

Maintenance & Management of Biodiversity around the Boyne Island Aluminium Smelter

by
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Centre for Land and Water Resources

Faculty of Applied Science

April 1996



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PREAMBLE

This document provides a general strategy for the management of the buffer zone surrounding the aluminium smelter. It suggests a philosophical environment within which the management of smelter lands could be undertaken. The strategy recommends an integrated approach to this management. It further identifies a number of processes which threaten the integrity of the buffer zone in terms of industrial function and maintenance of inherent conservation values.

General approaches for amelioration of these threats are recommended.

The strategy, however, does not provide detailed operational plans for undertaking any amelioration or general management.

SUMMARY

ETHIC OF ENVIRONMENTAL CARE

The natural environment within Boyne Smelters Limited buffer zone is reasonably intact and retains considerable conservation value.

The opportunity exists to manage this zone to maintain these conservation values.

The challenge, for Boyne Smelters Limited, is to grasp this opportunity by fulfilling the operational requirements of an industrial buffer zone while preserving conservation values, creating a pleasant work environment and satisfying the neighbourhood desire for a pleasing recreational environment.

In meeting this challenge Boyne Smelters should operate within an Ethic of Environmental Care. Under this Ethic the Smelter should be managed in a manner that minimises or eliminates direct or indirect environmental impacts. Direct impacts are those associated with the routine operation and maintenance of the smelter and associated infrastructure. Indirect impacts are those associated with the disposal of smelter products and by-products. Office and canteen wastes are smelter by-products.

Unavoidable by-product production should be considered a resource and a tertiary industry sought to utilise it. Where this is not possible the by-product should be biodegradable or rendered environmentally benign before disposal.

MANAGEMENT AND STAFF COMMITMENT

The management and staff should understand the value of the natural environment and its functioning around the smelter as well as the global implications of industrial impacts.

In particular they should be aware of the potential impact of their daily work on the environmental integrity of their workplace.

In general every effort should be made to integrate the smelter into the surrounding natural environment and co-operate with Nature rather than dominating it.

In establishing an Ethic of Environmental Care, Boyne Smelters management should indicate clearly that such an Ethic is to be developed and, once developed, will be implemented. The Ethic, however, should be developed by the staff required to operate within it on a daily basis.

The successful instigation of an effective Ethic of Environmental Care should provide benefits at both the corporate and community level.

Implementation of the Ethic would demonstrate a positive conservation benefit from industry. Economic benefits may arise through the avoidance of remedial action in environmental management as well as through taxation rebates on environmental management research. Political benefits may be gained through the conservation of biodiversity within an industrial landscape.

THE MANAGEMENT PLAN

The management and maintenance of the buffer zone should be undertaken within the framework of the Ethic of Environmental Care. It should be implemented within a 4 zone system, reflecting past and current landuse and industrial impacts.

Zone 1 (Industrial Impact Zone) encompasses the smelter, land immediately surrounding the smelter, spillway canal, power easements, the haul road and conveyor belts as well as the aluminium storage area and loading dock.

Zone 2 (Urban Buffer Zone) includes the land between Handley Drive and the urban estates south of the smelter. It also includes the land beyond Zone 1 which surrounds the weather station, is used for the cycle way, staff recreational parkland and surrounds the contractors' car park.

Zone 3 (Industrial Filter Zone) encompasses land outside of Zone 1 and Zone 2 and includes parts of the coastline above high tide and extending north about three kilometres.

It is land impacted by fluoride emissions from the smelter.

Zone 4 (Conservation Zone) is similar in composition to Zone 3 but extends north beyond the impact of fluoride outfalls from the smelter.

The management strategies adopted for these zones should run, with regular monitoring, for five years. A review of each strategy should be undertaken during the fifth year and changes, incorporated in a revised five year strategy, instigated in the following year.

INTEGRATED MANAGEMENT

The management of the buffer zone should be integrated with neighbouring landholder interests as Smelter property boundaries are complex and cut across physical and environmental boundaries.

Many of the environmental impacts on the buffer zone emanate from neighbouring landuse practice. Equally Boyne Smelter's management practices have the potential to impact on neighbouring land and water.

The public traditionally use some of the buffer zone for recreation and public utility and hold an interest in the conservation values of the land. Consequently, as far as efficient operation of the smelter, safety and security allow, Boyne Smelter's management should integrate neighbourhood parties and interests in the environmental management process.

Through this integration Boyne Smelters has the opportunity to become a community leader in environmental management in the Boyne Island region.

The Boyne Island Aluminium Smelter and surrounding land is part of a regional mosaic of relatively undisturbed land systems.

This mosaic forms a 'green belt' along the coast and across the centre of Boyne Island. The Smelter buffer zone forms the centre of this 'belt' linking the coast and the inland rocky ridges.

Boyne Smelter's management should initiate the establishment of this 'green belt' (The Boyne Island Green Belt) and facilitate the formation of a management committee to advise the bodies with management responsibility over various parts of the Green Belt.

This committee could be used by Smelter Management to co-ordinate land management, disseminate advice to interested parties, and facilitate community and staff participation in smelter land management.

REHABILITATION AND RESEARCH

Four key processes were identified as threatening the integrity of the smelter buffer zone.

These were:

1. erosion of batters, bare earth and tracks and associated water management problems;
 2. invasion of destructive weeds and associated land management problems;
 3. fire management, and
 4. public recreation.
- As it is not possible to stop the natural process of erosion, management should be directed to contain erosion to acceptable levels. Erosion management is complicated by highly variable, and often highly erodible, soils in association with landform engineering which contributes to the erosion problems.

Despite this complexity an integrated management approach is needed to set priorities, assess risks and allocate resources. Some research will be required to develop the appropriate rehabilitation and management technique for individual soil types and engineered landform.

- A weed response strategy should be developed. This strategy would become active when designated weed species are identified in key areas or when management actions which may favour the spread or establishment of weeds are recognised. Some monitoring and research will be required to develop the appropriate methods within the Ethic of Environmental Care.
- Inappropriate burning-off threatens the industrial buffering capacity of Zone 2, as well as degrading conservation values throughout the buffer zone. Research is required to determine the appropriate fire management strategy to maintain the appropriate plant community structure.
- Public recreation occurring in Zone 2 and in the coastal areas of Zone 3 and Zone 4 is causing environmental change and threatens the physical integrity of the buffer zone. Amelioration of the impacts will result in changed patterns of recreational use within the buffer zone. An investigation of recreational alternative and community attitudes should be linked to this amelioration.

In the preparation of this strategy the impact of fluoride was considered an agent of change rather than a threat to the integrity of the buffer zone. The threat arises from the nature of subsequent management within the fluoride affected areas.

Development of an Ethic Environmental Care will take time and should be considered as a long term programme. Some aspects, such as seeking out or developing tertiary industry to utilise smelter by-products or establish environmentally benign outfall conditions, will require ongoing research and monitoring.

325,700 mE

7,361,600 mN

Boyne Smelters Buffer - Management Zones

- Zone 1 Industrial Impact
- Zone 2 Urban Buffer
- Zone 3 Industrial Filter
- Zone 4 Conservation

Note: Based on 1995 DCDB from Queensland Department of Natural Resources.
Due to complex land boundaries, Zones 3 and 4, as displayed, cover lands not owned by Boyne Smelters. It is not intended to imply management obligations to any land managers.



KILOMETRES

0 0.5 1.0 1.5 2.0 2.5

7,350,500 mN

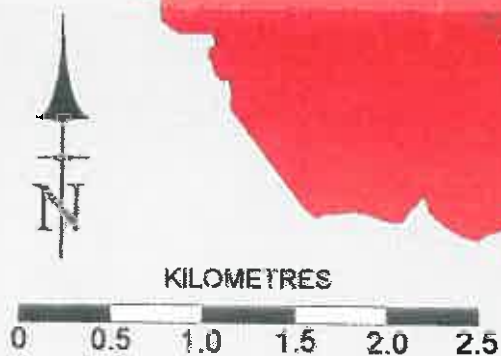
333,600 mE

325,700 mE

7,361,600 mN

Boyne Island Land Tenures (based on 1995 DNR DCDB)

- Vacant Crown Land
- Queensland Alumina Ltd
- Gladstone Port Authority
- Comalco Aluminium Ltd
- Calliope Shire Council
- Boyne Smelters Ltd
- Unknown



7,350,500 mN

333,600 mE

VEGETATION MAP UNIT KEY - CLASSIFIED INTO STRUCTURAL/FLORISTIC GROUPS

1 Rainforest Dominated Communities

- 1a Low Microphyll Vine Forest
- 1b Low Microphyll Vine Forest with emergent *Eucalyptus tessellaris*

2 Eucalypt Dominated Communities

- 2a *Eucalyptus tessellaris* Tall Woodland with understorey of Low Microphyll Vine Forest / Low Microphyll Vine Thicket
- 2b *Eucalyptus tessellaris* Tall Woodland with mid stratum of shrubs and grassy ground stratum
- 2c *Eucalyptus citriodora* Very Tall / Tall Woodland with mid stratum of *Allocasuarina leuhmannii* / *Allocasuarina torulosa* and grassy ground stratum
- 2d *Eucalyptus citriodora* Tall Woodland with shrub mid stratum and grassy ground stratum
- 2e *Eucalyptus exserta* / *E. crebra* Tall Woodland with mid stratum of shrubs and grassy ground stratum
- 2f *Eucalyptus exserta* / *E. clarksoniana* Tall Woodland with mid stratum of shrubs and grassy ground stratum
- 2g *Eucalyptus tereticornis* / *Lophostemon suaveolens* Tall Open Forest / Woodland with grassy ground stratum
- 2h *Eucalyptus tereticornis* Tall Open Woodland with dense small tree and shrub mid stratum, and grassy ground stratum
- 2i *Eucalyptus tereticornis* Tall Very Open Woodland with dense grass and forb ground stratum
- 2j *Eucalyptus tereticornis* / *Melaleuca dealbata* Tall Forest / Open Forest with very sparse understorey
- 2k Mid-high Woodland of immature eucalypts, small trees and shrubs with sparse ground stratum of grasses and forbs

3 Melaleuca Dominated Communities

- 3a *Melaleuca dealbata* / *Casuarina glauca* Very Tall Closed Forest / Forest with very sparse understorey
- 3b *Melaleuca dealbata* / *Eucalyptus tereticornis* Tall Open Forest with sparse understorey

4 Casuarina Dominated Communities

- 4a *Casuarina glauca* Tall / Mid-high Forest / Open Forest / Woodland with *Sporobolus virginicus* ground stratum
- 4b *Casuarina equisetifolia* Tall Forest / Open Forest with understorey of Low Microphyll Vine Forest / Low Microphyll Vine Thicket and strand vegetation
- 4c *Casuarina equisetifolia* Tall Forest / Open Forest with sparse ground stratum of grasses and herbaceous vines

5 Communities Dominated by Low Trees and Shrubs

- 5a *Cupaniopsis anacardioides* / *Acacia eulacocarpa* Mid-high Open Woodland
- 5b Very Tall *Acacia* Shrubland
- 5c Closed / Open Shrubland

6 Grasslands

- 6a Open Grassland +/- emergent *Casuarina equisetifolia*
- 6b *Sporifex sericeus* Open Grassland

7 Vegetation of Streambanks and Drainage Areas

- 7 Vegetation of streambanks and drainage areas

8 Littoral Communities

- 8a Mangrove Communities
- 8b Saltmarsh Communities
- 8c Saltflats

9 Highly Disturbed Areas

- 9 Highly disturbed areas

Sampling Sites

- Vegetation Sampling Site

325,700 mE

7,361,600 mN

Map C

General Location of
Vegetation Maps A - C

Map B

Map A



KILOMETRES



7,350,500 mN

323,600 mE

329,600 ME

Response	Percentage
Yes, the U.S. should take action to reduce global warming	50%
No, the U.S. should not take action to reduce global warming	50%

332.600 mE

7,350,600 mN

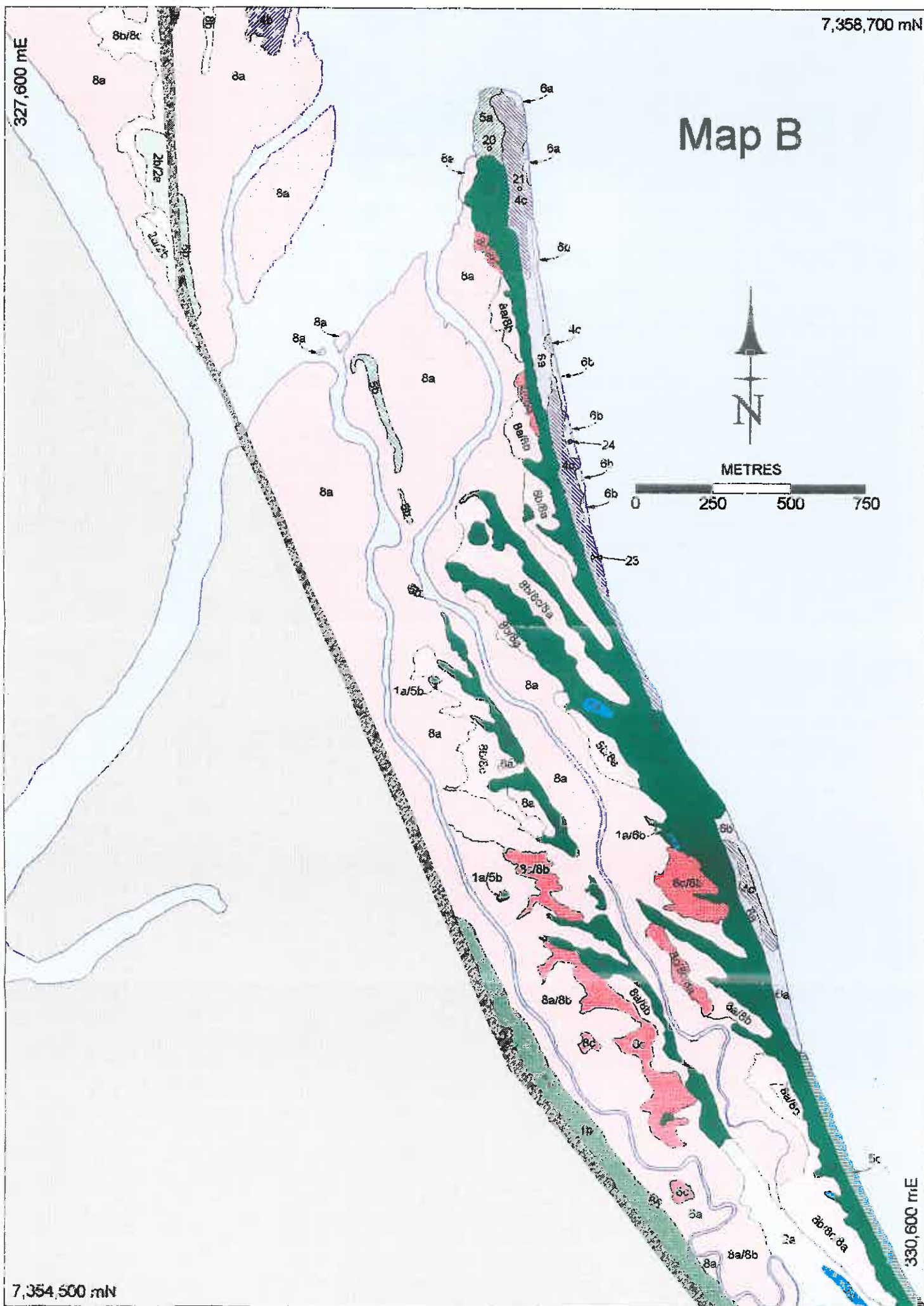
7,358,700 mN

Map B



METRES

0 250 500 750



327,600 mE

7,354,500 mN

330,600 mE

326,650 mE

7,361,450 mN

Map C



1. INTRODUCTION

Most of the land around the aluminium smelter owned by Boyne Smelters Ltd has been disturbed to varying degrees by smelter construction and the activities associated with the adjacent urban community. Many areas have been cleared for construction purposes as well as road and track access. Apart from physical damage, these disturbances have encouraged the spread of weeds throughout the remaining natural bush. Gaseous outfalls from the smelter have led to changes in the structure and composition of the bush as some plant species have declined and others have expanded. Recreational activities (particularly off-road vehicles) have caused erosion and facilitated access for rubbish dumping and further weed expansion. Unauthorised dumping has introduced additional weeds and lowered the aesthetic amenity of the natural bushland. Too frequent fires are further changing the nature of the bush, probably reinforcing the plant community changes induced by the industrial outfalls.

1.1 THE CHALLENGE

Despite the environmental changes, the plant and animal assemblages appear reasonably intact and retain considerable conservation value. The opportunity exists to manage these lands for the maintenance of these conservation values. The challenge is to grasp this opportunity by fulfilling the operational requirement of Boyne Smelters Ltd for an industrial buffer zone while creating a pleasant work environment for the work force and satisfying the desire of the adjacent urban community for an aesthetically pleasing recreational environment.

This challenge can be met through a continuous and long-term commitment to conservation and considered environmental management (an ethic of environmental care) extending throughout the work force and including the industrial and urban neighbours. Ideally management should aim to integrate the smelter with the surrounding environment and, as part of this integration, avoid stressing the adjacent plant and animal communities.

Integrating the smelter into its relatively natural surroundings will require an ability to respond to or anticipate changes within each of the plant and animal assemblages on Boyne Smelters Ltd land. At the same time management must account for the, at times competing, human demands of the land. Consequently this Strategy has been developed to address these various interests while providing a plan for integrating the smelter with the surrounding natural lands.

2. THE *ETHIC OF ENVIRONMENTAL CARE*

Boyne Smelters Ltd and its work force should endeavour to operate the smelter in a manner that minimises or eliminates direct and indirect environmental impacts. Direct impacts are those associated with the routine operation and maintenance of the smelter and associated infrastructure. Indirect impacts are those associated with the disposal of smelter products and by-products. Ideally the production of unnecessary waste products should cease. This includes office and canteen wastes. Unavoidable by-product production should be considered a resource and a tertiary industry sought to utilise it. By-products for which a suitable tertiary industry cannot be found should be rendered biodegradable or environmentally benign before disposal. The work force should understand the value of the natural environment and its functioning around the smelter as well as the global implications of industrial impacts. In particular they should be aware of the potential impact of their daily work on the environmental integrity of their workplace. In general every effort should be made to integrate the smelter into the surrounding natural environment and cooperate with nature rather than dominating it.

2.1 ESTABLISHING THE *ETHIC*

To establish an *Ethic of Environmental Care* the Management of the smelter should indicate clearly that the *Ethic* should be developed and that, once developed, it would be accepted and implemented. The development of the *Ethic*, however, should be undertaken by the staff who would be required to operate within the *Ethic* on a daily basis. As details for operating within the *Ethic* would be formulated by parties with a direct knowledge of the local work environment they are more likely to have an

effective outcome. In other words the details of the *Ethic* would be developed from a richer information base.

An integral part of the “ground - up” development of the *Environmental Ethic* is the provision of resources and information to the staff to allow details of the ethic to be developed in an informed manner.

Development of an *Ethic of Environmental Care* will take time and should be considered as a long-term programme. Some aspects, such as developing tertiary industry to utilise smelter by-products or establishing environmentally benign outfall conditions, will require ongoing research and monitoring.

3. INTEGRATION WITH THE SURROUNDING NATURAL ENVIRONMENT

The first step in developing an *Ethic of Environmental Care* is the realisation that the smelter operates within the natural environment - not apart from it. This realisation is brought about by integrating the smelter with the environment. This integration should occur at three levels. These levels are psychological, aesthetic, and ecological.

3.1 PSYCHOLOGICAL INTEGRATION

The psychological integration of the smelter with the surrounding environment requires that the smelter management and work force understand that there is an environmental continuum between the smelter and the adjacent natural systems. Information available to the staff and operations management should demonstrate an awareness of this continuum. Environmental awareness and care should be a part of the routine work schedule.

Additionally, staff should be able to see the continuity between the smelter environment and the surrounding environment.

For example, this may be most easily achieved through imaginative construction of artificial wetlands where the smelter discharges (and associated traps) are clearly visible. These wetlands would attract *high profile* wildlife (especially abundant aquatic vegetation, birds and frogs). The associated and visible discharge points would allow the staff to see the direct link between the smelter and the natural environment. The traps should allow the staff to see rubbish and spills emanating from their actions within the smelter.

3.2 AESTHETIC INTEGRATION

The physical boundaries around the smelter should be softened as much as safety and security allow. Landscaping adjacent to access points to the smelter, along the smelter perimeter and within the grounds of the smelter softens the outlook for the workers and may attract some wildlife (eg. birds and butterflies) into the smelter grounds. Strategic planting on tracks and fences around the smelter would soften the industrial appearance of the adjacent lands.

Programmes that encourage employees and the Boyne Island community to understand and experience the natural systems operating adjacent to and across the smelter boundary will increase the aesthetic integration.

3.3 ECOLOGICAL INTEGRATION

There are many points of contact between the smelter and the natural environment. A number of these contact points impose ongoing stresses on the surrounding environment. Others are incompatible with the environment at the contact point and will lead to ongoing environmental degradation. Minimising the environmental stresses requires a functional understanding of the natural ecosystem dynamics, a detailed understanding of the assimilative capacity and resilience of the ecosystem and regular, up to date information on changes in environmental conditions. Such information must be devolved to the staff responsible for the design, construction, operation and maintenance of the contact points. Without the information these staff will not be able to operate within the *Ethic of Environmental Care*.

4. BENEFITS OF AN EFFECTIVE *ENVIRONMENTAL ETHIC*

The successful instigation of an effective *Ethic of Environmental Care* within Boyne Smelters Lt should provide benefits at both the corporate and community level.

The operation of an effective environmental ethic would demonstrate that there can be positive conservation benefits arising from industry and public perception of the smelter would improve.

There would be:

- a significant contribution to the regional conservation and research of poorly understood flora and fauna,
- an increased awareness of environmental issues within the staff as well as the associated urban community,
- an enhancement of the work environment of the staff and the aesthetic and recreational environment of the adjacent suburbs.

There would be economic benefits to the company as the *Ethic* should act as a preventative measure for environmental impacts. Consequently savings would be made by avoiding major remedial action particularly on erosion and weed management. Further, research into issues related to environmental management should attract a taxation rebate. Additional benefits may be gained by attaching a “green” label to products from the smelter.

Political benefits may also develop as the successfully applied *Environmental Ethic* would provide an example of conservation of biodiversity outside of the traditional reserve system. Boyne Smelters Ltd would be seen as leading the way. In addition the instigation of the *Ethic* may avoid future government regulations designed to bring individual operations into line with widely held community standards.

5. PRIMARY STRATEGY

5.1 THE STRATEGY

The Primary Strategy provides a framework on which structure and direction can be given to management of the land surrounding the smelter.

The smelter has been in operation since the early 1980's and the associated urban areas are almost fully developed. Consequently a broad spectrum of impacts and impact intensity exists across the land and has been developing for over a decade. Any management strategy must deal with these pre-existing impacts as well as any future effects of the smelter on the surrounding environment. In general the intensity of impact and the range of impacts decreases with distance from the smelter on one hand and from the urban centre on the other. Similarly land use pressures vary in relation to the smelter and the housing developments. The lands immediately adjacent to the smelter are heavily disturbed and are subject to regular impact from smelter outfalls. They provide restricted opportunities for conservation of biota and require intensive management to reduce erosion and limit down-stream impacts. The land between the houses and the smelter must act as a visual buffer while providing an aesthetic backdrop for residential living and a conservation zone. At intermediate distances from the smelter industrial impacts are largely restricted to the effects of gaseous outfalls. Although changes to the biota as a result of the outfall effects are inevitable, significant conservation values are likely to remain in this area. Beyond this impact zone and at greatest distance from the housing estate there appears to be very little ongoing impacts, apart from some limited impacts of recreation. Some areas disturbed during the construction of the smelter and associated infrastructure remain. The conservation value of the biota in this region is high.

These pre-existing impacts suggest that a zoning system would be appropriate to facilitate management of the various degrees of impact and the different land use objectives. Within each zone, a Secondary Strategy would direct management to meet the specific objectives of the zone. It must be remembered, however, that these strategies are not the end of the management process. Continual monitoring and

refining of the strategies will have to be undertaken over the life of the smelter. Each strategy should run, with regular monitoring, for five years. A review of the strategy should be undertaken during the fifth year and changes, incorporated in a revised five year strategy, instigated in the following year.

5.2 THE ZONING SYSTEM

Four zones are suggested to provide the range of functional areas considered necessary for adequate management of the lands. These zones are:

- Zone 1 - Industrial impact zone
- Zone 2 - Urban buffer zone
- Zone 3 - Industrial “filter” zone
- Zone 4 - Conservation zone

Each zone has three functional levels. These are:

- Level 1 - Industrial utility
- Level 2 - Human amenity
- Level 3 - Conservation

The principles of the *Environmental Ethic* should be considered within each functional level. As part of that ethic it is recognised that human impact has created or is creating new plant and animal associations and that the interaction between exotic species, hardy native species and an anthropomorphic environment will produce habitats that allow species of conservation significance to persist in an otherwise hostile environment. Accordingly, in zones where industrial utility or human amenity dominate, conservation interests must still be considered.

5.2.1 Zone 1 - Industrial impact

This zone encompasses the smelter, land immediately surrounding the smelter, spillway canal, power easements, the haul road and conveyor belt as well as the aluminium storage area and loading dock.

Level 1 - Industrial amenity

This is the primary function of this land which will be managed for the efficient running of the smelter. Road verges will be mowed regularly, woody shrubs and tree regrowth will be discouraged in the vicinity of the conveyor belt. Areas of bare earth which constitute an erosion risk to smelter infrastructure will be stabilised and, where possible, rehabilitated. Storm water run off as well as outfalls from the smelter will be managed in accord with the relevant regulations. Where ever the operation of the smelter and the safety of the work force is not at risk natural plant and animal communities should be encouraged to establish as this will assist in incorporating the smelter into the surrounding landscape. The use of machinery, storage of materials and the use of chemicals should be undertaken in such a way as to avoid impacting the natural bush. Undisturbed soil and plant communities should not be disturbed unless absolutely necessary. Generally already impacted land should be used before consideration is given to the use of natural bush or rehabilitated land.

Level 2 - Human amenity

Where possible the management of this zone shall provide a safe and pleasant environment for the work force. Landscaping of the car park, road verges, open spaces and building entrances should provide amenity for the workers while making a visual connection with the surrounding lands. Despite this, public recreation in this zone should not be encouraged for security, health and aesthetic reasons. Official guests and tours will use this zone and some facilities within parkland settings should be available for points of congregation, outdoor meetings and rest areas. Amenity planting should be of fluoride resistant native species planted with a structure that provides food and shelter for native wildlife. Only when fluoride hardy native species are not available should exotic species be used. Care should be taken to ensure species selected do not have the potential to escape into the surrounding natural bush. The landscaping should soften the distinction between the smelter and the adjacent forests and woodlands. Strategic landscaping should be undertaken to reduce “industrial wasteland” perspectives of the smelter from the outside community.

Level 3 - Conservation

Although this zone is heavily disturbed it still contains some conservation values. The remnant *Eucalyptus citriodora* forests between the smelter and Handley Drive support a faunal assemblage which includes the vulnerable Central Queensland Scaly Foot (*Paradelma orientalis*). The overflow canal is visited by wading birds, including the Burdekin Duck, and is used as a feeding and watering point as well as a breeding area for a wide range of fauna. Where possible the remaining plant and animal assemblages should be preserved and encouraged to expand. The work force, contractors and visitors should be informed of the significance of the environment and directed to avoid degrading the habitat of species of particular conservation significance.

5.2.2 Zone 2 - Urban buffer

This zone includes the land between Handley Drive and the urban estates south of the smelter. It also includes the land beyond Zone One which surrounds the weather station, is used for the cycle way, staff recreational parkland and surrounds the contractors car park.

Level 1 - Industrial utility

Primarily Zone Two is required to act as a physical and visual buffer between the smelter and the urban environment. There are two options for achieving these requirements. Firstly a wall (similar to the timber fences adjacent to motorways) could be built through this zone to provide an artificial barrier. Secondly the natural vegetation could be used to meet these requirements. This option would require careful management of the plant communities to ensure the correct vegetation structure is maintained to act as an appropriate buffer. Fire and seed or tube-stock augmentation would be appropriate tools for this purpose. Some trials and regular monitoring would be required to establish the correct management regimes. To remain consistent with the inherent environmental ethic, alien species should only be used if they are unlikely to become management problems and if suitable native species cannot be found. Similarly, all management activity within the zone must be undertaken in a manner that does not create or enhance environmental management problems (eg. track development creating erosion problems or burn-offs which favour weed establishment or spread).

Level 2 - Human amenity

The bike path through this zone is used by the smelter work force for commuting and by the general public for recreation. Existing tracks beyond the bike path are used for unofficial access to the houses that abut the zone, recreation in the form of walkers, horse riders, trail bikers and off-road vehicle users. Children play throughout the zone. Unauthorised rubbish dumping occurs within the zone along access tracks leading off Handley Drive and behind the houses where domestic and garden rubbish is frequently dumped. A number of households use the zone as an extension of their back yards - parking vehicles, mowing, planting amenity trees and shrubs (generally exotics) and incinerating rubbish. Parts of the zone are burned regularly either deliberately to reduce fire risk and a perceived threat from snakes. Fire is perceived as a threat to those households that abut directly to the zone.

There are three options for the management of this zone. One option is to exclude unauthorised use of the zone beyond the use of the cycle path. The second is to allow unimpeded access by the public to the zone. The third is to allow controlled access to the zone - excluding certain activities which are considered detrimental to the industrial utility and conservation functions of the zone.

Since the lands are owned by Boyne Smelter Ltd as part of the smelter facility granting access to this zone for other than official purposes may raise issues of public liability. Consequently, subject to legal advice to the contrary, it is recommended that access to this zone for other than official purposes should not be sanctioned and that infrastructure that facilitates access to this zone should be removed or closed off.

As the zone abuts directly onto urban areas and is subject to periodic intentional and natural fires, access to the rear of the houses should be maintained for fire fighting and emergency service purposes. This access should form part of a fire break between the natural bush and the houses. Rubbish harbours undesirable fauna such as mosquitos (breeding sites) and red-back spiders. Combustible rubbish and some weed plant species can increase the fire risk adjacent to the houses. Both weeds and rubbish reduce the aesthetic value of the forest view. The dumping of garden rubbish and the planting of alien amenity gardens within the zone encourages the establishment and spread of weeds throughout the zone. Some of these weeds will complicate the fire

management of the zone and the facilitation of weed establishment within the zone is contrary to the environmental ethic. All rubbish should be removed from the zone and the dumping of household rubbish prohibited.

To develop a cooperative response from the urban residents it is recommended that the reasons behind the management actions within the zone be explained to the neighbours. Further, if the neighbours are expected to behave in a responsible manner then the smelter management and work force (especially those who work within the zone) must behave similarly.

Level 3 - Conservation

Zone Two encompasses a number of plant communities all of which are of local conservation significance. The communities include at least two forms of *Eucalyptus* open forest and elements of low microphyll vine thicket. Their conservation significance arises from the ongoing development of urban estates in the Boyne - Tannum region and the consequent loss of bushland. The Zone Two bush provides the only significant link between the Lily Hills Environmental Park and the coastal communities. The faunal assemblages within this zone are diverse and are a significant component of the species diversity of the local region. The zone contains the habitat of one animal of national conservation significance - the Central Queensland Legless Lizard (*Paradelma orientalis*). The habitat requirements of this species are not known and research should be undertaken to expand the knowledge of the ecology of this lizard. Particularly research should examine any likely impacts on the lizard population from the proposed management strategy for the zone. In general, management should maintain or enhance the conservation values of the zone through considered burning practices, rehabilitation of degraded areas and sensitive weed control.

5.2.3 Zone 3 - Industrial filter

This zone encompasses land outside of Zone One and Zone Two and includes parts of the coastline above high tide and extending north about three kilometres. The zone buffers the smelter from some inclement weather and coastal erosion. It includes land not required as a buffer between urban residences and industry and does not provide any authorised amenity to the smelter work force (such as the cycleway in Zone Two).

Level 1 - Industrial utility

This land is subject to gaseous outfalls from the smelter. Fluoride toxicity is progressively killing fluoride sensitive plant species within the zone. The impact of the fluoride decreases with distance from the smelter and varies according to the prevailing winds. Beyond this zone fluoride impacts are not observable. Generally the zone requires no management for industrial purposes. The environmental buffering capacity of this zone is, however, dependent on the height and integrity of the vegetation. Tree height and density probably reduce the extent of salt spray, storm surge and wind action on smelter infrastructure while the integrity of the vegetation reduces erosion. Consequently, vehicle access to the dunes should be restricted and managed. Degraded tracks and dune faces should be rehabilitated. Removal of trees and extension or widening of tracks should be prohibited.

Level 2 - Human amenity

Zone Three provides both recreational and aesthetic amenity. The beach is used for walking, fishing, off-road driving rest and relaxation. Unauthorised access to the beach is made through parts of Zone Three. The beach, below high tide, allows access to coastal parts of Zone Three (above high tide) for camping, vehicle driving, recreation with pets and bush toilet facilities. The vegetation of this zone provides an aesthetic backdrop to recreation along the beach as well as a visual buffer between coastal recreation and the smelter.

This zone is an erosion prone area and the sand dunes are sensitive to disturbance from camping, trampling and vehicles. The mobilisation of these sands would result in a loss of visual amenity for coastal recreation. There are also significant environmental values to be managed (see below). As in Zone Two the three options for managing public access to this zone are uncontrolled access (the current state), limited access for approved activities and no public access. Again, as with Zone Two, it is recommended that unauthorised access to the zone should not be sanctioned and access points to the zone through Boyne Smelters Ltd land should be closed. Existing unauthorised camp and picnic areas should be disbanded. The reasons for these management actions should be explained to the public and their cooperation sought.

Some tree species will continue to die from the effects of fluoride in the gaseous outfall from the smelter. These dead trees may be considered to detract from the visual amenity of the zone. One option is to fell these trees. Such action may lead to secondary environmental impacts which would be contrary to the environmental ethic and degrade the conservation significance of the zone. Consequently it is recommended that fluoride affected trees and shrubs should be left standing unless they represent a hazard to workers or the public and unless they interfere with the operation of the smelter.

Level 3 - Conservation

Zone Three consists of a complex of coastal strand communities, *Eucalyptus* open forest with low microphyll vine thicket elements, low microphyll vine thicket, *Melaleuca* forest, *Casuarina* woodlands and grasslands. The low microphyll vine thicket and related vegetation types represent significant ecosystems at a State and probably National level. Although some species are being affected by fluoride related dieback there is, at present, little evidence of low microphyll vine thicket species being effected. A thorough investigation of the sensitivity of the plant species within this zone should be undertaken to ascertain the extent and direction of possible changes to the structure and composition of the vegetation. It is expected that a slow change will occur in the structure and composition of the plant communities within this zone. With careful management, these changes will produce a new association which may retain many of the conservation values of the former community. Control of weed invasion and limitations on fire are likely to be the two main elements in any management regime. These two elements are linked to the retention of an intact canopy. The felling of dead fluoride effected trees will cause a disturbance which may allow destructive weeds such as Guinea Grass to dominate. Careful monitoring over a number of years should indicate the nature of the new associations and define their conservation significance.

5.2.4 Zone 4 - Conservation

This zone encompasses a similar range of plant and animal assemblages to Zone Three. Unlike Zone Three there is little if any impact from the smelter's fluoride emissions. The zone includes degraded grazing land and impact sites from smelter construction. On going impacts are possible from the management of Zone One which bounds and at the northern end crosses this zone.

Level 1 - Industrial utility

Zone Four provides an erosion buffer between the haul road and the sea as well as acting as a visual buffer between the smelter and recreational users of the coastline. Recreational use of the coast and associated unauthorised camping and driving above the high tide line have degraded the fore-dunes in places. Although the damage is currently minor continued disturbance may lead to erosion of the dunes and a reduction in the buffering capacity of the coastal dunes. These impacts should be stopped.

Level 2 - Human amenity

There is significant public use of this zone and significant impacts derived from this usage. As with Zone Three this zone provides a scenic backdrop for recreational activities below the high tide line. There are, however, better opportunities for camping and driving on the dunes in Zone Four. At the northern end of the beach there is considerable evidence of camping. Vegetation has been destroyed by vehicles and tents and many areas of sand dune are denuded of vegetation. Both four-wheel drive vehicles and motor bikes were observed driving along the fore-dunes. Bush toilets and buried rubbish have been excavated, presumably by scrub turkeys. Domestic dogs were in evidence. The three options apply - no public access, limited public access and uncontrolled access. Again as issues of public liability may apply it is recommended that public access to Zone 4 (lands above high tide) should not be sanctioned.

Level 3 - Conservation

Although this zone encompasses a variety of plant assemblages, the low microphyll vine thicket is best developed here. Since there is no requirement to disturb this land for the routine functioning of the smelter this zone provides an opportunity to protect a plant community of conservation significance. Some management of the zone is required to rehabilitate the degraded grazing land and land disturbed during smelter construction.

In some areas careful management of fire and weeds is required to avoid adverse impacts on patches of low microphyll vine thicket.

6. INTEGRATED MANAGEMENT

The aluminium smelter and surrounding buffer zone borders land and waters controlled by the Queensland Department of Natural Resources, Calliope Shire Council, Queensland Alumina Ltd, Comalco, the Gladstone Port Authority, Comalco Aluminium Ltd and numerous freehold residential blocks. The land falls within both Gladstone City and Calliope Shire. Parts of the land are subject to an *Erosion Prone Area Plan SC 3379 D 3-12-84* under the *Beach Protection Act 1968-1990* and will probably be part of a *Coastal Management Plan* under the *Coastal Protection and Management Act 1995*. Further, operation of the smelter and management of discharges, outfalls and other environmental impacts are subject to licence agreements under the *Environment Protection Act 1994*.

The geometry of the property boundaries with neighbours is complex and cuts across natural physical and environmental boundaries. In addition, many of the environmental impacts on the buffer zone emanate from land use practices by the neighbours. Equally, management practices on Boyne Smelters land have the potential to impact on neighbouring land or water. Further, legislative requirements, such as the *Erosion Prone Area Plan*, apply equally to a number of landholders as well as Boyne Smelters.

The general public have an interest in the management of the lands associated with the smelter through an appreciation of the conservation, public utility and recreational values of the buffer zone.

As far as efficient operation of the smelter, safety and security allow, Management should consider neighbourhood interests and views in environmental management. Where possible the interested parties should be included in the management process. Given the extent and diversity of the bodies that have a direct or indirect interest in environmental management of the smelter, inclusion should be undertaken collectively, perhaps through a community advisory committee.

6.1 INDUSTRIAL UTILITY

The smelter will need to undertake management actions within the for management zones to maintain the industrial utility of the land. These actions may impinge on the industrial and regulatory interests of some parties and on the lifestyle and recreational interests of other parties.

A mechanism should be established to:

- co-ordinate management actions with neighbours where there are common goals,
- liaise with regulatory bodies to ensure compliance or resolve conflicts, and
- liaise with neighbours where management goals impact on neighbouring land or water.

6.2 HUMAN AMENITY

Management actions may directly affect the human amenity values of the Smelter's land as well as the adjoining land and water.

A mechanism should be established so that:

- Management is aware of all parties who may suffer loss of amenity,
- the nature of all amenity loss is recognised,
- the reasons for the loss of amenity are clearly explained to the affected parties, and
- any possible compensatory actions are considered.

6.3 CONSERVATION

There is considerable conservation value within the smelter land. Management actions directed at maintenance of industrial utility and human amenity may directly impact on the conservation values of the land. Conversely, management of the conservation values of this land may be contrary to some management options for the maintenance of industrial utility or human amenity. Further, as property boundaries do not always follow environmental boundaries, successful management for conservation may require co-ordinated and complimentary management by neighbours.

The Management of Boyne Smelters should establish a mechanism so that:

- management actions within each of the three functional levels are co-ordinated at all staff levels,
- management actions fall within the bounds of the *Ethic of Environmental Care*,
- liaison between neighbours occurs to achieve co-ordinated management for conservation, and
- where industrial utility and human amenity are constrained by conservation management issues, effective communications at all staff levels and through the general community ensures that the reasons are clearly understood.

7. LEADING THE WAY

The opportunity exists for Boyne Smelters Ltd to become a community leader in environmental management in the Boyne Island region.

The Boyne Island aluminium smelter and surrounding land is part of a mosaic of relatively undisturbed land systems extending south from South Trees Island to the Boyne River and west from the coast through the Lily Hills. This complex of tidal inlets, mud flats, mangroves and salt flats; coastal beaches and sand dunes; dry coastal vine thickets, melaleuca swamps and dry eucalypt ridges forms an important regional environmental resource.

This resource is under the control of (variously) the Queensland Department of Natural Resources, Queensland Department of Environment, Queensland Alumina Ltd, Comalco, Calliope Shire Council, the Gladstone Port Authority and the Beach protection Authority as well as Boyne Smelters Ltd.

The environmental mosaic forms a “green belt” along the coast and across the centre of Boyne Island. The smelter land forms the centre of this “belt”, linking the coastal strip and the inland rocky ridges.

Boyne Smelters Management should initiate the establishment of this “green belt” (perhaps called the *Boyne Island Green Belt*) and facilitate the formation of a management committee to provide advice to the bodies with management responsibility over various parts of the “belt”.

Smelter Management should use this management committee as a vehicle for:

- co-ordination of management on neighbouring lands,
- dissemination of advice to interested parties, and
- community and staff participation in the management of smelter land.

8. SECONDARY STRATEGIES

8.1 GENERAL PRINCIPLES

A - Management of weeds

Twenty one percent (55 of 262 species and subspecies) of the plants found within the buffer zone of the aluminium smelter are exotic weeds. Not all of these weed species are necessarily destructive to the natural systems operating around the smelter. It is recognised that most of these species have become incorporated (naturalised) within the native communities forming new assemblages of plants. A limited number of species have the potential to, or are already, destroying the native communities of the buffer zone.

Weed eradication should focus on these few destructive species. These species are

Guinea Grass *Panicum maximum var maximum* ;

Green Panic *P. m. var trichoglume*;

Rubber Vine *Cryptostegia grandiflora*;

Groundsel Bush *Baccharis halimifolia*;

Lantana *Lantana camara*;

Creeping Lantana *Lantana montevidensis*;

Mother of Millions *Bryophyllum spp.*; and

Century Plant *Agave americana*.

A strategic approach should be taken to the treatment of weed infestation.

The officer responsible for the management of the buffer zone should regularly patrol the zone, note the distribution, abundance and vigour of known weed species, and identify the arrival of new weeds. Other staff required to work within the zone should be able to identify key weed species and should report new infestations to the responsible officer.

Control programs should concentrate on containment of large infestations and eradication of isolated plants or minor infestations. Individual plants may be spot sprayed or manually removed. Generally the most efficient use of available resources such as fire, mowing, mechanical removal and spraying should be undertaken.

Care should be taken not to spread propagules during the removal process. In the case of Mother of Millions, any part of the leaf will root and establish a new plant. Generally outlying plants or populations should be removed before attacking the main population. Removal, burning or spraying a weed population will commonly “release” seed stored in the soil. Secondary treatment is essential and should include spot spraying or hand weeding.

During the weeding process, care should also be taken not to create gaps in the canopy of any adjacent native plant community and not to unduly disturb the soil. In particular fire scorching of adjacent native plant communities or die back from spray drift should be avoided.

The weed control process should aim to have all “on ground” staff aware of the weed problem. They should be provided with sound, practical advice on how to manage the weed species.

B - Feral Animal Management

Dogs, cats and cane toads are the key feral animals in all management zones. Their management is intractable.

Although toads are easily caught and destroyed their capacity for reproduction in both brackish and fresh water and rapid dispersal precludes their eradication from the smelters lands. At best some local reduction in population density could be achieved. This result, however, could only be sustained by constant labour intensive management. If no management regime is imposed, the toad population would probably reach some plateau (based on available food resources) and balance with the native biota established.

Unattended dogs found within the smelter property should be considered feral and either shot or caught by the shire dog catcher. Co-operation should be sought from the Calliope Shire Council so that dog owners who allow unleashed dogs onto smelter land are fined. This policy should be publicly declared to allow dog owners to modify their behaviour.

All cats found within the management zones should be destroyed. Private cat owners should be made aware of this policy and the Calliope Shire Council should be encouraged to instigate and enforce cat control by-laws similar to those enacted by the Gladstone City Council.

It should be explained to the public that both dogs and cats present a significant risk to the conservation of the Central Queensland Legless Lizard (*Paradelma orientalis*) in zones 1 and 2 as well as preying on native fauna generally. Further, dogs would disturb resting migratory wading birds affecting their ability to restore body condition and potentially driving the birds from the local area.

The environmental basis for the control of feral animals within the management zones should be explained publicly as part of community explanations of general management actions within the buffer zone.

C - Management of Public Access

Generally public access to the smelter is excluded by a security check point on the access gates. Access to the hall road, conveyor belt and wharf facilities is monitored but only lightly controlled. The buffer zone surrounding the facility and associated infrastructure is effectively uncontrolled and significant environmentally destructive

impacts are occurring. This section looks at the management of public access to the buffer zone in relation to the environmental impacts. Management for security is beyond the scope of this management strategy.

Zones 3 and 4

Public utilisation of these zones is traditional and largely associated with beach recreation - fishing, camping four wheel and motor bike driving as well as family and individual recreational activities on foot. Domestic pets, particularly dogs but also cats and horses are commonly associated with these activities. The smelter buffer zone boundary is the high tide mark and public access to management zones 3 and 4 is predominantly from the intertidal beach zone - beyond the control of smelter management. Some access to the beach is made across the southern end of zone 3 from an esplanade under the control of the Calliope Shire Council. In all, public access to these two management zones can be made along over 8 km of coast. The only effective point to restrict access to these zones is at the point of entry on the council esplanade. Consequently total exclusion of the public to these zones will require the cooperation of the Calliope Shire Council and the total closure of the beach.

Most of the environmental impacts on these zones are a consequence of the public moving above the high tide mark for vehicle access, camping, picnicking, bush toilets or running domestic animals. The impacts are largely disturbance of wildlife and degradation of the vegetation covering the dunes and adjacent low microphyll vine thickets and relate to human activity. The intensity of the impacts varies with the activity. Vehicles cause more damage than pedestrians. Vehicles and domestic animals disturb wildlife to a greater extent than people. The damage caused by camping varies with the location, duration and intensity of the camping. These types of human activity are routinely managed by government instrumentalities on public and reserve lands. Generally there is acceptance of this management as the public is aware of the conservation, recreation and aesthetic values of these lands and the need to manage so as to retain these values.

Consequently, an alternative to seeking to exclude access to zones 3 and 4 is to make the public aware of the role of the land as an industrial buffer, and the conservation significance of the biota preserved within the zones. This public education could be

matched with limited, controlled public access to less sensitive areas and closure and rehabilitation of sensitive or degraded areas. All management activities should be explained to the public by on-site notices and in the community press. Where possible public participation in the management of these zones should be facilitated.

Zone 2

Apart from usage of the bicycle track, smelter car park and recreation ground, public utilisation to this zone is traditional and largely utilitarian. Informal tracks provide access to the rear of houses bordering the zone. Domestic and garden rubbish is regularly dumped through out the zone (where access is provided by tracks). Some neighbouring residents have established defacto control of parts of the zone by extending gardens, establishing lawn or clearing native vegetation.

Limited recreation occurs within the zone. This predominantly takes the form of trail bike riding, walking, usually with domestic pets, and some horse riding. There are indications that some children play in this zone.

Environmental impacts associated with public use of this land include erosion, associated with tracks and trail bike paths, rubbish dumping and uncontrolled burning. In general it appears that this zone is used as public waste land. Although the forest provides an appealing backdrop to the residential land, the effects of frequent fire, numerous tracks, erosion, rubbish and noise, associated with trail bikes, preclude any general public appreciation of the environmental values of this land. Further, there appears to be no publicly discernible role for the zone in the buffering of the smelter.

There are multiple public and private entry points to this zone. Public access could be restricted, but only through the construction of a barrier fence. Apart from the community response to the closure of this land such a fence may provide a barrier to the movement of native fauna.

An alternative approach may be to increase the public awareness of the industrial role of this zone (especially the significance of the vegetation) and the conservation significance of the environment within the zone. Such an awareness programme should focus on the residential land holders bordering the zone. The defacto land

control exercised by some residents could be incorporated into the land management plan. Both this land and the unauthorised vehicle accesses to the residential blocks could be incorporated into the fire management plan. All other vehicle tracks should be closed and subject to weed and erosion management. Trail bike riding could be transferred to another venue if a suitable location could be found. Alternatively trail bike riding could be confined to prescribed areas which would be subject to intensive management to control erosion, weeds and fire. Walking paths could be established and managed to maintain the aesthetic appeal as well as control erosion, litter, weeds and fire. These tracks should follow essential fire trails and generally avoid the designated trail bike areas.

All management actions should be publicly explained.

As in the management of public access in zones 3 and 4, a sense of community participation in and ownership of the environmental management should reduce the environmental degradation of this zone. Management actions should be publicly explained.

Zone 1

Public utilisation of this zone has generally been slight. Parts of the zone have been used for unauthorised rubbish dumping. Horse riding occurs from time to time. The publicly accessible parts of the zone are of limited extent. The proximity of this zone to the smelter raises smelter security and public health concerns. As there is little traditional usage of the area, public access should be restricted. This action should be accompanied by a public explanation of the reasons for the restriction. The security and health concerns should be discussed. In addition the industrial role of this zone as a buffer and the environmental significance of the vegetation should be explained. The area should be fenced and community information signs installed. The fence should be constructed of three strand, low tensile barbed wire. A chain fence would preclude the movement of native fauna while a high tensile barbed wire fence would increase mortality in gliders and fruit bats.

D - Public Education and Information Dissemination

There is an extensive public interface between the smelter and the community. This interface operates at a physical level through community members working at the smelter, residential lands directly adjoining smelter land and traditional community usage of smelter land for recreation and public utility. The interface operates at a psychological level through public concerns over health and the environment as well as through the smelters direct involvement in the community through its role in employment generation and financial support for community projects.

This complex of deliberate and defacto involvement in community issues by the smelter provides its management with a duty of care to fully inform the public of management actions that may restrict or alter traditional use patterns or increase levels of public anxiety.

1. Boyne Smelters should determine the management regime that best fulfils management objectives.
2. Management actions with significant impacts on traditional usage should be announced through the local media.
3. Management of the buffer zone will require co-operation from neighbouring landholders and land managers. Boyne Smelters should establish a mechanism for co-ordinated management of some lands. This mechanism may be as formal as a regularly constituted meeting (eg with neighbouring home owners) or constitute informal discussions with individual parties (eg with the Environment Officer of Queensland Alumina Ltd).
4. Smelter staff should be fully briefed on the scope of the environmental management and the need to work within the Ethic of Environmental Care. The staff should also be encouraged to take the message home to their families and friend, and apply the principles to their private use of the natural environment around Boyne Island and Tannum Sands.
5. School projects which deal with the environmental and management issues in the buffer zone should be facilitated.

6. A public meeting should be held at least once every 18 months to allow the Management of Boyne Smelters to ascertain public reaction to the management strategy.
7. A news letter which deals with the management of the buffer zone should be produced periodically. The newsletter should provide a forum for announcing and explaining the reasons for management actions. It would also publish environmental or natural history stories from the buffer zone.

8.2 MANAGEMENT OBJECTIVES

A - Zone 1 Industrial Impact

The management objectives for this zone are to:

- ensure the efficient running of the smelter and compliance with environmental license agreements as well as with the *Ethic of Environmental Care*,
- maintain the security of the facility,
- manipulate the physical structure and composition of the plant communities to provide a physical and visual buffer around the smelter,
- integrate the industrial infrastructure with the surrounding environment, and
- conserve the habitat of the Central Queensland Legless Lizard (*Paradelma orientalis*).

These objectives will be achieved by:

- frequent, regular inspections of all infrastructure perimeters and regular monitoring of outfalls, discharges, and environmental contact points;
- public exclusion from the zone apart from designated safe access points;
- facilitating the establishment of locally occurring fluoride resistant native species;
- carefully managing fire to ensure an appropriate forest structure is maintained;
- carefully managing spray teams to avoid spray drift onto native communities, public lands or work areas;
- controlling the distribution and vigour of target weeds;
- restricting the introduction of new weed species by routinely inspecting sites of domestic and industrial activities such as earth moving, rubbish dumping, as well as lay down areas and soil dumps, and instigating weed control measures where necessary;

- establishing trials to develop optimal stabilisation or revegetation strategies for erosion prone surfaces;
- identifying areas at risk of eroding if disturbed;
- avoiding activities likely to create erosion (this includes uncontrolled trail bike and four-wheel drive activity);
- strategic land and vegetation management (earth works, revegetation, rehabilitation) to soften the boundaries between industrial infrastructure and the adjacent environment;
- monitoring the biological state of the zone;
- researching the distribution and habitat requirements of the Central Queensland Legless Lizard (*Paradelma orientalis*) to establish conservation management criteria;
- public education as to the environmental values of the zone; and
- public information on the impact of the smelter and a rationale for management actions.

B - Zone 2 Urban Buffer

The management objectives for this zone are to:

- manipulate the structure and composition of the plant communities so as to provide a physical and visual buffer between the industrial infrastructure and the urban residences,
- as far as possible, preserve the natural systems operating within the zone,
- as far as possible, reduce risks of damage by fire and tempest, which may emanate from the zone, on adjoining residential and public lands and infrastructure,
- conserve the habitat of the Central Queensland Legless Lizard (*Paradelma orientalis*), and
- provide a sustainable public resource for conservation, education, recreation and relaxation.

These objectives will be achieved by:

- controlling weeds, especially in canopy gaps caused by fluoride induces decline of overstorey species;
- facilitating the establishment of locally occurring fluoride resistant native species in these gaps;

- avoiding any further physical disturbance of native communities, in particular any activity that opens up the vegetation canopy or causes soil disturbance (this includes the felling of fluoride affected trees for aesthetic purposes);
- carefully managing fire to ensure an appropriate forest structure is maintained;
- carefully managing spray teams to avoid spray drift onto native communities or residential areas;
- controlling the distribution and vigour of target weeds;
- restricting the introduction of new weed species by limiting domestic and industrial activities such as earth moving, rubbish dumping, as well as directing lay down areas and soil dumps to designated sites;
- stabilising and revegetating areas subject to unnatural erosion;
- identifying areas at risk of eroding if disturbed;
- avoiding activities likely to create erosion (this includes uncontrolled trail bike and four-wheel drive activity);
- monitoring the biological state of the zone;
- researching the distribution and habitat requirements of the Central Queensland Legless Lizard (*Paradelma orientalis*) to establish conservation management criteria;
- public education as to the environmental values of the zone;
- public information on the impact of the smelter and a rationale for management actions; and
- considered management of recreational activities within the zone.

C - Zone 3 Industrial Filter

The management objectives for this zone are to:

- retain the physical and biological structure of the zone so as to maintain an environmental buffer around industrial infrastructure,
- facilitate the natural progression from fluoride sensitive native plant communities to fluoride resistant native plant communities,
- as far as possible, given the effects of fluoride, preserve the natural biotic and abiotic systems operating within the zone,
- provide a sustainable public resource for conservation, education, recreation and relaxation.

These objectives will be achieved by:

- controlling weeds, especially in canopy gaps caused by fluoride induces decline of overstorey species;
- facilitating the establishment of locally occurring fluoride resistant native species in these gaps;
- avoiding any further physical disturbance of native communities, in particular any activity that opens up the vegetation canopy or causes soil disturbance (this includes the felling of fluoride affected trees for aesthetic purposes);
- carefully managing fire to avoid leaf scorch or burning of the low microphyll vine thickets;
- carefully managing spray teams to avoid spray drift onto native communities;
- controlling the distribution and vigour of target weeds;
- restricting the introduction of new weed species by limiting industrial activity, lay down areas and soil dumps to designated sites;
- stabilising and revegetating areas subject to unnatural erosion;
- identifying areas at risk of eroding if disturbed;
- avoiding activities likely to create erosion;
- monitoring the biological state of the zone;
- public education as to the environmental values of the zone;
- public information on the impact of the smelter and a rationale for management actions; and
- considered management of recreational activities within the zone.

D - Zone 4 Conservation

The management objectives for this zone are to:

- retain the physical and biological structure so as to maintain an environmental buffer around industrial infrastructure,
- preserve the natural biotic and abiotic systems operating within the buffer zone, and
- provide a sustainable public resource for conservation, education, recreation and relaxation.

These objectives will be achieved by:

- avoiding any physical disturbance of native communities, in particular any activity that opens up the vegetation canopy or causes soil disturbance;
- carefully managing fire to avoid leaf scorch or burning of the low microphyll vine thickets;
- carefully managing spray teams to avoid spray drift onto native communities;
- controlling the distribution and vigour of target weeds;
- restricting the introduction of new weed species by limiting industrial activity, lay down areas and soil dumps to designated sites;
- stabilising and revegetating areas subject to unnatural erosion;
- identifying areas at risk of eroding if disturbed;
- avoiding activities likely to create erosion;
- monitoring the biological state of the zone;
- public education as to the environmental values of the zone;
- public information on the impact of the smelter and a rationale for management actions;
- considered management of recreational activities within the zone.

9. THREATENING PROCESSES AND THEIR AMELIORATION

9.1 ZONE 1 - INDUSTRIAL IMPACT ZONE

9.1.1 Erosion and water management

Threatening process:

There are some major erosion and water management problems within this zone. Some of these relate to construction associated with the recent smelter expansion. Others relate to the failure of older water management structures. Of particular concern are:

- erosion of batters and bare earth and the associated discharge of sediment into drainage lines;
- instability of recently constructed batters and the failure of hydromulching to reduce erosion potential;

- tunnelling and gully erosion along Spillway Canal and the associated failure of drop structures;
- poorly maintained (partially blocked with a resulting reduction in capacity) or poorly constructed drainage lines producing the potential for uncontrolled drainage from the smelter and;
- a lack of silt-fences or bunding for temporary management of erosion at earth works.

Consequently smelter infrastructure (batters, drainage systems, roads and tracks) is damaged and the relic natural systems remaining in Zone 1 are degraded by siltation, erosion and physical disturbance.

Amelioration

It is not possible to stop the natural process of erosion. Furthermore, the cost of controlling erosion increases exponentially with the magnitude (or recurrence interval) of the rainfall events causing the erosion. Management should be directed to contain erosion to acceptable levels. The regime adopted must balance the cost of the erosion-control works against:

- the cost of repair and maintenance between erosion events,
- the environmental risk of failure of control measures, and
- the wholistic imperatives of the Environmental Ethic.

It is worthwhile determining if there is **low environmental risk**.

A low environmental risk implies that the environment is unlikely to be damaged in any significant way for any significant period of time, that no rare and endangered species are put at risk, that there are no cumulative or additive factors that have to be taken into account in the risk assessment, and that the management regime will maintain ecological sustainability. This risk may be assessed in terms of environmental license provisions or with reference to the environmental management strategy. In some cases additional research or monitoring may be required to fully assess the risks.

A highly variable soil regime exists on the site. Highly erodible soils are common. The spatial variability precludes a uniform, standard approach to water and erosion management across the site. Management is further complicated by landform engineering which is contributing to the erosion problems.

Despite the unsuitability of a uniform, standard erosion management regime for the site, an integrated management approach is needed to set priorities, assess risks and allocate resources. These considerations should be undertaken with reference to the management strategy and within the context of the Environmental Ethic.

No single erosion control method will be successful all of the time and backup control systems should be incorporated within any management regime. A revegetated batter together with an armoured below-batter drainage line that leads to a sedimentation-basin, possibly operated as either a perennial or ephemeral wetland is an example of an erosion control system with backup. Multiple in-line backup systems should be used in sensitive areas or areas where the potential for failure is high. A strategic approach should be taken to the installation of these backup systems so that, if possible, each may have a positive benefit to the other. For example a sedimentation basin may also provide water for irrigation of revegetation plots.

Water and erosion management should prefer “natural”, self sustaining systems. A vegetated surface is a more sustainable, long-term option for erosion control management than a sealed surface because it has the potential to:

- maintain itself with minimum management,
- reduce runoff by increasing infiltration,
- reduce the export of potential contaminants, and
- be easily repaired, as well as
- fulfilling the aims of the management strategy, and
- being consistent with the Ethic of Environmental Care.

A weed response strategy should be developed. This strategy should become active when designated weed species are identified in key areas or when conditions which are known to favour weed invasion or expansion are created with the buffer zone.

The goals of this strategy should be

- to limit the spread of target weed species
- to reduce the dominance of target weed species in sensitive environments
- to avoid management actions which encourage the spread of weeds.

The method used to control weeds should themselves be within the Ethic of Environmental Care and should not cause significant environmental impacts on natural systems within the buffer zone.

Management of Batters

Batter stability will be an ongoing issue, particularly with dispersive soils. The desired goal is grass and shrub-covered, low gradient, short batters with no over-crest run-on. This is not always achievable, and different strategies should be devised to suit the circumstances.

A drainage line, armoured with vegetation or rocks on a geofabric base (for steep slopes) should be established at the base of each batter. Energy dissipaters should be installed on the steeper sections. Sedimentation basins should be installed along the drainage line. Where possible, larger sedimentation basins should be installed so as to provide artificial wetlands to “polish” the water before final discharge, provide a water resource for irrigation and, enhance the “natural attributes” of Zone 1.

Silt-fences should be used along the base of all unvegetated batters until such time as the management regime is in place and the erosive potential reduced.

It must be accepted that, despite the management actions undertaken, some degree of repair will always be required following major rainfall events.

Irrigation should be used where-ever possible to encourage successful vegetation. Irrigation would encourage rapid and dense growth of grasses and other ground cover species as well as ensuring the establishment of slower growing deep rooted woody species. There is 2000 cubic metres of water discharged each day from the smelter. The use of this water in the strategic management of erosion would have the added benefit of reducing the discharge to the surrounding environment.

Repair and maintenance of discharge points to Spillway Canal

There are several points along the northern margin of the smelter where uncontrolled runoff discharges into the Spillway Canal. Gullies have developed at these sites and drop structures have been undermined and failed. Gullying in the Canal wall has intercepted the table drains. In addition some table drains are blocked. These have lost capacity, overflowed and are contributing to the gullying. These drains need repair and, in some cases, replacement. More generally, the drainage system along the northern section of the smelter needs to be redesigned. Specific issues in this redesign are: discharge points should not be constructed in areas of dispersive soil, drainage lines to the canal should be expanded and reconstructed as shallow-gradient, vegetated entry points rather than relying on drop structures which are likely to surcharge in intense storms, and in-line sedimentation and detention basins should be constructed in areas some distance from the canal.

9.1.2 Weed Invasion

The extensive soil disturbance and vegetation clearance associated with the expansion of the smelter has created the ideal environment for aggressive expansion of weeds within Zone 1. Of concern is the likely dominance of Guinea Grass (*Panicum maximum var maximum*), on batters and wetter areas as well as the drainage line running through the power easement, Lantana (*Lantana camara*) and Rubber Vine (*Cryptostegia grandiflora*) along the cleared easement drainage line.

Amelioration

These disturbed lands should be repaired in such a way as to contribute to the management goals of incorporating the smelter into the natural environment while mitigating environmental impacts and management costs to management. There is the possibility of conflict between the management objectives of Boyne Smelters for Zone 1 and those of CapElec for the power easement. Before rehabilitation commences both parties should develop an agreed position on the rehabilitation objectives and subsequent management. Given this qualification and despite any rehabilitation strategy adopted, there are some functional characteristics which should be achieved. These are: the drainage line should be rehabilitated in such a way that bank stability is

achieved, erosion is minimised and the structure of the vegetation, banks and creek bed can function as habitat and dispersal environment for a diverse faunal assemblage;

9.2 ZONE 2 - URBAN BUFFER ZONE

9.2.1 Erosion, water and track management

Threatening processes:

There are erosion and water management problems related to construction, which will have to be prioritised and addressed as soon as possible. Some areas of particular concern are:

- southern and eastern margins of the plant area, associated with car parks and pot line 3 construction. There are gullies on the surface and along the base of the batters. Many hundreds of tonnes of sediment have been discharged into stream lines and the structural integrity of the edges of the batters is at risk. There are no sedimentation basins, no formed drainage lines above or below batters, minimum control of discharge, and little in the way of standard erosion control measures. Erosion has not been more severe because of the low rainfall of this (95-96) Wet season;
- loose construction material not bunded with silt-fences as a temporary measure of erosion control along the eastern boundary;
- deterioration and major gullying of the aborted bike track on the eastern side of the plant;
- poorly constructed drainage lines across the new bike track;
- erosion of tracks to the east and south east of the plant.

Amelioration

There are a number of areas where tracks, largely installed for survey and bush management, but now used by trail bikes and other vehicles, are eroding. In most cases the tracks can be easily restored by the use of bund walls, deflecting water into well-vegetated adjacent areas. In some cases this bunding is not possible because the tracks have incised or been graded well into the landsurface and to install bundwalls would be equivalent to building small dams, which would fail in storms and increase erosion.

Some of the tracks in the south east of the property are located on areas which have been scrapped for gravels, exposing more erodible soils. Bund walls constructed in the usual manner (pushing up soil from the upslope side of the track) would encourage further erosion. Alternative methods of diverting road drainage will be required.

Some of the landsurfaces appear to be protected from erosion by a thin layer of lag gravel and biogenic crust which, if disturbed, will increase the potential for erosion. Care will be needed in the design of water management structures. Site specific issues will preclude any single solution.

Options for track maintenance include:

- closing the tracks, ripping and revegetating;
- closing the tracks and allowing to naturally revegetate;
- constructing table drains, detention basins, drainage cross over points, and sedimentation basins.

A critical factor in ensuring successful track maintenance will be traffic control and serious thought should be given to providing alternative venues for trail bike riders as well as restricting their access to tracks.

Some new drainage lines across the new bike track will need upgrading as they redirect flow onto bare soil, are not aligned along drainage lines, have unsuitable energy dissipaters, or have not utilised geofabric armouring systems to protect bare banks and beds while surfaces revegetate.

Deterioration of the aborted bike track is likely to continue as a result of erosion, exacerbated by drainage from the new construction area (car park). Short term options for management include a sedimentation basin at the major stormwater outlet, table drains to redirect flow, and silt-fences along batters. However, as the timetable for the construction is unknown, and as details of the construction relating to water management are unclear, it is not possible to make detailed recommendations.

9.2.2 Weed invasion

Weed invasion is currently a minor problem on the dry ridges and skeletal soils within Zone 2 (Vegetation map units 2c, 2d, 2e). The threat of significant weed invasion in these areas is present. The threat comes from the ongoing dumping of garden waste and deliberate planting of exotic species by neighbouring residents, as well as the repeated soil disturbance on the network of tracks.

Major weed invasions are occurring throughout the remainder of the Zone on moist gullies and alluvial fans as well as the sandy lowlands (Vegetation map units 2a, 2b, 2f, 3a, 3b).

These intense infestations of Guinea Grass (*Panicum maximum* var. *maximum*), Rubber Vine (*Cryptostegia grandiflora*) Lantana (*Lantana Camara*) form dense thickets within and on the margins of the natural plant assemblages. Guinea Grass and Lantana rapidly colonise after any soil or canopy disturbance. They have the capacity to permanently alter the structure and composition of the natural plant assemblages. Guinea grass infestations will increase fire risks and further promote its own spread.

Amelioration

A weed response strategy should be developed. This strategy should become active when designated weed species are identified in key areas or when conditions which are known to favour weed invasion or expansion are created with the buffer zone.

The goals of this strategy should be

- to limit the spread of target weed species
- to reduce the dominance of target weed species in sensitive environments
- to avoid management actions which encourage the spread of weeds.

The method used to control weeds should themselves be within the Ethic of Environmental Care and should not cause significant environmental impacts on natural systems in the buffer zone.

In general the intensive weed management already employed in this Zone up to 1995 should be continued. The method of spot spraying and protection of natural

regeneration is clearly effective in these sensitive communities. The approach should be expanded to include all the weed infestations bordering on low microphyll vine thickets and related vegetation forms (map units 1a, 1b, 2a, 2b).

On land adjacent to residential areas Mother of Millions (*Bryophyllum spp.*) and Century Plant (*Agave americana*) have the potential to produce chronic infestations. They should be removed manually, or where possible by intense burning. All vegetative parts of Mother of Millions should be removed and destroyed. Follow-up monitoring is essential to remove this species.

9.2.3 Fire

Fire is probably the dominant threatening process in this zone. Fire frequently is determining the nature and extent of the *E. tereticoris* communities as well as the structure and composition of the ground and midstoreys throughout the zone.

There will also be consequential impacts on the fauna of this zone.

The primary requirement of zone 2 is to provide a physical and visual buffer between the smelter and the urban environment.

This buffering is largely determined by the nature of the midstorey. The species composition, relative abundance as well as crown and stem density are directly affected by fire. Too frequent burning will open up the midstorey. The favouring of a dense midstorey followed by the exclusion of fire may provide conditions favourable for wild fires and threats to residential areas. Too frequent burning of moist patches within the zone (eg gullies) may favour their colonisation by Guinea Grass and an increase in the fire risk to adjacent property and fire sensitive plant communities.

An inappropriate fire frequency or intensity may also have the affect of simplifying the plant communities within the zone reducing habitat diversity and the environment value.

Amelioration

Removal of fire risks to the buffering capacity of zone, the adjacent urban environment and the natural environment will require careful planning and management.

An intensive survey and mapping exercise would identify areas where fire should be excluded or where fire frequencies should be very low; where midstorey densities should be relatively high for visual buffering purposes; and where specific habitual structures should be maintained for environmental or conservation purposes.

A series of trials would establish burning regimes (fire frequency, intensity, season of burn) to achieve the desired end in conjunction with physical manipulation of some areas (clearing, seeding on tube stack planting).

A public information program would explain to the adjacent residents, recreational users and government authorities the reasons for the management regime and the consequences of maintained burning-off or dumping of combustible material in the zone.

Fire trails and breaks should not be seen as having a role in the amelioration of fire risks in this zone. The creation and subsequent use for unauthorised access to the zone generates ongoing, intractable management problems and are of limited value in stopping fire.

9.2.4 Trail bike riding

Trail bike riding in this zone is causing significant environmental degradation through the creation of new, and exasperating existing, erosion sites (see 9.2.1).

Amelioration

The use of trail bikes in this zone should be prohibited or restricted to designated tracks or areas where their impact can be contained and managed (eg routes where drainage and soils are less likely to cause erosion).

The provision of alternative venues for the trail bike riders should be considered.

These measures should be instigated in conjunction with a program of public information.

9.2.5 Boyne Island sewage treatment works

The sewerage works forms an enclave in zone 2. It is a site of active disturbance, weed invasion and probable nutrient pollution of the adjacent natural systems. Vigorous growth of Lantana and Guinea Grass and other weed species fringe the works.

This concentration of weeds will hamper the environmental management of the adjacent buffer zone.

Amelioration

Closure of the sewage works and restoration of a forest canopy over the site would alleviate the problem. More realistic short term solutions will require some study and the instigation of trials to develop a site specific solution.

Such studies should consider:

- the establishment of a dense forest edge, composed of non-invasive species, which creates a light environment not favourable to Guinea Grass or Lantana,
- weeding and spraying strategies
- controlled intensive grazing by horses.

Whatever measures are instigated must be undertaken in conjunction with the Calliope Shire Council.

9.3 ZONE 3 - INDUSTRIAL 'FILTER' ZONE

9.3.1 Foredune erosion

Currently, active erosion of the foredunes is minor. The current levels of impact, primarily by vehicles, will lead to sand mobilisation in the near future.

Apparently natural erosion is occurring along the coast. This erosion may be part of a general regression of sand beaches throughout eastern Queensland. This process is

probably a natural process and should not be considered a threat to the natural environment of the buffer zone.

These coastal processes involve a dynamic feeding of sand along the coast from south to north by onshore currents. Interference in this process by the construction of groins or by changing the inshore currents may change the sand deposition processes.

Consequently construction of port facilities, groins or extensive inshore dredging must be considered potential threatening processes through their potential impact on coastal erosion and deposition.

9.3.2 Vehicle activity and track management

Vehicle tracks on the coast extend from the Calliope Shire Council esplanade through portions of map units 1, 3, 4 and 6b within Zone 3 to provide access directly to the beach and along the foredunes to points further north. In places short tracks lead from the beach across the foredunes to small camp sites in the vegetation behind the foredunes.

These tracks are currently creating minor degradation to the plant communities they traverse. In places small sand blows are developing. Continued utilisation of these tracks will, however, lead to their widening in Map units 1 and 3 with a consequent opening up of the canopy and an expansion of weed species along the road edges. The points of vehicle access across the foredunes will lead to destabilisation of these communities and subsequent sand movement inland over the hinterland low microphyll vine thickets and *Melaleuca* communities.

All these tracks should be closed and allowed to revegetate. Interpretative signs should be placed at each track closure explaining the environmental reasons for the closure. The authorised beach access point on the esplanade should be upgraded (corduroyed) to remove the need for alternative access points. Such an upgrade should include a one-way entry exit point properly sign-posted. Bollards should be used to contain vehicle traffic to authorised routes across the dunes.

At a number of points along the haul road access tracks and open drainage lines cut across the western edge of Zone 3. These disturbances have breached the natural canopy and are now largely dominated by Guinea Grass and Lantana.

Where possible the tracks should be rehabilitated by spot spraying or hand removal of destructive weeds, protection of native species regeneration, augmentation planting and avoiding further disturbance. Where it is necessary for tracks to remain open, they should be managed to remove Guinea Grass and Lantana from the native community edges and eradicated from the site. Ongoing management should be undertaken to avoid reintroduction of these weed species. Track maintenance should be by slashing only. Care should be taken to avoid disrupting the canopy of the native community as well as any unnecessary soil disturbance. Where earth works are required, they should be followed up with intensive surveillance and weed control.

9.3.3 Weed invasion

Rubber Vine (*Cryptostegia grandiflora*) occurs at a number of sites within this zone. Almost all infestation sites are inaccessible to vehicles. The zone should be systematically surveyed for the occurrence of this weed. When found it should be sprayed (generally basal spraying to avoid spray drift onto adjacent native species). The effectiveness of spraying should be checked by a follow-up visit and all infestation sites should be resurveyed annually until eradication of seedlings and suckers is achieved.

Lantana (*Lantana camara*) occurs throughout the zone. Where it occurs it should be removed by chipping and follow-up weeding or spot spraying. Any canopy gaps should be revegetated to reduce light intensity and consequently reduce the vigour of the regenerating Lantana.

Guinea Grass (*Panicum maximum var maximum*) occurs in dense stands where the plant community has been disturbed changing the light environment and disturbing the soils. In other areas throughout the zone it forms a dense grass community up to the edge of intact native communities. The grass should be sprayed, burned or weeded (depending on the sensitivity of the native community). Treatment should be followed

up with spot spraying and/or weeding of regrowth Guinea Grass while protecting naturally regenerating native species.

In all cases care should be taken to avoid further soil disturbance or the creation of new canopy gaps in native communities.

9.3.4 Physical disturbance

The aborted cycle-way:

The aborted clear-line established for the cycle-way has created a channel for the invasion of weeds and the expansion of established weeds by breaching the canopy and increasing the ambient light intensities as well as disturbing the soils. Lantana and Guinea Grass, in particular are expected to form dense, near impenetrable thickets along this path.

Remediation on this site requires a removal of any ongoing soil disturbance, a restoration of the canopy to reduce light penetration to the gap and adjacent forest. All vehicle access to the track should be prevented. Selective spraying and weeding of destructive weeds should be undertaken as soon as possible, and continued as required until the predisturbance light environment is restored.

Storm water drainage from the contractor's carpark:

The venting of storm water directly to Zone 3 without provision for any energy dissipation has resulted in significant erosion of the sandy soils and silting of surrounding communities. The resulting erosion channel will eventually feed into a dune swale supporting a *Melaleuca dealbata* seasonal wetland (map units 3 a and 3 b). No settlement ponds or traps have been installed at the discharge point and suspended solids and oils washed from the car park will enter this system.

Energy dissipation structures, settlement ponds and traps should be installed and the discharge point managed to limit the establishment of weed species on the disturbed lands associated with the impact.

Similar but smaller discharge points occur at a number of points along the boundary of Zone 2 and Zone 3. These points should be examined and their design reviewed in

light of the management objectives for the zone and the impact of the discharge point discussed above.

Storm water drains from beneath the haul road:

At a number of points along the haul road open drainage lines cut across the western edge of Zone 3. These disturbances have breached the natural canopy and are now largely dominated by Guinea Grass and Lantana.

Establishment of woody species along the drains may cause erosion and changes in the direction of flow during storm periods. Where possible a canopy should be established over the drains without introducing stems or roots to the drain line. Any reduction in the incident light would reduce the vigour of weed growth on the drain edges. Until such time as a canopy is established or where unshaded drains remain weeding and spot spraying should be undertaken to remove destructive weeds from the area.

In some drains, bank erosion (due to undercutting) is evident. This process is widening the gap in the native communities and is a site of weed invasion. Careful weeding should be undertaken in such a way as to avoid further destabilisation of the drain banks. These sites should be monitored and if the process is ongoing then remedial action should be undertaken to restrict those drains to their course.

9.3.5 Inappropriate project management

The clearing of the aborted cycle-way through this zone and the channelling of storm water from the contractors car park into the zone are examples of project design and management decision making which must be considered a threatening process to the management goals for this zone.

The *Ethic of Environmental Care* should be established at all levels within Boyne Smelters Ltd and an awareness of this ethic and a knowledge of the management goals for each zone should be a condition on all consultants and contractors wishing to work on smelter projects. A reporting system should be established so that staff, consultants and contractors at any level can seek guidance from the responsible environment officer before commencing work in an area or approving the design of any project or installation of any infrastructure.

9.4 ZONE 4 - CONSERVATION ZONE

9.4.1 Coastal camping, vehicle access and coastal erosion

Apparently natural erosion is occurring along the coast. This erosion may be part of a general regression of sand beaches throughout eastern Queensland. This process is probably a natural process and should not be considered a threat to the natural environment of the buffer zone.

These coastal processes involve a dynamic feeding of sand along the coast from south to north by onshore currents. Interference in this process by the construction of groins or by changing the inshore currents may change the sand deposition processes

Consequently construction of port facilities, groins or extensive inshore dredging must be considered potential threatening processes through the potential impact on coastal erosion and deposition.

Recreational vehicle activity, camping and associated high levels of human activity are degrading the coastal environment on the spit at the northern end of the beach. Relatively large areas have been denuded of vegetation behind the foredunes while pedestrian and bike tracks are evident on the foredunes. Although active erosion is minor the current levels of impact will lead to sand mobilisation in the near future. The current camping practice is within a zone of colonisation and expansion of the low microphyll vine thickets within the buffer zone. This natural process is in decline due to the camping impacts. Domestic animals (dogs and cats) accompany the campers and day-visitors. These animals are free-ranging and may be impacting on the fauna of the adjacent natural communities.

Consideration should be given to excluding all vehicles and domestic animals from this zone and subsequently rehabilitating the area. Rehabilitation should include:

- bollarding the rehabilitation area,
- erecting signs explaining the purpose of the exclusion,
- manually removing or spot spraying destructive weed species, and
- allowing natural processes to re-establish.

If it is considered that only camping should be excluded and that day visitation should be allowed then bays could be constructed within the rehabilitation zone, above the high tide mark and behind the foredunes. Access to these bays should not be through the foredunes and should be sheltered from the prevailing winds to minimise funnelling of sand. Access to the bays should be via a corduroy track. Access tracks should be aligned so as to avoid tunnelling winds and hence reducing sand movement. Vegetation should be established up to the edge of the bays and the track for similar reasons.

If it is considered that camping is to be permitted in association with day use then additional infrastructure will be required. A formal camping ground should be established. This camp-ground should be constructed as a series of camp sites, each with a vehicle parking bay. These camp sites should be layed out in a scattered array separated by a wall of vegetation (at least three meters thick). Each camp site should be surrounded bollards and separated from the parking bay by bollards to restrict the extent of soil disturbance by vehicles. All tracks servicing the camp sites should be bollarded and corduroyed. If possible the camp ground should include a one-way access track. Pedestrian access from the camp ground to the beach should be along the vehicle access track or along a narrow bollarded and corduroyed track through the foredunes. This track should be aligned in such a way as to avoid funnelling the wind and include some bends so as to trap sand and break air flow patterns. The site should be surveyed and the maximum number of camp sites that can be established without further degrading the environment established. Once this is determined, camping access to the site should be carefully managed, perhaps through a “permit and ranger” system, to ensure that visitation does not exceed the site capacity.

Irrespective of the option selected:

- an officer should be appointed to regulate visitation and impacts on the coast,
- interpretive signage should be installed at all points of rehabilitation, management and access,
- information on management of the area should be published in the local media,
- vehicles should be prohibited from driving on the foredunes at points other than designated tracks,

- access to the plant communities beyond the foredunes and the camp ground or parking areas should not be encouraged or facilitated,
- the duration of camping should be restricted to no more than two nights,
- all rubbish should be taken home,
- all domestic animals should be excluded from the zone,
- collection of fire wood (including kindling) from the zone should be prohibited,
- fires should be limited to designated camp grounds and below the high tide mark, and
- if environmental degradation continues then visitation should be further restricted rather than increasing the investment in infrastructure and site hardening.

9.4.2 Weed invasion

As with the other management zones, the presence of Guinea Grass (*Panicum maximum var maximum*), Lantana (*Lantana camara*) and Rubber Vine (*Cryptostegia grandiflora*) is a threat to the integrity of the plant communities present.

A systematic strategy of control should be instigated as soon as possible. This strategy should:

- target destructive weed species rather than all exotics,
- be highly selective so as to eliminate the target species while retaining native species,
- avoid the creation of canopy gaps in low microphyll vine thicket,
- avoid unnecessary soil disturbance,
- repair canopy gaps or soil disturbances to inhibit weed growth and germination rates.

The most severe weed infestation in this zone occurs throughout map unit 2 I, *Eucalyptus tereticornis* tall very open woodland with a dense grass and forb ground stratum. Weed species dominate the ground and lower mid strata. These include Guinea Grass (*Panicum maximum var maximum*), Lantana (*Lantana camara*) and Rubber Vine (*Cryptostegia grandiflora*) and to a lesser extent Guava (*Psidium sp*) and Groundsel (*Baccharis halimifolia*). The scale of management of this vegetation unit requires a distinct strategy from that applied to the rest of the zone. The key actions in this strategy are:

- establish a fire break between map unit 2 i and the adjacent low microphyll vine thicket, map unit 1a,
- under controlled conditions burn (moderate intensity) all of map unit 2 i,
- follow the burn with selective spraying and hand weeding of regrowth,
- retain all native seedlings and suckers (protect from spray drift),
- exclude all future fire, and
- allow “rainforest” species to colonise the site.

It is expected that there will be a mass germination of *Acacia* spp. after the fire. These species are a natural component of the other plant communities in the buffer zone. The thickets should be allowed to grow through to maturity and eventual death and decay in seven or more years. The *Acacia* mid storey will provide a shelter canopy for the regenerating rainforest species. As the *Acacia* dies a heavy fuel load will develop and increase the fire risk to the regenerating community. Particular care should be taken to exclude fire until the *Acacia* debris has decayed.

9.4.3 Fire

Any intensity of fire would have a deleterious impact on the plant communities of this zone. Unless it is being used as a carefully controlled management tool it should be excluded from within the zone.

The best developed low microphyll vine thicket (map unit 1 a) within the buffer zone is located at the northern end of Zone 4, on the western side of, and immediately adjacent to, the conveyor belt. The western edge of this community abuts an open *Eucalyptus tereticornis* woodland with a dense, tall Guinea Grass (*Panicum maximum* var *maximum*), understorey (map unit 2 i). This community has not been burned for some time. Any fire occurring in this grassy community may severely damage the fire-sensitive low microphyll vine thicket.

The establishment of a fire break along the western boundary of the low microphyll vine thicket should be a high priority management action. The fire break should be a slashed zone at least 10 metres wide. The fire break should be mowed frequently and carefully managed until the fire risk in the adjacent community is removed. After the first slashing the break should be raked to remove the fuel load. Stands of Guinea

Grass adjacent to the vine thicket should be chipped by hoe and removed from the site. Care should be taken to avoid breaching the canopy of the vine thicket during the weeding or slashing process. If an area is difficult to slash it should be cleared by hand. Where possible regenerating native species should be left.

10. MONITORING, REVIEW, RESEARCH AND REPORTING

10.1 REVEGETATION, EROSION AND WATER MANAGEMENT

10.1.1 Monitoring:

There is a need to establish a monitoring program associated with the revegetation and landform design undertaken as part of the erosion control and water management strategy. The approach to erosion control and water management should be staged, each stage being monitored to judge success before the next one is undertaken. Areas of critical concern, where problems of environmental impact and degradation are greatest, would be attended to first. There are two or three key areas, and these should be identified and ranked in order of importance through consultation with Boyne environmental staff. Other areas that need attention, but where a wait for a year or two will not result in a catastrophe or serious cost to the company, should be ranked low on the list of areas requiring attention.

The monitoring program will be developed in conjunction with Boyne staff, who will undertake the routine monitoring schedule. CQU will help design the program and its installation and quality control, and interpret the results. At this stage no further details can be given until the key sites and the rehabilitation design for them is determined.

An integrated monitoring program should be adopted, where trial vegetation, erosion and water management sites are combined and jointing assessed. An integrated approach to management dictates that this is the preferred option for the monitoring regime.

10.1.2 Review:

There needs to be a review of the water management strategy outside of the operational area of the plant. This review may require additional monitoring once the first stage of analysis is complete. The first stage involves reviewing available hydrological data, assessing its quality and reporting on deficiencies then a monitoring program should be established and at least one year of data collected in order to develop models and further refine the understanding of the hydrologic system of the area and its cross-linkages with the plant.

10.1.3 Research

There is a need to better understand the erosion and hydrologic characteristics of the site. However, before any detailed research programs are begun it is necessary to review the available information in more depth that was possible for the feasibility phase of this study. The imperative of attending to a number of critical areas, with rehabilitation designs for erosion control and revegetation, means that the associated monitoring programs will effectively be research programs of the effectiveness of the rehabilitation strategies. In a staged approach the results of monitoring will be research results for the next stage of rehabilitation.

10.1.4 Reports:

Reports should be sixth monthly, prior to the Wet Season and following the Wet season, the period of most erosion and hydrologic activity. The Dry season period is the time for analysis and assessment, the Wet season is obviously the period of data collection (monitoring).

10.2 NATURAL SYSTEMS MANAGEMENT

10.2.1 Monitoring

Generally:

A single office should be responsible for over seeing and collating reports on the state of the natural systems within the buffer zone.

An Officer should have the responsibility of regularly travelling over and inspecting all parts of the buffer zone. (This would be a position similar to that of the Open Cut

Examiner in Coal Mines.) The frequency of inspection should be sufficient to allow the Officer to be familiar with all aspects of the zone and be able to identify problems in soil and water management, changes in weed distribution and abundance, maintenance requirements on tracks, batter slopes and drainage systems as well as changes in natural plant communities (especially fluoride effects) and related issues such as fire management.

On ground staff should report perceived problems to the Office responsible for buffer zone management. Such reporting should be seen as a requirement of their job. A mechanism should be established to receive similar reports from government agencies, neighbours and the public.

Specifically:

Periodic detailed monitoring of the natural systems should be instigated within the buffer zone. The monitoring should be able to recognise an industrial impact of industrial cause as well as the impact of fluoride outfalls.

To achieve this, a series of monitoring sites should be established across the predicted outfall concentrates of fluoride for each natural system likely to be impacted. These sites may then be compared to identify possible impacts. External reference sites should be established to assess impacts related to the general proximity of neighbouring industry. Ideally five reference sites should be established for each natural system being monitored. For potential impact sites running parallel to the coast it may be necessary to establish reference sites above and below the potential impact sites.

At each site three 'replicate' samples should be taken and averaged.

Initial sampling should be of a frequency that allows natural variation to be recognised. All sites should be sampled at the same time. Where possible the sampling of the terrestrial environment should be undertaken in association with any marine and aquatic monitoring.

Parameters measured during monitoring should allow recognition of changes in community structure and species composition and abundance.

Fugitive fluoride and other outfall components should be monitored across the buffer zone and particularly at the sample sites.

Detected changes in the plant and animal communities in the buffer zone may then be related to known outfall concentrations. Where the changes cannot be related to the known outfalls then the responsible Office should instigate secondary investigations to identify the cause of the changes.

10.2.2 Review

Periodically the responsible Officer should collate the general and specific monitoring reports and produce a 'state of the buffer zone' report.

This report should be available to the general staff as part of the maintenance of the 'Ethic of Environmental Care'. After four years a thorough review of the Buffer Zone and its management should be undertaken. The review should provide recommendations on changes in management of the zone, if necessary, and set management directions for a further 5 year period.

10.2.3 Research

The structure and ecology of the plant and animal assemblages in the buffer zone are poorly understood. The results of the monitoring programs should form the basis for a fuller study of these assemblages. A study of the low microphyll vine thickets should be a priority given their conservation significance.

10.2.4 Reports

Reports should be delivered annually after the wet season growth periods so as to fully account for drought/fluoride effects on canopy foliage. Less formal reports should be compiled on a three monthly basis by the responsible Officer. These reports should record general observations on erosion, weeds and recreation impacts as well as 'natural history notes' on plant flowering, leaf flush, wildlife observations and other general comments that may provide anecdotal information on the state of the buffer zone.

10.3 RECREATION MANAGEMENT

10.3.1 Monitoring

A strategy should be established between the 'Buffer Zone Office' and the Calliope Shire Council to monitor the nature, intensity and seasonality of recreational pursuits on the buffer zone. This strategy should be designed to achieve the objectives of recreation management for the buffer zone.

A formal survey of recreation usage during periods of peak usage of the buffer zone should be undertaken; and an environmental impact assessment should be undertaken immediately after these periods of peak usage (Christmas, New Year, Easter, long weekends, major fishing seasons)

Where the monitoring detects recreational activities which are contrary to the management intent for the zone or detects unacceptable impacts, the strategy should trigger some control or remedial action. All staff should be required to report inappropriate activities or environmental impacts from recreation to the responsible Officer.

The responsible Officer should regularly visit all parts of the buffer zone where recreation occurs and note generally recreational activities and their impacts.

10.3.2 Review

The management of recreation or the buffer zone should be reviewed after each peak recreational period. This review should consider:

- changes (if any) to the **intensity** of recreation
- changes (if any) to the **nature** of recreation
- closure of parts of the buffer zone for natural regeneration or active revegetation
- changes to the public education program to alter the nature of community use of the buffer zone environment.

This review should be conducted in conjunction with the Calliope Shire Council and, if necessary, peak recreational organisations such as 4WD associations and recreational fishing groups.

After 4 years the long term management of recreation should be reviewed and recommendations or changes to the strategy made for the next 5 year period.

10.3.3 Research

The information gathered as part of this management issue should form the basis of an ongoing study program providing benefits for the management of similar coastal recreational areas elsewhere.

Where remedial action is required it may be necessary to undertake a review of existing studies and then establish trials on the impacted areas.

10.3.4 Reports

The review of recreation during peak periods and of resultant impacts assessed after the peak periods should be compiled into a formal report for possible presentation to the Calliope Shire Council and peak recreation groups.

Such reporting should occur informally after the peak periods and formally on an annual basis.

The annual report and management recommendations should be publicly released.

After 4 years the overall management strategy should be reported on and include 4 years trends in key parameters related to recreational use and environmental impacts.