm. Elevated manganese concentrations were not evident for other sampling locations in 1986. There is no apparent trend of increasing or decreasing manganese concentrations downstream from the Project site. The elevated manganese value in 1986 of 1.34 mg/L was also coincident with a high total iron value of 1.56 mg/L and occurred at the high tide reading only. This may indicate contamination of the sample with sediment.

- The salinity of the river adjacent to the Project site is roughly equivalent to sea water.

In summary, the monitoring data does not indicate deterioration of river water quality adjacent to the Project site. The chemical data indicates conditions adjacent to the site to be generally similar to conditions in the North Arm of the Hunter River, with the exception of a single elevated manganese concentration recorded at high tide adjacent to the Project site in 1986.

I1.6 ESTIMATED POLLUTANT LOADINGS

Groundwater discharge from the Project site is conservatively estimated (high) to fall within the range 300 m^3/d to 450 m^3/d (section I.4.3). The contaminant loading using the site mean concentration of total PAH in monitoring wells located adjacent to the Hunter River (river front) of 366 µg/L (0.000366 kg/m^3) over the full length of the site along the South Arm of the Hunter River is presented in Table I.3.

TABLE I.3- ESTIMATED CONTAMINANT LOADING (MONITORING WELLS)

Predicted Discharge in m^3/d	x	[PAH] concentration in kg/m^3	=	Total PAH Loading in kg/d
300	x	0.000366	=	0.11
400	x	0.000366	=	0.15
450	x	0.000366	=	0.17

The corresponding estimates for river concentrations fall in the range 0.2 µg/L to 0.85 µg/L.

The potential contaminant loading using the average concentration of Total PAH in the seep samples collected along the Hunter River (river front) of 11.7 µg/L (0.0000117 kg/m^3) over the full length of Hunter River frontage is presented in Table I.4.

TABLE I.4 - ESTIMATED CONTAMINANT LOADING (SEEPS)

Predicted Discharge in m^3/d	x	[PAH] concentration in kg/m^3	=	Total PAH Loading in kg/d
300	x	0.0000117	=	0.004
400	x	0.0000117	=	0.005
450	x	0.0000117	=	0.005

The estimates for river concentrations, based on the seep data, fall in the range 0.005 µg/L to 0.025 µg/L.

The estimate of PAH concentration in the river is consistent (with the exception of the higher range estimate using monitoring well concentrations) with the river water quality monitoring program (Chapter 7), which is that PAHs are found to be consistently less than the analytical detection limit of 0.2 µg/L.

I1.7 IMPACTS OF PROPOSAL

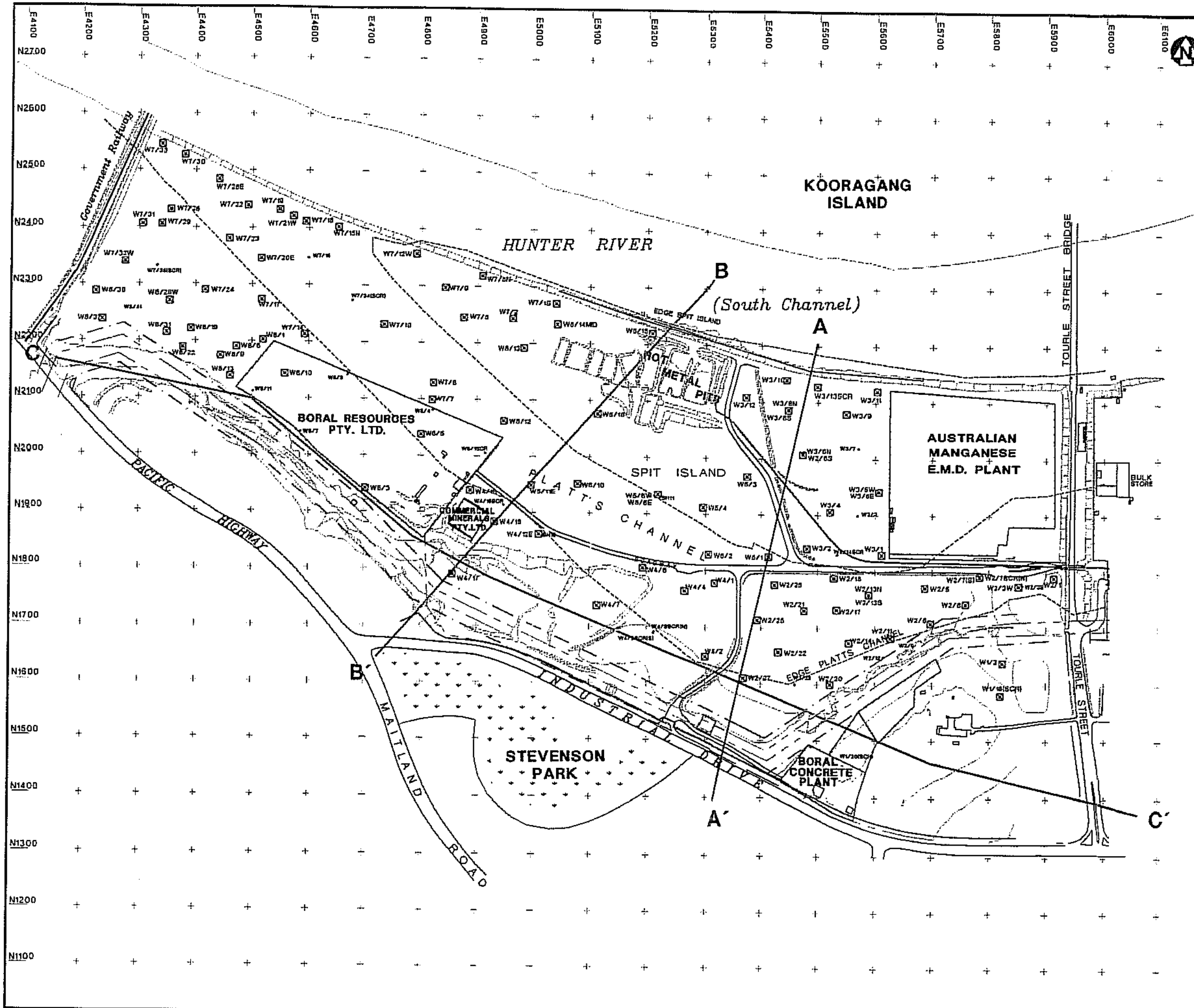
Seepage flow rates and contaminant loading to Hunter River *after* the implementation of the remedial action have been calculated (Attachment I-A). The remedial action assumes that 75% of site area will be under structures and road seal, therefore no infiltration (0%) can be expected, and, that the remaining 25% will be under landscaped redevelopment (parks, gardens, trees, grass). Surface drainage across the latter areas will be optimised to minimise infiltration, and was assumed in the calculations (Attachment I-A) to be ≤ 2.5%.

Therefore, the range of infiltration rates after remedial action works have been estimated (Attachment I-A) at 53 m^3/d to 61 m^3/d. This rate represents a 75% to 80% reduction on the nominal 242 to 300 m^3/d range of infiltration driven discharge rates.

The predicted reduction of rainfall infiltration brought about by the proposed remedial action works will reduce the PAH loading to the Hunter River from up to 170 g/day down to between 12.2 g/day and 22.1 g/day (from river front monitoring well data) or down to between 0.6 g/day and 0.7 g/day (from seep PAH data).

After remedial works and redevelopment of the site have been completed and infiltration reduced by ≤ 75%, the groundwater mound (divide) which has resulted in groundwater high E-W across the site will eventually subside producing significantly lower gradients across the site (south to north), which, in turn, will reduce the groundwater flows (and any residual contaminant load) to the river.

The groundwater mound (Figure I-5) is expected to recede (subside) under natural gravity flow conditions (vertical flow) after remedial action has been implemented. Using Darcy's Law the time for the mound to recede is estimated to be between 0.5 years and 5 years variably across the site.



REVISION: B | DESIGNED: SDP
SCALE: AS SHOWN | DRAWN: LJE/HC
DRAWING No: A85 245/0001 | CHECKED:
CAD FILE NO: Q.015 | APPROVED:
DATE: 30·4·1997 | STATUS: FINAL

LEGEND

- W7/21 MONITORING WELL LOCATION (NOT SAMPLED)
- W7/2 GROUNDWATER MONITORING WELL (SAMPLED)
- A—A´ GEOLOGICAL CROSS-SECTION SCHEMATIC
- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- EASEMENT
- FENCE LINE
- ELECTRICITY LINE

SOURCE: CMPS&F, R.CARR, BHP

metres
0 50 150 250
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
MONITORING WELL LOCATION PLAN

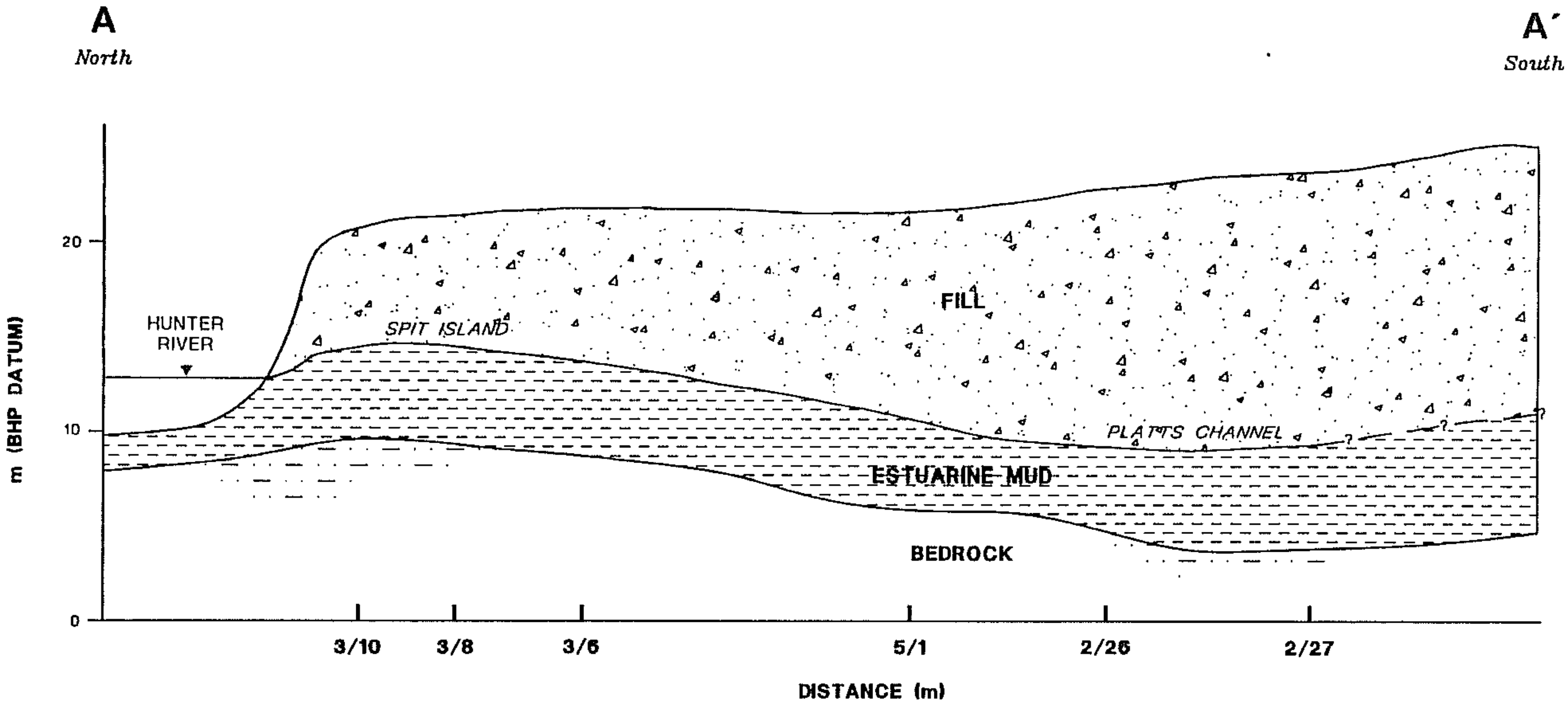
FIGURE
I-1

A3

Woodward-Clyde

NOTE: NO BEDROCK INTERSECTED ALONG THIS TRANSECT. CONTACT ONLY BETWEEN ESTUARINE CLAY AND FILL WAS INTERSECTED.

CROSS-SECTION LOCATION SHOWN ON FIGURE I-1.



DATA

BORE	DEPTH (m)	RL (BHP DATUM)
3/10	15	20.53
3/8	13	21.87 (PIPE)
3/6	13	21.95 (PIPE)
5/1	13	21.94 (PIPE)
2/26	15.5	22.71 (PIPE)
2/27	16.3	22.89 (PIPE)

metres

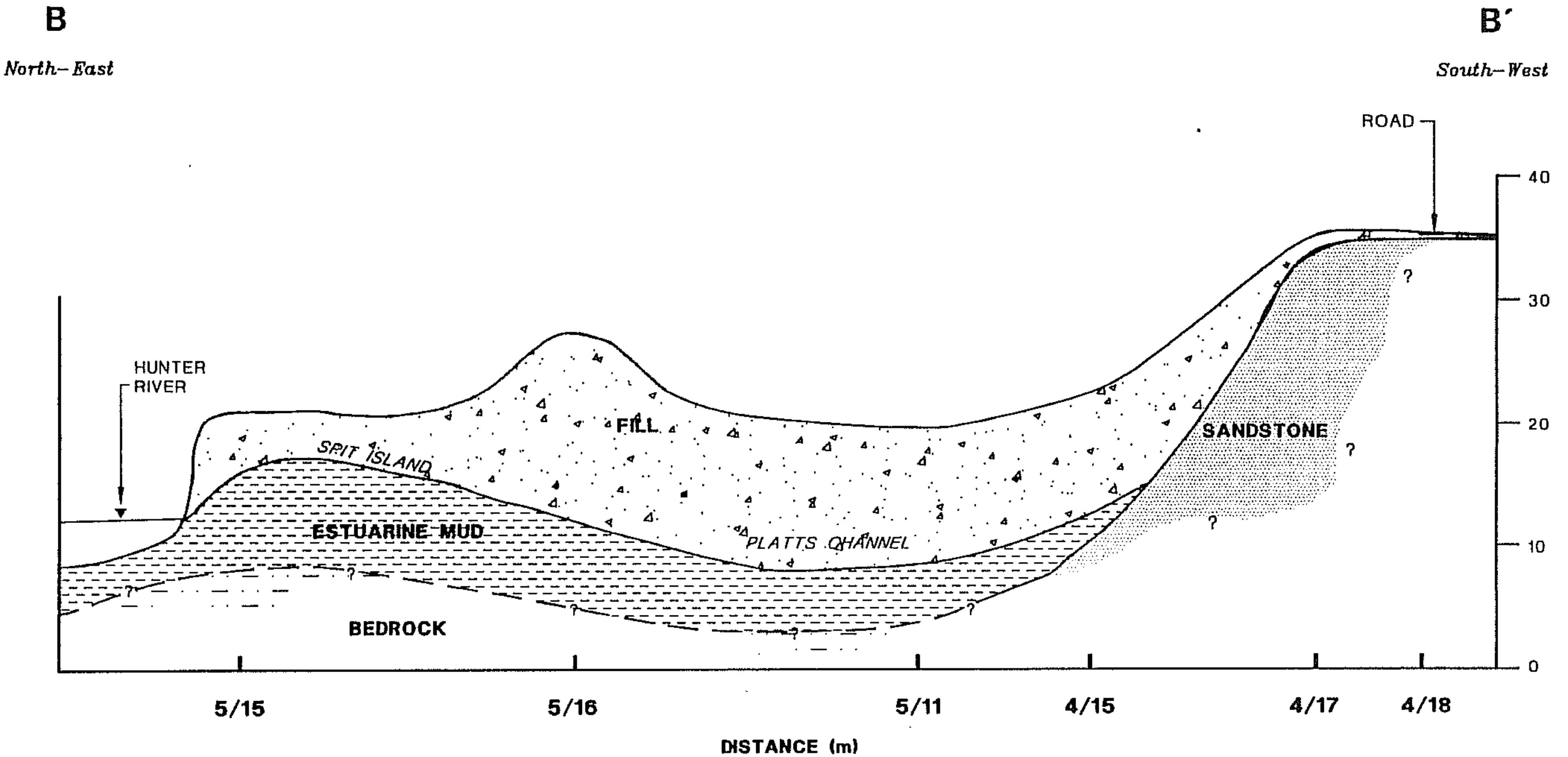
0 50 100 150

HORIZONTAL SCALE
VERTICAL EXAGGERATION : 10

Woodward-Clyde

CLIENT **BHP STEEL (NEWCASTLE)** PROJECT **STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS**	REVISION: B SCALE: AS SHOWN DRAWING No: A88 246/0001 CAD FILE NO: Q.012 DATE: 21/5/97	DESIGNED: PDS DRAWN: LJE CHECKED: SKT APPROVED: CS STATUS: FINAL	TITLE **SCHEMATIC GEOLOGICAL CROSS-SECTION A-A´** FIGURE **I-2** A4

NOTE: CROSS-SECTION LOCATION ON FIGURE I-1.



DATA		
BORE	DEPTH (m)	RL (BHP DATUM)
5/15	13	20.97
5/16	17.5	28.95
5/11	16	21.61
4/15	12.7	22.48
4/17	1	36.88
4/18	0.4	36.76

metres
0 25 50 75 100
HORIZONTAL SCALE
VERTICAL EXAGGERATION : 6.5

Woodward-Clyde

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT
REMEDIAL ACTION PLAN EIS

REVISION: B
SCALE: AS SHOWN
DRAWING No: A66 246/0001
CAD FILE NO: Q.013
DATE: 21/5/97

DESIGNED: PDS
DRAWN: LJE
CHECKED: SKT
APPROVED: CB
STATUS: FINAL

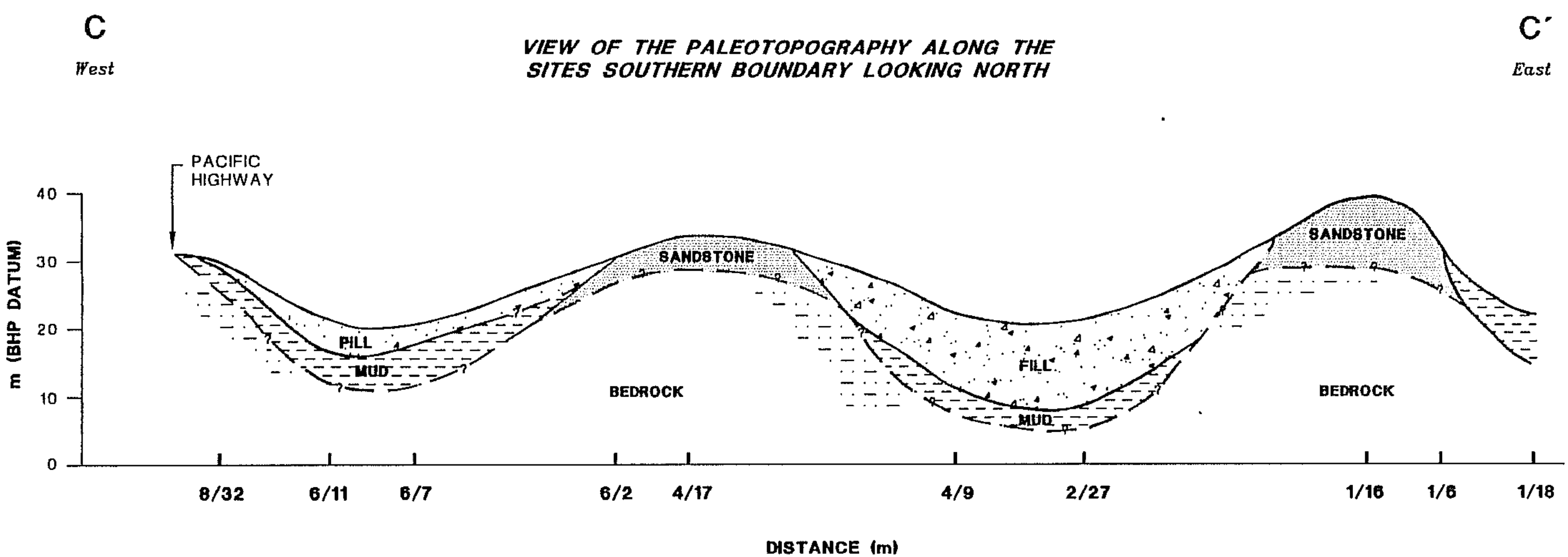
TITLE
SCHEMATIC GEOLOGICAL CROSS-SECTION B-B'

FIGURE
I-3

A4

NOTE: CROSS-SECTION LOCATION ON FIGURE I-1.

VIEW OF THE PALEOTOPOGRAPHY ALONG THE SITES SOUTHERN BOUNDARY LOOKING NORTH



DATA

BORE	DEPTH (m)	RL (BHP DATUM)
8/32	6.0	30.28
6/11	7.7	21.34
6/7	6.8	21.68
6/2	3.9	30.34
4/17	1.0	36.88
4/9	16	23.08
2/27	16.3	22.89 (PIPE)
1/16	3.0	37.38
1/6	1.5	30.08
1/18	6.5	23.36

metres

0 50 100 150 200

HORIZONTAL SCALE
VERTICAL EXAGGERATION : 6.5

Woodward-Clyde

CLIENT
BHP STEEL (NEWCASTLE)

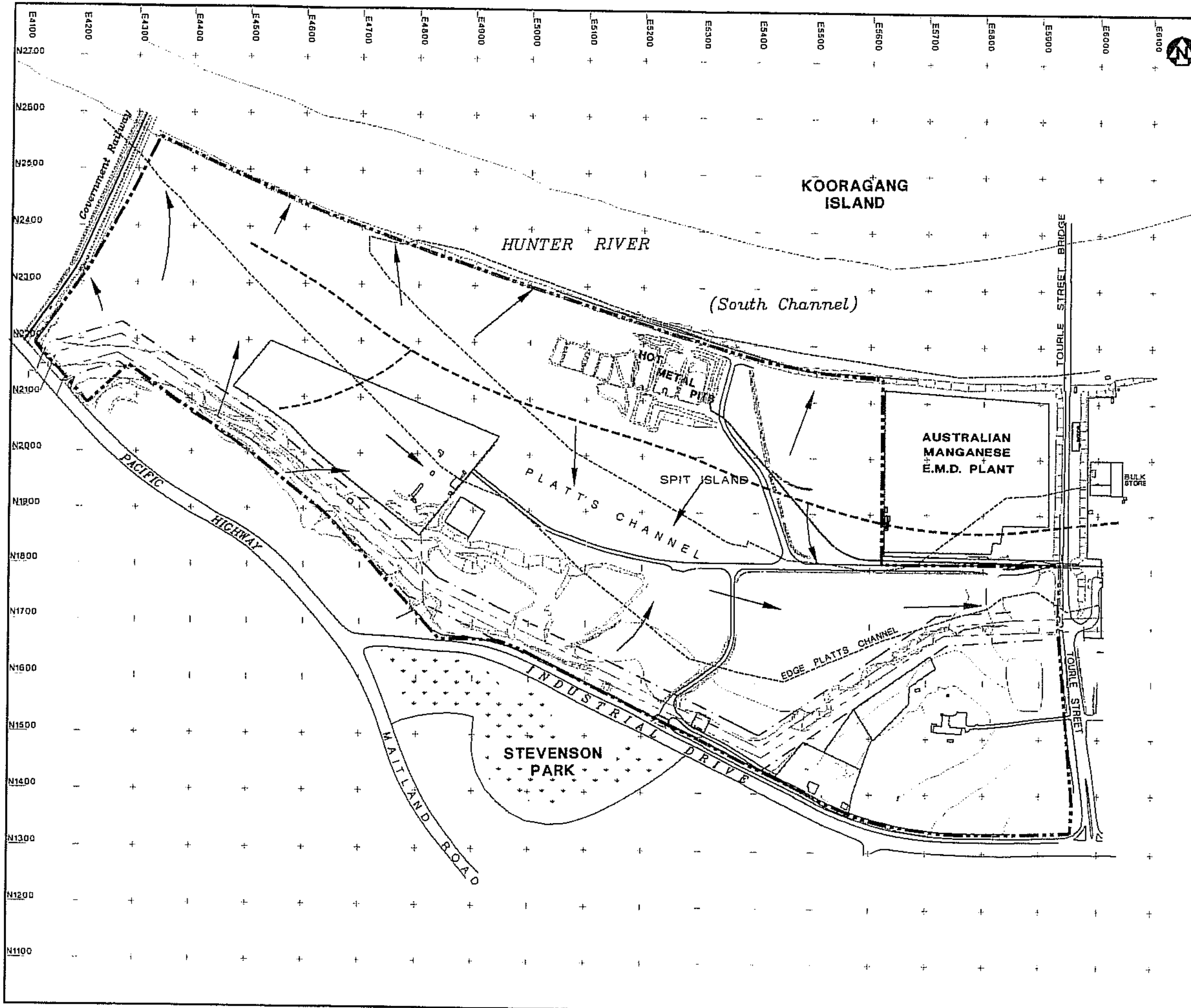
PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

REVISION: A	DESIGNED: PDS
SCALE: AS SHOWN	DRAWN: LJE
DRAWING No: A86 246/0001	CHECKED: SKT
CAD FILE NO: Q.014	APPROVED: CS
DATE: 21/5/97	STATUS: FINAL

TITLE
SCHEMATIC GEOLOGICAL CROSS-SECTION C-C'

FIGURE
I-4

A4



REVISION:	B	DESIGNED:	RKH
SCALE:	AS SHOWN	DRAWN:	LJE/HC
DRAWING No:	A86 246/0030	CHECKED:	RH
CAD FILE NO:	G.019	APPROVED:	G
DATE:	30-4-1997	STATUS:	FINAL

LEGEND

- PLATTS CHANNEL FROM 1946 SOUNDINGS DRAWING
- GROUNDWATER DIVIDE IN SHALLOW/FILL AQUIFER
- GROUNDWATER FLOW DIRECTION IN SHALLOW AQUIFER
- EASEMENT
- FENCE LINE
- ELECTRICITY LINE

SOURCE: CMPS&F (1996)

metres
0 50 150 250
APPROX. SCALE

CLIENT
BHP STEEL (NEWCASTLE)

PROJECT
STEEL RIVER PROJECT REMEDIAL ACTION PLAN EIS

TITLE
GENERALISED GROUNDWATER FLOW PATHS

FIGURE
I-5

A3

Woodward-Clyde

ATTACHMENT I-A

ESTIMATION OF GROUNDWATER DISCHARGE TO THE HUNTER RIVER

DARCY'S LAW METHOD
AND
BASIC WATER BALANCE MODEL
FOR THE
STEEL RIVER PROJECT SITE

ATTACHMENT I-A
ESTIMATES OF GROUNDWATER DISCHARGE TO THE HUNTER RIVER

DARCY'S LAW METHOD

Since the various aquifers discharge groundwater (north of the groundwater divide, Figure 3.1) under known hydraulic gradients to the Hunter River, calculations of the rate of groundwater discharge to the river were initially undertaken using standard Darcy's Law methods (Robert Carr Assoc. 1996). For Darcy's Law, the defining parameters controlling the potential discharge, Q, are:

- Hydraulic Gradient, **i**, acting at the seepage interface (saturated zone of the river embankment);
- Hydraulic Conductivity, **K**, of the aquifer unit; and
- Area of seepage interface, **A** (length times width of flow through area).

Darcy's Law defines the discharges as, **Q = K i A**.

Darcy's Law calculations of flow rates provide results based on observed and measured parameters of hydraulic conductivity, hydraulic gradient, a known length of river frontage and an estimate of the width of the flow zone (seep zone width along the river frontage).

The hydraulic gradients within the aquifer units (particularly the shallow fill aquifer) are variable and dependent on the highly variable permeability (hydraulic conductivity) of the aquifer matrix, which, in the case of the shallow aquifer, comprises fill materials. The hydraulic conductivity values, measured using slug test methods, range from 2.2×10^{-6} m/s to 1.2×10^{-4} m/s for the shallow fill aquifer, the primary aquifer zone (Robert Carr Associates, 1995 amended 1997). This broad range of K values, almost 2 orders of magnitude, gives rise to an even broader range of discharge values when substituted in the Darcy's Law equation, when conservatively high values of the flow zone *area* (that is, flow zone width, or saturated thickness, of ≤4.2 m) are used.

For example, the discharge values determined for the shallow aquifer ranged from 20 m^3/day to 3500 m^3/day (Section 7, Robert Carr Associates, 1995, amended 1997). When used to calculate contaminant loading, these discharge values produced an equally broad range of PAH flux, namely 0.0005 kg/day to 17.5 kg/day from the 1 650 m of river frontage.

The full set of results of the Robert Carr Associates (1995, amended 1997) discharge calculations are provided in the following summary tabulation:

TABLE IA-1 SUMMARY TABLE OF DISCHARGE DATA (ROBERT CARR ASSOCIATES, 1995 AMENDED 1997)

	Shallow Aquifer*	Estuarine Aquifer	Bedrock Aquifer
Maximum Estimated Discharge	3 500 m^3/d	230 m^3/d	not significant
Minimum Estimated Discharge	20 m^3/d	10 m^3/d	not significant
Best Estimate	210 m^3/d	75 m^3/d	not significant

* Layer of fill materials.

Discharge flows to the Hunter River from the bedrock aquifer are regarded as insignificant due to the low permeability of the aquifer and the measured upward hydraulic gradient measured within this aquitard layer.

The PAH loadings calculated from these discharge rates and the PAH concentration statistics, namely, maximum (upper bound), median (lower bound) and 95% confidence limit concentration obtained from the monitoring well analytical data, are presented in summary in the following tabulation:

TABLE IA-2: SUMMARY TABLE OF ESTIMATED PAH LOADINGS (ROBERT CARR ASSOCIATES, 1995, AMENDED 1997)

Estimated PAH Loading*	Shallow Aquifer	Estuarine Aquifer	Bedrock Aquifer
Upperbound	17.5 kg/d	0.18 kg/d	not significant
Lower Bound	0.0005 kg/d	0.00008 kg/d	not significant
Suggested Design Estimate **	0.14 kg/d	0.0145 kg/d	not significant

* based on the discharge flow rate presented above.

** based on the 95% confidence limit of PAH concentrations from all monitoring well samples analysed.

The very broad range in outcomes produced by the basic Darcy's Law calculations of discharge necessitated that an alternative method be employed to verify the results and possibly reduce the range of the calculated values. Hence, the method selected for the purpose of checking the predicted discharges was a simple analytical water balance model.

BASIC WATER BALANCE MODEL FOR BHP STEEL RIVER PROJECT SITE

Object: To confirm the groundwater flow and seep discharge rates from the Steel River Project site initially evaluated using Darcy's Law (carried out by Phil Hitchcock of Robert Carr Associates 1995/1997 and CMPS&F, 1995/1997) and assess the consequences of site redevelopment for industrial usage.

Task Definition: To use a simple water balance model to evaluate/verify initial groundwater discharge rates (seep flow rates) and contaminant loading calculations (by Robert Carr Associates, 1995, amended 1997) as currently exist at the Project site and to estimate post remediation impacts on these discharge rates.

References:

(1) Phil Hitchcock (Roberts Carr Associates, 1995, amended 1997) Hydrogeological Investigation, WOTS site Newcastle NSW.

(2) Todd (1980) Groundwater Hydrology.

(3) CMPS&F (1995, amended 1997) Environmental Audit Report, West of Tourle Street.

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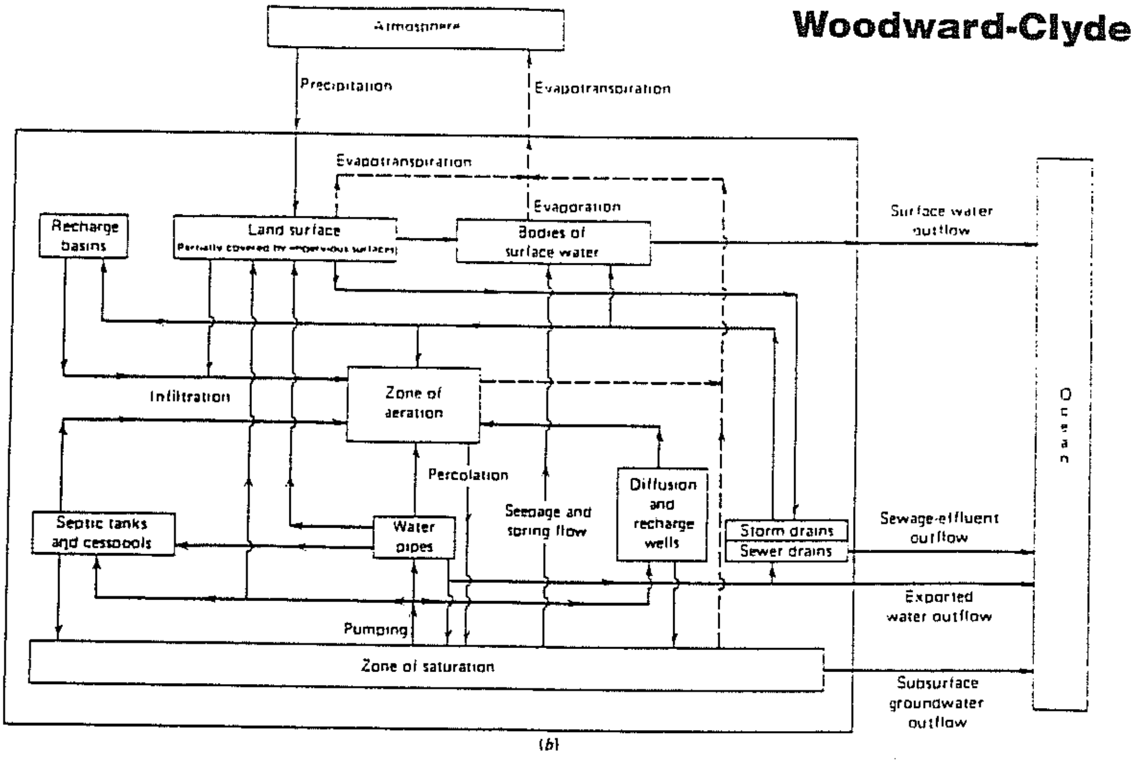


Water Balance: "In terms of the hydrologic cycle for a particular groundwater basin, a balance must exist between the quantity of water supplied to the basin and the amount leaving the basin. The equation of hydrologic equilibrium provides a quantitative statement of this balance. In its most general form it may be expressed in the following equation:

$$\begin{bmatrix} \text{Surface Inflow} \\ + \\ \text{Subsurface Inflow} \\ + \\ \text{Precipitation} \\ + \\ \text{Imported Water} \\ + \\ \text{Decrease In Surface} \\ \text{Storage} \\ + \\ \text{Decrease In} \\ \text{Groundwater Storage} \end{bmatrix} = \begin{bmatrix} \text{Surface Outflow} \\ + \\ \text{Subsurface Outflow} \\ + \\ \text{Consumptive Use} \\ + \\ \text{Exported Water} \\ + \\ \text{Increase In Surface} \\ \text{Storage} \\ + \\ \text{Increase In} \\ \text{Groundwater Storage} \end{bmatrix}$$

.. (equation 1)"

"In this form the equation includes all waters-surface and subsurface-entering and leaving a basin. There are many situations in which it is possible to eliminate certain items from the equation because they are negligible or because they do not affect the solution. For example, a confined aquifer may have a hydrologic equilibrium independent of overlying surface waters; therefore, items of surface flow, precipitation, consumptive use, imported and exported water, and changes in surface storage can be omitted from the equation."

"Each item of the equation represents a discharge, a volume of water per unit of time. The equation can be applied to areas of any size, although for meaningful results a hydrologic entity, such as an aquifer, a groundwater basin, or a river valley, is best."

"The equation of hydrologic equilibrium in theory must balance. In practice, if all items can be valued, it will rarely balance exactly. This may be attributed to inaccuracies of measurements, lack of adequate basic data, or incorrect approximations. The amount of unbalance should not exceed the limits of accuracy of the basic data. In order to achieve a balance, adjustments should be made in items subject to large error. If the unbalance exceeds the limits of accuracy of the basic data, further investigation is necessary. Application of the equation requires good judgement, adequate hydrologic data, and careful analysis of the geology and hydrology of the particular area."

.. from Reference Todd, 1980

Steel River Project Site:

Site Conceptual Groundwater Flow Model can be described in the following idealised hydrogeological cross section:

FIGURE IA-2 CONCEPTUAL GROUNDWATER FLOW MODEL FOR THE STEEL RIVER PROJECT SITE

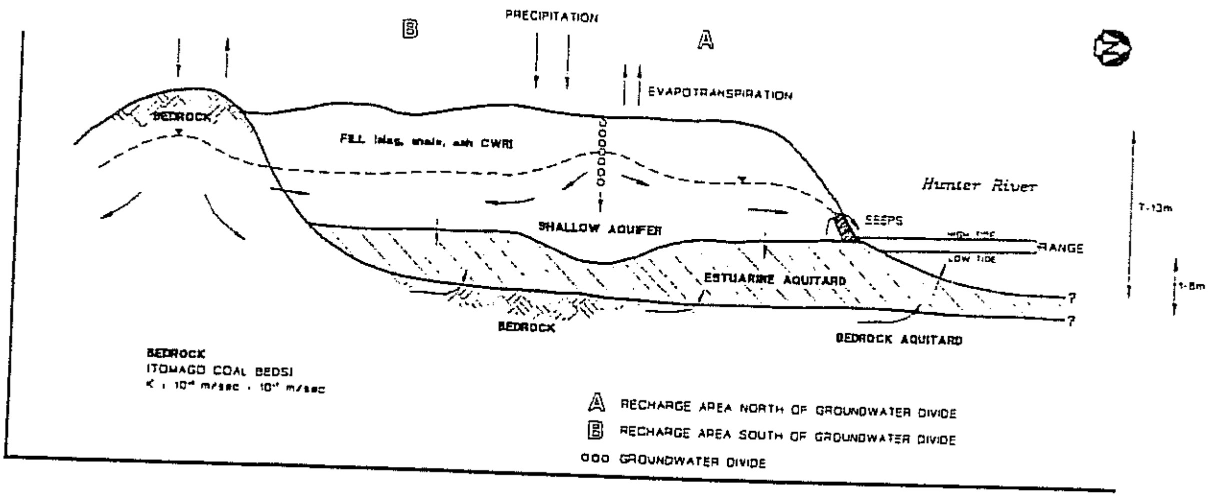


FIGURE I-2: CONCEPTUAL GROUNDWATER FLOW MODEL

The following assumptions have been made in setting up the water balance model for the Steel River Project Site:

Assumptions: (A) **Inputs**

(1) Surface Inflow = 0 (no rivers or creeks cross the site).

(2) Subsurface Inflow = negligible (assume zero) - defined in reference (1) as upward hydraulic flow from bedrock aquifer (Figure IA-2). Bedrock is very low permeability. Some limited on site flow is expect from the Stevenson Park saddle (Section I.4.2).

(3) Precipitation - see tables from Bureau of Meteorology and Hunter Valley Research (Tables IA-3 to IA-5) for this primary input to the hydraulic system.

(4) Imported water = 0 (no imported water is assumed to find its way to the hydraulic system, although some piped water is used by the EMD Plant located in the north east corner of the area and some leakage to the groundwater system may be occurring).

(5) Decrease in surface storage = 0 (no dams or containment's are located on the site).

(6) Decrease in groundwater storage = 0 (no groundwater extraction/injection is undertaken at the site).

(B) Outgoings

(1) Surface outflow = negligible (because the site is flat and has no formal surface drainage network, runoff is assumed to be negligible, say zero).

(2) Subsurface outflow = ? This is the unknown being sought by the model. Darcy's law calculations have put an upper estimate of ≤ 3500 m^3/d (Robert Carr Associates, 1995, amended 1997) on the value.

(3) Consumptive use = 0 (no groundwater extraction/ injection is undertaken at the site).

(4) Exported water = 0 (imported and exported water is assumed to be entirely contained; fresh water and sewerage pipework assumed to be integral).

(5) Increase in surface storage = 0 (no dams or containment's are located on the site).

(6) Increase in groundwater storage = 0 (no groundwater extraction/injection is undertaken at the site).

SITE CATCHMENT STATISTICS

The site catchment area was calculated using a planimeter on Figure 3.1. The total area and other site statistics are tabulated below:

			MAIN SITE AREA		AMCL EMD PLANT
(1)	Area	=	113.4 ha (1.134 km^2)	+	9.75 ha (0.098 km^2)
		=	1.134×10^6 m^2	+	9.75×10^4 m^2
		=	1.2315×10^6 m^2		

(2) Grade assumed = 0 (flat)

(3) Fill thickness h_f = 7 m - 13 m

(4) Saturated Fill Thickness h_{sat} = 4 m - 5 m.

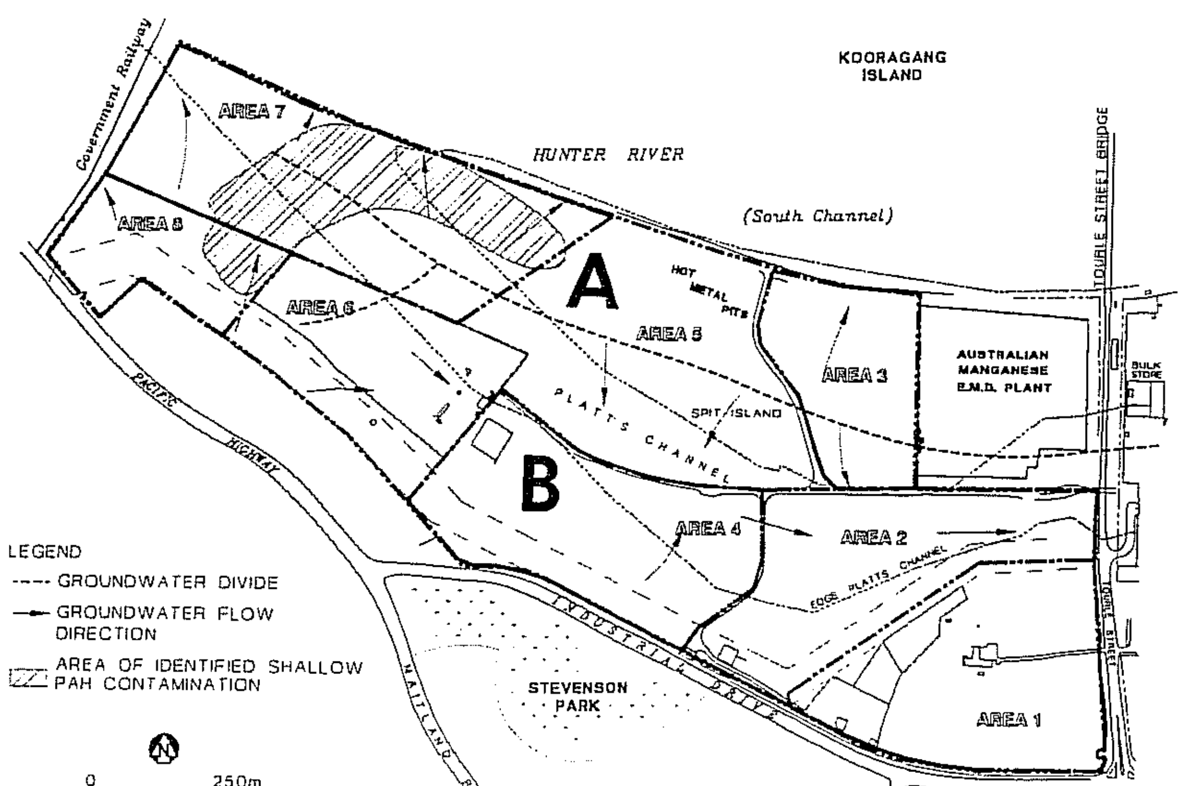
(5) Surface soil permeability is such that infiltration could be *moderate* to *high*. This arises from observations of the surface soils, namely that, the site has an engineered surface which is furrowed and grassed over much of its area, has a poor surface soil layer (CWR over much of its area) and is flat. Therefore, surface runoff has been assumed to be ≤10% (say 10% a conservatively low value).

The most important input to the model is, therefore, the contribution of rainfall/precipitation infiltration to the groundwater system. This has been calculated below (page IA-11). First it is appropriate to review the hydrogeology of the site. The work of Robert Carr Associates (1995, amended 1997) and CMPS&F (1995, amended 1997) have produced a concise picture of the hydrogeology and hydrochemistry, including shallow soil contamination (PAH), groundwater flow patterns and groundwater divide (the groundwater flow pattern has been reported in detail in Robert Carr Associates 1995, amended 1997). This has been distilled in the Figures IA-2 and IA-3.

The most important feature of the hydrogeological system beneath the Steel River Project site is the existence of a groundwater mound/ridge or divide across the northern portion of the site. Water level measurements collected from the monitoring well network define the groundwater divide as running approximately east-west across the site (Figure I-5). From this divide groundwater flows northward to the Hunter River, and southward and eastward along a higher permeability zone which correlates to the pre-existing Platt's Channel alignment. The limited water level information available from the southernmost boundary area of the site indicates a potential component of minor groundwater flow migrating northward from off-site locations south of Maitland Road and Industrial Drive (Stevenson Park area).

This groundwater flow pattern plays an important role in defining the likely groundwater flow rates (volumes and therefore contaminant loadings) to the Hunter River.

FIGURE IA-3 SITE LOCATION PLAN SHOWING SITE SUBDIVISION, SHALLOW SOIL CONTAMINATION (PAH), GROUNDWATER FLOW PATTERNS AND GROUNDWATER DIVIDE



CALCULATIONS OF THE PRIMARY INPUT TO THE GROUNDWATER SYSTEM, *RAINFALL AND EVAPORATION INPUTS*

The quantity of rainfall waters infiltrating to the groundwater system over any particular area will be governed by a number of processes, primarily:

1. duration and severity of the rainfall or storm event;
2. evaporation rate;
3. runoff (already discussed); and
4. surface permeability (already discussed).

For this water balance, interaction of storm duration/severity (and their influence on infiltration) have not been assessed in detail and only monthly rainfall figures used to assess the likely infiltration affects. Based on the nature of the site (zero gradient, low runoff and engineered surface) the effect of storm duration/severity is unlikely to have a major impact on the infiltration rate calculations when assessed against the results of the water balance calculated on the basis of monthly averaged data.

The method of calculating the amount of rainfall potentially infiltrating to the groundwater system/s is, thus, as follows:

The rainfall data from the most appropriately located rainfall gauging stations was assessed to determine which months the amount of rainfall (in metres) exceeds the amount of evaporation. For these months, which will be referred to as 'credit months', it was assumed that the amount of rainfall infiltrating the ground surface would be the difference between the total rainfall less the amount of evaporation. Of this figure 10 % is assumed to leave the site as run-off (a conservatively low number). The remaining 90 % of rainfall during these 'credit months' will then infiltrate the surface.

For the months during which the amount of rainfall does *not* exceed the amount of evaporation, which will be referred to as 'deficit months', it was assumed that the amount of rainfall infiltrating the ground surface would be between 2.5 % and 20 % of the total rainfall (based on 80% and 97.5% of rainfall evaporating before infiltration can occur, generally accepted figure in the literature). This range of likely evaporation rates, and consequential infiltration rates, can not be more precisely defined without detailed testing and hence the water balance model was calculated on a range of such parameters.

All calculations have been undertaken for the range of infiltration values for the 'deficit months' (only). Rainfall data for 3 neighbouring gauging stations (Williamtown, Newcastle (Nobby's Signal Station) and Maryville stations) was sought and assessed in determining likely inputs to the model. This information follows:

RAINFALL AND EVAPORATION DATA - Williamtown, Newcastle (Nobby's Signal Station) and Maryville stations:

TABLE IA-3 RAINFALL AND EVAPORATION DATA FOR THE WILLIAMTOWN WEATHER STATION

	Jan	Feb	Mar	Apr	May*	Jun*	Jul	Aug	Sep	Oct	Nov	Dec	Annual Totals
Summary of Total Monthly Precipitation using available data between 1942 and 1996													
Mean	107.5	116.4	121.6	96.9	107.2	120.6	69.1	78.9	58.0	76.9	77.0	83.3	1114.7
Median	90.8	91.3	115.4	64.0	96.6	101.4	54.8	62.7	48.8	56.2	70.1	63.2	1097.7
Highest	327.3	599.6	398.5	361.2	246.2	324.5	172.2	427.5	155.1	237.5	187.7	238.0	1793.7
Lowest	2.2	5.6	2.2	4.4	2.3	18.5	0.0	0.0	0.8	1.0	6.8	14.2	541.0
Number	48	48	49	49	49	49	49	50	51	51	51	49	46
Summary of Total Monthly Evaporation using available data between 1974 and 1996													
Mean	206.3	173.7	149.6	115.4	*80.2*	*74.4*	81.2	110.2	141.0	165.8	191.0	228.2	1715.6
Median	201.3	173.8	144.4	114.6	75.4	75.8	78.4	107.5	136.0	167.9	185.8	217.3	1667.7
Highest	269.6	216.6	205.3	152.0	111.6	95.6	107.8	163.8	247.6	217.0	268.8	307.1	2205.4
Lowest	157.2	121.4	114.5	76.8	60.6	55.3	42.0	75.5	108.2	80.8	163.4	179.8	1530.2
Number	23	23	23	23	23	23	23	23	23	23	22	22	22

* rainfall 'credit months' (see boxed data)

Credit Months: Therefore, the number of months in which *Rainfall* exceeds *Evaporation*, i.e. in May and June only, is as follows:

May	=	107.2 - 80.2	=	270 mm	=	0.027 m		
June	=	120.6 - 74.4	=	46.2 mm	=	0.046 m		
Therefore, May + June, is					=	0.073 m		(i)

For deficit months (*except* May & June), the total rainfall is 886.9 mm or 0.8869 m. (ii)

TABLE IA-4 RAINFALL DATA FOR THE NEWCASTLE (NOBBYS SIGNAL STATION) WEATHER STATION

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Totals
Summary of Total Monthly Precipitation													
Mean	92.1	105.6	121.8	114.3	115.0	117.1	95.8	75.9	73.8	74.5	69.2	83.6	1132.7
Median	74.1	81.9	96.1	89.3	101.1	84.8	80.8	59.8	57.2	64.2	63.3	63.8	1072.4
Highest	404.0	559.2	544.4	546.4	361.5	485.7	351.1	545.3	283.1	277.5	203.9	326.5	1919.4
Lowest	2.0	0.5	2.8	0.0	2.1	3.6	0.0	0.8	1.6	4.6	2.4	4.6	596.9
Number	133	133	133	133	133	133	132	133	132	132	132	131	131

No evaporation data available - hence no "rainfall over evaporation" calculations (credit months) could be made.

TABLE IA-5 RAINFALL AND EVAPORATION DATA FOR THE MARYVILLE STATION (HUNTER VALLEY RESEARCH STATION) WEATHER STATION- MEAN RAINFALL FIGURE ONLY (NO OTHER STATISTICS AVAILABLE)

	Jan	Feb	Mar	Apr*	May*	Jun*	Jul*	Aug	Sep	Oct	Nov	Dec	Annual Totals
Summary of Total Monthly Precipitation using available data between 1942 and 1996													
Mean	111.1	116.3	133.4	$\boxed{102.7}$	$\boxed{101.6}$	$\boxed{127.4}$	$\boxed{51.9}$	55.5	56.1	80.5	82.1	87.3	1103.4 (n=33)
Summary of Total Monthly Evaporation using available data between 1974 and 1996													
Mean	175.4	144.0	127.8	91.5	*63.1*	*55.5*	66.2	88.5	115.1	141.0	149.9	173.6	1397.0 (n=15)

* rainfall 'credit months' (see boxed data)

Credit Months: Therefore, the number of months in which ***Rainfall*** exceeds **Evaporation**, i.e. during the months of March, April, May and June, is:

March	=	133.4 - 127.8	=	5.6 mm				
April	=	102.7 - 91.5	=	11.2 mm				
May	=	101.6 - 63.1	=	38.5 mm				
June	=	127.4 - 55.5	=	71.9 mm				
				127.2 mm	or	**0.127 m**		(iii)

For rainfall deficit months (*except* March, April, May and June), the total rainfall is 636.8 mm or 0.6368 m (iv)

Having compiled and calculated the likely rainfall data for the area, the next calculation required to complete the water balance is to assess the potential rates. The **Maryville Station** and **Williamtown** rainfall data were selected for the next step in the calculations, since they include both rainfall and evaporation figures, and hence credit and deficit data was able to be calculated.

WATER BALANCE MODEL INPUTS

[1] Infiltration (from available precipitation/rainfall water)

Assumptions: to recap, calculation of the volume of rainfall infiltrating to the groundwater system:

(1) Assume: 10% runoff (conservative) of rainfall for credit months;

(2) Therefore assume: **90%** of rainfall seeps/infiltrates to groundwater, that is, 90% after 10% runoff - conservative assumption (runoff likely to be more than 10%); and

(3) For deficit months, assume between **2.5%** and **20%** of all other months rainfall (except deficit months) infiltrates subsurface (10% is considered most likely).

Calculate range of infiltration using [A] Williamtown rainfall data and [B] Maryville rainfall data:

[A] Williamtown Data

Volume Infiltrating Subsurface Q_y = (Site Area) x (Rainfall available for Infiltration) =

Area x {[(May+June)* x 90%)] + [Other Months** @ 0%, 2.5%, 5%, **10%**, 15% and 20% infiltration]} .. in m^3/yr

10% is considered most likely.

Next, calculate Volume of surface water infiltrating the subsurface based on ***Williamtown*** rainfall data for a range of infiltration factors (0% to 20%):

Qy = annual infiltration: Q_y = (1.2315 x 10^6 m^2) x {[(0.073) x 0.9]* + [0.8869 x 0%, 2.5%, 5%, 10%, 15% and 20%]**} in m^3/yr (v)

* credit months, ** deficit months

TABLE IA-6 CALCULATION OF INFILTRATION RATES FROM WILLIAMSTOWN RAINFALL DATA

Percent Infiltration* =		0%	2.5%	5%	7.5%	**10%**	15%	20%	Units
Annual Infiltration Rate, from (v)	Q_y = m^3/yr	80 909	108 215	135 520	162 826	**190 131**	244 742	299 353	m^3/yr
∴ Infiltration Rate	Q_d =	[Annual Infiltration per year] ÷ 365							m^3/day
Infiltration in m^3/d: *or*	Q_d =	222	296	371	446	**521**	671	820	
Infiltration Rate in L/sec:	Q_s =	2.6	3.4	4.3	5.2	**6.0**	7.8	9.5	

[B] Maryville:

Volume Infiltrating Subsurface Q_y = (Site Area) x (Rainfall Infiltration) =

Area x {[(March+April+May+June*) x 90%)*] + [Other Months** @ 0%, 2.5%, 5%, **10%**, 15% and 20% infiltration]} .. in m^3/yr

10% is considered most likely.

Next, calculate Volume of surface water infiltrating subsurface based on ***Maryville*** rainfall data for a range of infiltration factors (0% to 20%):

Qy = annual infiltration: Q_y = (1.2315 x 10^6 m^2) x {[(0.127) x 0.9]* + [0.6368 x 0%, 2.5%, 5%, 10%, 15% and 20%]**} (vi)

* credit months, ** deficit months

TABLE IA-7 CALCULATION OF INFILTRATION RATE FROM MARYVILLE RAINFALL DATA

Percent Infiltration =		0%	2.5%	5%	7.5%	10%	15%	20%	Units
Annual Infiltration Rate, from (vi)	Q_y = m^3/yr	140.760	160 366	179 971	199 578	**219 184**	258 396	297 608	m^3/yr
∴ Infiltration Rate	Q_d =	[Annual Infiltration per year] ÷ 365							m^3/d
Infiltration in m^3/d. *or*	Q_d =	386	440	493	547	**600**	708	815	
Infiltration Rate in L/sec:	Q_s =	4.5	5.1	5.7	6.3	**7.0**	8.2	9.4	

CALCULATION OF SUBSURFACE OUTFLOWS:

SPECIFIC WATER BALANCE MODEL *INPUTS*

[1] Surface Inflow = 0 (no rivers or creeks cross the site).

[2] Subsurface Inflow = negligible (assume zero) - defined in reference (1) as upward hydraulic flow from bedrock aquifer (Figure IA-2). Bedrock is very low permeability. Some limited on site flow is expect from the Stevenson Park saddle (Section I.4.2).

[3] Precipitation Infiltration - see tables from Bureau of Meteorology and Hunter Valley Research (Tables IA-3 to IA-5) for this primary input to the hydraulic system.

[4] Imported Water = 0 (no imported water is assumed to find its way to the hydraulic system.

[5] Decrease in Surface Storage =0(no dams or containment's are located on the site; evaporation incorporated in calculations in Table IA-6.

[6] Decrease in Subsurface Storage = 0 (no groundwater extraction/injection is undertaken at the site).

SPECIFIC WATER BALANCE MODEL *OUTGOINGS*

[1] Surface Outflow (runoff) = negligible (because the site is flat and has no formal surface drainage network, runoff is assumed to be negligible, say zero); for credit months ≤10% - as incorporated in calculations in Tables IA-3 to IA-5.

[2] Consumptive Use = 0 (no groundwater extraction/injection is undertaken at the site).

[3] Subsurface Outflows = see calculations below (includes seep and groundwater flows off-site).

Assume:

(1) Site is subdivided into 2 groundwater regimes by a *Groundwater Divide* (see Figure IA-3 and Section I1.4.2 for discussion), here called [A] and [B];

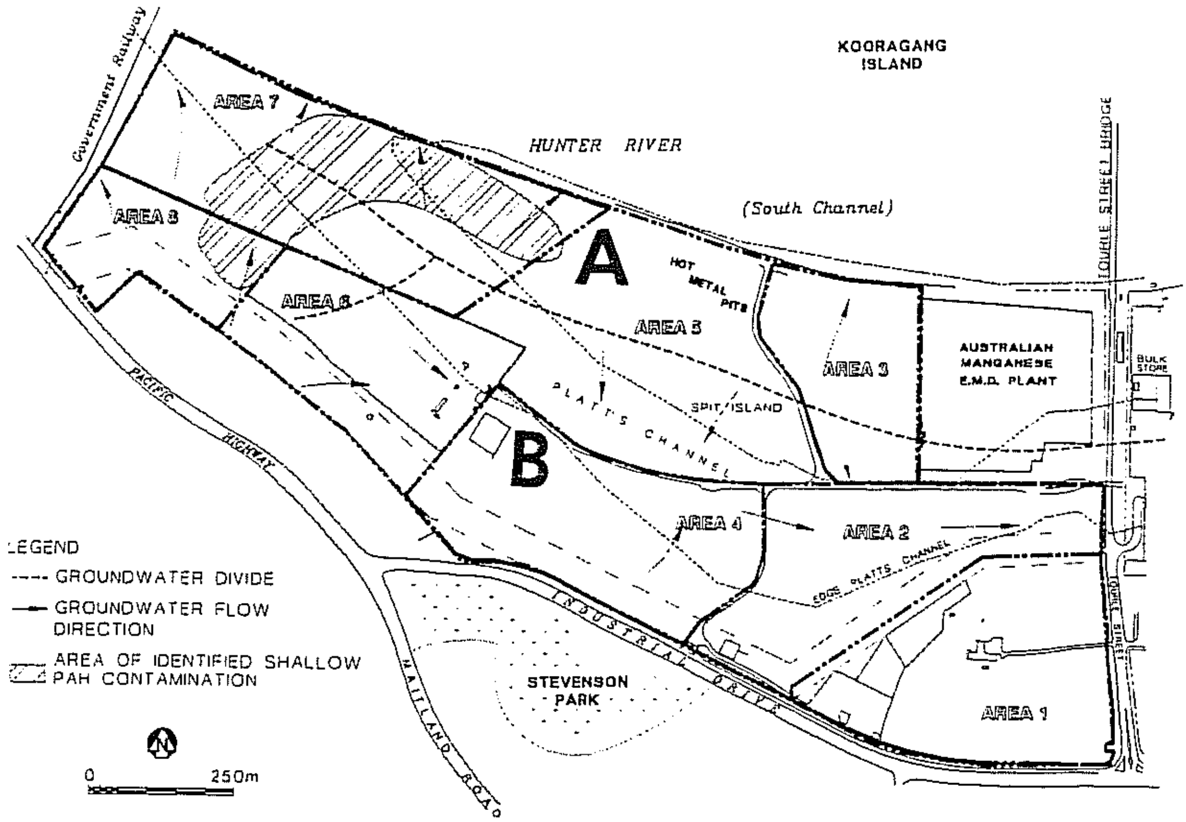
(2) Groundwater in Groundwater Regime [A], northern half of site, flows off-site (output) as:
   - (a) seeps to Hunter River (major proportion)
   - (b) subsurface groundwater flows off-site to the NW and to the East;

(3) Groundwater in Groundwater Regime [B], southern half of site, flows off-site (model output) as subsurface groundwater flows off-site to the East (positive gradients from the bedrock hills to the south mean zero or negative outflows in the southerly direction ∴ assume = 0);

(4) Area [A] recharge (surface infiltration) flows to N to River and to NW and E off-site (see Figure IA-4); and

(5) Groundwater Regime [B] recharge (surface infiltration) flows off-site to East (see Figure IA-4).

FIGURE IA-4: GROUNDWATER FLOW REGIMES



Calculation

Since the *Water Balance Model Equation* reduces to ***Inputs = Outgoings,*** where Inputs are dominated by Precipitation Infiltration and Outgoings are seep exfiltrations (to river) + off-site groundwater flow.

∴ *Area A* = 55% of Total Site Area: (1.2315 x 10^{-6} x 55%) = 673 325 m^2

Area B = 45% of Total Site Area: (1.2315 x 10^{-6} x 45%) = 554 175 m^2

∴ **Total outflows from Area A** = *Inputs* x 55%,

where *inputs* referred to are those calculated as infiltration rate data for the entire site (see Tables IA-6 and IA-7) and the are presented here for a range of percentage infiltration for the *deficit months* (only):

TABLE IA-8 TOTAL GROUNDWATER OUTFLOW TO HUNTER RIVER FROM AREA A

Percentage infiltration* =		0%	2.5%	5%	7.5%	10%	15%	20%	units
Williamtown	Q_d =	122	162	204	245	**287**	**369**	**451**	m^3/day
Maryville	Q_d =	212	242	272	300	**330**	**389**	**450**	m^3/day
Williamtown	Q_s =	1.4	1.9	2.4	2.8	**3.3**	**4.3**	**5.2**	L/sec
Maryville	Q_s =	2.5	2.8	3.1	3.5	**3.8**	**4.5**	**5.2**	L/sec

* percentage infiltration for deficit months (2.5 % to 20 %).

and **Total outflows from Area B** = *Inputs* x 45%

where *inputs* referred to are those calculated as infiltration rate data for the entire site (see Tables IA-6 and IA-7) and are presented here for a range of percentage infiltration for the *deficit months* (only):

TABLE IA-9 TOTAL GROUNDWATER OUTFLOW OFF-SITE FROM AREA B

Percentage infiltration* =		0%	2.5%	5%	7.5%	10%	15%	20%	
Williamtown	Q_d =	100	133	167	200	234	302	369	m^3/day
Maryville	Q_d =	174	198	222	246	270	319	367	m^3/day
Williamtown	Q_s =	1.2	1.5	1.9	2.3	2.7	3.5	4.3	L/sec
Maryville	Q_s =	2.0	2.3	2.6	2.8	3.1	3.7	4.2	L/sec

* percentage infiltration for deficit months (2.5 % to 20 %).

Thus, **Seepage Outflows to Hunter River**: *Area A River Frontage*, are as follows:

Q_{seeps} = [Total Outflows] - [Off-site Groundwater flows to NW and E] .. for Area [A]

As a first pass calculation assume that off-site groundwater flow to NW and E are negligible, that is, [Off-site Groundwater flows to NW and E] = zero. This assumption is not unreasonable since groundwater flow directions are approximately parallel with both site boundaries (to the NW and E), thus implying minimal flow off-site in the NW and E directions.

Seep flows north to the Hunter River (Area [A]) are summarised as follows:

TABLE IA-10 SUMMARY OF SEEPAGE RATE DATA CALCULATED FROM WILLIAMTOWN AND MARYVILLE RAINFALL DATA

DATA:	% Infiltration* =	0%	2.5%	5%	7.5%	**10%**	**15%**	**20%**	Units
Using Williamtown Data:	Q_d =	<u>122</u>	162	204	245	**287**	**369**	**451**	m³/day
Using Maryville Data:	Q_d =	212	242	272	300	**330**	**389**	**<u>450</u>**	m³/day
Using Williamtown Data:	Q_s =	1.4	1.9	2.4	2.8	**3.3**	**4.3**	**5.2**	L/sec
Using Maryville Data:	Q_s =	2.5	2.8	3.1	3.5	**3.8**	**4.5**	**5.2**	L/sec

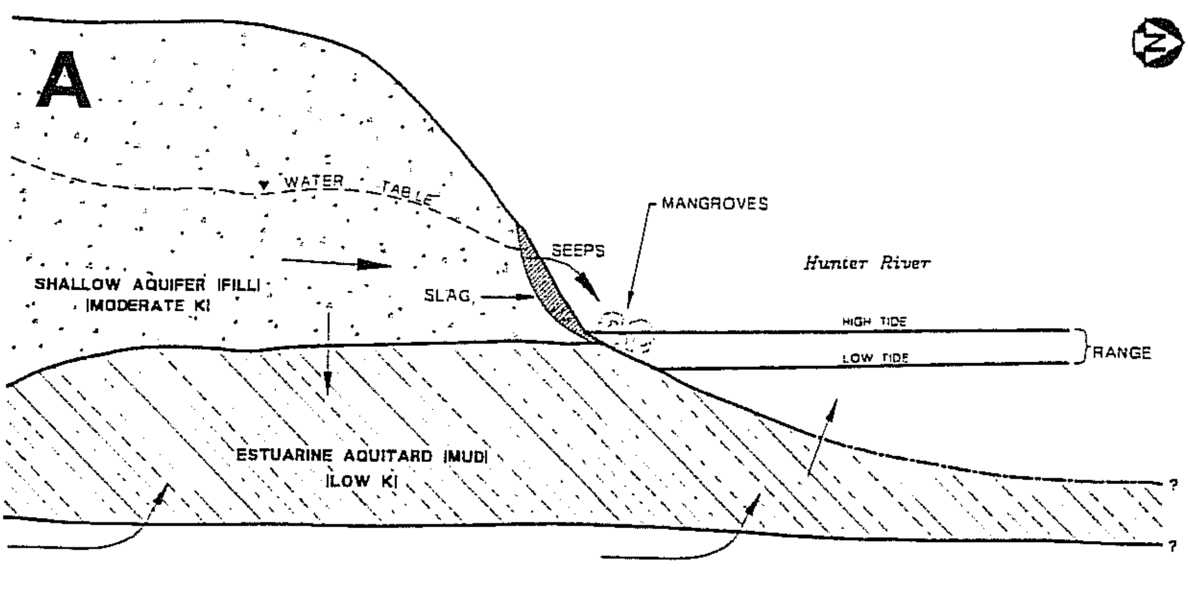
* percentage infiltration for deficit months (2.5 % to 20 %). See Table IA-8 under 0% to 2.5% infiltration.

Conclusions

From information contained in the Robert Carr Associates Report (1995, amended 1997) and the known site geology, the flow from the fill layer is predominantly seep flow with minimal groundwater flow to river (through river bed sediments)

In summary, discharges to Hunter River range from 287 m^3/d to 450 m^3/d (1.4 L/sec to 5.2 L/sec). The range of seepage numbers calculated for the site arise from the uncertainty of the likely infiltration rates which might operate over the site surfaces and under varying storm event conditions. The values presented here were selected from Table IA-10 for the 10 % to 20 % infiltration rate (for deficit months only, 90 % for credit months) and are therefore considered conservatively high than is likely to be the case in practice. Figure IA-5 illustrates a conceptual model of the seepage process which is believed to occur at the embankment.

FIGURE IA-5 SCHEMATIC DIAGRAM SHOWING LIKELY SEEP PROCESSES (NOTE: OBSTRUCTIONS ILLUSTRATED AT POINT OF EXFILTRATION ON THE EMBANKMENT WHERE NUMEROUS LAYERS OF SOLIDIFIED SLAG PREVENT UNIFORM SEEPAGE IN PLACES)



Note: (1) Realistic (observed) mean flow rates are likely to be at the low end of this range.

(2) This is very much in line with the Robert Carr Associates Report values for seepage discharge to the Hunter River (Table IA-1) of **210 m^3/d** (best estimate).

PAH LOADING

Based on the predicted range of seep flow rates of 287 m^3/d to 450 m^3/d the contaminant loading based on a PAH mean concentration from two sources, i.e. monitoring well groundwater analyses *and* seep water samples, is as follows:

- 366 µg/L or 0.000366 kg/m^3 - average Total PAH concentration for monitoring wells[1] lying along the Hunter River Bank over the **full length** of Hunter River frontage; and

- 11.7 µg/L or 0.0000117 kg/m^3 - average Total PAH concentration for seeps[2] lying along the Hunter River Bank over the **full length** of Hunter River frontage.

TABLE IA-11 AVERAGE PAH LOADING DATA FROM RIVER FRONT DATA AND SEEPS PATH DATA

	A	*Average PAH Concentration for River Front Monitoring Wells Samples**			B	*Average PAH Concentration from River Front Seep Samples***		
Predicted Discharge in m^3/d	x	[PAH] concentration in kg/m^3	=	Total PAH Loading in kg/d	x	[PAH] concentration in kg/m^3	=	Total PAH Loading in kg/d
300	x	0.000366	=	0.11	x	0.0000117	=	0.004
400	x	0.000366	=	0.15	x	0.0000117	=	0.005
450	x	0.000366	=	**0.17**	x	0.0000117	=	0.005

* Assumes $[PAH_{TOT}]$ = 366 µg/L (0.000366 kg/m^3) average concentration *over full length* (1600 m) of river frontage

** Assumes $[PAH_{TOT}]$ = 11.7 µg/L (0.0000117 kg/m^3) average PAH concentration analysed in the seep indicated levels (Robert Carr Associates, 1995, amended 1997).

---

1 Monitoring Wells included in the estimation of the "mean" were W3/10, W3/11, W5/15, W7/1a.W7/1B, W7/1N, W7/1S, W7/8A, W7/8N, W7/8S, W7/12A, W7/12B, W7/12E, W7/12W, W7/21, W7/22, W7/25B, W7/25E and W7/25W.

2 Seep samples included in the estimation of the "mean" were W1, W2, W3, W4, W5, W6, W7, W8, W9, W10, W11 and W12.

EVALUATION OF SEEPAGE FLOW RATES AND CONTAMINANT LOADING TO HUNTER RIVER *AFTER* REMEDIAL ACTION

Assumptions

After Remedial Works:

(a) 75% of site area will be under structures + road seal and therefore will reduce rainfall infiltration to negligible levels (say 0%), and,

(b) The remaining 25% will be under landscaped redevelopment (parks, gardens, trees, grass .) with surface drainage optimised to minimise rainfall infiltration. For this calculation the infiltration of ≤ **2.5**% is considered practical/achievable.

Therefore, from Table IA-10 the range of infiltration rates (using Maryville data) for infiltration during deficit month of 0 % and 2.5 % have been extracted and used in the table below to estimate the likely reduction in discharge rates and PAH loading to the Hunter River from the remediated Steel River Project site. Note, given that the re-engineering of the site which will take place during remediation will also affect the credit months (previously infiltration was assumed to be approximately 90%) and that infiltration is likely to be less than 90 % since the increased surface run-off and improved drainage will reduce this number substantially. As a consequence using the data from the Table IA-10 will introduce an additional level of conservatism (on the over estimate side) to the results, that is, they will be conservatively high.

TABLE IA-12 ESTIMATES OF POST REMEDIATION PAH LOADING USING RIVER FRONT MONITORING WELL PAH DATA

	Source of PAH Data		*0% Infiltration*	*to*	*2.5% infiltration*
		Discharge, Q_d	212 m^3/d x 25%		242 m^3/d x 25%
		=	**= 53 m^3/d**	to	**= 61 m^3/d***
A	PAH Loading based on monitoring	PAH Loading**, kg/d =	Q_d x [PAH_{TOT}]		Q_d x [PAH_{TOT}]
	well data**	=	0.019 kg/d	to	0.022 kg/d
		=	**19.2 g/d**	to	**22.1 g/d**

** Assumes [PAH_{TOT}] = 366 µg/L (0.000366 kg/m^3) average concentration *over full length* (1 600 m) of river frontage (monitoring well data).

TABLE IA-13 ESTIMATES OF POST REMEDIATION PAH LOADING USING SEEP PAH DATA

	Source of PAH Data		*0% Infiltration*	*to*	*2.5% infiltration*
		Discharge, Q_d =	212 m^3/d x 25%		242 m^3/d x 25%
			= 53 m^3/d	to	**= 61 m^3/d***
B	PAH Loading based on Seep data ***	PAH Loading** =	Q_d x $[PAH_{TOT}]$		Q_d x $[PAH_{TOT}]$
		=	0.0006 kg/d	to	0.0007 kg/d
		=	**0.6 g/d**	to	**0.7 g/d**

* Represents a 80+% reduction on nominal 300 m^3/d infiltration driven discharge rates (see Table IA-10 on page 18-23 , under "0% to 2.5%" infiltration); and

*** Assumes $[PAH_{TOT}]$ = 11.7 μg/L (0.0000117 kg/m^3) average concentration *over full length* (1 600 m) of river frontage (seep data).

From these calculations, it can be seen that the remedial action works are likely to achieve a 80+% reduction on a nominal 300 m^3/d pre-remediation flow/discharge rate to Hunter River.

Based on this potential reduction of discharge rate to the Hunter River, the PAH loading after remediation works have been completed will range from **0.6 g/d to 22.1 g/d.**

APPENDIX J

WIND FREQUENCY ANALYSES

(PD)

New South Wales Regional Office
Climate and Consultancy Section

PO Box 413
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Cover Sheet

Date: 24 / 07 / 1996

Your Reference: ....

Our Reference: ....

To: STUART HODGSON............

Address:..
....
....

FAX Number: 9934 6710..

FROM: Phillip Dyke

Number of pages including this page: 10.....

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Remarks:

WITH KINDEST REGARDS,
PHILLIP DYKE

te Number 061078 Latitude 32°47'47"S Longitude 151°49'59"E :levation 9 metres Opened Jan 1942 Still Oper. All available data have been used

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years o. Record
Mean Daily Maximum Temp (°C)	27.7	27.2	26.1	23.6	20.2	17.5	16.9	18.4	20.9	23.3	25.3	27.1	22.9	46
Highest Temperature (°C)	44.1	42.0	40.7	37.0	29.6	26.6	27.8	30.1	36.0	39.4	43.2	42.8	44.1	46
Lowest Maximum Temperature (°C)	18.1	19.2	18.1	15.2	11.8	10.7	9.2	10.4	10.9	14.4	14.1	17.4	9.2	46
Mean Number of days over 30°C	8.3	6.3	4.4	0.9	nil	nil	nil	0.1	0.6	2.6	5.1	8.0	36.3	46
Mean Number of days over 35°C	2.6	1.4	0.4	nil	nil	nil	nil	nil	0.1	0.3	1.5	2.3	8.6	46
Mean Daily Minimum Temp (°C)	18.0	17.9	16.3	13.2	10.1	7.9	6.2	6.8	8.9	12.0	14.2	16.5	12.3	46
Lowest Temperature (°C)	9.4	9.8	8.7	3.9	-0.6	0.0	-3.9	-1.9	0.4	3.0	5.1	7.9	-3.9	46
Highest Minimum Temperature (°C)	25.7	24.5	23.5	21.7	18.7	16.3	15.2	15.2	17.8	'20.2	20.8	24.0	25.7	46
Mean Number of Days below 2.2°C	nil	nil	nil	nil	0.2	0.7	2.6	1.5	0.2	nil	nil	nil	5.2	46
Mean Number of Days below 0°C	nil	nil	nil	nil	nil	nil	0.6	0.2	nil	nil	nil	nil	0.8	46
Mean Daily Terrestrial Minimum (°C)	15.4	15.3	13.4	10.0	7.4	4.8	3.0	2.6	4.8	8.1	11.1	13.7	9.1	25
Lowest Daily Terrestrial Minimum (°C)	5.8	3.9	4.0	-1.6	-2.8	-3.4	-6.5	-7.6	-4.4	-2.1	1.5	3.0	-7.6	25
umber of Days Terrestrial below -0.9°C	nil	nil	nil	nil	0.5	2.1	5.0	5.9	1.7	0.3	nil	nil	15.5	25
Mean 9am Temperature (°C)	23.0	22.5	21.5	18.2	14.2	11.5	10.3	12.0	15.3	18.7	20.5	22.2	17.5	49
Mean 3pm Temperature (°C)	26.2	25.9	24.8	22.6	19.3	16.7	16.2	17.5	19.7	21.7	23.7	25.4	21.6	49
Mean 9am Relative Humidity (%)	72	76	75	75	79	80	77	71	66	63	64	67	72.0	46
Mean 3pm Relative Humidity (%)	58 14	61 15	60 13	57 22	59 28	60 27	54 23	50 21	49 17	53 22	52 17	55 13	55.7	45
Mean 9am Cloud Cover (oktas)	5.0	5.1	4.8	4.1	4.3	4.1	3.5	3.3	3.5	4.6	4.5	4.9	4.3	49
Mean 3pm Cloud Cover (oktas)	4.5	4.7	4.5	4.3	4.5	4.4	4.0	3.9	3.9	4.5	4.4	4.4	4.3	49
Maximum Wind Gust (km/h)	111	93	148	135	130	113	104	137	108	109	105	137	148	38
Mean Daily Wind Run (km)														0
Mean Number of Days of Strong Wind	1.6	1.7	1.5	1.7	3.0	3.8	5.0	5.3	4.6	4.2	3.5	3.0	39.0	49
Mean Number of Days of Gales	0.1	nil	nil	nil	0.3	0.6	0.6	0.6	0.4	0.4	0.3	0.1	3.6	49
Mean Daily Pan Evaporation (mm)	6.7	6.2	4.8	3.9	2.6	2.5	2.6	3.6	4.6	5.5	6.4	7.4	4.7	22
Mean Daily Sunshine (hours)	7.3	7.1	7.0	7.0	6.1	5.7	6.6	7.4	7.6	7.5	7.8	7.7	7.1	39
Mean Number of Days with Hail	0.1	0.1	0.1	nil	nil	0.1	nil	0.1	0.1	0.2	0.1	0.3	1.2	49
Mean Number of Days with Snow	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	nil	49
Mean Number of Days with Frost	nil	nil	nil	nil	0.3	1.3	3.5	3.2	0.8	0.1	nil	nil	9.2	49
Mean Number of Days with Fog	1.3	1.4	2.5	3.2	3.9	3.4	2.9	2.5	2.5	2.2	1.1	1.7	28.5	49
Mean Number of Days with Thunder	3.5	3.1	2.0	1.4	0.8	0.9	0.6	1.2	1.9	3.0	3.9	4.4	26.6	49
Mean Number of Clear Days	5.9	4.4	6.0	7.2	7.4	7.9	10.7	11.2	9.6	6.4	5.5	5.6	87.8	49
Mean Number of Cloudy Days	11.2	11.0	10.2	8.7	9.9	9.4	7.2	6.8	6.6	10.6	9.8	10.7	112.2	49
Mean Monthly Rainfall (mm)	107.5	116.4	121.6	96.9	107.2	120.6	69.5	79.0	57.9	77.5	76.8	83.3	1114.2	49
Highest Monthly Rainfall (mm)	327.3	599.6	398.5	361.2	246.2	324.5	172.2	427.5	155.1	237.5	187.7	238.0		49
Lowest Monthly Rainfall (mm)	2.2	5.6	2.2	4.4	2.3	18.5	0.0	0.0	0.8	1.0	6.8	14.2		49
Mean number of Rain days	12.1	11.8	12.8	10.8	12.2	12.5	9.5	10.5	9.7	12.2	11.0	10.9	136.1	44
Highest number of Rain days	23	18	21	20	22	26	18	19	18	23	19	20		44
Lowest number of Rain days	5	4	4	3	4	3	0	0	1	1	2	4		44

Prepared by Climate and Consultancy Section in the New South Wales Regional Office of the Bureau of Meteorology on 24 July 1996
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HOW TO INTERPRET A WIND FREQUENCY ANALYSIS

Wind is a vector, that is, it has both direction and speed. The term *velocity* incorporates both direction and speed – it is not synonymous for speed.

Prevailing winds, the incidence of sea breezes and so on, are of great interest to many clients of the Bureau of Meteorology. To show these, it is necessary to present winds in a form that shows both the direction and speed. The way we do this is to use a *Wind Frequency Analysis* (WFA).

The WFA available on microfiche is an analysis of the winds recorded at the station over a period. (WFAs can be computed for individual years by our computer section in Melbourne. If these are required, they should be discussed with staff.)

The WFA shows the frequency with which winds occur within particular speed ranges from particular directions. Thus if the figure for a northeasterly at 5–10 Km/h is 16, it means that 16% of the time, the wind was a northeasterly at 5–10 KM/h. WFAs are done for 9am and 3pm for each month of the year. There can be significant variations in both direction and speed between the morning and the afternoon.

Information given on the WFA includes the *name* and *number* of the Station, the *first* and *last year of record* of the years that have been analysed, the *number of years* that have been analysed, and the *number of missing observations* expressed as a percentage of the total. This last point shows, to a certain extent, the reliability of the observations. If observations were taken every day at 9am and 3pm for the period of the analysis, the number of missing observations would be zero. If observations have been missed, then these are expressed as a percentage of the number of observations that could have been made. Each block of the analysis also carries the actual *number of observations* that were considered for the analysis.

The analysis itself gives a lot of information. The horizontal axis shows the wind speed in kilometres per hour, while the vertical axis shows the wind direction to eight points of the compass. The figure on the analysis shows the percentage frequency of occurrence of winds of that direction and speed at that time of the month. The percentage of recordings of *calm* is the figure in the top left corner. An asterisk (*) shows that winds did occur at that speed and direction but the percentage of occurrence was less than 0.5%.

At the bottom and to the right of each analysis are columns marked *All*. On the horizontal axis, these show the percentage frequency of occurrence of winds of a particular speed from any direction, while on the vertical axis, they show the percentage frequency of occurrence of winds from a particular direction at any speed.

PERCENTAGE OCCURRE[illegible] OF SPEED VERSUS DIRECTION BASED ON 4[illegible] YEARS OF RECORDS

NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) 10 6[illegible] %

FIRST YEAR : 1942 LAST YEAR : 1993

32 48 S, 151 50 E 9.0 M ELEV

STATION : 061078 WILLIAMTOWN AMO

JANUARY 0900 HOURS LST

SPEED (KM/HR) CALM 20

DIRN	1 TO 5	5 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	3	2	*	*	*		7
NE	2	3	5	1	*			11
E	1	3	5	1	*	*		10
SE	1	3	6	3	*	*		14
S	1	2	6	5	1	1		16
SW	1	1	3	1	*	*		6
W	1	2	3	1	*	*		7
NW	2	3	3	1	*	*	*	8
ALL	11	21	32	13	2	1	*	

NO. OF OBS. 1395

FEBRUARY 0900 HOURS LST

SPEED (KM/HR) CALM 28

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	2	1	*				5
NE	1	4	4	1	*	*		10
E	1	2	4	1	*	*		8
SE	1	2	6	3	*	*	*	12
S	1	3	6	4	1	*	*	14
SW	1	2	3	1	*	*		7
W	2	3	2	1	*	*		7
NW	3	3	1	*	*	*		8
ALL	11	20	27	11	2	1	*	

NO OF OBS. 1272

MARCH 0900 HOURS LST

SPEED (KM/HR) CALM 28

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	2	2	*				6
NE	2	2	3	*	*			7
E	1	1	3	1	*			6
SE	1	1	4	2	*	*	*	9
S	1	2	4	4	1	*	*	12
SW	1	1	3	2	*	*		7
W	3	3	4	2	*	*		12
NW	3	5	3	1	*	*		12
ALL	14	18	27	11	1	1	*	

NO. OF OBS. 1425

APRIL 0900 HOURS LST

SPEED (KM/HR) CALM 26

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	*				4
NE	1	1	1	*	*			3
E	*	1	1	1	*			3
SE	*	1	1	2	*	*		4
S	*	1	2	2	1	*		5
SW	1	2	4	1	*	*		8
W	3	6	9	4	1	1	*	24
NW	4	7	8	2	1	*	*	23
ALL	11	20	27	11	4	2	*	

NO. OF OBS. 1380

JANUARY 1500 HOURS LST

SPEED (KM/HR) CALM 1

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1	*				1
NE	*	1	5	5	1	*		12
E	*	2	12	12	2	*		28
SE	*	2	16	12	2	*	*	32
S	*	1	6	7	3	1	*	18
SW	*	*	*	1	*			1
W		*	1	1	*	*		2
NW	*	*	2	2	*	*		4
ALL	2	6	42	39	8	2	*	

NO. OF OBS. 1395

FEBRUARY 1500 HOURS LST

SPEED (KM/HR) CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1	*	*			2
NE	*	1	3	2	1	*		8
E	*	2	12	9	2	*		25
SE	1	3	17	11	2	*	*	33
S	*	1	7	9	3	1	*	21
SW	*	*	1	1	*	*	*	2
W	*	1	1	1	*	*		2
NW	1	1	1	1	*	*		4
ALL	3	10	42	33	8	2	*	

NO. OF OBS. 1270

MARCH 1500 HOURS LST

SPEED (KM/HR) CALM 4

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	*				2
NE	*	1	4	3	*	*		9
E	1	3	13	8	1			25
SE	*	4	19	8	1	*	*	32
S	*	1	6	7	2	1	*	17
SW	*	*	1	1	*	*		3
W	*	*	1	1	*	*		4
NW	*	1	1	1	1	*		4
ALL	3	11	45	29	5	1	*	

NO. OF OBS. 1426

APRIL 1500 HOURS LST

SPEED (KM/HR) CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	*				3
NE	*	2	3	1				6
E	1	2	8	3	*	*		14
SE	1	5	15	4	*	*		26
S	*	1	8	6	2	1		18
SW	*	*	2	1	*	*		4
W	*	2	3	3	2	1	*	11
NW	1	1	3	3	2	*	*	10
ALL	5	15	43	21	6	2	*	

NO. OF OBS 1378

PERCENTAGE OCCURRE[illegible] OF SPEED VERSUS DIREC[illegible]ION [illegible]

FIRST YEAR : 1942 LAST YEAR : 1993 NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) 16.69 %

STATION : 061078 WILLIAMTOWN AMO 32 48 S. 151 50 E 9 0 M ELEV

MAY 0900 HOURS LST

SPEED (KM/HR)

CALM 20

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*		*			1
NE	*	*	*	*				1
E	*	*	1	*	*			2
SE	*	*	1	1	*	*	*	2
S	*	*	*	1	*	*	*	2
SW	*	1	3	1	*	*		5
W	3	8	13	7	3	1	*	36
NW	5	8	11	3	2	1	*	30
ALL	10	18	29	14	6	2	1	

NO. OF OBS. 1426

JUNE 0900 HOURS LST

SPEED (KM/HR)

CALM 14

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	*		*			1
NE	*	*	*	*				1
E	*	*	*	*				1
SE	*	*	1	1	*	*	*	2
S		*	1	1	*	*	*	2
SW	*	1	3	1	*	*		5
W	2	8	16	9	4	2	1	41
NW	4	9	11	5	2	1	*	32
ALL	7	19	31	17	6	3	2	

NO. OF OBS. 1380

JULY 0900 HOURS LST

SPEED (KM/HR)

CALM 17

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	*					1
NE	*	*	*					1
E	*	*	*	*	*	*		1
SE		*	*	*	*	*	*	1
S	*	*	*	*	*	*	*	1
SW	*	*	2	1	*	*	*	4
W	2	7	16	11	3	2	*	42
NW	3	7	12	7	2	2	1	34
ALL	5	15	31	19	6	5	1	

NO. OF OBS. 1426

AUGUST 0900 HOURS LST

SPEED (KM/HR)

CALM 16

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	*		*		2
NE	1	*	1	*				2
E	*	*	*	*	*			1
SE	*	*	1	1	*	*	*	2
S		*	1	*	*	*	*	2
SW	*	*	2	1	*	*		4
W	2	7	12	10	5	2	1	39
NW	3	8	11	6	3	2	*	32
ALL	7	16	28	19	8	5	1	

NO. OF OBS. 1457

MAY 1500 HOURS LST

SPEED (KM/HR)

CALM 14

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	*	*				2
NE	1	1	2	*				3
E	1	2	3	1	*			6
SE	1	4	7	1	*			14
S	1	3	9	4	1	*	*	18
SW	1	1	4	2	1	*	*	8
W	1	3	7	4	3	2	1	21
NW	1	2	4	3	2	1	*	13
ALL	8	16	35	15	7	4	1	

NO. OF OBS. 1425

JUNE 1500 HOURS LST

SPEED (KM/HR)

CALM 13

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	*	*	*	*			2
NE	*	1	*		*			2
E	1	1	1	*	*	*		3
SE	2	3	3	2	*	*		10
S	1	3	8	4	1	*	*	17
SW	*	2	5	3	1	*	*	12
W	1	3	8	6	4	2	2	27
NW	1	2	4	4	2	1	1	16
ALL	8	15	30	19	9	4	3	

NO. OF OBS. 1379

JULY 1500 HOURS LST

SPEED (KM/HR)

CALM 12

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	*	*				2
NE	*	1	1	*	*			2
E	*	1	1	*		*	*	[illegible]
SE	1	2	3	*	*	*	*	6
S	1	2	8	4	1	*		15
SW	*	1	4	3	1	*		10
W	1	3	8	7	4	3	1	28
NW	2	3	6	5	3	2	1	22
ALL	6	13	32	20	9	6	2	

NO. OF OBS. 1424

AUGUST 1500 HOURS LST

SPEED (KM/HR)

CALM 6

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	*	*	*		3
NE	1	1	1	1	*			4
E	1	1	3	1	*			6
SE	1	4	9	2	*	*	*	15
S	1	2	8	5	1	1	*	16
SW	*	1	2	2	1	*	*	6
W	1	2	5	6	5	3	2	23
NW	1	3	4	5	3	3	1	21
ALL	5	14	33	21	11	7	3	

NO. OF OBS. 1456

PRODUCED BY M.I.S.S 30/ 3/94

PERCENTAGE OCCURRE[illegible] OF SPEED VERSUS DIRECTION BASED ON [illegible]

FIRST YEAR : 1942 LAST YEAR : 1993 NUMBER OF MISSING OBSERVATIONS (AS PERCENTAGE OF MAXIMUM POSSIBLE) 10.69 %

STATION : 061078 WILLIAMTOWN AMO 32 48 S, 151 50 E 9.0 M ELEV

PTEMBER 0900 HOURS LST

CALM 7

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	1	1	1	*			*	4
NE	1	1	2	*				4
E	*	1	1	*	*			2
SE	*	*	*	*	*	*		2
S	1	1	2	1	1	*		5
SW	*	1	3	2	1	*		8
W	2	6	10	8	4	2	*	31
NW	3	7	8	4	2	1	*	26
ALL	9	18	27	16	8	4	1	

NO. OF OBS. 1430

OCTOBER 0900 HOURS LST

CALM 18

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	2	2	*	*			6
NE	1	2	4	1	*		*	8
E	*	1	2	1	*		*	4
SE	*	1	3	1	*	*	*	6
S	1	2	5	3	1	*	*	12
SW	1	2	4	2	1	*		10
W	1	3	6	4	3	1	*	19
NW	3	5	5	2	1	1	*	18
ALL	9	18	31	13	7	3	1	

NO. OF OBS. 1483

NOVEMBER 0900 HOURS LST

CALM 15

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	3	2	*				7
NE	1	2	4	1	*			9
E	1	1	4	1	*			7
SE	*	2	4	2	*	*	*	9
S	1	2	6	3	1	1	*	14
SW	*	2	3	2	1	*		8
W	1	3	5	4	1	1	*	16
NW	2	5	5	2	1	1	*	15
ALL	8	20	33	17	4	2	*	

NO. OF OBS. 1440

DECEMBER 0900 HOURS LST

CALM 17

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	2	2	2	*				6
NE	1	3	6	1	*			12
E	1	2	4	1				9
SE	1	3	5	3	*			12
S	1	2	6	4	1	1		16
SW	1	1	3	1	*	*		6
W	1	2	4	2	1	*	*	10
NW	2	4	4	1	1	*	*	12
ALL	11	20	34	14	3	1	*	

NO. OF OBS. 1454

EPTEMBER 1500 HOURS LST

CALM 4

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	*	*			3
NE	*	1	3	2	*	*		6
E	*	2	7	3	*			12
SE	*	3	14	4	1	*	*	23
S	*	1	5	6	3	1	*	16
SW	*	*	1	1	1	1	*	4
W	*	1	3	5	3	3	1	16
NW	*	2	4	5	3	2	1	17
ALL	2	10	39	25	11	6	3	

NO. OF OBS. 1428

OCTOBER 1500 HOURS LST

CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	*	*	*		3
NE	*	1	4	3	1			9
E	*	2	9	7	2			19
SE	*	2	15	7	1	*		25
S	*	1	5	7	3	1	*	17
SW		*	1	1	1	1	*	3
W		1	2	3	2	2	1	10
NW	*	1	3	3	2	2	1	11
ALL	1	8	39	31	11	5	2	

NO. OF OBS. 1483

NOVEMBER 1500 HOURS LST

CALM 2

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	*	1	*	*	*		2
NE	*	1	4	4	1			10
E	*	2	9	11	3	*		25
SE	*	2	13	11	1	*	*	27
S	*	1	4	6	3	1	*	15
SW	*	*	1	*	*	*	*	2
W	*	*	1	2	[illegible]	1	1	7
NW	*	1	2	2	2	1	1	8
ALL	1	7	35	36	12	4	2	

NO. OF OBS. 1436

DECEMBER 1500 HOURS LST

CALM 1

DIRN	1 TO 5	6 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 & UP	ALL
N	*	1	1	*	*	*		2
NE	*	1	3	5	2	*	*	11
E	*	2	11	13	3	*		28
SE	*	2	12	13	2	*		29
S	*	*	3	6	3	2	*	14
SW		*	*	1	*	*		2
W	*	*	1	1	1	1	*	5
NW	*	1	2	2	1	1	*	7
ALL	1	6	33	41	12	4	1	

NO. OF OBS. 1456

* OCCURRED BUT LESS THAN 0.5 PERCENT

PRODUCED BY M.I.S.S. 30/ 3/94

APPENDIX K

PLANT SPECIES LIST

SALICACEAE
Coronopus didymus

PRIMULACEAE
Anagallis arvensis

CASUARINACEAE
Allocasuarina littoralis
Casuarina glauca

ROSACEAE
Rosa bracteata
Rosa rubiginosa
Rubus fruticosus sp. agg.

MALACEAE
Malus x *domestica*

PROTEACEAE
Banksia integrifolia

MYRTACEAE
EUCALYPTUS ALLIANCE
Corymbia maculata
Eucalyptus punctata
Eucalyptus siderophloia
Eucalyptus tereticornis
Eucalyptus sp.

OTHER ALLIANCES
Callistemon salignus
Callistemon viminalis
Melaeuca armillaris
Melaleuca quinquenervia
Melaleuca stypheloides

SALICACEAE

Coronopus didymus

PRIMULACEAE

Anagallis arvensis

CASUARINACEAE

Allocasuarina littoralis

Casuarina glauca

ROSACEAE

Rosa bracteata

Rosa rubiginosa

Rubus fruticosus sp. agg.

MALACEAE

Malus x *domestica*

PROTEACEAE

Banksia integrifolia

MYRTACEAE

EUCALYPTUS ALLIANCE

Corymbia maculata

Eucalyptus punctata

Eucalyptus siderophloia

Eucalyptus tereticornis

Eucalyptus sp.

OTHER ALLIANCES

Callistemon salignus

Callistemon viminalis

Melaeuca armillaris

Melaleuca quinquenervia

Melaleuca stypheloides

FABIOIDEAE
Kennedia rubicunda
Medicago polymorpha
Melilotus indicus
Trifolium fragiferum
Trifolium repens

MIMOSOIDEAE
Acacia falcata
Acacia filicifolia
Acacia irrorata subsp. Irrorata
Acacia longifolia
Acacia saligna

PITTOSPORACEAE
Pittosporum undulatum

APIACEAE
Centella asiatica
Ciclospermum leptophyllum
Foeniculum vulgare

LOBELIACEAE
Pratia purpurescens

ASTERACEAE
Ageratina adenophora
Ambrosia artemisiifolia
Aster subulatus
Bidens pilosa
Chyrsanthemoides monilifera
Cirsium vulagre
Conyza bonariensis
Conyza canadiensis

Coreopsis lanceolata
Delairea adorata
Hypochoeris radicata
Lactuca serriola
Senecio linearifolus
Senecio madagascariensis
Tagetes minuta
Taraxacum officinale

SOLANACEAE
Solanum nigrum

OLEACEAE
Ligustrum sinense
Olea europaea subsp. Africana

GENTIANACEAE
Centaurium erythraea

APOCYNACEAE
Nerium oleander

ASCLEPIDACEAE
Araujia hortorum
Gomphyocarpus fruticosus

SCHROPHULARIACEAE
Verbascum virgatum

PLANTIAGINACEAE
Plantago lanceolata

VERBENACEAE
Lantana camara
Verbena bonariensis

Verbena rigidus

AVICENNIACEAE

Avicennia marina var. australasica

ARACEAE

Alocasia brisbaniensis

AGAVACEAE

Agave americana

ALLIACEAE

Nothoscordum borbonicum

CYPERACEAE

Cyperus sesquiflorus

POACEAE

Agrostis avenacea
Axonopus affinis
Briza ? subaristata
Bromus catharticus
Chloris gayana
Cortadieria selloana
Cynodon dactylon
Danthonia sp.
Lolium sp.
Melinis repens
Paspalum dilatatum
Pennisetum alopecuroides
Pennisetum calndestinum
Phyllostachys aurea

ARECACEAE

Livistonia australia

EXPLAINATION OF TAXONOMIC TERMINOLOGY

sp. =	.unidentified species	var. =	variety
? =	unconfirmed species	subsp. =	subspecies
		sp. agg. =	an aggregate of several species

For simplicity, author citations for scientific names are not given, these follow:

Hill & Johnson (1995) for *Corymbia*
Harden (1990-93) for all other species

APPENDIX L

LANDFILL ENVIRONMENTAL MANAGEMENT PLAN

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