INTERNATIONAL ALUMINIUM

Sustainable Bauxite Mining Guidelines

Second Edition

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AUSTRALIAN ALUMINIUM COUNCIL LTD

abal ASSOCIAÇÃO BRASILEIRA DO ALUMÍNIO

This edition includes the following key updates:

- Tailings dam management systems and regulations
- Community initiatives
- Case studies
- Issue specific guidance, protocols, and standards

International Aluminium Institute (IAI)
international-aluminium.org

Current IAI membership represents producers across all major regions involved in bauxite, alumina, and aluminium production. Since its foundation in 1972, members of the IAI have been companies engaged in the production of bauxite, alumina, aluminium, the recycling of aluminium, or fabrication of aluminium or as joint venture partners in such. The key objectives of the Institute are to:

- Increase the market for aluminium by enhancing world-wide awareness of its unique and valuable qualities;
- Provide the global forum for aluminium producers on matters of common concern and liaising with regional and national aluminium associations to achieve efficient and cost-effective cooperation;
- Identify issues of relevance to the production, use and recycling of aluminium and promoting appropriate research and other action concerning them;
- Encourage and assisting continuous progress in the healthy, safe, and environmentally sound production of aluminium;
- Collect statistical and other relevant information and communicating it to the industry and its principal stakeholders; and
- Communicate the views and positions of the aluminium industry to international agencies and other relevant parties.

Through the IAI, the aluminium industry aims to promote a wider understanding of its activities and demonstrate both its responsibility in producing the metal and the potential benefits to be realised through their use in sustainable applications and through recycling.

Australian Aluminium Council (AAC)
aluminium.org.au

The Australian Aluminium Council is the industry association representing the Australian aluminium industry. The Council's members are the companies operating in bauxite mining, alumina refining, aluminium metal production and semi-fabricated aluminium production and distribution. The Council aims to:

- Increase understanding of the aluminium industry in Australia and internationally;
- Encourage the growth of the aluminium industry in Australia and in the use of aluminium in Australia and overseas;
- Act as a focal point for the industry on key national issues such as climate change, trade, health, and the environment; and
- Inform and assist all those with an interest or involvement with the industry.

Brazilian Aluminium Association (ABAL)
abal.org.br

The Brazilian Aluminium Association (ABAL) was founded in 1970 by the primary aluminium producing companies. Then, a common forum aimed to address aluminium industry related issues was established, towards combining interests from both producers and processors with the growing representation of the aluminium industry before the government and the community in these industry-concerned matters. ABAL is comprised of companies that represent 100% of primary aluminium producers. Also, part of ABAL are aluminium processing companies, representing around 80% of the Brazilian domestic consumption, consumers of aluminium products, raw material suppliers, service suppliers and traders. The Association works through Technical Committees and Market Committees to develop its activities and meet its major challenges, among which are competitiveness, disseminating aluminium applications and incentives to its new applications, consolidating the industry's economic interests, and representing them before government agencies, while watching over its institutional image and the product "aluminium".

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Executive Summary

Aluminium is produced from one of two sources, recycling of aluminium scrap and primary production from ore. The main ore for the primary route is bauxite, which is refined into an intermediate product, alumina, that is then smelted into aluminium. Other uses of alumina include chemical grade applications.

Bauxite demand has historically been met by a handful of significant market players, operating large scale mines. In response to the current and forecast demand, there has been an increase in mid and small tier miners exploiting lower margin deposits. This changing nature of the industry means that it needs to assess cumulative impacts of both large- and small-scale operations and their required governance. The influx of new entrants has, in some situations, led to the emergence of inadequate mining and environmental practices, with some authorities responding by imposing moratoria or bans on bauxite mining and shipping. To address such unsustainable practices a coalition of global and national aluminium associations and companies developed Sustainable Bauxite Mining Guidelines in 2018 and these represent an update to those Guidelines.

The aluminium industry's objective is a long-term, sustainable bauxite mining industry with acceptably low social and environmental impacts during operation and post-closure. Sustainable bauxite mining is not a "one-size fits all" prescriptive process but involves risk management and applying technologies appropriate to the circumstances of each mine. The needs of each site are influenced by climatic, geographic, and environmental conditions as well as government policies, regulatory framework, and importantly, community factors.

The large footprint of (predominantly open cut) bauxite mines and the fact that they are commonly found in tropical and sub-tropical areas mean that deposits often overlap, or are adjacent to, areas of high conservation value. Effective mitigation of biodiversity impacts is critical to achieving sustainable outcomes. In addition, mining and related activities often take place on, or near, indigenous lands and/or local communities. Mining frequently requires access to large tracts of land and water that must also sustain local communities. At the same time, mining related activities can have positive benefits for local communities, providing business opportunities and creating both direct and indirect employment. The promotion of positive outcomes and mitigation of negatives help to ensure more sustainable operations.

The principles of sustainable bauxite mining practices are common to the mining of other minerals and are focused on reducing impacts on biodiversity, land, and water; on promoting community engagement and on integrated rehabilitation and closure activities. Developing and integrating practices across safety, environment, economy, efficiency, and the community can also improve sustainability of mining operations.

Principles include:

- Ethical business practices and sound governance;
- Sustainable development considerations in decision making;
- Respect for human rights;
- Effective risk management;
- Health and safety performance;
- Environmental performance;
- Conservation of biodiversity and land use planning;
- Responsible use and supply of materials;
- Social contribution; and
- Engagement and transparent reporting.

Good governance, reduced environmental legacies, fewer safety incidents, and increased community benefits result in not only better financial outcomes and increased competitiveness, but also enhance company, country and industry reputation and credibility.

Overcoming misalignment between the overall benefits of the activity and its local impacts remains one of the major challenges for mining, especially in less developed regions. Bauxite mining companies, through structured and innovative programmes, should strive to be a catalyst for local sustainable development.

Bauxite mine operators should assess the social, environmental, and economic impacts of their activities before the commencement of mining. Such an assessment includes identifying affected stakeholders, the potential impacts of the planned mine and those measures which should be applied to prevent and limit negative and maximise positive outcomes.

During operations and throughout the life of mine, environmental management systems and community engagement mechanisms need to be implemented and reviewed. Risk management techniques are essential components of such systems.

Community engagement at the earliest possible time is essential, as the community may be neighbours to the operating mine for many decades. Community liaison or advisory groups established specifically for the mine may help the operation to focus its engagement programme.

Strategies to mitigate negative environmental and social impacts of bauxite mining may include:

- Identification of culturally and environmentally significant areas and considered mine design to minimise impacts;
- Control of dust levels by watering, road maintenance and vehicle speed limits, load limits and covering of vehicles;
- Construction of settling ponds and other drainage control structures;
- Rehabilitation planning and implementation as early as possible and progressively throughout the life of the mine, including landform design, topsoil usage and revegetation outcomes;
- Biodiversity management that identifies opportunities for improvement by introducing innovative and sustainable land management practices;
- Noise abatement measures such as provision of buffer zones, altered timing of operations, modification of equipment, adjusted drill and blasting methods; and
- Procedures to minimise fuel (hydrocarbon) and other spillages.

The integration of operational mine planning and closure planning from an early stage in the life of mine maximises the likelihood of effective mine closure and reduces the negative effects of any unplanned closure. Adequate financial provision for rehabilitation and closure activities is essential as companies may have liabilities which extend long after production has ceased. Risk assessment techniques may be used to demonstrate to the community and regulators that potential closure-related impacts have been suitably identified and management plans put in place.

Summary of Guidelines for Sustainable Bauxite Mining

Sustainable bauxite mines should:

Governance

1. Document the values, policies, and procedures for their processes, including decision-making;
2. Comply with government regulations; and
3. Publish their performance, including details of significant non-conformance or penalties.

Community assessment and contribution

4. Undertake a social impact assessment (SIA) prior to mining and ensure any significant risks identified are appropriately mitigated;
5. Ensure social and economic contributions are directed towards identified community needs;
6. Support community development through long-term engagement and partnership in community initiatives;
7. Identify key stakeholders and have a formalised plan and schedule for interacting with them;
8. Consult with the community about the operation and ultimate closure of the mine;
9. Communicate to the community on progress against any agreed actions;
10. Understand the role, customs and decision-making practices of Indigenous Peoples impacted by the mine;
11. Consult with Indigenous Peoples prior to commencement of mining or mine construction;
12. Understand and plan to preserve key aspects of cultural heritage relevant to the mining area;
13. Survey prior to mining and protect any additional cultural heritage sites identified during mining;
14. Not used forced or child labour (as defined by ILO Conventions C138 and C182) and shall comply with related national laws;
15. Provide documented, fair working conditions to all employees appropriate to local standards;
16. Ensure the health and safety of all employees and contractors;
17. Have a traffic management plan, developed in consultation with key stakeholders, if transport of bauxite on public roads or through the community cannot be avoided;
18. Ensure all transport through the community includes safety training;
19. Ensure that transport personnel adhere to speed restrictions and cover all vehicles appropriately;
20. Consider the need for economic mitigating measures or compensation for loss of land use and its other community values;
21. Avoid physical community displacement if possible;
22. If physical displacement cannot be avoided, then engage with the affected community and government to jointly develop a resettlement action plan; and
23. Seek approval from the government to implement any community relocation.

Health and safety

24. Have a system that identifies, assesses, manages and minimises health and safety hazards and control the risks;
25. Understand the health needs of the local community and how these relate to the needs of the mine operation;
26. Use a risk-based approach to understand and manage potential impacts from the mine;
27. Work with the community, government, and emergency services to develop, document and implement an emergency plan; and

28. Use a risk-based approach to determine appropriate security needs and ensure that any private security personnel used are adequately trained to respect the rights of employees and the local community.

Environmental management and performance

29. Complete a pre-mining impact assessment;
30. Have a documented EMS which identifies hazards and assesses and controls risks;
31. Have a plan on how to report their performance publicly;
32. Include all infrastructure associated with the mine when assessing environmental and social impacts;
33. Have a plan for safe operation of roads, ports, and railways, whether they are public or private, including consideration of community impacts;
34. Understand the social, cultural, and environmental value of water in the mine catchment;
35. Develop targets on water use and water quality, and report on these;
36. Avoid, or at least minimise, turbid water leaving the site through effective sediment control;
37. Not be established or developed in World Heritage areas;
38. In the case of significant risks to biodiversity, have a biodiversity management plan, integrated with the mine and business plan, based on the mitigation hierarchy;
39. Use buffer areas to minimise the impact on habitats of high conservation value;
40. Understand where the nearest sensitive people and other organisms for noise and dust are located;
41. Control noise and dust at source to minimise the impact on sensitive people and other organisms;
42. Maintain safe human health working conditions for all employees and contractors;
43. Optimise their energy use to achieve environmental and economic benefits;
44. Consider how long-term changes in rainfall patterns and severe weather events may affect the operation and host community and mitigate these risks where possible;
45. Comply with all regulations as a minimum;
46. Have a WMP based on the waste minimisation hierarchy;
47. Develop a tailings management plan where there is a beneficiation plant in order to account for the whole life cycle of the mine, from design through to decommissioning;
48. Ensure these tailings management plans are subject to independent expert review; and
49. During and after use, independently monitor tailings dams on a regular basis using both internal and external experts.
50. Have tailings management systems aligned with internationally recognised standards; and
51. Have tailings dam design and monitoring aligned with internationally recognised standards and subject to regular internal and external expert independent review.
52. Have a soil management plan describing how soils are to be classified, salvaged, stockpiled, and respread;
53. Have a progressive rehabilitation plan, integrated with mining operations, which includes completion criteria;
54. Ensure completion criteria are agreed with regulators and, where appropriate, other stakeholders;
55. Have a closure plan, developed with local stakeholders, and agreed with regulators; and
56. Establish appropriate financial provisioning for closure and ongoing monitoring and maintenance activities.

1. Introduction

This document is an update to the Sustainable Bauxite Mining Guidance published in 2018. The updates in this version are focused on global bauxite supply and demand, tailings management and longer-term community impact and initiatives. There is also number of new case studies included throughout to provide specific examples of sustainable practices in action.

Aluminium is a comparatively young metal and its commercial use dates back only about 150 years. However, more aluminium is produced today than any other non-ferrous metal. Aluminium is one of the most widely used metals in transport, construction (roofing, wall cladding, windows, and doors), packaging (cans, aerosols, foil and cartons) and in the electrical sector (Figure 1). It is valued for being light, strong, durable, flexible, impermeable, thermally and electrically conductive and noncorrosive.

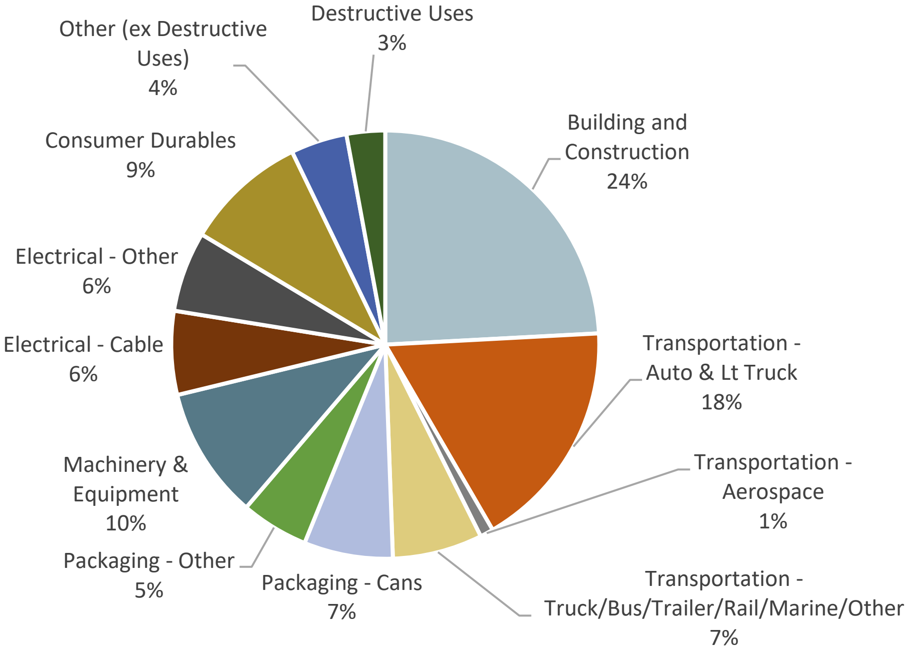
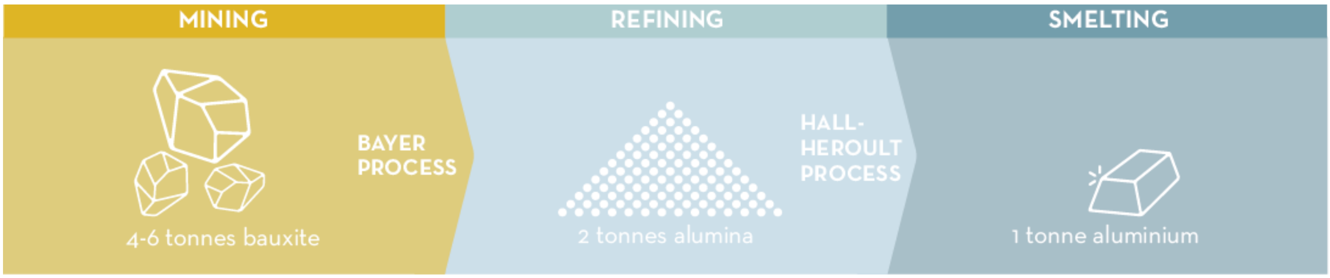


Figure 1. 2019 Semi Finished Shipments by End Product[i]

Bauxite is the primary ore used to make aluminium. Around 85% of bauxite is used to produce aluminium, 8% is used to produce alumina chemicals and 7% is used for abrasives, refractories, proppants and in cement. Depending on the ore grade, 4-6 tonnes of bauxite are required to refine into 2 tonnes of alumina, which in turn is smelted to make approximately 1 tonne of aluminium metal.



Most of the world's bauxite comes from surface mines in tropical and sub-tropical areas, where bauxite typically occurs in extensive relatively thin near-surface layers, normally beneath a few meters of overburden. Because bauxite deposits often cover a very large area, bauxite mining involves disturbance of comparatively large land areas compared to the mining of other minerals. Only a small proportion of global bauxite is produced from underground mines.

The early 21st Century has witnessed significant structural change to the aluminium industry, including the bauxite supply chain. Bauxite mining traditionally formed part of a vertically integrated corporate model, with companies engaged in production processes all the way from raw material extraction to cast metal production and even to the manufacture of fabricated products. Today these traditional production and supply models have been replaced or sit side-by-side with new industry approaches, in which bauxite mining (and other processes in the aluminium value chain) are independently owned and operated, in some cases becoming detached from mainstream aluminium producers.

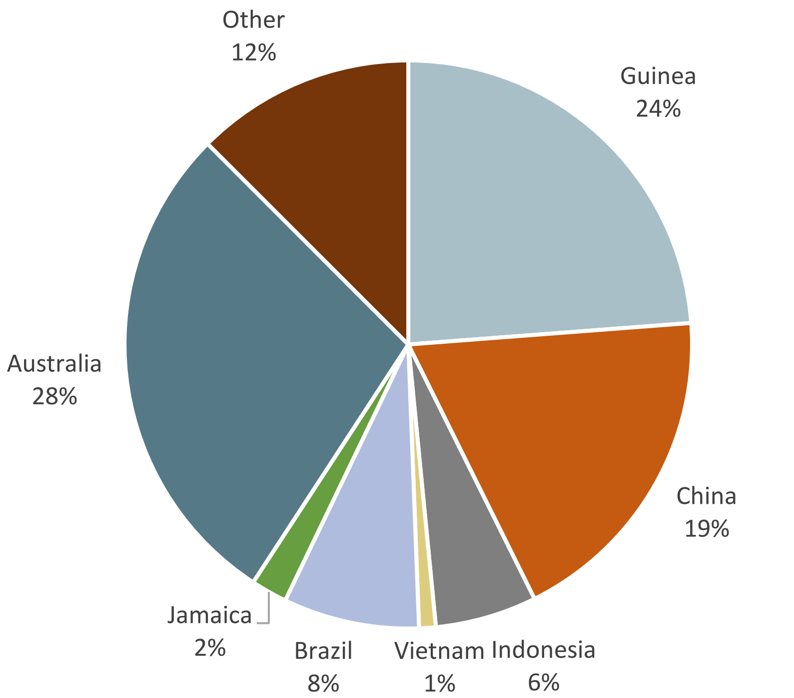


Figure 2. 2020 Bauxite Production by Country[ii]

Bauxite is today a globally traded commodity in its own right, a response in part to increasing demand from China's primary aluminium industry, which accounts for more than half of global production. This increase in demand has also driven the development of new bauxite producing regions (in, for example, Indonesia, Malaysia, Fiji, New Caledonia) and the establishment of many new operations in both traditional (e.g., Ghana, Guinea, Australia and India) and newly producing countries, by operators with limited bauxite mining experience (Figure 2). This influx of new entrants has, in some situations, led to the emergence of poor mining and environmental practices, with authorities imposing moratoria or bans on bauxite mining and shipping in response.

These Guidelines elaborate the aluminium industry's objective to ensure bauxite mining is sustainable and social and environmental impacts during operation and post-closure are minimised. Sustainable bauxite mining is not a single "one-size fits all" prescription to bauxite mining, it involves managing each risk with best available technologies and strategies appropriate to the circumstances. This will be influenced by local climatic, geographic and environmental conditions as well as government policies, the regulatory framework and, importantly, community factors.

These Guidelines reference current Best Practice Bauxite Mining (BPBM) guidelines jointly developed by industry in Brazil (ABAL) and Australia (AAC), in addition to the Aluminium Stewardship Initiative (ASI) Performance Standard (aluminium-stewardship.org/asi-standards/asi-performance-standard). However, it is intended that these Guidelines are relevant to all bauxite producers globally who strive to operate sustainably, not just those who are seeking to achieve best practice.

These Guidelines aim to identify the key topics affecting sustainable bauxite mining and provide information and case studies to enable a more sustainable basis for all mines. Aspects relating to auditing, monitoring, risk and stewardship are not covered as separate issues but are instead integrated within the four main sections in these Guidelines – governance, community assessment and contribution, health and safety, and environmental management and performance.

These Guidelines are primarily intended for use by a range of stakeholders including managers of bauxite mines, representatives of non-government organisations (NGOs), neighbouring communities and government regulators.

2. Background

Global Bauxite Supply and Demand

Primary aluminium demand is strong and the IAI forecasts growth from 64 Mt in 2020 to 88 Mt by 2050. The growth in primary aluminium will drive subsequent growth in the alumina and bauxite markets. China currently represents over 60% of global primary aluminium demand and will continue to have the greatest demand for primary aluminium of any region beyond 2050 (Figure 3).

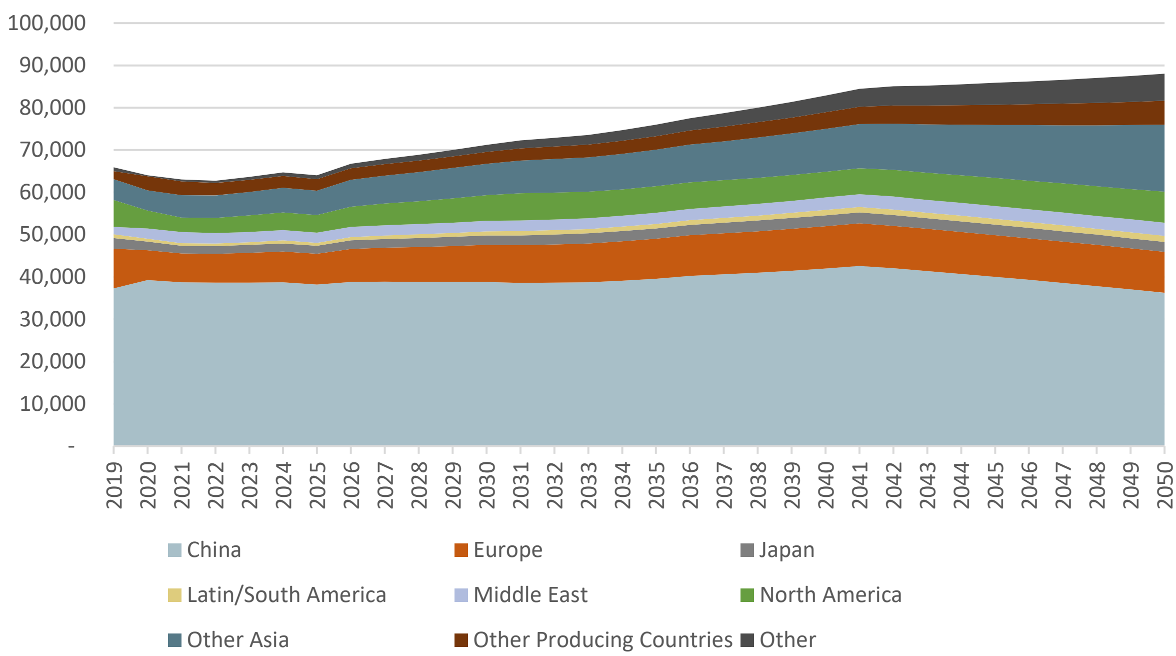


Figure 3. Primary Aluminium Consumption by Region, 2019–2050 ('000 t) [i]

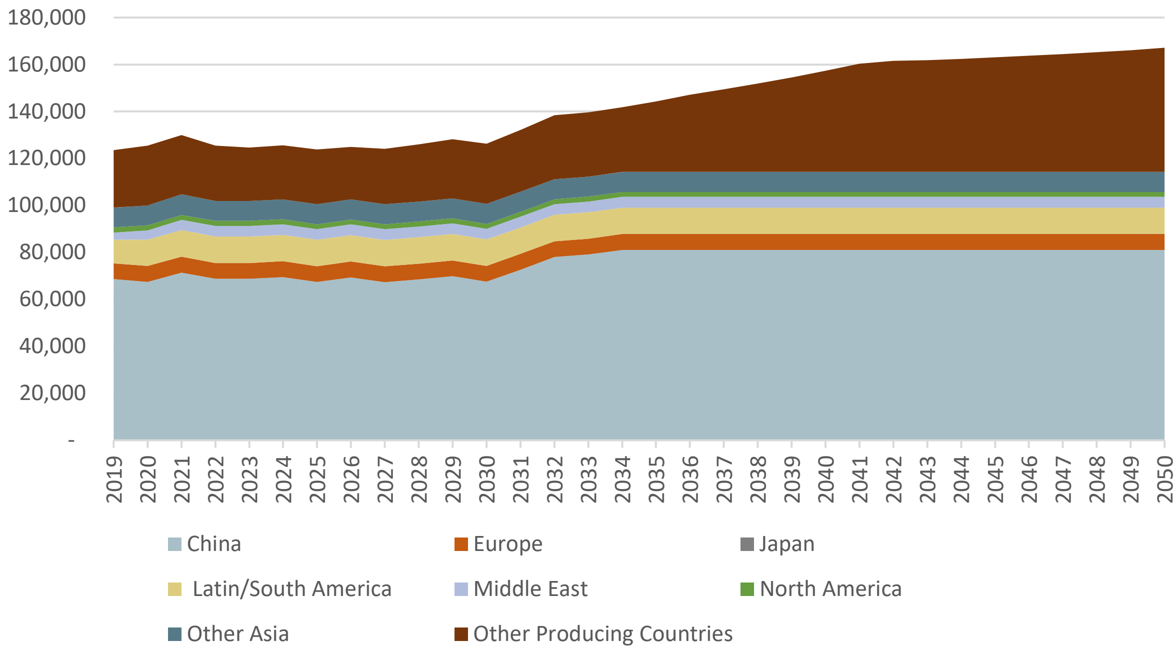


Figure 4. Metallurgical Alumina production by Region, 2019–2050 ('000 t) [i]

Chinese demand for bauxite imports to meet alumina production is expected to remain steady over the next few years and increase from latter half of this decade. Domestic bauxite availability and quality continue to decline in key provinces and Chinese domestic production is not expected to increase to meet demand. By 2050, bauxite imports are expected to grow to 115 Mt, up from 83 Mt in 2020 (Figure 5). China's increasing requirement for bauxite over the past few years has stimulated an unprecedented structural change within the bauxite supply sector, with the development of a major third-party bauxite trade established to meet this demand. There has been an influx of new producers and new countries into the bauxite market. Many countries including Guinea, Vietnam, Malaysia and Indonesia now export significant volumes of bauxite to China, leading to a diverse and dynamic industry. Guinea remains the largest bauxite exporter to China, accounting for approximately 45% of Chinese bauxite imports in 2019, followed by Australia which accounted for 34% of bauxite imports (Figure 6).

Historically, bauxite demand has been met by a few large players in the market, which have operated large scale mines. In order to meet future demand as the demand for primary aluminium grows, there may be an increase in the number of smaller mines or new market entrants seizing opportunities in the market. This changing nature of the industry means that it needs to assess cumulative impacts of these small operations and their required governance.

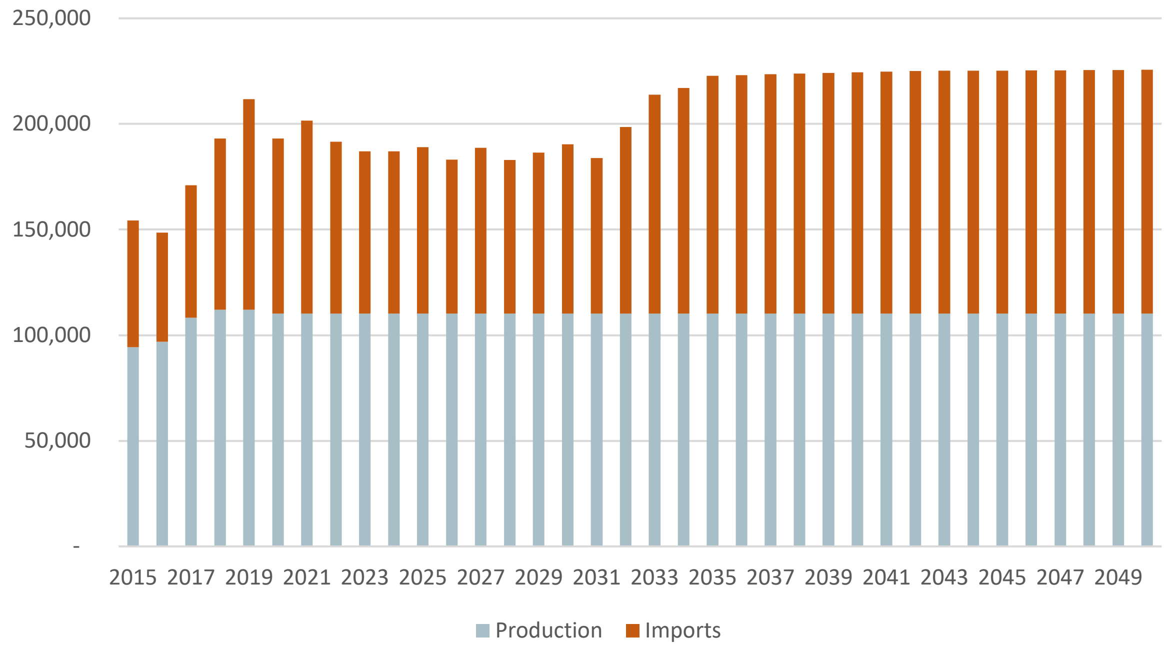


Figure 5. Chinese Bauxite imports forecast to increase to 2050 ('000 t)[i]

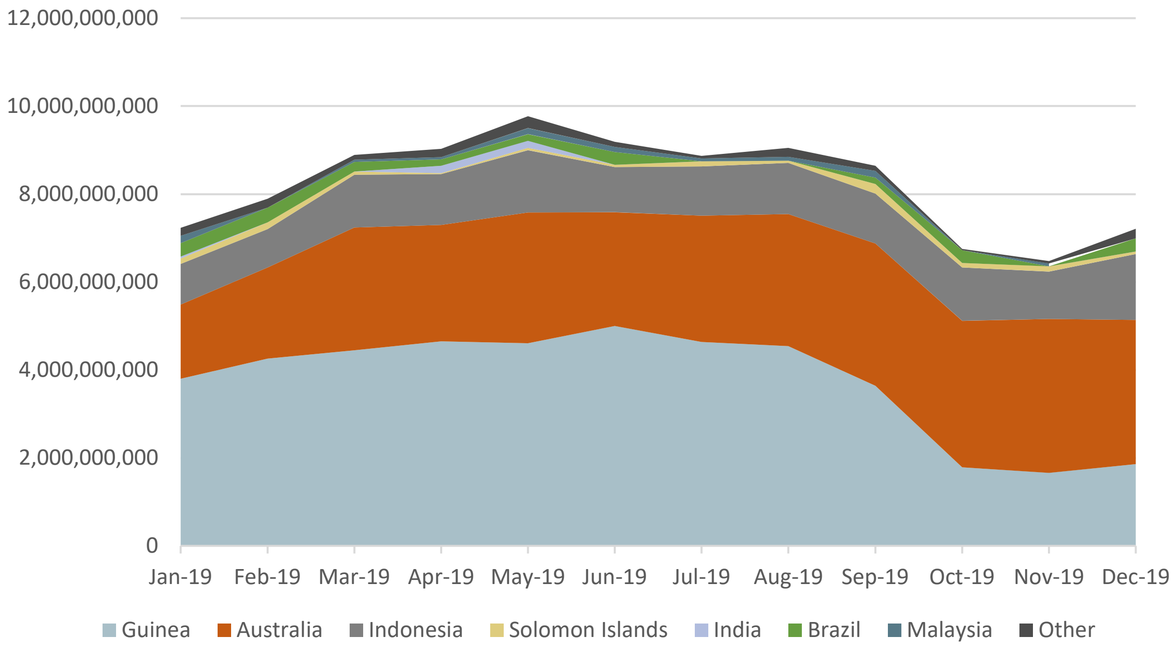


Figure 6. Monthly Chinese Bauxite Imports (t)[i]

Geology

Aluminium is the most abundant metal in the earth's crust. The aluminium-containing bauxite minerals gibbsite, böhmite and diaspore are the basic raw material for primary aluminium production. Proven, economically viable reserves of bauxite are sufficient to supply at least another 100 years at current demand. Therefore, while demand for bauxite is expected to grow as demand for high quality aluminium products increases, it is expected that new reserves will be discovered or known resources become economically viable.

Approximately 90% of the world's bauxite reserves are concentrated in tropical and sub-tropical regions as large blanket deposits in West Africa, Australia, South America and Southeast Asia (Figure 7). These flat layers typically lie near the surface, extending over an area that may cover tens or even hundreds of square kilometres. Layer thickness is typically 4-6 m, although it may be less than a metre and up to 40 metres in exceptional cases.

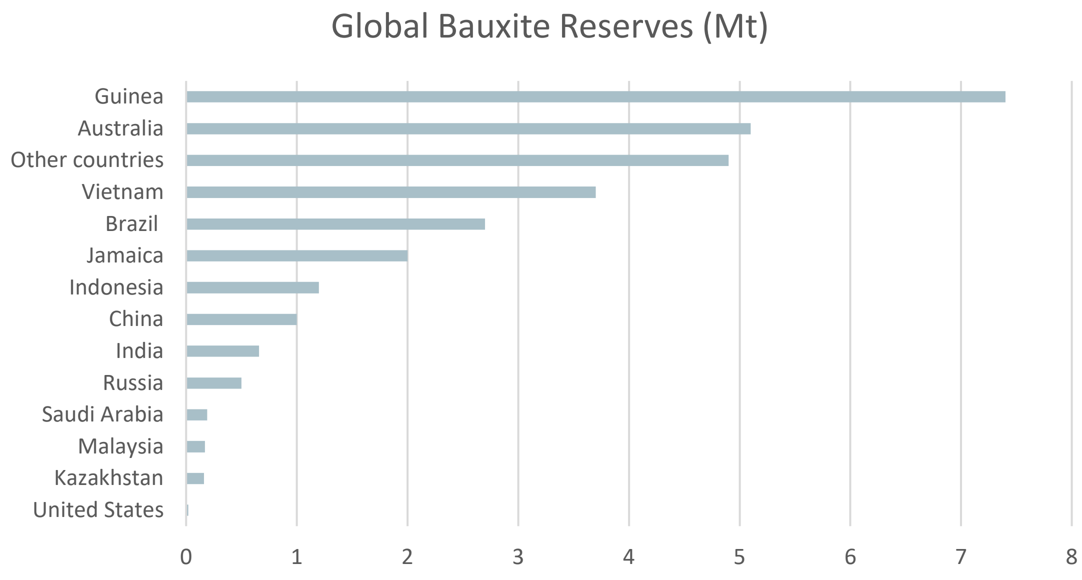


Figure 7. Global Bauxite Reserves[iii]

Bauxite is predominately mined by surface (open cast) mining methods and typically disturbs larger surface areas than underground or deep open pit mining. However, as the life of any given part of a bauxite mine is comparably short, rehabilitation may often commence more quickly after ore is removed compared to more traditional mining operations. For this reason, it is important that rehabilitation activities are integrated into the bauxite mine plan so that it is conducted as efficiently and effectively as possible.

Due to the large mining footprint - combined with the fact that bauxite is commonly found in tropical and sub-tropical areas - deposits often overlap, or are adjacent to, areas of high conservation value. As such, effective mitigation of any biodiversity impacts is critical to achieving sustainable outcomes. In addition, mining and related activities often take place on, or near, indigenous lands and/or local communities. This large-scale mining frequently requires access to large tracts of land and water that is often the basis of livelihoods for local communities. However, at the same time, it should be noted that mining related activities may have positive benefits for local communities, providing business opportunities and creating both direct and indirect employment. Therefore, to create a more sustainable mine it is important to promote positive outcomes and at the same time mitigate any negative outcomes.

Mining Process

Bauxite is generally extracted by open cast mining, with methods varying depending on the location. A typical sequence involves:

- Clearing the land of vegetation and salvaging useful timber;
- Collecting seeds, where appropriate and feasible for use in revegetation;
- Removing topsoil (and sometimes subsoil) for use in rehabilitation, either by way of direct replacement on mined-out land or by stockpiling for future use;
- Removing the overburden (the layer between the soil and the bauxite);
- Excavation of the bauxite using mechanical methods or in some cases drill and blast;
- Once the bauxite is loosened, it is loaded into trucks or rail wagons or on to conveyors, and transported to a beneficiation plant (if processing is required) or to stockpiles;
- Beneficiation may improve ore quality and is a relatively simple process involving improving the bauxite grade through the removal of waste materials through screening, crushing, washing and dewatering. The process produces a higher-grade ore product and tailings (mainly clay and fine sands);
- Transporting the bauxite to alumina refineries, and
- Once this removal is completed, rehabilitating the areas affected.

3. Sustainable Bauxite Mining Practices

Key Principles

The principles of sustainable bauxite mining practices are like those for the mining of other minerals, and focus on reducing the impact on biodiversity, land and water and promoting community engagement and integrated rehabilitation and closure activities. Bauxite mining may become more sustainable by developing and integrating practices which improve the outcomes from the bauxite mine across a variety of areas including safety, environment, economy, efficiency and the community. The International Council of Mining and Minerals has stated that principles of sustainable mining include:

- Ethical business practices and sound governance;
- Sustainable development considerations in decision making;
- Respect for human rights;
- Effective risk management;
- Health and safety performance;
- Environmental performance;
- Conservation of biodiversity and land use planning;
- Responsible use and supply of materials;
- Social contribution; and
- Engagement and transparent reporting.

Figure 8. Community Engagement at Alufer

In summary, the impacts of bauxite mining will be positive and negative, direct and indirect, local and national, and are fundamentally inter-generational as they may last for several decades, from the exploration stage to mine decommissioning. However, the impacts also depend on geographic location, local governance and capacity, climate, population density, cultural aspects and local infrastructure. That is, while bauxite mining may contribute to development, it may also create or intensify local socio-environmental problems, requiring specific mitigating actions.

Key Impacts during Life of Mine Phases

Sustainability requires the complex relationships between various risks be well understood, especially the potential for links between environmental, social, economic and reputation risks. Planning and implementation of an effective monitoring framework should occur as early as possible in a mine's life cycle.

As such, bauxite mine operators should assess the social, environmental and economic impacts of their activities before commencement of mining through environmental and social impact assessments (EIA and SIA) process. This assessment includes identifying all affected stakeholders as well as the identification, prediction, evaluation and mitigation of the potential impacts of the planned mine. This should be followed by identification of which measures should be applied to prevent and limit any negative impacts while at the same time maximising positive impacts.

During operations, environmental management systems (EMS) and community engagement mechanisms need to be implemented and reviewed throughout the mine's life cycle. Risk management techniques are essential in managing these impacts during operations.

Figure 9. Some elements of Sustainable Bauxite Mining practices

In addition to these traditional perspectives of sustainability incorporating broader social, economic and community aspects, a mine employing sustainable development principles must also be efficient in the way the resource is managed and extracted. Examples of short-sighted mining practices include 'high grading' the ore body, which entails mining only the highest-grade material for short-term gain. This practice can sterilise lower quality material, indicating a general lack of commitment to broader sustainability principles. Developing a longer-time mine plan that includes mining the lower-grade product would extend the mine's life and create a better overall balance of impacts and benefits.

The early application of such risk management principles lays the foundation for good relationships throughout the whole life cycle of the mine. In particular, community engagement at the earliest possible time is essential – the community may be neighbours to the operating mine for many decades and community liaison or advisory groups established specifically for the mine may help the operation focus its engagement programme.

- Identifying culturally and environmentally significant areas and alterations to the mine plan to minimise impacts on these areas;
- Controlling dust levels by watering, road maintenance and vehicle speed limits, load limits and covering vehicles;
- Constructing settling ponds and other drainage control structures;
- Encouraging rehabilitation planning and implementation need to take place early and progressively throughout the life of the mine including landform design, topsoil usage and revegetation outcomes;
- Promoting biodiversity management that identifies opportunities for improvement by introducing innovative and sustainable land management practices;

- Implementing noise abatement measures such as provision of buffer zones, altered timing of operations, modification of equipment, changes to mining and blasting methods; and
- Procedures to minimise fuel (hydrocarbon) and other spillages.

These strategies, and others, are discussed in more detail throughout these Guidelines.

All mines close; some close earlier than planned. The integration of operational mine planning and closure planning from an early stage in the mine's life maximises the likelihood of effective mine closure and ameliorates the negative effects of any unplanned closure. Adequate financial provisioning for rehabilitation and closure activities is essential as companies may have rehabilitation and closure liabilities which extend long after production has ceased. Risk assessment techniques may be used to demonstrate to the community and regulators that potential closure-related impacts have been suitably identified and that management plans have been put in place.

In these Guidelines, these stages of sustainable bauxite mining are discussed in regard to four main areas – governance, community assessment and contribution, health and safety, and environmental management and performance. A number of case studies are used to better illustrate these principles.

Case Study - Sustainable Operations, Juruti, Alcoa, Brazil

In the heart of the Amazon, Alcoa's bauxite mining project in the pristine Juruti region of Brazil has been recognised as a sustainability benchmark by generating positive social and economic effects in the local community and enhancing environmental conditions. At an estimated 700 million metric tons, Juruti is one of the largest high-quality bauxite deposits in the world. The Principles of the Juruti Mine Project are:

- Live up to the values and principles of Alcoa's human rights policy.
- Have respect for culture and diversity.
- Listen actively and respond to all stakeholders.
- Improve and preserve the region's biodiversity.
- Improve social and economic conditions.
- Develop local skills to minimise dependence on the project.
- Employ local and regional resources.
- Avoid paternalism at all costs.
- Apply world-class technology and management systems.
- Earn our right to operate the business day by day by living up to the foundations of Alcoa's sustainability structure.

Figure 10. Alcoa Juruti, Brazil

The Juruti region is home to 47,000 people, with 65% of them living in about 150 rural communities. The economy traditionally has been based on fishing, cattle-raising and agriculture. The average per capita income is US$23 per month, and the population has an illiteracy rate of 21%.

Alcoa sought to deepen its understanding of potential impacts of the Juruti project and solicit stakeholder participation early on including two opinion surveys, three public meetings attended by almost 8,000 people, almost 70 additional meetings with community members, and implementing a far-reaching communications programme. Alcoa also conducted extensive surveys, studies, and field research. In 2007/08, a series of surveys and discussions were carried out by a multidisciplinary team, including field research and collecting information about the local and regional reality. The resulting report, “A Sustainable Juruti: Diagnosis and Recommendations,” became the frame for Alcoa’s local sustainable development model. The project’s success was in part due to the concurrent implementation of three pillars:

(i) Creation of a multi-stakeholder council, Sustainable Juruti Council that serves as a channel for dialogue between civil society, the company and the public authorities;
(ii) A system of sustainability indicators and metrics, to generate knowledge and measure progress;
(iii) A development fund to allocate resources to be invested in sustainable initiatives proposed by the community itself.

The Sustainable Juruti Council serves as the key channel for dialogue between civil society, the company and the public authorities and brings together three representatives from the private sector, three representatives of Government institutions, and nine representatives from civil society. The Council’s mandate is to guide and monitor the overall sustainability agenda of Juruti, whether by the private or government sector, including Alcoa’s bauxite mining operation, the Environmental Control Programmes and the Positive Agenda initiatives, and to provide a forum for discussion and collective action. The Council contains eight working groups: environment, health, education, security, infrastructure, culture & tourism, economy & labour & rural development, and citizenship. Each stakeholder group plays a unique and vital role in the Council, with government serving an important regulatory and mediation role.

The Positive Agenda is a fund voluntarily established by Alcoa in the development phase of the project, with the objective of financing initiatives that would be of direct benefit to the local community, as well as address the social and environmental infrastructure priorities identified by the people of Juruti themselves in the areas of health, education, culture, the environment, urban and rural infrastructure, security and justice and social assistance. The fund is administered in partnership with the Municipal Administration, with initiatives implemented through partnerships with the local authorities, non-government organisations and the community. Examples of sustainable infrastructure initiatives include:

- Construction of the Juruti Community Hospital and the construction, refurbishment, or expansion of other health facilities throughout the region. Prior to this, many people in Juruti had to travel by boat for up to 12 hours to medical attention;
- Construction of 16 classrooms in eight municipal schools and an elementary school in the district;
- Construction of a legal complex, including the municipality’s first courthouse, and associated offices;
- Creation of three deep water wells to provide fresh, clean water to city residents;
- The New Business Training Programme, in partnership with the Juruti Trade and Business Association and the Supplier Development Programme of the State of Para Federation of Industries; and

- Establishment of a Juruti Cultural Centre.

From the outset of the Juruti project, Alcoa made a commitment to “mine bauxite and return the area to the same, if not better, condition than when we initially arrived”. Leveraging its world-class experience in land stewardship and rehabilitation in Australia, Alcoa is applying model mine-site rehabilitation techniques in Juruti to ensure biodiversity preservation and environmental sustainability in this pristine environment.

Figure 11. Bauxite Mine and Stockpile, Juruti, Brazil

In addition to this operational commitment to world-class environmental management and restoration, the Juruti project developed a series of Sustainability Indicators, through multiple stakeholder workshops, to monitor local development within Juruti. These also provide important input to the work of both the Council and Fund. The indicators were selected with input from over 600 community members, through town hall meetings and online consultation. The indicators also provide valuable input to the Environmental Control Plans, totalling 35 programmes, which were part of the bauxite mine’s Installation License. These covered activities such as the monitoring of climate, air, noise and water, biodiversity conservation, environmental education, medical, sanitary and educational support, public security, valuing local culture and support for the Juruti Master Plan.

After eight years of operation the bauxite mine is boosting the development of Juruti by improvement of governance, as well as by generations of employment and training of local labour, mitigating environmental impacts and leveraging community incomes. From 2009 to 2017, after the investments made by Alcoa in partnership with the government and stakeholders:

- Enrolment in middle school increased more than 400%;
- The Human Development Index (HDI) jumped from 0.39 to 0.59; and

Alcoa have engaged with the traditional community of Juruti Velho, located near the mine. The Association of Communities of the Juruti Velho Region (ACORJUVE), Alcoa and the National Institute of Colonization and Agrarian Reform (INCRA) have established a negotiation process on land use for mining and community. Based on common agreement, from October 2009 through December 2017, Alcoa have paid approximately US$ 17.6 million in royalties to ACORJUVE.

Rehabilitation of mined areas has been successful both on environmental and social grounds. All seedlings used in the rehabilitation are cultivated by community, who receive training and support from Alcoa, which has already bought almost 400,000 seedlings, generating more of US$ 200,000 in local income. In this sense of promotion shared results for environment and communities, Alcoa adopted the program "Green Locomotive", aiming to mitigate the carbon emissions generated by the operation of the locomotives, by planting trees at communities degraded areas. This is a voluntary action without accounting the mandatory rehabilitation of mined areas. As a result, we achieved a production of 10,000 seedlings, generating income for the Galileia community, covering 6 hectares of community land with species native to the Amazon Forest.

Juruti's experience of associating mining with conservation forces consideration of the different uses of the land in the region in a diversified and flexible way, based on mining production activities which are compatible with conserving biodiversity. This is both feasible and necessary for sustainable mining.

There are still huge challenges such as the design of common goals for sustainability, leverage social inclusion, the broadening of public policies and the development of value chains based on local biodiversity. The path is not given beforehand, but Alcoa are walking and building sustainability through social-public-private consultation, which is delivering a new mining model in the Amazon.

4. Governance

Key factors to good governance

Governance is how institutions and companies conduct their business affairs and manage resources. It includes the process of decision-making as well as the processes by which decisions are implemented. Transparency and accountability are central to the concept of good governance. Disclosure of information and transparent decision-making processes enable stakeholders to scrutinise actions and hold governments or companies to account. As such, good governance is essential, regardless of size or type of ownership structure of a bauxite mine, because it influences the way operations are managed and monitored and their relationships with other stakeholders, especially governments.

Bauxite mines are often located in areas where relationships with local and regional governments may be complex. A mine may be the first major commercial operator in a region and local government systems may suffer from significant capacity constraints. This may create a situation where the mining company is viewed as responsible for poor local government performance when there is in fact a lack of government capacity. Alternatively, in the absence of a local government, the company may end up becoming a proxy local government authority. Bauxite mining companies may help improve governance by:

- Managing the business with high standards of integrity, transparency and compliance with applicable laws and regulations;
- Partnering with governments, industry and other stakeholders to achieve effective public policy, laws, regulations and procedures within a national context; and
- Engaging with and responding to stakeholders through open consultation.
- Having a set of values and code of ethics applicable to employees, suppliers and relationships with authorities; including publishing and distributing these to all key stakeholders;
- Conducting employee training on ethical conduct;

- Comply with or exceed the requirements of laws and regulations;
- Providing communications channels available to employees and other stakeholders, so that they may provide feedback, including complaints, or report suspicions of corruption;
- Paying local, regional and national taxes, consistent with legal requirements in full and on time. There must also be full public disclosure of these payments;
- Publishing performance in a format, such as a Sustainability Reports, in accordance with globally accepted guidelines, such as the Global Reporting Initiative (GRI); and
- Documenting policies and procedures, including those regarding business decision making.

Sustainable Bauxite Mines should have:

- Documented values, policies and procedures for mine operations, including decision making;
- Comply with, or exceed, government regulations; and
- Publish performance, including details of any non-conformance or penalties.

Role of Governments

The role of Government is to provide a clear policy, legislative and regulatory framework for mining, including implementing enforcement as specified. While there will be regional and cultural variations in Government styles, lack of a clear policy or lack of enforcement of existing frameworks will not cultivate a strong industry which contributes positively to social, environmental and economic outcomes. Good operators value strong and well-informed regulators. Good governments will have sufficient funding for not only development of regulations but also for education and enforcement where required.

Role of Companies - Permitting and Legal Compliance

For companies, it is important that any value derived from a mining operation, for example through royalties or taxes, follows the permitting process. If one level of government issues a permit but the financial benefits flow elsewhere, then this can lead to inconsistent decision-making. The value the mine contributes also needs to flow through the whole value chain, particularly at the local and regional level, and through the whole life cycle of mine, from initial consultation to closure. Governance systems therefore need to be designed to prevent abandonment. The use of financial provisions or surety which are held until a mine has met agreed closure planning obligations can prevent this and may help to improve compliance, particularly in regions where there is a history of poor social and environmental management.

Regardless of local requirements completing an environmental and social impact assessment prior to the commencement of mining will help identify the impacts the mine will have on the environment and community and identify the permits required for that bauxite mine. While permitting processes will vary considerably between countries; operation of a bauxite mine typically requires more than just an environmental permit to operate. Bauxite mines may also require other permits, approvals and licences such as:

- Exploration permits;
- Feasibility study approval;
- Land use permits;
- Import / export permits;
- Port usage permits;
- Water allocation licences;
- Effluence discharge permit;
- Tailings dam approval;
- Sewerage treatment plant licences;
- Waste disposal licence;
- Transport of bauxite;
- Radio frequency permits; and
- Bulk fuel storage tank certification; and
- Mine closure plan approval

In addition, bauxite mines should publicly disclose information on fines, penalties and non-monetary sanctions for failure to comply with applicable law and payments to governments on a legal and/or contractual basis.

5. Community Assessment, Development and Contribution

Community Assessment

In addition to economic good governance and timely payments of taxes and royalties to governments as outlined above, bauxite mining operations need to also support local communities and institutions, including the workforce and their families, local suppliers, and customers. A mine benefits from having broad community acceptance, or what is commonly called a “social licence to operate”. Unless the community is engaged and accepting of a mining operation, opposition and confrontation may ensue. Community opposition has the potential to develop into disruptive actions which may directly interfere with mining activities or result in a Government and financiers withdrawing their support for ongoing mining.

Ways to achieve this social licence include developing resources, skills and capacities in the local population, working in collaboration with other organisations as appropriate to build partnerships, and creating business opportunities and employment both during operations and, importantly, after closure. Indeed, mining operations can work to provide social and economic benefits to local communities, commensurate with the size of the operation, in a variety of ways, including:

- Undertaking a social impact assessment to understand community needs, the impact of the mine on the community, and ensuring any significant risks identified are appropriately mitigated;
- Ensuring employment is appropriately paid and provided under conditions which comply with accepted labour standards;
- Prioritising employment for local and regional residents, including providing opportunities for women, indigenous peoples and disadvantaged groups;
- Providing training programmes to current and future employees through programmes such as apprenticeships;

- Providing education support (e.g., scholarships);
- Assist in the development of local suppliers of goods and services through a local procurement programme;
- Forming partnerships with governments and non-government organisations to help ensure community programmes (such as community health, education, local business development) are well designed and effectively delivered;
- Ensuring that people resettled by operations, or people incurring economic displacement due to operations, are provided with appropriate mitigating measures or compensation; and
- Paying local, regional and national taxes, in full and on in a timely manner.

It is particularly important for the cumulative environmental and social impacts on regions where multiple smaller mines within a close geographic area may be operating. This may need to be undertaken by a regional body or aggregator of these mines. These small mines may increase in number as demand increases and land holders who have historically operated agricultural activities seek to capitalise on the relative ease with which bauxite can be mined.

The overall aim for sustainable mining companies is to generate profit responsibly. This can then serve to underpin benefits to all stakeholders, including shareholders, employees, local communities and businesses which depend on the mine, as well as the governments that benefit by means of taxes and royalties.

The recent COVID-19 pandemic has been an example of where a good relationship between mine and local communities has been essential. There have been many examples where the mining industry, with its close relationship to many local communities, has provided critical services or access to key equipment or infrastructure (e.g., clinics, hospitals). Through close collaboration with local partners and assessment of community needs during the pandemic, companies have provided a range of support measures from financial contributions to personal protective equipment donations to educational campaigns about minimising spread within the community.

Sustainable Bauxite Mines should:

- Undertake a social impact assessment prior to mining and ensure any significant risks identified are appropriately mitigated.
- Ensure social and economic contributions are directed towards identified community needs.

Case study – Hydro Sustainability Fund, Bacarena, Brazil

In 2019, a non-profit organization, The Hydro Sustainability Fund, was created to promote sustainable development and support community-based projects. Local social conditions are challenging in the region with high levels of unemployment and poverty.The Hydro Sustainability Fund follows the guidelines of the Sustainable Barcarena Initiative and finances projects that contribute to sustainable development aligned with the real demands of the local community.

The Fund itself is maintained by the companies Hydro, Albras and Alunorte, and has an investment commitment of BRL 100 million in 10 years. With investments in the municipality of Barcarena (PA), located in the state of Pará, in the Brazilian Amazon.

An inclusive and participatory approach to defining investment guidelines has been adopted with partnerships and open dialogues between the Sustainability Fund, local communities, civil society organizations, academia and the Brazilian authorities The Fund's involvement and investment strategy aims to gather opportunities to identify resources from the Amazon that can be worked by local communities.

The process itself begins with a call for projects which is an announcement that asks for project proposals related to sustainable community-based projects in Barcarena. In 2021, the eight initiatives were selected with over 300 beneficiaries. The goal is to increase the number of organizations submitting projects with each public call for projects so that a broader range of organisations can put forward initiatives that have a positive impact and improve the quality of life for the community.

Figure 12: Community participants and products from the Travessia Bacarena Project

Two key projects that were developed in the region, Travessia Barcarena and Tipitix, received a total of BRL 4 million of investment. Travessia Bacarena was born from a union of efforts to bring humanitarian aid to families in Barcarena affected by the socioeconomic crisis during the Covid-19 pandemic. The Travessia project worked on two fronts: the first focused on family farming and the second on the production of masks for income generation to seamstresses in the region. The Tipitix project was a Community Agrifood Entrepreneurship project that invests in the development and creation of new community-based agri-food businesses. It enables and promotes an entrepreneurial culture and disseminates investment in local innovations as well as encouraging the development of the bioeconomy. The project recognizes the importance of ongoing support and through its Business Development Cycle, provides technical advice and infrastructure necessary for the processing of products.

Community Development

The bauxite mining industry can play a leading role in community development through long term engagement in community initiatives. Community development can increase the strength and effectiveness of communities, improving people's quality of life and empowering people to participate in decision making processes. Often, long term community development can create benefits for local people that last throughout the life of mine and in many cases can continue beyond closure.

Collaboration is an essential part of sustainable community development, and programs or initiatives often have a wider reach when a range of organisations work together around a mine site or mining region. Across the bauxite mining industry, there are numerous examples of companies, government agencies, community organisations and NGOs working together to build capacity, develop skills, training and employment opportunities for local communities.

Sustainable Bauxite Mines should:
• Support community development through long term engagement and partnership in community initiatives.

Case Study – Seamstress capacity building program - Companhia Brasileira de Alumínio, Brazil

Companhia Brasileira de Alumínio (CBA) has been a partner to the Intermunicipal Seamstress Association of Santo Antônio do Rio Preto (CONFISARP), in Brazil's south-eastern town of Miraí, since 2008, when the Company donated a plot of land to build the Association centre. In 2018, the partnership developed into a capacity building and professionalisation program as part of ReDes, an initiative in collaboration with the Votorantim Institute, the Brazilian Development Bank (BNDES) and the Inter-American Development Bank's (IDB) Multilateral Investment Fund (MIF). Supporting economic development in the region, the program aims to create additional sources of income for families, empower local seamstresses, and help the Association to become independent and to sustainably manage the business.

Among its key contributions, the initiative has helped to expand the Association's facilities, as well as providing more efficient and ergonomic equipment. To professionalise Association management, members developed a strategic plan, articulated their mission, vision and values, and established internal agreements and standards addressing sustainability.

As a tangible outcome from the program, in 2020 CONFISARP saw a 60% increase in monthly income, directly benefiting Association members and their families. The program has also provided training courses to further develop business management skills, as well as organising benchmarking visits to clothing manufacturers, assisting in the development of the Association's own brand and clothing collection, and organising a fashion show to launch the collection in 2021.

Figure 13. Intermunicipal Seamstress Association of Santo Antônio do Rio Preto (CONFISARP)

Case Study – Introducing fruit crops in São Sebastião da Vargem Alegre, Brazil

Created in 2010 by the Community Association for Sustainable Development in São Sebastião de Vargem Alegre-MG, the NGO Attitude has been supported by CBA since 2013. At this time, a program to introduce fruit growing in the municipality, beginning with bananas, was launched. More than 30,000 banana trees were planted by 23 growers to improve farmer income, attract people to farming and encourage the formation of local cooperatives.

In 2015, the initiative was expanded to include grapevine plantations. The produce of which - table grapes and grape juice, is sold in São Sebastião da Vargem Alegre and several neighbouring municipalities.

The microclimate and terrain of the municipality make it an ideal location for fruit growing. This has been further improved by sustainable practices developed by farmers as part of the program.


Figure 14. CBA Fruit Farming Program, Brazil

Community Engagement

Community engagement is a formalised system to identify and work with stakeholders and develop strategies to address their concerns and expectations. The objectives of community engagement include to:

- Identify stakeholders who have an interest in the mining operation;
- Facilitate two-way communication and engagement with stakeholders;
- Identify any expectations or concerns stakeholders may have with the operation;
- Understand which aspects of the mining operation may be contribute towards a positive impact on communities; and
- Address stakeholder expectations and concerns identified during the environmental and social impact assessment process.

Following the identification of stakeholders, a consultation and engagement programme should be developed to ensure the consultation activities are conducted in an appropriate manner to meet the specific needs of each stakeholder group. Stakeholders might include:

- Landholders;
- Elected representatives of local, State/Provincial and National government;
- Government department and agencies, particularly environmental agencies;
- Residents in neighbouring communities;
- Community health providers or organisations;
- Non-government organisations and local community groups;
- Indigenous groups;
- Local suppliers of good and services and other local businesses;
- Industry organisations (e.g., tourism, agricultural, fishing);
- Professional bodies, academic institutions, cultural groups;
- General public; and
- Employees and contractors.

The ongoing consultation and engagement process should involve local stakeholders in a range of activities designed to:

- Increase knowledge and awareness of the mining process;
- Provide accurate, timely and relevant information about the mining operation; and
- Develop and implement strategies to mitigate concerns and to investigate any complaints or grievances.

Ongoing community engagement requires both the mining company and the community to commit resources to the process. The level of commitment varies over the life of mine:

- Exploration – focusses on identifying cultural heritage areas, land access and developing a common understanding of a future mine;
- Mine planning – consultation starts to understand both risks and opportunities the mine may bring which can be a time of high resource requirements from both sides involving meetings, surveys and focus groups, often assisted by external facilitators;

- Operations – relationships formed between the mine and community need to be proactively managed; any agreements honoured, and results of monitoring are reported;
- Closure planning – as mine nears the end of life, there will be increased liaison with communities, government and stakeholders about developing closure plans; and
- Closure – a final land-use for the rehabilitated mine should be developed with consultation of all interested parties.

The International Council on Mining and Metals (ICMM) has a series of training materials to support the development of resilient company-community relations.

Sustainable Bauxite Mines should:

- Identify key stakeholders and have a formalised plan and schedule for interacting with them;
- Consult with the community about the operation and ultimate closure of the mine; and
- Communicate on progress against any agreed actions.

Case Study – Weipa Community Engagement, Rio Tinto, Australia

Australia's remote western Cape York Peninsula is home to Rio Tinto's Weipa bauxite mine, which produces more than 30 million tonnes of bauxite annually. Rio Tinto has mined and shipped bauxite from this area since 1963. Local communities surrounding the operation on the Western Cape include the township of Weipa and the three nearby Indigenous communities of Aurukun, Mapoon and Napranum.

The mine communities team administers a community feedback system, a formalised process whereby members of the local community may provide both positive and negative feedback on any aspect of the company's operations. To ensure accessibility and awareness:

- Multiple contact points are available, including a toll-free phone number and direct contact with Rio Tinto Weipa personnel; and
- The process is advertised in the local newspaper, in site newsletters, on community noticeboards and informally when Rio Tinto Communities personnel visit local communities (Figure 15).

Figure 15. Rio Tinto staff meeting Traditional Owners

The Weipa community feedback system reflects the six overarching principles for non-judicial grievance processes – legitimate, accessible, predictable, equitable, transparent and rights compatible. To ensure this, feedback is logged by the team following a well-established process:

- The Rio Tinto business system is used as a tool to log incidents, assign follow-up actions and track the closure of concerns and incidents;
- The system enables incidents to be escalated to appropriate management levels based on their significance, and ensures that all relevant work areas are informed;
- Once feedback has been received and logged, the Communities team make an initial assessment to identify and contact the relevant work area team;
- The work area leader and Communities team then establish an investigation team, classify the incident, and investigate it to determine the root cause(s) and identify any actions that are needed to address it;
- Where an incident is classified as ‘significant’, the Communities manager, the relevant work area manager and the General Manager are notified; and
- The feedback procedure includes provisions for engagement and dialogue with the affected people.

Figure 16. Rio Tinto Weipa Quarterly Community Forum

The Weipa Community Forum provides opportunities to engage directly with members of local communities on matters of interest and to discuss business activities that are likely to affect the community. The forum also enables the company to report back to the community on how complaints are received and addressed (Figure 16).

Indigenous Peoples

Bauxite is often found in areas where there are populations of Indigenous Peoples and, as such, the mining company needs to be cognisant of their cultural heritage and values in order to promote a sustainable working relationship. Indeed, while the role of the mine cannot, and should not, replace the role of governments, there is an opportunity for a bauxite mine to make a positive contribution. For example, community engagement between Indigenous Peoples and a mining company should aim to ensure:

- Indigenous Peoples understand their rights;
- Companies in turn understand and respect the rights, aspirations and concerns of Indigenous Peoples;
- Indigenous Peoples are informed about, and understand, the full range of social and environmental impacts, both positive and negative, which may result from the mine;
- Companies understand and address positive and any negative impacts;
- Companies recognise, respect and use traditional knowledge where appropriate to inform decisions about the mine; and
- There is mutual understanding and respect regarding their respective roles, responsibilities and any decision-making processes.

In ensuring good engagement with Indigenous Peoples, a bauxite mining company should:

- Listen to indigenous communities and allow adequate time for discussions;
- Understand and respect the Indigenous Peoples and their customs;
- Ensure open, clear and frequent communication in the local language where possible;
- Ensure senior management are committed and involved, supported by experienced staff;
- Be aware of any gender sensitivity, while ensuring inclusion;
- Understand the traditional decision-making structure;
- Undertake baseline studies and impact assessments; and
- Make a commitment to indigenous employment – both directly and via the supply chain.

All bauxite mines should work to obtain broad, ongoing support of the local Indigenous Peoples.

Sustainable Bauxite Mines should:

- Understand the role, customs and decision-making practices of Indigenous Peoples impacted by the mine; and
- Appropriately consult with Indigenous Peoples prior to commencement of mining or mine construction.

Case Study – Weipa's Indigenous Engagement, Rio Tinto, Australia

When bauxite reserves were first discovered in Weipa in 1955, it was with the help of local Aboriginal people. However, in the years that followed the discovery, the nearby Mapoon mission closed and in 1963 Aboriginal people were forcibly removed from the area. Although not instigated by then owner Comalco, it was a sad chapter in the history of the region. Some 55 years on, Rio Tinto is now working in partnership with local Indigenous people to create positive economic, cultural, social and environmental outcomes for future generations.

Figure 17. Rio Tinto Weipa, Australia

Three Aboriginal Agreements underpin all Rio Tinto's activities at the Weipa operations - the Western Cape Communities Co-existence Agreement (WCCCA), the Ely Bauxite Mining Project Agreement, and the Weipa Township Agreement. These agreements outline how the business and Traditional Owners work together towards mutual value. They provide the land access that's critical for Rio Tinto's operations and ensure the social and economic benefits are shared within the Western Cape region. A fundamental aspect of these agreements is ensuring stakeholders are involved in deciding how benefits should be used within their communities. Both the WCCCA and Ely agreement are linked to trusts which are used to fund sustainable community initiatives such as educational bursaries, outstations for Traditional Owners and other on-Country activities. The WCCCA trust's strategy is to accumulate more than A$150 million for Traditional Owners and Western Cape communities by 2022 and is currently tracking ahead of target.

Rio Tinto's Weipa's Indigenous Employment and Training strategy was developed in collaboration with members of the agreements, and defines our long-term commitment to increasing the participation, retention and advancement of local Aboriginal people in our operations. It includes a number of initiatives designed to improve Indigenous employment participation rates, while also ensuring the business has the skills needed to support its operations, including:

- A traineeship programme – this is 15-years strong and has helped local Aboriginal people gain practical industry experience – more than 250 have taken part in the programme, with over 100 transitioning into permanent positions or apprenticeships, and approximately 82 are still working on the site today.
- School-to-work pathways – this is a more than decade-long partnership with the Western Cape College which focusses on providing quality local education options to build the local talent pipeline. Since the partnership began, there has been a 186% increase in the number of senior certificates awarded to Indigenous students, plus improved attendance rates.
- A school holiday programme – this allows local Aboriginal boarding school students connected to Rio Tinto's Aboriginal agreements to spend time at Weipa and learn about the different parts of the business and possible career pathways.

As a result of Rio Tinto Weipa's strong Aboriginal and Torres Strait Islander workforce reflects the recognition that their mines operate on traditional lands. It is estimated that more than 60% of Australia's mining operations neighbour Indigenous communities, however Indigenous employees make up on average only 6% of the country's mining workforce, compared to 24% of Weipa's employees which are Indigenous, and 14% are local Aboriginal people. A key aspiration of local Traditional Owner Groups is sustainable long-term employment for local Aboriginal People.

Case Study – Indigenous-owned and operated mine, Gulkula Mining, Australia

Gulkula Mining Company (Gulkula) is Australia's first Indigenous-owned and operated bauxite mine. Located in East Arnhem Land, Northern Territory, the mine is situated on the traditional land of the Yolŋu people. Operations commenced in late 2017 with progressive rehabilitation being undertaken as mining advances across the plateau.

More an instrument of social change than a mining operation, Gulkula has been striving to empower Indigenous communities since its inception. Local Yolŋu people, often with no formal qualifications, are employed by Gulkula and then trained to operate machinery, undertake maintenance activities, and assist in environmental management practices. On-the-job training therefore aids the development of work readiness in addition to practical skills.

Figure 18. A team member undergoing language, literacy, numeracy and digital (LLND) skills training

Gulkula continuously adapts management practices to support and build capacity among the Traditional Owners. The lack of English language, literacy, numeracy, and digital (LLND) skills among Yolŋu employees was a significant factor that limited their ability to access other potential learning opportunities and career advancements. It was also recognised in the broader community that language barriers inadvertently foster Indigenous dependency on native English speakers. Such reliance can result in the unconscious propagation of personal agendas, resulting in poor representation of Yolŋu perspectives. Gulkula has therefore established an LLND program to help its Indigenous staff expand their learning potential, and to observe a trend towards community empowerment such that Yolŋu Traditional Owners have a deeper understanding of all matters and are able to provide independent, informed opinions to aid decision-making with regard to managing East Arnhem Land.

Gulkula currently works with the Arnhem Land Progress Aboriginal Corporation (ALPA) Community Development Program to deliver relevant work experience activities and LLND training to young adults. By providing the benefit of stable employment, Gulkula aims to build capacity of its Yolŋu workforce such that non-Indigenous personnel function only as consultants. By imparting LLND as well as practical operational skills to its employees, it is anticipated that Yolŋu may be empowered to operate and manage the business independently, thus serving as pioneers among other Indigenous groups undertaking mining or natural resource management in Australia.

Figure 19. Following tutoring with an accredited Driver Trainer, a team member is successful in passing his Heavy Vehicle Theory Test

At present, Gulkula's bauxite mine is the primary income generator that sustains the ongoing LLND program. Gulkula is in the process of gaining status as a Registered Training Organisation (RTO) to deliver nationally accredited training that aligns with the Australian Qualifications Framework and has started delivering accredited driver / heavy vehicle training. The LLND initiative will form the basis of the broader program to upskill the Gulkula workforce and will allow employees to graduate into the RTO or Driving School. As mining concludes, Gulkula aspires to move into Natural Resource Management (NRM) by adopting silviculture post-mining. This will help sustain the local timber industry while allowing employees to transfer skill sets obtained while conducting mining activities. Also, as Indigenous literacy and other skills increase, it is then anticipated that the RTO and Driving School will lose dependency on the LLND program and thereafter function as independent domains that can sustain Yolŋu education and employment in the future.

Gulkula's model may serve as a pilot program in itself by showcasing the influence of LLND education on developing a self-sustaining economy. Results may potentially be extrapolated to the East Arnhem region to help wean dependencies off of welfare, royalties, and non-local organizations while creating a more robust, resilient community.

Figure 20. A team member assisting in dozer maintenance

Figure 21. Setting up camera traps for fauna surveys

Cultural Heritage

Sustainable bauxite mines must effectively manage cultural heritage. Cultural heritage management and preservation involves protecting and enhancing both the tangible and intangible aspects of cultural heritage. Key principles of cultural heritage management include[iv]:

- Recognising and acknowledging tangible heritage such as buildings, landscapes and artefacts;
- Recognising and acknowledging intangible heritage such as language, music and customary
- practice;
- Ensuring effective management – failure to do this may delay or prevent a mine's development;
- Adapting cultural heritage management to suit the needs of each individual situation; and
- Changing and adapting management approaches to cultural heritage as required.

Cultural heritage management has four phases (Figure 22).

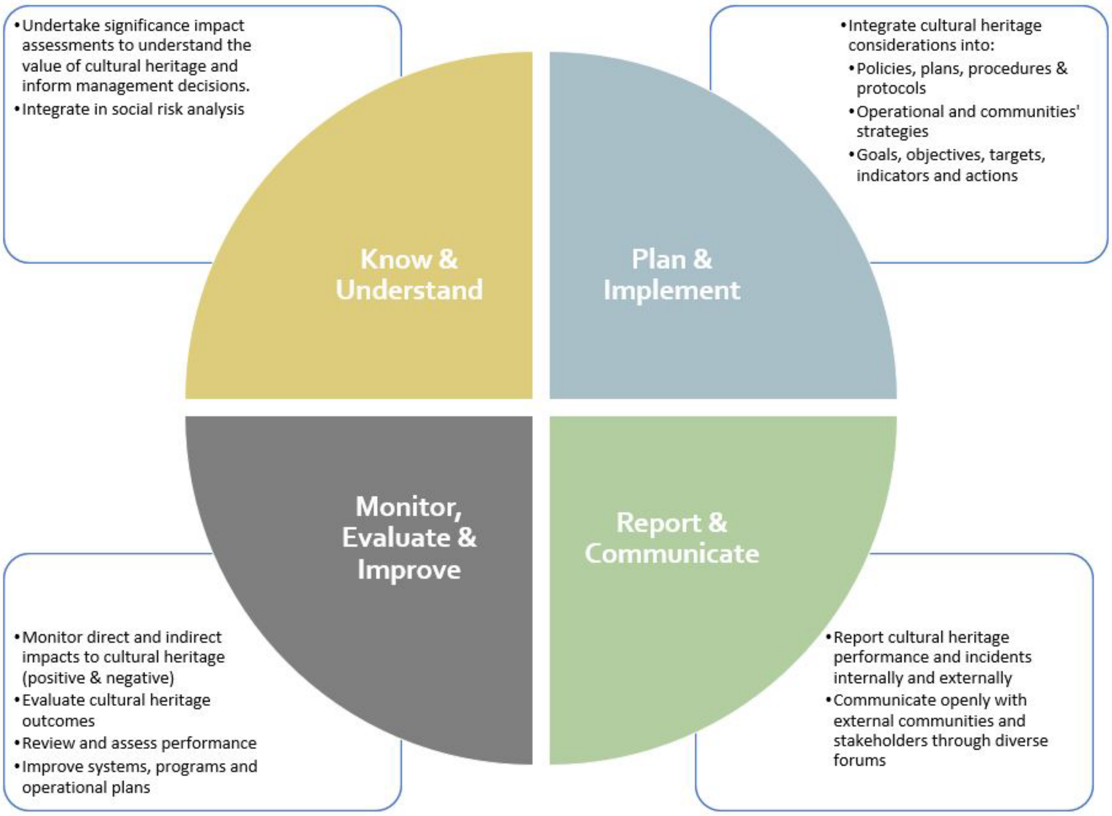


Figure 22. Phases of Cultural Heritage Management

These phases need to be considered at all stages in the mine's life cycle. Initially, cultural heritage should be surveyed prior to mining; however, previously unidentified sites may still be discovered during operations. All cultural heritage sites should therefore be managed using an ongoing process such as:

- Stopping work in the immediate area if any employee or contractors think they have discovered any cultural heritage materials;

- Establishing an appropriate buffer zone around the site until the suspected heritage items have been assessed;
- Assessing the heritage item – this needs to be carried out by a suitably qualified person (for example a historian, archaeologist or Traditional Owner representative group); and
- Making appropriate management recommendations based on the findings of the above before mining recommences.

Sustainable Bauxite Mines should:

- Understand and plan to preserve key aspects of cultural heritage relevant to the mining area; and
- Survey prior to mining and protect any additional cultural heritage sites identified during mining.

Case Study – Cultural Heritage, Weipa, Rio Tinto, Australia

In the Weipa region, the cultural heritage concerns of the Traditional Owners extend beyond archaeological sites to a strong and active spiritual connection to land and to an overall cultural landscape. Cultural heritage management in Weipa is therefore closely connected with the land, entailing significant rights and responsibilities of Traditional Owners over natural resource management. As such, the effective management of cultural heritage at Weipa requires the consideration of the entire cultural landscape as opposed to managing cultural heritage as disconnected objects. The challenge for Rio Tinto is to meets its obligations in a complex social and natural landscape with strong intangible cultural heritage values. For example, Figure 23 shows a senior Thanikiwithi Elder and a Rio Tinto heritage liaison officer collecting shell samples from a 500 year old midden for radiocarbon dating as part of a cultural heritage survey.

Figure 23. Cultural Heritage Survey

The development of a new mining region required an integrated and inclusive engagement approach by Rio Tinto to ensure that the Thanikwithi people's concerns about cultural heritage and environmental management were incorporated into the mine plan well before any site work commenced.

Specifically, the Traditional Owners raised concerns over the recreational use of an area called "Vyces Crossing". To the Thanikiwithi people, Vyces Crossing is a customary site used to welcome visitors to their land through a ceremony. While the Thanikiwithi people were comfortable for the site to continue to be used by the public, they expressed concerns about the environmental damage caused by 4WD vehicles driving on the creek bank, as well as people leaving their rubbish behind. Rio Tinto acknowledged these concerns as both a cultural heritage and a land management issue.

To address these concerns, the Rio Tinto worked with the Traditional Owners to introduce traffic control barriers to restrict people from driving on the riverbank, including a designated parking lot with bollards. These include interpretive signage and information pamphlets which focus on communicating the site's cultural significance to those who use it. The materials (Figure 24) also explain that continued access to depends on the goodwill of the Traditional Owners. The Thanikiwithi Traditional Owners and Rio Tinto jointly produced the brochure and other educational materials about this region.

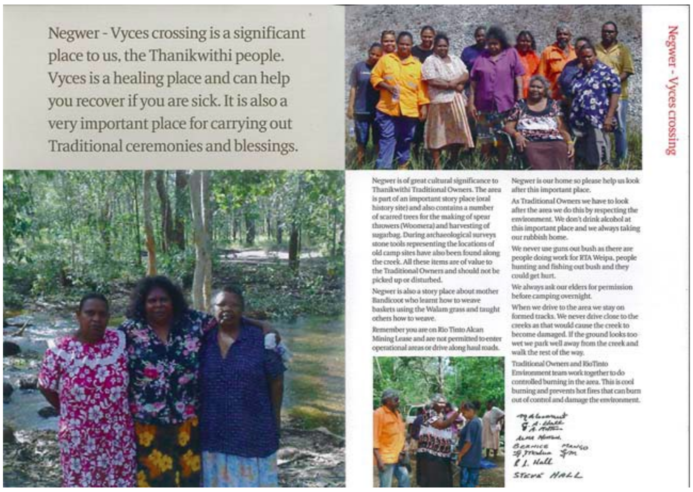


Figure 24. Cultural Heritage information brochure from Rio Tinto, Weipa, Australia

Inclusive engagement is needed to understand heritage at any operation, especially to identify appropriate management options for culturally significant places. The result of this inclusive engagement has been the development of an integrated management plan, the production of positive environmental outcomes in terms of land and water management, and the strengthening of relationships between the Weipa operation and the Traditional Owners.

Labour and Working Conditions

Bauxite mines provide employment and income. As such, companies need to also protect the rights of employees and contractors. By treating employees fairly and providing them with safe and healthy working conditions, companies create tangible benefits, including improved efficiency and productivity of the bauxite mine.

hours), public holidays and paid annual leave. All employees' right to a join a union or be part of a collective bargaining agreement should also be respected.

Further, there should not be discrimination based on any personal characteristics such as gender, race, national or social origin, religion, disability, political affiliation, sexual orientation, marital status, family responsibilities and age, which are unrelated to the inherent requirements of the work at the mine. Preventing discrimination extends to recruitment, hiring, compensation, working conditions, termination and discipline. This includes preventing harassment, intimidation and exploitation of all employees and contractors. Where targets are mandated by local legislation which require positive discrimination in favour of local residents, Indigenous Peoples, or individuals who have been historically disadvantaged, this is not regarded as discrimination. Indeed, prioritisation of local employees can help create more a more sustainable mining operation.

Children under the age of 15 should not be employed. Children under the age of 18 should not be employed for any hazardous work and should only be employed between the ages of 15 and 18 where it is not economically exploitative, will not interfere with the child's education, nor to be harmful to the child's development. All work of children under the age of 18 should be after an appropriate risk assessment and there must be regular monitoring of their health, working conditions and hours of work. Additionally, sustainable bauxite mines will not employ any forced labour.

With regards to providing a safe and healthy work environment, a sustainable mine should take steps to prevent accidents, injury and disease, including:

- Identification of potential hazards to employees and contractors with initial attention being paid to those that pose the greatest risk;
- Modification, substitution, or elimination of these hazardous conditions or substances to reduce the risk;
- Training of employees and contractors;
- Documentation and reporting of workplace accidents, illness and diseases, and incidents; and
- Emergency prevention, preparedness, and response arrangements.

The protection of the health and safety of employees and contractors extends to ensuring that the mine does not engage in nor tolerate the use of corporal punishment, verbal abuse, harassment or gender-based violence, including sexual harassment.

Sustainable Bauxite Mines should:

- Not used forced or child labour (as defined by International Labour Organization (ILO) Conventions C138 and C182) and shall comply with related national laws;
- Provide documented, fair working conditions to all employees appropriate to local standards; and
- Ensure the health and safety, of all employees and contractors.

Transport and Traffic

While transport of bauxite and traffic management within the mine gate form a routine part of mine planning and mine safety, bauxite needs ultimately to be transported offsite to an alumina refinery. It may be transported by road, rail, conveyor, pipeline or ship or a combination thereof. While alternatives to road transport on public roads are included in the Associated Infrastructure section of these Guidelines, sometimes there may not be an alternative. Smaller bauxite mines are less likely to have the capacity to construct their own associated infrastructure and are more likely to use public facilities. The cumulative impact of the use of public infrastructure therefore needs to be considered by a regional body or aggregator.

Mine traffic on public roads increases traffic congestion and with the increased heavy vehicle interaction there is an increased risk of accidents. Controlling and monitoring this vehicle traffic reduces risks and impacts on the surrounding communities. However, managing road hazards and users on roads that are not under the direct supervision and control of a mine may be more challenging than managing safety within the mining area. Some of the hazards associated with on public roads include:

- Inadequate road configuration for the heavy vehicles;
- Interaction with fauna;
- Unsafe speed with other traffic on roads; and
- Lack of driver training.

Strategies to improve safety on public roads may include:

- Understanding who are the key stakeholders in the management of safety on local roads (e.g., local or state government, police, community);
- Working with stakeholders who own the roads to upgrade key features such as signage, lighting, intersections, crossings, speed limits, line markings, guideposts and railings to improve safety for all users;
- Ensuring bauxite is transported in covered vehicles with appropriate load limits, to minimise dust which is a nuisance to community but also reduces visibility;
- Providing safe driving training for all employees who drive on public roads;
- Providing community education programmes on road safety and vehicle interactions;
- Identifying optimum transport routes which minimise traffic interactions with communities;
- Scheduling use of public roads based on other road users to avoid daily and seasonal peaks;
- Ensuring contracts are appropriately structured so as to ensure maintenance and insurance are pre-requisites and do not inadvertently incentivise speeding or insufficient fatigue breaks;
- Providing transport to and from the mine for employees and contractors to reduce traffic on the road and ensure they arrive fit for work; and
- Increasing public transport to reduce the number of other vehicles on the roads.

A traffic management plan may be prepared by:

- Understanding the existing traffic usage of a route, including the current proportion of heavy vehicles;
- Then understand the proposed routes and how these will vary during construction or operations including employee travel, incoming materials and outgoing bauxite;

- Assessing the impact of the mine on existing road traffic, by vehicle type and route, including the ability of the road to withstand weight and increased intersection impact; and
- Identifying and implement key actions to mitigate these risks.

Sustainable Bauxite Mines should have:

- Have a traffic management plan, developed in consultation with key stakeholders, if transport of bauxite on public roads or through the community cannot be avoided;
- Ensure all transport through the community includes safety training; and
- Ensure that transport personnel adhere to speed restrictions and cover all vehicles appropriately.

Case Study – Minimising the Community Impact of Bauxite Transport, Spring Energy, Malaysia

Spring Energy commenced mining bauxite in the Pahang State of Malaysia in late 2013. The bauxite mined at KotaSAS has a grade of approximately 33 - 40% and is sometimes quite high in clay. This high clay content combined with the high regional rainfall sometimes makes the bauxite stick to vehicles. Bauxite is transported to the Port of Kuantan, approximately 20 km away by public road. Spring Energy undertook a number of measures to minimise the impact of this bauxite transport on the local community:

- All vehicles entering and leaving the site are washed using a dedicated staffed wash station; and
- Vehicles are not overloaded and are securely covered to minimise bauxite spilling on the road and dust.

Figure 25 –Figure 28 show Spring Energy's implementation of these measures, compared to non-implementation by some other operators in the region.

Figure 25. Spring Energy Vehicle Wash

Figure 26. Unwashed Vehicle on Public Road

Figure 27. Spring Energy Well Loaded and Covered Truck

Figure 28. Poorly Loaded Truck with Non-Secure Cover

Additionally, as the mine is located adjacent to the construction of a new regional administrative centre, dust within the site is minimised using a water truck. All water from the truck wash is collected and recycled for use on the site, such as in the water truck (Figure 29).

Figure 29. Spring Energy Water Truck Onsite

Land Acquisition and Community Displacement

The location of bauxite deposits limits possible mine locations. If a mine needs to be established close to an existing community, it may result in economic and or community displacement. While community displacement is rarer for bauxite mines, economic displacement because of changing land use may be a more common issue and mitigating measures or compensation for this economic loss is often a major source of social concern and reputational risk. Sometimes, it is also not clear who the current landowner is, who the key stakeholders are and where mitigating measures or compensation, if any, should be directed.

As the bauxite mining industry undergoes a change which includes more smaller mines, this increases the challenges associated with land access. A single land holder who has previously engaged in agriculture or other activities may be willing to mine bauxite on their land, but this has flow on impacts for neighbouring properties. This emerging issue needs to be addressed, particularly the cumulative impacts of this.

Planning should start early, with companies meaningfully engaging with affected communities to assess and mitigate potential impacts from both land use change and any potential community displacement. Many projects focus on cash compensation but providing cash compensation to low-income households generally leads to unsustainable spending, contributing to longer-term impoverishment. Projects which minimise cash compensation and provide alternative mitigations are generally more sustainable and successful. However, failure to adequately compensate impacted households is one of the greatest causes of grievances and conflict on projects. There is no single formula for calculating compensation, if required, on land access. Nevertheless, using experienced valuation professionals and ensuring all stakeholders are consulted can help develop appropriate approaches. The outcome of this consultation should be mitigating measures, a compensation plan or a livelihood restoration plan where there is economic displacement and or a resettlement action plan where there is community (physical) displacement.

There are internationally recognised guidelines (e.g. ICMM Land Acquisition and Resettlement: Lessons Learned or International Finance Corporation) on land acquisition and displacement that may be referred to in such instances.

Community displacement occurs when households living in the area of the mine are required to move. This may only be done with the explicit approval of national or local government, but it nonetheless presents significant impacts, both to those affected and to the reputational risks to the company involved. For example, community displacement requires effective identification, design, planning and construction of alternative villages, housing and related facilities to mitigate effectively for not only physical losses, but also to support the future cohesion and success of the communities affected.

Resettlement packages and assistance should typically include:
- Cash mitigating measures or compensation for assets, including crops and structures;
- Provision of resettlement housing;
- Provision of a resettlement site;
- Allowances to facilitate the moving process; and
- Livelihood restoration programmes.

The choice of resettlement site is the single most important criterion in supporting the restoration of the livelihood of the impacted household. The mining company must ensure that the preferences of the different community stakeholders are understood and balanced with the pressure to cut costs by being close to existing infrastructure. The design of resettlement housing needs to include government to ensure that these settlements are sustainable in terms of maintenance and services.

Sustainable Bauxite Mines should:
- Consider the need for economic mitigating measures or compensation for loss of land use and its other community values;
- Avoid physical community displacement if possible;
- If it cannot be avoided, then engage with the affected community to jointly develop a resettlement action plan; and
- Seek approval from the Government to implement any relocation.

Case study – Livelihood Restoration in Guinea, Alufer Mining

Alufer is an independent mining company with significant bauxite assets in Guinea. The Bel Air mine, the Company's flagship project, commenced production in August 2018. Alufer's vision encompasses creating wealth for its stakeholders through the development and operation of a sustainable mining business. As part of this vision, Alufer promotes alternative livelihoods across the mine's footprint and support has been provided to a number of economic initiatives in host communities.

One of Alufer's key initiatives includes the development of local market gardening (aubergine, chilli pepper, watermelon, pineapple) opportunities which has been shown to be a viable and profitable pursuit, with 9 perimeters now established across the area. This employs up to 200 people, predominantly women, working either in cooperative structures or in family groupings. A range of small businesses have also been supported in the community, covering key services, catering and animal husbandry. Solar salt production and fruit farming, especially cashews, were also supported in the early stages of production. A small proportion of the produce thus generated is sold to the mine camp. Most of the production however and all the services, are destined to the wider market, the promoters' access is currently the main focus of the support provided by the mine.

Figure 30. First harvest of aubergine

6. Health and Safety

Health and Safety Considerations

The main safety risks in bauxite mining are common across the mining sector, such as mobile equipment, working at heights, confined spaces and electrical safety. An overview of the main types of workplace health related physical, chemical, biological and ergonomic risks associated with bauxite mining is available in the Journal of Occupational and Environmental Medicine, Vol 56, S5. It should be noted that opportunities to improve occupational and community health and well-being may be quite specific to the location. Actions to mitigate any risks or take advantage of the opportunities also need to be handled with sensitivity to the local context.

Occupational health and safety aspects occur during all phases of the mine cycle. It is good practice to conduct occupational health and safety risk assessments to identify, evaluate and mitigate key risks regularly. Occupational health and safety issues may be classified according to the following categories which should be considered under a comprehensive health and safety plan:

- General workplace health and safety
- Travel and remote site health
- Fitness for work
- Ionising radiation
- Thermal stress
- Noise and vibration
- Fatigue Management
- Mental Health and Well being
- Physical hazards
- Hazardous substances
- Confined spaces
- Hand tools
- Electrical safety and isolation
- Work at height
- Light vehicles and mobile equipment
- Machine protection
- Excavation

These risks may be quite specific to the location and need to be handled with sensitivity to the local context. For example, onsite, companies should provide safe and healthy working conditions for employees and contractors, taking all practical and reasonable measures to eliminate workplace fatalities, injuries and diseases, including implementing and maintaining a health and safety system. Health and safety system should include:

- A health and safety rights policy for all workers (employees and contractors) to recognise their rights and responsibilities in accordance with all relevant standards;
- Alignment with the World Health Organisation definition of "health" which states: *"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*."
- A documented occupational health and safety management system set up as part of this policy. This must be compliant with applicable national and, ideally, international standards, and must seek to identify hazards, and assess and control risks at workplaces;
- A regular audit of this system as well as certification to an international standard such as OHSAS 18000 or ISO 45001; and
- An evaluation and report on the mine's health and safety performance, including comparison to its mining peers.

There are a number of existing guidelines and frameworks that can support the identification of hazards and development of occupational health and safety work plans and risk assessments. Examples include:

- ICMM's Critical Control Management: Good practice guide (2015)
- ICMM's Good Practice Guidance on Occupational Health Risk Assessment (2016)
- The Mining Association of Canada's Safety and Health Protocol

In addition, a wider community approach to health and safety should also be considered. A healthy community means healthy families, which means a safer and motivated workforce. This should be done with the input of workers and may include programmes such as:

- Nutrition & weight management
- Smoking cessation
- Depression screening
- Work-life balance initiatives

- Stress management
- Cholesterol management
- Diabetes education
- Vaccination & immunisations
- Heart health programmes
- Sexual health
- Vector-borne disease control
- Drugs & alcohol programmes
- Sanitation infrastructure

In addition, depending on the level of infrastructure around the mine, there may be little or no formal government capacity for meeting the more urgent medical needs of employees and contractors, their families and communities. A bauxite mine may therefore invest in the building of healthcare infrastructure and in the establishment of emergency response personnel and equipment, including doctors, nurses and hygienists.

Sustainable Bauxite Mines should:

- Have a documented system to identify, assess, manage and minimise health and safety hazards and control the risks; and
- Understand the health needs of the local community and how these relate with the needs of the mine operation.

Case Study – Community Health, Durgmanwadi, Hindalco, India

At Hindalco's Durgmanwadi mine, responsibility as a sustainable bauxite operation includes a comprehensive plan which leads to overall improved health and wellbeing in the community. Initiatives as part of this plan include:

- Education: investment in primary and adult educational activities, including construction / renovation of school building, provision school uniform, books & other instruments;
- Healthcare: the mine provides free medical services to the community through their dispensary, the medical team regularly conducts health check camps and distributes free medicines;
- Sustainable Livelihood: formation of women's self-help groups in many villages and provided vocational training to local women. The women now actively participate in economic activities such as a milk co-op dairy, mushroom cultivation, nursery raising, vermi compost (Figure 31), goat-rabbit rearing and handicrafts;
- Social Projects: investment in social projects such as organic farming, providing smokeless Chulas, a fuel stand, solar lamps to reduce the smoke; wheelchair cycles provided to disabled people, and fruit bearing sapling distributed to the villagers; and
- Infrastructure Development: construction of roads, gutters, latrines, and a water treatment plant as well as provision of irrigation schemes for farmers, streetlights and house repairs in the local community and the renovation of a gravity water flow scheme.

Figure 31. Vermi Compost

Case Study – Reducing Occupational Safety Risks: Anti Fatigue and Collision Avoidance System, Paragominas, Brazil

This case study features in the IAI's Guidelines for Developing Fatigue Risk Management Systems.

The operation of equipment at Hydro's bauxite mine in Paragominas, Brazil is characterized as a level 4, major risk and as a result, it is necessary to seek measures to eliminate or reduce risks associated with the mining activity. In bauxite ore transport, one of the main risks is collision between equipment and overturning caused by fatigue events. In addition to other measures, such as speed control, Mineração Paragominas, has implemented technology-based anti-fatigue and collision avoidance systems. The anti-fatigue system monitors operator fatigue and alerts them during work shifts, as well as providing online reports to the control room. Among the fatigue events that are monitored are:

- Microsleep (criterion: continuously closed eyes over 2.9 seconds);
- Slow blink (criterion: above 60% of the time with eyes closed in a 10 second period);
- Distraction (characterised by looking sideways, losing focus on the track).

The system's artificial intelligence creates an event history for each operator, including the hours worked by those individuals, and files it in a database, mapping the date and time of fatigue events and types of events recorded. Based on this database, the system can develop an individualized profile of each operator registered. The system generates alarms in case of fatigue both in the equipment cabin and in the operations control room, which requests the equipment to be stopped immediately, thus preventing an accident. Regarding the employee who presented fatigue signs, their supervisor is communicated and goes to the equipment to take the employee to assistance from occupational medicine. In addition to triggering these immediate actions, the system works in concert with the Mineração Paragominas collision avoidance system (based on the equipment's GPS positioning) both of which are connected to the dispatch system. Thus, the mine control room has the ability both to operationalize the dimensioning of the mine and to request a stop due to fatigue issues. Since implementation of the two systems Mineração Paragominas has seen a reduction of 100% in overturning events and of 60% in fatigue events.

Emergency Preparedness

Responding effectively to emergencies is essential for bauxite mines; to better protect employees, local communities and wider region from harm. One of the major risks from bauxite mining is from tailings dams where there is onsite beneficiation. More recently, the COVID-19 pandemic has also tested the preparedness of many sites to respond swiftly to crises situations ensuring the health and wellbeing of their workforces and local communities.

While a bauxite mine has a responsibility to be prepared for emergencies through internal mechanisms, it's equally important to work with communities living near mine sites to increase their understanding of potential threats to safety. This is particularly important for bauxite mines which are in remote regions where the mining company may provide considerable local infrastructure and personnel. A fast and effective local response to an emergency incident may be the most important factor in limiting illness or injury to people, property and the environment.

A structured approach, such as the use of a Local Emergency Response Planning Group, to developing an emergency response plan helps companies work with local authorities and communities to identify who does what in an emergency, advise on training and scope possible community liaison functions (Figure 32).

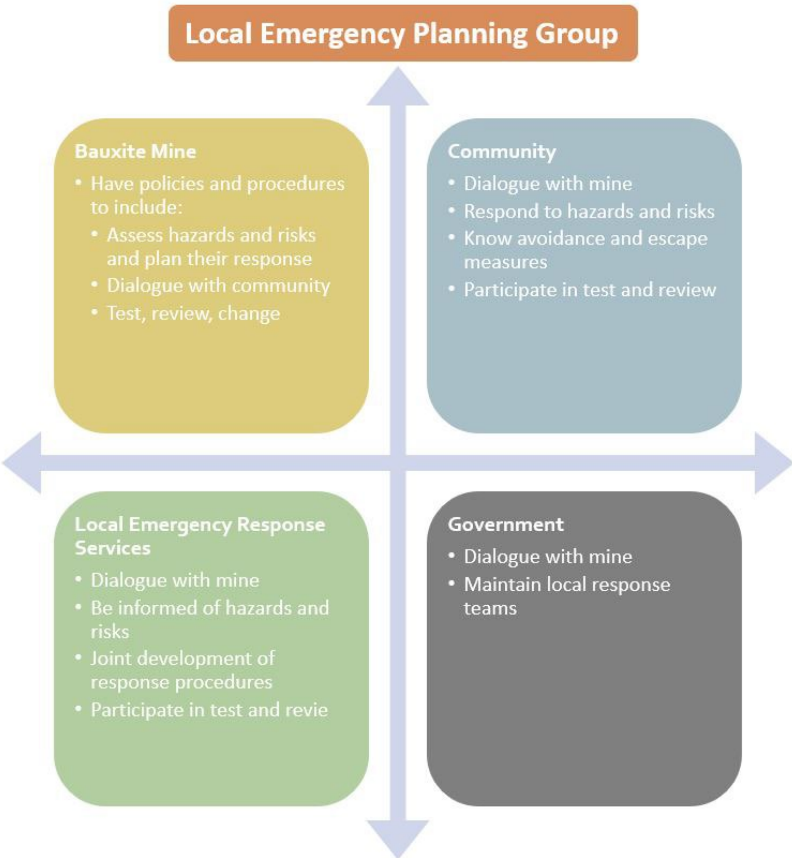


Figure 32. Local Emergency Planning Co-ordinating Group[V]

Emergency response plans define:

- Responsibilities, organisation and coordination for response to an emergency;
- Emergency situations;
- Evaluation of areas and effects;
- Communication and warning systems;
- Evacuation procedures;

- Duration of emergency and follow-up; and
- Updating the plan.

By continually training teams and updating the plan, companies may ensure the safety and integrity of their employees and contractors and communities around any tailings dams and other immediate health and safety risks.

Sustainable Bauxite Mines should:

- Use a risk-based approach to understand and manage potential impacts from the mine; and
- Work with the community, government and emergency services to develop, document and implement an emergency plan.

Security Considerations

It is essential that bauxite mines maintain not only the safety but also the security of their operations. This can be particularly challenging when operating in areas of conflict or weak governance. Mine operators need to assess risks to the security of personnel, local communities and assets. Such assessments require credible input from a range of stakeholders, including local and national governments, security firms, other companies, institutions, public bodies and individuals knowledgeable about local conditions. A risk assessment should consider the following:

- Identification of security hazards and assessment of risks, which can result from political, economic, civil or social factors. Certain personnel and assets may be at greater risk than others. In some cases, action by a Company may heighten risk;
- Potential for violence; depending on the environment, violence can be widespread or limited to particular regions, and it can develop with little or no warning;
- Human rights records of public security forces, paramilitaries, local and national law enforcement, as well as the reputation of private security. Awareness of past abuses and allegations can help to avoid recurrences as well as to promote accountability. Identification of the capability of different entities to respond to situations can help develop appropriate risk mitigation measures;
- The local prosecuting authority and judiciary's capacity to hold accountable those responsible for human rights abuses and for those responsible for violations of international humanitarian law in a manner that respects the rights of the accused; and
- Identification of and understanding the root causes and nature of local conflicts, as well as the level of adherence to human rights and international humanitarian law standards by key stakeholders.

Although governments have a primary role in maintaining law and order and in ensuring public safety, mine operators have an interest in ensuring that actions taken by governments, particularly the actions of public security providers, are consistent with the protection and promotion of human rights. Where companies provide additional resources to supplement existing security they should:

- Regularly consult with host governments and local communities about the impact of their security arrangements on those communities;
- Communicate their policies regarding ethical conduct and human rights to security providers, and including the need for adequate and effective training of personnel to uphold these policies; and
- Encourage host governments to permit making security arrangements transparent and accessible to the public, subject to any overriding safety and security concerns.

Mining companies should consider the following principles in the use of either public or private security:

- Individuals credibly implicated in human rights abuses should not provide security services;
- Force should be used only when strictly necessary and to an extent proportional to the threat;
- The rights of individuals should not be violated while exercising the right to exercise freedom of association and peaceful assembly, the right to engage in collective bargaining, or other related rights of company employees;
- In cases where physical force is used by public or private security, such incidents should be reported to the appropriate authorities and to the host mining company, medical aid should be provided to injured persons, including to offenders; and
- A need for the recording and reporting of any credible allegations of human rights abuses by public or private security to appropriate host government authorities, including investigation and action taken to prevent any recurrence.

Sustainable Bauxite Mines should:

- Use a risk-based approach to determine appropriate security needs and that any private security personnel used receive adequate training to respect the rights of employees and the local community.

6. Environmental Management and Performance

Environmental Management

While the environmental management of all mining operations is of great importance, bauxite is commonly found in high rainfall tropical areas which often have particularly high levels of biodiversity. As such, the main aims of environmental management of bauxite mining should be:

- Minimising the impact of dust and noise emissions from mining operations and traffic on communities and the environment;
- Mitigating impacts on flora and fauna from land clearing by limiting open area based on annual mine plan;
- Controlling erosion and minimising sediment-laden runoff;
- Management of water resources and water quality in consideration of local community needs;
- Implementing a high standard of rehabilitation of disturbed areas;
- Minimising impacts from waste disposal, including tailings, over the life of the mine and beyond; and
- Use energy and water efficiently.

Mines should conduct a range of assessments of their activities before commencement of mining, including:

- Baseline monitoring of surface and groundwater flows and water near proposed mining areas;
- Impact assessment of mining activities on other water users (farmers, fishermen, municipal users, industry, recreational users);
- Baseline surveys and assessment of impacts on terrestrial and aquatic flora and fauna;
- Baseline monitoring of dust and noise levels and assessment of impact on neighbours and wildlife;
- Baseline community health assessments where relevant; and
- Socio-economic survey and assessment of social and economic impacts.

Where it is likely that there will be multiple smaller mines within a close geographic area it is important for the cumulative environmental and social impacts to be assessed.

In particular, all bauxite mines should have a documented EMS which is integrated with the mine and business plan. The development of an EMS should include:

- A systematic review of all operations to identify potential environmental impacts using a recognised risk assessment framework. This is used to rank the environmental aspects and impacts according to potential consequences (including environmental, regulatory, community and financial) and the likelihood (or frequency) of occurrence;
- A system to mitigate or minimise the impact of all potential impacts ranked as ‘significant’ on the environment and communities;

- A plan to monitor and improve environmental performance, and to report relevant information to stakeholders, including local communities; and
- A complete audit, both internal and external, and ideally certification to an international standard such as ISO14001.

Sustainable Bauxite Mines should have:

- Completed a pre-mining impact assessment;
- Have a documented EMS which identifies hazards and assesses and controls risks; and
- A plan on how to report their performance publicly.

Case study - Baphlimali Mines Integrated Environment and Biodiversity Management, Hindalco, India

Since 2018, Hindalco has adopted the biodiversity policy and technical standards of Aditya Birla Group, its parent company, on Biodiversity Management. The policy defines an ambition to achieve "No Net Loss" of biodiversity. Through its partnership with the International Union for Conservation of Nature (IUCN), Hindalco has conducted comprehensive biodiversity assessments over 3 seasons and developed biodiversity management plans at 4 of its key locations.

Figure 33. Mass plantation on reclaimed land at Baphlimali Mines, India

The Baphlimali bauxite mines located in Odisha was identified as one of Hindalco's priority sites for developing a biodiversity management plan. Mining operations commenced at these mines in 2013 and approximately 3 million tonnes of bauxite per year is supplied to Hindalco's Utkal Alumina refinery complex via a long-distance conveyor.

The biodiversity plan for the Baphlimali mines focuses on:

- Increasing native vegetative cover in backfilled areas;
- Developing green belts in peripheral areas;
- Enhancing native species for nursery development and plantation;
- Developing a water body using mined out areas as wetland habitat;
- Habitat enhancement through improvised plantation techniques, riparian habitat development, bio filter check dam; and
- Increasing the number of nest boxes for bird conservation.

By identifying these focus areas and integrating biodiversity considerations into the mine's management, the site has been able to rehabilitate and revegetate over 67 ha of backfilled mine area as of March 2020 and have set a goal to increase this to around 94 ha by 2022. Recognising the importance of water to rehabilitation and biodiversity efforts approximately 250 ha of previously mined out areas are proposed be developed into water bodies across the mine site over the next decade.

In addition to the five focus areas outlined above that have direct impacts on the mine's biodiversity, there are multiple community and livelihood programs that have been taken up. These employ almost 2000 farmers across 50 local villages. The programmes serve multiple purposes of:

- Encouraging engagement with local communities and improve livelihoods;
- Increasing local biodiversity through good land management practices and crop development (e.g., orchards, nut plantations, lemon grass cultivation and vegetable farming); and
- Installation of infrastructure to support longer term efforts (e.g., irrigation dams and canals).

Figure 34. Revegetated land at Baphlimali Mines, India

To maintain the momentum built over the past few years, the mine also runs a number of awareness programs. One example is of World Environment Day celebration when there is a mass plantation event with many site workers and locals coming together to plant new vegetation on reclaimed land. As part of its long-term commitment to biodiversity, the mine is establishing a dedicated biodiversity team which will include four local villagers in supervisory roles working with a specialist team leader and other experienced experts on site.

Figure 35. Lemon grass cultivation at Baphlimali Mines, India

Case study: Concurrent rehabilitation effort, Alufer Mining, Bel Air Mine, Guinea

Alufer Mining's Bel Air Mine in Guinea began operations in 2018. Recognising the importance of mine rehabilitation efforts as part of the wider environmental management approach, within months of starting production, work began on establishing two nurseries in the community. These nurseries were set up to grow all local saplings to support the mine's rehabilitation efforts.

Borrow pits in the camp's immediate surroundings and a small section of Pit 2 were revegetated by this means in 2019, with regular monitoring undertaken on a quarterly basis until the plants are fully established. In 2020, these two nurseries, which now employ up to 15 people year-round, delivered 27,000 saplings to the mine. A further 50 young local people were employed to assist with the revegetation efforts planting the saplings and grass seeds and reeds to prevent erosion. During 2020, the spent areas of pits 2 and 5 were the main focus of the rehabilitation campaign. Eight school playgrounds were also planted up in a bid to raise environmental awareness and rehabilitation efforts more broadly across the community.

Associated Infrastructure

Bauxite transported onsite needs to be managed to minimise noise and dust using methods such as road watering and speed limits. Additionally, the bauxite product needs to be transported offsite to alumina refineries, either directly or indirectly – this is commonly via third party transport. Therefore, in addition to the bauxite mine itself, mines usually have other associated infrastructure, including:

- Ancillary infrastructure such as power station, workshops, warehouse, administration facilities, sewage treatment plants, waste disposal and fuel storage;
- Permanent camps or construction camps for employees and contractors;
- Health care facilities especially in remote locations;
- Water supply infrastructure such as dams;
- Ports, ship loading and unloading facilities;
- Roads, both mine only use and public;
- Overland conveyors;
- Airports;
- Pipelines for transporting of bauxite slurries; and
- Rail lines.

Depending on the scale and location of associated infrastructure, transport should be considered as part of the environmental and social impact of the mine itself or even as an independent project with its own SIA and EIA. That is, the extent to which the bauxite mine is a key user or developer of this infrastructure needs to be considered – for example, small bauxite mines are less likely to have the capacity to construct their own associated infrastructure and may increasingly rely on community infrastructure (particularly roads, power and water). As the number of these small mines increases, the impacts to the community through the use of this shared infrastructure can be significant.

However, while reducing transport of bauxite on public roads may reduce social concerns about traffic, the implementation of alternate transport such as the construction of a new port may itself introduce new risks. Additionally, with existing ports or rail, an increase in the movement of vessels or trains increases the risk of collision, resulting in a safety incident or environmental harm. The benefits of improved public amenity from one form of product transport therefore needs to be compared to the environmental and social impact of another.

While bauxite is non-hazardous, such spillages during loading and unloading are possible. Control measures should therefore be adopted to minimise the risk of spillage, including:

- Use of catch trays under transfer points;
- Positioning belt scraping with water sprays on conveyors to clean the belt and the water used for belt cleaning should be returned to sedimentation ponds;
- Using variable speed drives on conveyors to minimise potential for spillage;
- Installing belt drift switches on the conveyor that shuts down the conveyor drives if a belt moves from the designed position;
- Locating maintenance areas including on ship loaders and unloaders, such that runoff is captured for treatment prior to discharge.

In addition, accidental spillage of fuel and oil may occur. Hydrocarbon spills can be minimised by:

- Ensuring all fuel tanks are double skinned and bunded, and not installing underground tanks;
- Using alarms which provide a visual or audible alert if there has been a hydrocarbon spill;
- Using automatic shut off valves when refuelling;
- Installing and maintaining efficient oil and grease traps or sumps at refuelling facilities, workshops and fuel storage depots; and
- Providing hydrocarbon spill kits and disposing of any contaminated material appropriately.

Sustainable Bauxite Mines should:

- Include all infrastructure associated with the mine when assessing environmental and social impacts; and
- Have a plan for safe operation of roads, ports, railways whether they are public or private, including consideration of community impacts.

Case Study – Infrastructure Options, Pará State, Brazil

Bauxite is an abundant raw material in Pará State, Brazil (Figure 36). There are multiple mines in the region, and it is one of the most important mining areas in the world. The mines located there have approached the operational and community challenges of bauxite transport in different ways.

Mineração Rio do Norte (MRN) was one of the first large-scale industrial projects in the Amazon. MRN started operations in 1979 and the plants' capacity is 18.3 million tons per year. MRN operates a 28-kilometre railroad to transport bauxite from the wash plant to the port. The bauxite is sold to the partners and transported by ship from the Port of Trombetas (Figure 37), also operated by MRN. From there, it is transported for approximately 1,000 kilometres on ships to alumina refineries such as Hydro's Alunorte, Consórcio Alumar and other international customers.

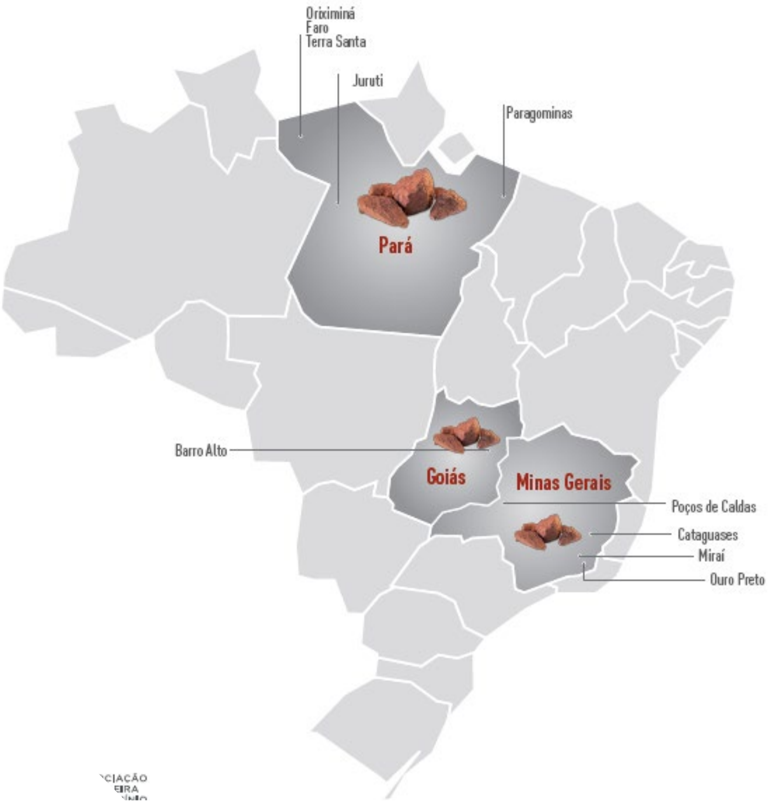


Figure 36. Bauxite Mines in Brazil[vi]

Figure 37. Port of Trombetas

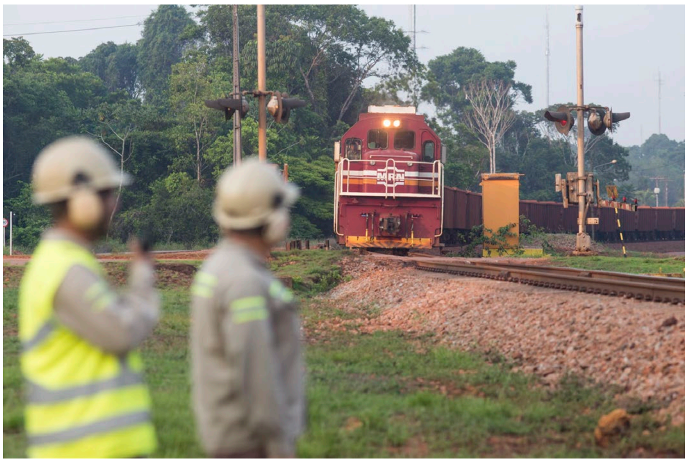


Figure 38. MRN Railroad Operations

The Norwegian owned Hydro bauxite mine in Paragominas is 64 km from urban areas, in the northeast of Pará state, 350 km from the capital, Belém. It started operations in 2007 and transports all its bauxite along a 244 km pipeline. This pipeline, with a capacity of 15 million tons per year, is a global pioneer in bauxite transportation. It sends the ore to the municipality of Barcarena, in Pará, to also feed the Hydro Alunorte alumina refinery. Transporting the bauxite through pipeline reduces the environmental impact – the surrounding habitat is not cut off or isolated, there are no noise or dust concerns except during construction, and there are fewer resettlement impacts for the community. As the bauxite pipeline is underground it is better protected and more secure as the local population is not exposed to moving railways or trucks.

Another mine, Alcoa's Juruti mine, in the west of Pará state, started operations in 2009 and its current production capacity is 5.3 million tons a year. In addition to mining, other facilities at the project include a railroad built by the company, approximately 55 km long, to transport the bauxite from the processing facilities to the port terminal on the banks of the Amazon River, located two kilometres from the centre of the municipality.

Water Management

Water is a shared and finite resource, with high social, cultural, environmental and economic value. It is also an essential component of all bauxite mining operations. Bauxite mining companies should aim to minimise water consumption, maximise reuse of water, avoid contamination of any neighbouring bodies of water, and maintain monitoring programmes to measure their performance.

Further guidance on water management is available from the ICMM Water Stewardship Framework and the ICMM Practical Guide to Catchment-Based Water Management.

Bauxite mines often use large quantities of water, especially in beneficiation plants and in dust suppression. Mines in high rainfall areas may experience high run-off flows which require careful management. Bauxite mines should:

- Consult with key stakeholders to understand any conflicting water use demands and the communities' and environment's dependency on water resources in the area;
- Establish a site-wide water balance based on the best available long-term meteorological information and use this to optimise infrastructure design; and

- Maximise reuse and recycling of water (e.g., return of decant water from tailings dams to beneficiation plants) to minimise use of groundwater and surface water supplies and minimise impacts on other water users.

With regards to water quality, the main potential impacts on water quality are associated with increased turbidity in runoff and accidental hydrocarbon spills (chemicals are not used in the bauxite beneficiation process). Recommended practices to manage impacts on water quality include:

- Ensuring discharges to surface water do not result in unacceptable increases in contaminant concentrations in receiving waters;
- Installing efficient oil and grease traps or sumps and maintaining these at refuelling facilities, workshops, fuel storage depots;
- Ensuring hydrocarbon spill kits are available;
- Treating sanitary wastewater to a standard such that discharge does not compromise human health or the receiving environment; and
- Monitoring the quality and quantity of discharges to the environment, including storm water, which have the potential to cause environmental harm – this needs to be done at monitoring points agreed with the regulator.

The key approaches to management of stormwater include separation of clean and dirty water, minimisation of exposed erosion-prone and/or contaminated ground surfaces and use of sediment control measures. Recommended practices include:

- Clearing schedule land during the driest months;
- Providing sumps in the mine pit to retain storm water;
- Establishing direct runoff from pits and haul roads to sediment retention ponds;
- Using phytoremediation in ditches and sediment ponds to reduce TSS (total suspended soils) and metal concentrations;
- Planning the mine such that there are multiple smaller pits interspersed with rehabilitated areas rather than a single large pit;
- Ripping pit floors to increase infiltration and reduce runoff;
- Revegetating disturbed areas as soon as possible after completion of mining; and
- Maintaining an appropriate buffer zone of undisturbed vegetation around riparian zones.

Sustainable Bauxite Mines should:

- Understand the social, cultural and environmental value of water in the mine catchment;
- Develop targets on water use and water quality; and report on these; and
- Avoid, or at least minimise, turbid water leaving the site through effective sediment control.

Case Study – Turbidity Management and Education, Alcoa, Australia

Alcoa's bauxite mining operations in Western Australia are located within drinking water catchments. Water in these forested catchments is naturally clear and non-turbid, so Alcoa has adopted a proactive approach to educating all operators about their role in maintaining water quality and meeting regulatory limits. All mine operators are provided training, in appropriate language and with visuals to aid understanding, on the causes and impacts of increased suspended solids, such as mud and silt, termed turbidity.

When areas are cleared for mining, trees and plants which stabilise the soil are removed, leaving the land without protection hence the soil is easily washed away. Runoff from open areas, including roads, can result in high turbidity in streams. However, with appropriate education mine operators can help ensure there is sufficient drainage protection in place during and after undertaking their work, by:

- Ensuring water on haul roads is being directed into sumps and that these sump inlets are open and clear of obstructions;
- Not pushing road fines into a sump which can cause it to silt up and overflow;
- Not making tracks unless they are approved as this can disturb drainage slots causing them to fail;
- Checking that the lowest part of an operating mine pit can contain water and, if not, then installing additional drainage control measures such as digging another sump;
- Decreasing runoff rates by ripping along contours; and
- Being aware of forecast extreme weather events where high rain is predicted and working with operational leaders to respond where possible in advance of these events.

Figure 39. Drainage Management, Alcoa

This training is supported by monitoring at designated points along streams for turbidity. Results of this monitoring are then used to improve the management of turbidity and drainage on a site. Operators also assist by reporting any:

- Turbid water flowing into the forest, rehabilitation or stream zone in an uncontrolled manner (i.e., not via sumps);
- Failed sumps or sumps not operating correctly; and
- Areas that may result in water flowing into the forest due to insufficient drainage control.

This approach of management, education and monitoring help Alcoa maintain its regulatory compliance in this important area.

Case Study – Water Harvesting and Greenhouse Clusters, Jamaica

There are two major impediments to the agricultural sustainability and food security in depleted bauxite areas in Jamaica:

- Limited access to arable lands for farming due to the acquisition of lands for bauxite mining and related purposes; and
- Insufficient irrigation water to support agricultural activities due to the absence of surface water associated with Jamaica's white limestone, seasonal and intermittent rainfall and drought cycles.

In seeking a more sustainable outcome, the Jamaican Bauxite Institute (JBI), in conjunction with other stakeholders, aimed to develop water harvesting and crop production technologies and practices appropriate for post mining land uses.

A critical aspect of this project is facilitating and funding the establishment of water storage facilities through the conversion of depleted bauxite pits to catchment ponds for providing irrigation water for greenhouse and open field production. Agriculture provides a strong multiplier effect to rural communities and the farm economy has important linkages with other sectors of the rural economy. Under the project, a total of one hundred and sixty farmers from eight communities in St. Ann and Manchester and St. Elizabeth benefited from the JAM$ 245 million (approximately US$ 2 million) project, undertaken by the Jamaica Social Investment Fund (JSIF), the World Bank and the JBI.

A total of 20 greenhouses have been constructed in each of the eight targeted communities, with a bauxite mine pit at each site converted into a surface water reservoir used for irrigation purposes. In addition to the construction of the water pits and greenhouses, designated areas for pesticide storage, food packing, bathrooms and change rooms, hand washing have been constructed. Water is pumped using electricity generated from solar panels to secondary storage, where it is then fed into an internal drip irrigation system.

Figure 40. Bauxite pit converted to 5-million-gallon capacity pond, Tobolski, St Ann, Jamaica

Twenty farmers from each of the eight sites were trained in greenhouse production, administration and water management techniques. The result is the production of a range of sustainable food crops, by placing small scale subsistence farmers on former bauxite mines and providing the necessary infrastructure and equipment for them to do farming on a larger scale, creating viable livelihoods.

The project is currently being expanded with the construction of more greenhouse clusters and the inclusion of more farmers.

Figure 41. Greenhouse clusters at Watt Town (left), Tobolski (centre) and Clapham (right), St Ann, Jamaica

Biodiversity

Bauxite is often found in areas which have high biodiversity (a high variety of plant and animal life). Minimising adverse impacts of biodiversity is fundamental to sustainable bauxite mining. The mitigation of impacts requires that conservation and land use needs of local communities are carefully considered and integrated into the mine plan. The following measures contribute to the mitigation of biodiversity impacts:

- Consulting with key stakeholders to understand the land use demands, the community dependency on natural resources, and the conservation requirements that may exist in the area;
- Carrying out pre-mining flora and fauna surveys to identify species and habitats of conservation significance, particularly rare or endangered species;
- Avoiding designated protected areas;
- Avoiding bauxite exploration or mining in World Heritage areas;
- Limiting clearing of natural habitats to those areas which are essential for the operation;
- Leaving strips of native vegetation within mining areas as wildlife corridors;
- Leaving islands of native vegetation within mining areas to act as seed sources;
- Leaving buffers of native vegetation around riparian areas, wetlands and areas of high conservation value;
- Collecting seeds of local species for use in rehabilitation;
- Using freshly salvaged and returned topsoil;
- Transplanting species of high conservation significance from areas to be mined to rehabilitated areas;
- Establishing nurseries to propagate local native plant species for use in rehabilitation;
- Controlling weed infestation and the spread of other undesirable biota (e.g., soil pathogens);
- Providing fauna habitats using rocks and logs taken from areas being cleared for mining;
- Providing fauna nesting boxes in rehabilitated areas to encourage recolonisation of species of conservation significance; and
- Establishing reserves on other company-owned land, where possible, which are managed to enhance biodiversity.

In addition, protective buffers areas should be established around areas of high conservation value. The width of buffers should be determined after taking into consideration the presence of sensitive vegetation types, locations of threatened flora and fauna, local hydrology and the presence of streams.

The width of buffers may be set based on distance from a stream bank, or edge of wetland, or edge of a sensitive vegetation type. Buffer width varies depending on site-specific factors, but is typically in the range of 50 – 200 m.

In order to limit, as far as possible, the adverse impacts of mining projects on biodiversity and ecosystem services, companies should use a 'mitigation hierarchy' plan comprising four key actions:

- **Avoid** – anticipate and prevent adverse impacts on biodiversity before actions or decisions are taken;
- **Minimise** – reduce the duration, intensity, significance and extent of impacts which cannot be avoided;
- **Restore** – repair degradation or damage to specific biodiversity features and ecosystems; and
- **Offset** – compensate for significant and adverse impacts that cannot be avoided or restored through alternate conservation actions.

Where the risks and materiality of the impacts on biodiversity are assessed as significant, bauxite mines should then develop a biodiversity management plan documenting:

- The existing flora and fauna for the mine site and its ecological status;
- Operational and external impacts (for example fire, weeds) on biodiversity;
- How the mitigation hierarchy has been considered in planning;
- How opportunities to mitigate any impacts and/or enhance biodiversity have been evaluated;
- Targets to maintain or enhance biodiversity;
- How regular monitoring of progress against these targets will be conducted; and
- How progress is documented and publicly reported.

There are many internationally recognised guidelines and frameworks to support companies in developing a biodiversity management plan – some are listed below:

- Good Practices for the Collection of Biodiversity Baseline Data
- A Cross-Sector Guide For Implementing The Mitigation Hierarchy
- Good Practice Guidance for Mining and Biodiversity
- Biodiversity Conservation and Sustainable Management of Living Natural Resources

Sustainable Bauxite Mines should:

- Not be established or developed in World Heritage Areas;
- In the case of significant risks to biodiversity, have a biodiversity management plan, integrated with the mine and business plan, based on the mitigation hierarchy; and
- Use buffer areas to minimise impacts on habitats of high conservation value.

Case Study – Biodiversity, Mineração Rio do Norte (MRN), Brazil

The MRN mine is located within the borders of the Amazon rainforest. Ongoing reforestation starts as soon as an area is depleted and MRN initiated this in 1984, 5 years after operations began. The oldest areas have now reached a profile resembling the original state. MRN continue to improve on this and have taken further action to increase the biodiversity and sustainability of their rehabilitated areas, including:

- Installing beehives in reforested areas older than 10 years to accelerate revegetation. In addition to increased pollination, beehives give an extra income to surrounding communities of traditional Amazon peoples;
- Collecting seeds and planting of seedlings – these are also sources of income for communities; and
- Completing surveys of the area – in total more than 50 Masters and 25 PhD theses have studied the flora and fauna in the reforested areas, therefore providing increased educational opportunities.

In total MRN has used 450 different plant species in the rehabilitation programme – around 120 different species are commonly used, including epiphytes like bromeliads and orchids. The rehabilitation programme includes:

  - Taking the collected epiphytes to MRN’s tree nursery where they are classified and cultivated (Figure 42);
  - Collecting species – since 2001 more than 63 thousand epiphytes of 123 species have been collected, including 83 species of orchids, 25 species of bromeliads and 75 species of *Araceae*; and
  - Reintroducing these years later into the replanted forests, taking into consideration the species of the tree from which it was removed.


Figure 42. Tree nursery at Mineração Rio do Norte (MRN), Brazil

Case Study - Jarrah Dieback, Alcoa, Western Australia

In the Jarrah forest of Western Australia, a plant disease (dieback) is caused by the introduced soil-borne pathogen *Phytophthora cinnamomi*, which may lead to severe degradation in susceptible sites. Many of the dominant jarrah trees are killed in these infested areas, along with a range of mid-storey and understorey plants. This results in significant impacts on the biodiversity values of affected areas, with or without mining activity in the area.

Alcoa's bauxite mining operations occur in these affected jarrah forests and degraded sites are present within the mine area. In 1979, the company made a commitment to support a rehabilitation programme for these sites within the areas surrounding its three mines. The works programmes are jointly planned and funded by Alcoa and the State Government. The overall objective of the programme is to rehabilitate forest degraded by dieback, improving the potential of the forest to meet the designated land use objectives. The specific land use objectives are to:

- Increase biodiversity by using sustainable forest management practices;
- Maintain potable water quality; and
- Improve aesthetics.

Only local trees and local understorey plants are re-established. Alcoa has worked in partnership with local universities to understand the processes leading to degradation and effective revegetation approaches to be used in these areas. This successful partnership between industry research groups and the State Government has led to the improvement of degraded vegetation around the mining area (Figure 43).

Figure 43. Dieback Rehabilitated Area, Alcoa

Case study: Community initiative to protect Chelonian populations in the Amazon, Mineração Rio do Norte (MRN), Brazil

In western Pará, Brazil, Mineração Rio do Norte (MRN) alongside the Brazilian Environmental Institute (IBAMA) and the Federal University of Amazonas (UFAM), municipal and community governments have engaged in a project for environmental conservation in the Amazon known as 'Pé-de-Pincha'. The longstanding project has contributed to conservation for over 20 years and is focused on the preservation of chelonians in 26 communities in the municipalities of Oriximiná and Terra Santa. The project has resulted in more than 5 million hatchlings being released into the wild.

As part of the project, the community has played an important role in supporting and developing a nest and through engagement in hatchling protection work. Professor Paulo Cesar Andrade, coordinator of the 'Pé-de-Pincha' project at UFAM has noted the importance of community engagement in the initiative, stating that *"*the most important thing in this work is the awareness change by the community taking part in the project, who start to value and protect this species*".*

For Mineração Rio do Norte, engaging in the project reinforces the care and enthusiasm the company has for the environment and also leaves a legacy of chelonian preservation for the future. For the first half of 2020, even with the difficulties prompted by the COVID-19 pandemic, approximately 65,000 chelonians were released through the project in the municipalities of Oriximiná and Terra Santa.

Figure 44. Community volunteers with hatchlings, Para, Brazil

Air Quality and Noise

The nature of bauxite mining means large areas of exposed land are present. These are a potential source of dust generation during dry and windy conditions. The surface of tailings dams, if dry, may also be a source of wind-blown dust. In addition, the high volume of transport in these areas such as haul trucks and heavy mine equipment can further create the spread of dust as well as impacting on noise pollution.

Depending on the location of neighbouring communities, this effect on both air quality and noise pollution has the potential for major community impacts. However, with appropriate planning and controls, both dust and noise impacts can be minimised and good relationships with communities – as well as safe working conditions for all employees and contractors – can be maintained. In order for this to occur, the location of people and other organisms which may be impacted by noise and dust must be identified to evaluate the potential impact on health and the environment of these emissions. It is also important to understand the potential increased sensitivity to exposure due to factors such as age and health (e.g., schools, day care centres, hospitals, nursing homes), status (e.g., sensitive or endangered species), proximity to the source, or the facilities they use (e.g., water supply well). Again, this needs to be done through ongoing environmental monitoring.

Air Quality

With regards to air quality, an initial assessment of potential air quality impacts should be undertaken prior to mining and include particulates (dust), sulfur dioxide (SO_2) and oxides of nitrogen (NO_x). The mining and beneficiation of bauxite does not involve the use of chemical reagents and does not give rise to odours; dust suppressants may, however, be used in controlling dust but these may require regulatory approval for use. The main impact on air quality is therefore usually particulates (dust). Dust reduces visibility, may become a safety hazard, may be a nuisance to neighbours, and may cover the foliage of crops and other vegetation. The main sources of dust during bauxite mining operations include:

- Vegetation clearance and any burning of vegetation;
- Stripping of topsoil;
- Mining - excavation of bauxite ore by heavy machinery and loading;
- Hauling of bauxite, particularly on unsealed roads;
- Dumping of bauxite into crushers or directly into trucks or rail wagons;
- Conveying and ship loading;
- Stockpiles;
- Surface of dry tailings dams; and
- Rehabilitation activities including replacement of topsoil.

In particular, the assessment of particulates should consider the dispersion of mine-derived total suspended particulates (TSP), particulate matter less than 10 microns (PM10), and particulate matter less than 2.5 microns (PM2.5). The cumulative level of mine-derived particulates and pre-existing background levels should be compared to relevant regulatory limits and international guidelines. The potential impact of SO_2 and NO_x emissions should also be assessed if there are diesel or fuel oil powered electricity generating plants onsite. Greenhouse gas emissions are addressed separately in these Guidelines.

Recommended dust management strategies include:

- Considering the initial layout of roads, stockpiles, occupied mine buildings and camps to take into consideration dust sources, wind direction and the location of existing neighbours;
- Watering of unsealed roads and work areas;
- Lowering speed limits, checking load limits and mandating covered loads;
- Constructing roads using appropriate materials to minimise dust creation;
- Revegetating or prompt covering of exposed soils and other erodible materials;
- Clearing of new areas should only be done when necessary;
- Using dust suppression sprays on stockpiles;
- Ensuring the loading, transfer and discharge of bauxite takes place with a minimum height of fall, and is shielded against the wind where possible;
- Considering the use of dust suppression spray systems; and
- Covering conveyor systems and equipping them with water sprays at transfer points.

Noise emissions

With regards to noise emissions, the main sources associated with bauxite mining may include:

- Engines of heavy equipment (bulldozers, excavators, loaders, haul trucks);
- Crushers and beneficiation plants;
- Conveyors;
- Railways;
- Loading, unloading and stockpiling of bauxite;
- Power generation;
- Dozer ripping; and
- Drilling and blasting.

Recommended strategies to minimise noise impacts include:

- Fitting vehicles with broadband (white noise) reversing alarms in place of traditional tonal alarms;
- Avoiding night-time mining in noise sensitive areas;
- Relocating mining activities to other pits under adverse weather conditions;
- Using mechanical ripping, where possible, to avoid or minimise the use of blasting;
- Using specific blasting plans following a blast acoustics model to predict noise levels in areas surrounding the mine when blasting cannot be avoided;
- Avoiding blasting when modelled blast noise levels are above the blast noise limits; and
- Regular measuring of noise levels at the nearest location of sensitive people and other organisms to ensure the operation meets noise guidelines.

Sustainable Bauxite Mines should:

- Understand where nearest sensitive people and other organisms for noise and dust are located;
- Control noise and dust at source to minimise impact on sensitive people and other organisms; and
- Maintain safe human health working conditions for all employees and contractors.

Case Study – Dust Management, Weipa, Rio Tinto, Australia

Managing dust emissions at Rio Tinto's Weipa operations is a major focus during the dry season. Dust emissions from operations in Weipa, combined with windy conditions and the smoke that is often present from natural bushfires in the region, may adversely impact air quality for the local community.

A dust management plan was developed in 2010 which included the development of a model which predicts dust spread within the air shed and determines the risk of impact on the community. This information is used in mine planning decisions. In 2011, monitoring activities were enhanced with the installation of automatic dust monitoring stations at Nanum, Napranum and Rocky Point and a fourth station was installed in 2012 at Sherger to provide baseline information. These stations enable real time monitoring of Total Suspended Particulate (TSP) matter and dust deposition (Figure 45).

Figure 45. Rio Tinto Weipa Dust Monitors

The stations send SMS messages to a member of the site environment team if dust levels are approaching license limits and allow a much faster response time. Responses to high levels of dust emissions may include watering haul roads or moving mine operations to another location until wind conditions change.

Case Study – Noise and Dust Control, Durgmanwadi, Hindalco Mines, India

Dust and noise emissions from Hindalco's Durgmanwadi Mines were minimised through a combination of environmental and mine planning (Figure 46):

- The use of dozers for ripping eliminated the need for drilling and blasting, minimising noise and dust;
- Spray suppression systems minimise dust generation due to vehicular traffic and crushing;
- Accumulated water bodies in mined out pits improve the ground water table and provide water for dust suppression; and
- Endemic revegetation, using seedlings from the onsite nursery for creation of a green belt and rehabilitation of mined out areas also minimise dust emissions.



Figure 46. Dust suppression at all stages of Hindalco operations

Greenhouse Gas Emissions and Energy Conservation

Bauxite mining consumes a relatively small amount of energy, and consequently has low greenhouse gas emissions compared to other parts of the aluminium life cycle. The global average energy consumption is less than 100 MJ per tonne of bauxite, with each tonne of bauxite having to be transported on average 50 km from the point of extraction to the shipping point or local refinery stockpile. Bauxite mining emits, on average, less than 50 kg CO_2 per tonne of bauxite produced. However, there are greenhouse gas emissions associated with the temporary removal of vegetation prior to the establishment of a mine – diesel fuel and fuel oil combustion provide most (95%) of the energy required to extract and haul the mined ore. Key sources of greenhouse emissions are:

- The on-site generation of electricity (e.g., diesel-fired power station);
- Diesel used in heavy mobile equipment for mining and haulage; and
- Vegetation clearing prior to mining.

Despite the relatively low consumption of energy, implementation of energy efficiency measures has the dual benefit of reducing operational greenhouse gas emissions whilst improving productivity and reducing costs, making the bauxite mine more sustainable. Recommended energy conservation measures include the following:

- Correctly sizing motors and pumps and use of variable speed drives in applications with highly varying load requirements;
- Using larger, more energy efficient mining equipment and trucks;
- Using advanced truck dispatch systems to optimise truck cycle times and reducing idling and waiting times;
- Improving maintenance of mining and transport equipment; and

- Minimising average haul distances by centralising locations of beneficiation plants and stockpiles.

In addition, depending on location, a changing climate may create risks for a bauxite mining operation. These risks may include long-term changes in rainfall patterns, changes in the frequency of droughts or floods, and changes in the frequency of severe storms (including cyclones). Such effects may result in increases or decreases in water availability, changes in the frequency of flood and storm damage to infrastructure, and transport disruption affecting supply chain reliability.

Bauxite mines in vulnerable regions should assess how these risks need to be considered in planning. There may be a need, for example, to construct more water storages, alter design standards for tailings dams, alter flood immunity standards for transport infrastructure, or change emergency response procedures. Lessons learnt from such assessments might be able to be used to assist a host community in adapting to change.

Sustainable Bauxite Mines should:

- Optimise their energy use to achieve environmental and economic benefits;
- Consider how long-term changes in rainfall patterns and severe weather events may affect the operation and host community and mitigate these risks where possible.

Case Study – Energy Generating Transport, Jamalco, Jamaica

In 2007 Jamalco Operations (formerly Alcoa) installed a sustainable solution to transport bauxite 3.4 kilometres from the Mount Oliphant bauxite mine to a railway station, before the bauxite is railed to the Clarendon alumina refinery. This is done using a rope conveyor system which moves bauxite through mountainous terrain. In addition to transporting bauxite, the system generates approximately 1,200 kW of electricity per hour, which is used to power the mine and is also fed back into Jamaica's power network. Alcoa saved approximately $1.5 million in energy costs in the first five years.

The rope conveyor consists of a belt with corrugated side walls and integrated wheel sets running on fixed track ropes guided over 11 towers, driven by two AC induction motors. As the conveying system is loaded with bauxite and begins its decent, the drives begin operating in continuous braking (regeneration) mode, generating the electrical power. In addition to providing an alternative energy source, the system provides other environmental benefits:

- The conveyor operates mid-air, minimising space requirements and easily crossing obstacles on the ground;
- It is quiet, dust-free and has a small footprint, using less land than road transport.

Switching to the rope conveyor system saves 1,200 truck journeys a day along with the associated greenhouse emissions, noise, and dust.

Figure 47. Jamalco Conveyor

Waste Management

A "waste" is anything that is left over, or an unwanted by-product or surplus to the activity generating the waste. Developing a waste management plan from mine conception stages through design, construction, operation and decommissioning helps minimise the environmental harm that could occur if wastes are not managed properly and contaminants were released to the environment. A waste management plan should be implemented which incorporates the waste minimisation hierarchy in the following order of preference:

- **Waste avoidance** – minimising the amount of waste generated;
- **Waste segregation** – separating wastes into categories increases reuse and recycling options;
- **Waste reuse** – using waste as a resource;
- **Waste recycling** – increasing the efficiency of use of resources;
- **Energy recovery** from waste; and
- **Appropriate waste disposal** – minimising the impact of waste on the environment and human health.

Typical wastes from a bauxite mine include:

- Green waste and vegetation from mine clearing;
- Overburden removed prior to mining;
- Tailings and oversize materials from a beneficiation plant;
- General waste (food scraps, paper and cardboard, plastic, wood, electrical equipment) from workshops and offices;
- Reusable wooden pallets from workshops;
- Scrap metal from plant and workshops;
- Tyres from light and heavy vehicles;
- Conveyor belt (if applicable);
- Excavated waste from any dredging of ports (if applicable);
- Sewerage from mine toilet facilities;
- Medical waste from onsite clinics;
- Waste oil, waste grease and oil contaminated rags, matting and absorbent from workshops; and
- Liquid hazardous wastes (e.g., solvents, coolants, paints) from workshops.

A WMP for a bauxite mine should therefore include:

- Documenting regulatory requirements;
- Identifying the waste streams to be produced for that mine;
- Assessing options for each waste stream for potential reuse or recycling;
- If a feasible reuse or recycling option is not available, then identifying an appropriately licensed and appropriately managed disposal facility;
- Identifying an appropriate waste transporter to conduct this transfer;
- Outlining how wastes are to be stored appropriately to prevent pollution until they are transferred offsite; and
- Documenting the auditing and monitoring of waste volumes and types generated.

Waste management plans should also be regularly reviewed to see if alternative options may reduce the impacts on the environment.

Sustainable Bauxite Mines should:

- Comply with all regulations as a minimum; and
- Have a waste management plan based on the waste minimisation hierarchy.

Case Study – Waste Management in Africa

For mining projects in developing countries, including Guinea, developing a waste management plan (WMP) can be challenging as certain wastes such as waste oils, medical wastes, hazardous wastes, sewage and contaminated soils pose particular challenges due to the lack of public waste collection, disposal facilities and infrastructure. For instance, the only functioning hazardous waste incinerators on the African continent south of the Tropic of Cancer are in South Africa and the Basel Convention bans the transboundary transport of wastes.

The key to conceiving an effective WMP is to understand and control the life cycle of wastes from the point at which they are produced to their final method of elimination. To do this, the project description must have been sufficiently well developed and disseminated through the project company structure to enable forecasts of waste production from all phases of the project to be collated.

- The starting point is procurement: eliminating or reducing waste production on-site by having a procurement policy to seek alternatives for chemicals, replacement parts, hazardous materials and packaging can reduce or eliminate wastes before they are produced.
- The next step is to identify and quantify as far as possible all the different waste streams the project will produce at each phase. For instance, the amount of used tyres was estimated from the number of vehicles maintained onsite and their re-use planned as protective barriers, slope stability buttresses and road bollards. Remaining used tyres made available for re-cycling off-site or by local residents are cut to ensure they cannot be refitted to other vehicles.
- Maintenance plans for motorised plant machinery and vehicles will give the frequency and volumes of engine oil changes and hence the amount of waste oil to be disposed of. Peak waste oil production is usually during the latter half of the construction phase. The preferred method of

disposal is by return to the oil supplier with an audit of the suppliers' recycling facilities to follow the waste oil 'chain-of-custody' through transport, refining and onto resale and final disposal.

- Next the recycling and final disposal methods need to be planned for each of the waste streams, including methods for controlling distribution of wastes which have the potential for re-use offsite. For instance, where bottles and containers that have not contained hazardous materials are re-cycled by distribution to local residents, then facilities are needed to collect, wash and securely store them before distributing for a token charge. The payment of this charge will ensure that containers have a value to the recipient and are kept for use; giving away containers usually leads to littering in local villages, roads and water courses.
- Where combustible, solid non-hazardous wastes need to be disposed of on-site then skid mounted, portable, diesel fuelled incinerator units are a viable solution provided trained operators are employed to sort wastes and operate it. Care should be taken at the procurement stage to ensure that the incinerator meets appropriate air emissions criteria.
- Finally, in the waste stream life cycle analysis, on-site disposal to landfill may be the only viable alternative to offset disposal. Here the quantifying of the volumes of wastes remaining after reduction, re-use and recycle is a critical parameter in designing the capacity of the non-hazardous waste landfill. Landfills need to be located in securely fenced areas within the mine concession on areas that have been sterilised for mineral resources.

A detailed WMP based on quantifiable estimates for each waste stream and specific methods for their final disposal are the key to best practice in waste management at all stages in the life of mine.

Figure 48. Alufer Monthly Site Inspection

Case Study – Waste Management in Guinea, Alufer Mining, Bel Air Mine

Alufer Mining's Bel Air mine camp is in the village of Khoundinde. To address management of solid waste from the village, a consultation and numerous discussions between mine shareholders and other local stakeholders (local authorities, local young people and the environment department) led to the development of a new local association to manage the solid waste in the village. The association, one of the first of its kind in rural Guinea, is made up of local women and headed by a local female entrepreneur. They have been supported in establishing a suitable landfill site and provided with appropriate equipment such as metal drums and a tricycle to support waste collection and disposal at the landfill. Funding for this initiative was provided one of Bel Air Mining's major shareholders, Resource Capital Funds.

Figure 49. Waste collection tricycle, Khoudinde Village, Guinea

Tailings and Residues

While in some regulations tailings means a hazardous waste, this does not apply for bauxite. Bauxite is non-hazardous and therefore bauxite tailings – as opposed to bauxite residue from the alumina refining process – are also therefore considered non-hazardous. Further, not all bauxite mines will need to beneficiate, therefore not all bauxite mines will have tailings. Beneficiation involves separation of the bauxite and waste materials through screening, crushing, washing and dewatering. No chemicals are added to the process. This process produces tailings consisting of water, fine bauxite pisolite, sands and clays.

The management of tailings, both during and after mining, is the responsibility of the mining company. This means that tailings management needs to be effective throughout the life of an operation, from initial feasibility through to closure and for any ongoing monitoring and maintenance post closure. Typically, bauxite tailings do not contain harmful substances, only increased concentrations of naturally occurring minerals. However, bauxite tailings should always be analysed to determine if they contain hazardous levels of any substances compared to local, national or international guidelines.

The long-term management strategy is to drain water from the tailings storage facility to safeguard its physical stability, and then re-shape to aid drainage, cover with soil and vegetate. To reduce the water content of bauxite tailings mines may reuse and recycle water from natural compaction into the process; and use additional equipment and processes such as filter presses, thickeners and dry stacking. Over time, the tailings settle and dry in the reservoir. Once residual water is eliminated, using the methods outlined, and after consolidating the solids, the surface should be rehabilitated.

Figure 50. Bauxite Mine Tailings, Juruti Brazil

All tailings dams should have detailed plans which cover location, engineering design, construction, dam operation, monitoring, decommissioning and closure. The safety of dams depends on rigorous design and careful construction, operations and decommissioning. The proposed design should be subject to a dam failure impact assessment and the design modified if the risk of failure is unacceptable. The dam should also be only used for the purpose it was designed. Storing water for example in a dam designed for tailings storage over time can lead to failure of the wall structure.

In developing a site-specific tailings management plan, matters to be considered should include:

- Ensuring the design, operation and maintenance of structures according to internationally recognised standards based on a detailed risk assessment;
- Establishing an appropriate independent review at both design and construction stages, with ongoing monitoring of both the physical structure and water quality both during operation and decommissioning. This should also include a check on the maximum design earthquake assumptions;
- Designing tailings storage facilities to consider the specific risks associated with failure. This should also be linked to the site's emergency preparedness plans;
- Building any diversion drains, ditches, and stream channels to divert water from surrounding catchment areas away from the tailings structure to a conservative flood event recurrence interval;
- Ensuring seepage management and related stability analysis are a key consideration in the design and operation of tailings storage facilities; and
- Detailing and justifying the design specification based on site-specific risks, the maximum design rainfall event, and the required freeboard in order to safely contain it across the planned life of the tailings dam, including its decommissioned phase.

A tailings management plan should include:

- Defined responsibilities;
- Description of the process and operation, including water management;
- Schedule and scope of inspection and operational monitoring;
- Schedule and scope of audits and stability assessments by specialists;
- Training requirements;
- Decommissioning plan; and
- Emergency response plans.

Preparation of a tailings management plan requires the use of recognised expertise and cannot generally be completed using only internal company resources, as external auditing at all stages of the process is required.

Sustainable Bauxite Mines:

- Develop a tailings management plan where there is a beneficiation plant in order to account for the whole life cycle of the mine, from design through to decommissioning;
- Ensure these tailings management plans are subject to independent expert review; and
- During and after use, independently monitor tailings dams on a regular basis using both internal and external experts.

Case Study – Optimised Beneficiation, Ketapang, Harita Group, Indonesia

At Ketapang, West Kalimantan, the Harita Group studied the mineralisation of bauxite deposits to minimise waste, maximise economic efficiency and ultimately optimise the Bayer Process in the alumina refinery. The existing operations included crushing, spraying, solar drying and blending prior to use (Figure 51).

Figure 51. Existing mine operation process at Harita Group Ketapang, Indonesia

The objectives of the study were to:

- Identify particle size distributions of the bauxite and its mineral identification;
- Identify available alumina (Al_2O_3) and how to increase the alumina content from in-situ bauxite;
- Determine how to reduce elements such as SiO_2, Fe_2O_3, H_2O;
- Optimise mine recovery after beneficiation and improve mine beneficiation washing plants; and
- Reduce bauxite mine cost to be more competitive.

While bauxite is predominantly minerals such as gibbsite, boehmite and diaspore (Harita Bauxite is predominantly gibbsite), it may also contain other minerals which are reactive in the Bayer process. Lateritic bauxite deposits are developed from lateritic weathering and secondary enrichment of igneous rocks rich in alumino-silicate minerals or intermediate rocks. The lateritic bauxite at Ketapang (Figure 52) has a relatively low grade of bauxite (42-49%) and high silica (5-25%). Lateritic bauxite may be challenging to beneficiate due to bedrock types and lateritisation stage. Fine-grained gibbsite and interlocked kaolinite within bauxite are difficult to separate with existing beneficiation methods.

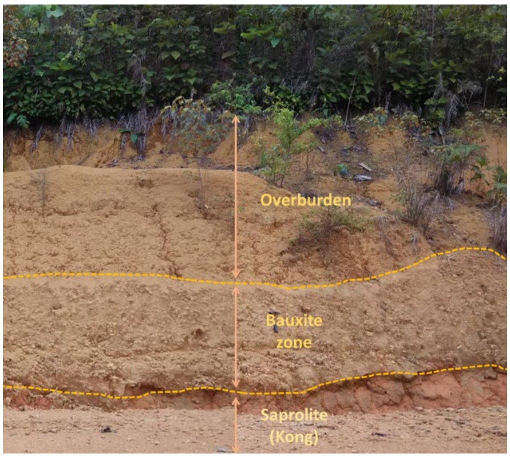


Figure 52. Ketapang Lateritic Bauxite Profile

The kaolinite clays are identical in size to the reactive silica and may cause caustic soda losses in the Bayer Process; high operating cost. Developing an integrated bauxite map may help future mine determine a "wash or no wash" and "crush or no crush" decisions during operations, minimising waste and maximising mine efficiency. Using a combination of techniques (Figure 53) including mapping particle size distribution analysis, X-ray fluorescence, wet chemistry and semi quantitative X-ray diffraction to better understand the mineralogical data was effective to improve the existing beneficiation methods, reducing waste and improving the economics of the subsequent Bayer processing.

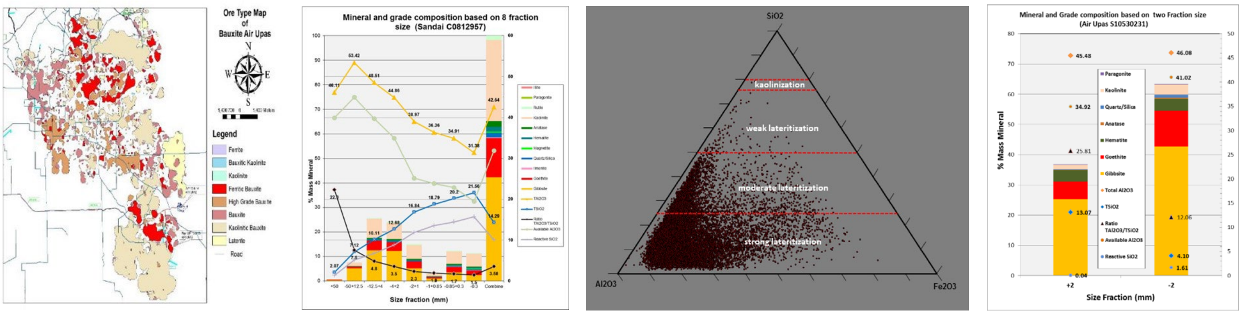


Figure 53. Combined bauxite mapping and analysis techniques at Harita Group Ketapang, Indonesia

Case study – Tailings Dry Backfill at Norsk Hydro, Paragominas, Brazil

Hydro's Paragominas bauxite mine is in the Pará state, northern Brazil. It is the second-largest bauxite mine in Brazil, producing around 11 million metric tons per year. In 2019, Hydro Paragominas started a pioneering project on tailings disposal management. The methodology developed, called tailings dry backfill (TDB), consists of using the current tailings storage facility – RP1 for tailings drying – and from there, mechanically removing and transporting the tailings for final disposal at the mine pits. Thus, avoiding the need for the construction of new dams and reducing the tailings disposal associated costs. The disposal method used in RP1 consists of the disposal of thickened tailings, with an average solids content of 35%, in layers of approximately 50 cm that are later exposed to solar drying, allowing tailings to reach 60% solids contents. Disposal alternates among the four quadrants, allowing enough sun exposure time for the tailings to desiccate. After 30 to 60 days, the dry tailings are excavated and transported by trucks to the mine area and backfilled into mine pits. Subsequently, the tailings are covered by overburden, and the area is revegetated.

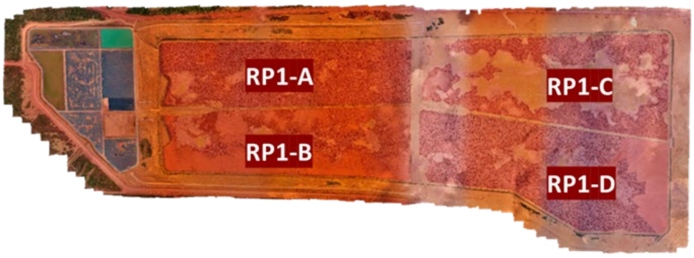


Figure 54: RP1 DAM

Figure 55: Tailings desiccation process

Currently, more than 4 Mt of tailings have already been backfilled. Hydro has achieved solids content of up to 80% by solar drying, enabling an excellent tailings removal rate of about 200% during the Amazon dry season. Environmental and geotechnical monitoring was performed throughout the project. Results for groundwater and soil quality are compliant with Brazilian legislation and are within expected values from the background studies conducted prior to the start of mining activities in Paragominas. Also, groundwater level monitoring at the mine has not indicated any changes due to tailings backfilling operations. Dam instrumentation and inspection have not shown any anomalies related to the project.

Figure 56: Removal of dry tailings from RP1 dam and disposal at the mine pits

The TDB technology has significantly changed the way tailings are managed at Hydro Paragominas, creating a more sustainable and safer approach.

The benefits of this approach include:

- Reduced environmental footprint and operational risk: tailings storage facility area reduced by 64% and no further tailings dams built or raised in Paragominas;
- Reduction in capital costs for building new disposal quadrants; and
- Reduction in rehabilitation costs.

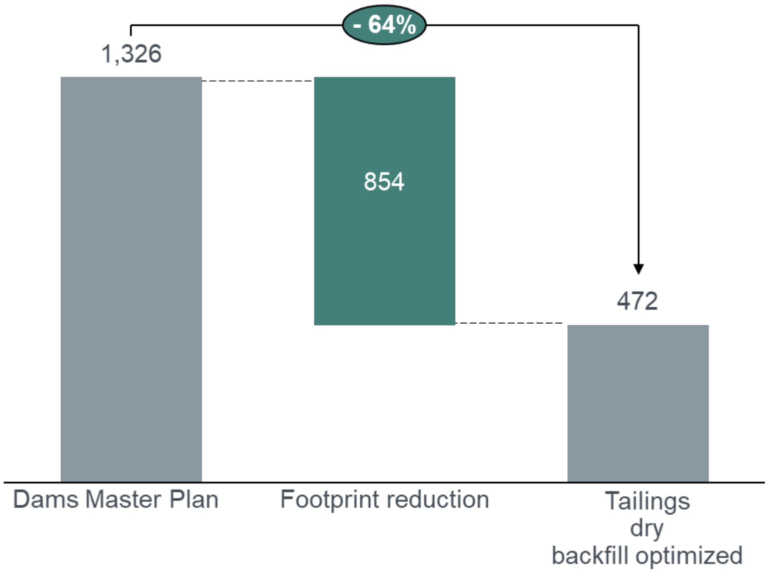


Figure 57: Reduction in environmental footprint

Other intangible benefits include reduced risks for stakeholders, including regulators and shareholders, providing a higher level of comfort for tailings-associated operations.

Tailings Management Systems and Regulations

The standards and processes related to the safe management of bauxite mine tailings dams are related to those of other mine tailings containment facilities. The bauxite industry in general should look to leading mining industry organisations to ensure their systems and standards meet or exceed practices in the wider mining industries, and to learn from the wider experience base.

The Mining Association of Canada (MAC) has been a leader in the development of systems and standards for the management of tailings facilities for mining in Canada, and its management principles and standards are widely referenced in the mining industry.

A critical aspect of mine tailings dam design is ensuring the physical stability of walls and embankments to prevent failure and outflow of tailings into the surrounding area. This requires an understanding of the foundations on which these structures are built and the selection of materials which will ensure stability in the case of extreme local weather or seismic events. Heavy rainfall causing walls to overflow is a common cause of such disasters, and the reason why mine tailings dams are required to have a safety limit to water storage levels. Mine tailings dam design and monitoring are understandably heavily regulated and the standards of design, construction and of their monitoring through their life are carefully considered and reviewed.

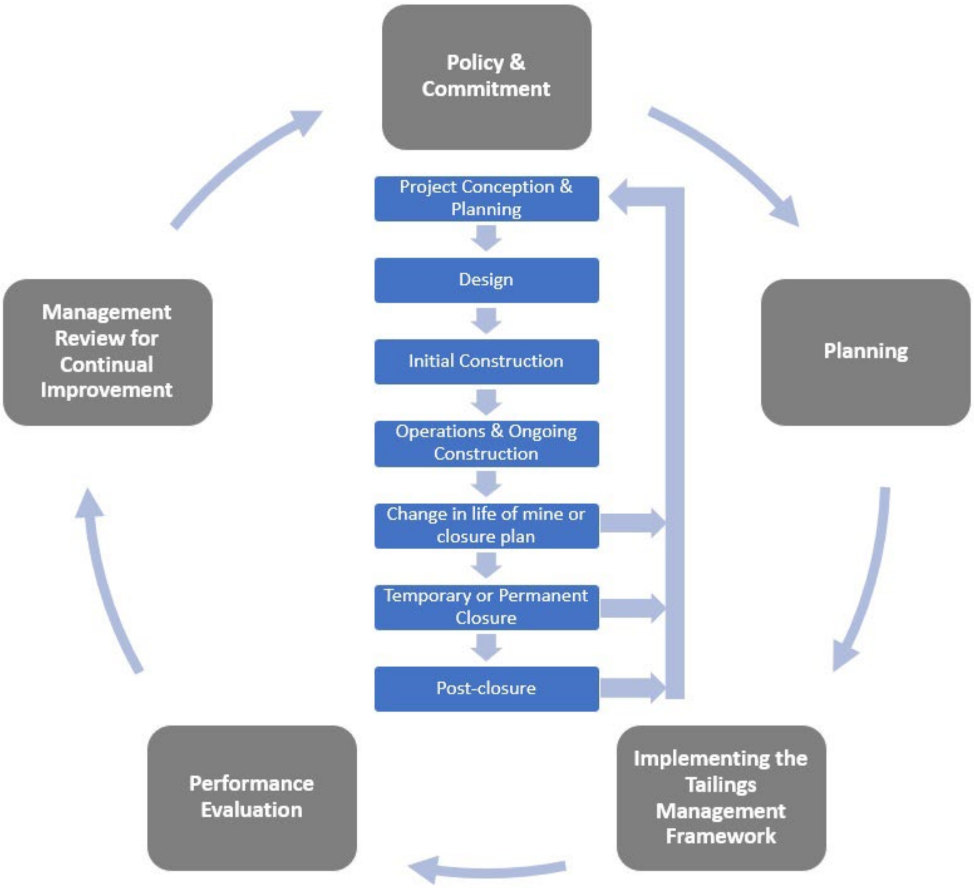


Figure 58. Management through the phases of the life of a Tailings Facility

A number of tailing dam failures across the mining industry have demonstrated the devastating impact of failures, especially where communities are downstream. Deaths, severe property and environmental destruction can result.

In 2018, The International Council on Mining and Metals (ICMM), the United Nations Environment Programme (UNEP) and the Principles for Responsible Investment (PRI) co-convened the Global Tailings Review to establish an international standard for the safer management of tailings storage facilities. The Global Industry Standard on Tailings Management was published in August 2020 and is directed at operators to prevent catastrophic failures and progress towards a goal of zero harm. The Standard applies to existing and future tailings facilities and is arranged around six topic areas, fifteen principles and seventy-seven auditable Requirements. In 2021, ICMM published Tailings Management – Good Practice Guide, aligned with the Global Industry Standard and focuses on technical issues, providing recommendations on good practice for design, construction, operation and closure.

Figure 59. Layers of a Tailings Management System

Mine tailings dam management goals should drive a culture of continuous improvement. Inter-operational benchmarking should use agreed, standardised industry measures to allow benchmarking with similar operations.

Sustainable Bauxite Mines:

- Tailings management systems should be aligned with internationally recognised standards; and
- Tailings dams design and monitoring should be aligned with internationally recognised standards and subject to regular internal and external expert independent review.

Soil Management

Soil suitability should be assessed before mining and soil types classified and mapped based on erodibility and stability for use in rehabilitation. It should be noted that the depth of topsoil, which contains most of the seed and organic matter, and subsoil vary considerably between mine sites.

Prior to mining, topsoil, subsoil and overburden overlying the bauxite is stripped. Depending on suitability and depth, soil may be double stripped to keep the seed and organic matter rich topsoil separate from the subsoil. Soil is respread in the reverse order – subsoil first, followed by topsoil. Soil handling is most efficient if the amount of soil stored in stockpiles is minimised and the amount of soil respread immediately on mine-out areas (the 'direct return') is maximised. This direct return also has environmental benefits, encouraging the regeneration of native plants from propagules in the soil, and minimising damage to the soil's structure and loss of organic matter and nutrients. This technique also helps minimise the area of mined land exposed at any one time.

If direct return is not possible, soil should be stockpiled. If stockpiled, soil should be not handled when wet to minimise compaction. Low and wide stockpiles are better than tall and narrow stockpiles as the former minimises the risk of anaerobic conditions forming. If stockpiles are to remain for many months, they should be temporarily revegetated to control erosion and dust. In addition, stockpiled soil should be typically used within 1 year to maximise the benefits of the natural seed bank and conserve symbiotic micro-organisms. However, there is an exception to the general rule to minimise the time that soil is stockpiled – if soil is stripped from an area with abundant weeds present, stockpiling for several years may significantly reduce the rate of weed germination when the soil is respread.

A soil management plan should be developed including site-specific procedures for:

- Characterising and mapping soil suitability;
- Measuring in situ soil inventory and stockpiled soil inventory;
- Carrying out soil stripping, stockpiling and placement activities; and
- Ensuring quality assurance to ensure suitable soils are salvaged and managed appropriately.

Sustainable Bauxite Mines should have:
• Have a soil management plan describing how soils are to be classified, salvaged, stockpiled and respread.

Case Study - Topsoil Management, Alcoa, Australia

The bauxite mine rehabilitation programme conducted by Alcoa in the jarrah forest in the southern regions of Western Australia is an excellent example of how conservation of the soil seed bank may significantly enhance the botanical diversity of the post-mining vegetation community. Wherever possible, after vegetation is cleared, the top 150 millimetres of soil, which contains most of the soil seed bank and nutrients, is stripped prior to mining and then directly returned to a pit about to be rehabilitated. Alcoa has found that approximately 60% of the species in restored sites originate from seeds in the fresh topsoil that is stripped from 'donor' sites that have been cleared in advance of mining and immediately 'returned' to areas that are being restored. Indeed, using fresh topsoil from donor sites is important because fresh topsoil results in at least 33% more species in restored sites than topsoil that has been stockpiled before use.

Figure 60. Fresh Topsoil Spreading at Alcoa

Previously, fresh topsoil was returned using scrapers. However, it is challenging to apply thin layers of topsoil evenly using scrapers. To enable more efficient use of limited fresh topsoil, a recent development has been to spread thin (between 10 and 25 mm deep) layers of soil using a modified articulated truck (Figure 60).

In addition, botanical monitoring data from unmined and pre-mining forests are used to identify species that are abundant in the forest, but that are either absent from or occur in very low numbers in rehabilitated areas. These species are targeted for inclusion in either the broadcast seed mix or for nursery propagation. If seed is available in large quantities, broadcast seed application is the preferred option. However, the Jarrah forest also contains a significant number of long-lived, slow growing re-sprouter species, particularly rushes and sedges which are highly abundant in unmined forest but do not re-establish from the fresh topsoil used in restoration and often produce few seeds, making them unsuitable for inclusion in a broad cast seed mix.

By identifying species which do not re-generate easily from fresh topsoil or seed, Alcoa is able to ensure these so called 'recalcitrant' species are propagated in Alcoa's nursery and may then planted into newly restored areas (Figure 61). Often these are surrounded by a plastic mesh guard to discourage grazing by kangaroos. Currently, Alcoa targets production and planting of around 900 recalcitrant plants per hectare of rehabilitation established, complementing the use of fresh topsoil and seeding. Together, the combined use of fresh topsoil return, seeding, and planting of 'recalcitrant' plants have now resulted in numbers of plant species at 15 months-of-age equal to those recorded in equivalent-sized plots in unmined forest.

Figure 61. Tissue culture produced plant at Alcoa operations, Western Australia

Rehabilitation

Once the bauxite deposit is depleted, companies have a responsibility to rehabilitate the land – the nature of bauxite mining is that rehabilitation should be carried out progressively through the life of the mine. The overall objective of the rehabilitation programme should be to return mined areas to a safe, stable and non-polluting landform, that meets agreed land use objectives and requires minimal ongoing maintenance.

Figure 62. Nursery Crops at Alufer

A typical process for the rehabilitation of a bauxite mine includes:

- Developing a rehabilitation plan in consultation with end users and regulators;
- Reshaping the mined area, if necessary, to remove steep batters and re-establish drainage patterns;
- Mechanical ripping of compacted areas to increase water infiltration and promote plant root penetration;
- Returning the overburden, subsoil and topsoil layers in sequence;

- Cultivating, preferably along the contour, to minimise erosion and prepare a seed bed;
- Seeding and fertilising – the species seeded, and the method of seeding are very site-specific.
- Native plant species adapted to the local environment and capable of become self-sustaining are commonly preferred. Seed is typically broadcast by hand, tractor/crawler or, on large sites, by aircraft;
- Planting seedlings instead of seeding or as a supplement to seeding, particularly in countries where labour is abundant; and
- Creating additional habitat for fauna by returning rocks and woody material in certain areas.

Following completion of rehabilitation, monitoring against defined objectives or outcomes should be undertaken. Monitoring results can be used to identify areas of rework, where required, and provide feedback to improve future rehabilitation. These results should be reported to the community and local regulator or agency. A rehabilitation plan should be prepared which includes:

- Facilitating integration with the mine plan, showing how rehabilitation is being undertaken progressively along with mining activity;
- Outlining clearly defined rehabilitation objectives and completion criteria;
- Documenting roles and responsibilities;
- Documenting any proposed trials and research aimed at improving performance;
- Implementing a quality assurance process;
- Documenting a rehabilitation monitoring programme; and
- Documenting a maintenance strategy including control of weed species, fire management, remediation of eroded areas and remediation of areas of unsuccessful revegetation.

These rehabilitation completion criteria are quantifiable milestones in the biophysical development of the rehabilitated area that show the site will eventually reach a sustainable state – they indicate the success of rehabilitation. As such, they should ideally be drafted at the commencement of mining and in consultation with regulators and other key stakeholders (such as neighbouring communities). They should then be revised and updated as knowledge and experience are gained from research, monitoring and progressive rehabilitation practice.

The rehabilitation monitoring programme should focus on a range of indicators that align with the completion criteria. Indicators typically reflect vegetation composition and structure, including species richness, plant density, foliar cover, structural composition, native species recruitment and presence of weed species. In some circumstances, recolonisation by certain fauna species is a good indicator of the development of the vegetation towards a self-sustaining ecosystem.

Sustainable Bauxite Mines should:

- Have a progressive rehabilitation plan, integrated with mining operations, which includes completion criteria; and
- Ensure completion criteria are agreed with regulators and, where appropriate, other stakeholders.

Case Study - Completion Criteria, Alcoa, Australia

Alcoa started developing completion criteria for its bauxite mining operations in Western Australia in the 1990s. Prescriptions for rehabilitation used prior to 1988 (early era) were different from those used in the current era which meant that two sets of criteria were needed. Alcoa regularly review the criteria for current era rehabilitation to be able to integrate improvements in knowledge, new technologies and changes in stakeholder expectations. Two revisions have been completed so far.

The criteria were designed to reflect the guiding principles of meeting rehabilitation objectives, landscape integration, sustainable growth, resilience and land management integration. Assessment of rehabilitation is undertaken during various stages of the rehabilitation operations and during the early and later years of ecosystem development. This early assessment for selected criteria enables any corrective actions to be carried out effectively and cost-efficiently.

One example of the current 34 completion criteria, approved by the local regulator, is an adequate stocking of overstorey trees of the two dominant forest species jarrah and marri (Table 1). This is assessed 9 months after establishment, allowing replanting/reseeding or thinning (by herbicide application) to be carried out at an early stage if required. Alcoa undertakes this assessment internally, with field inspection and audit by the Western Australian government on an annual basis. Both a minimum and a maximum limit apply to balance timber production objectives with water, conservation and other forest values.
Later assessments indicate whether rehabilitation is exhibiting sustained growth and development and ensure that regional scale requirements such as the reinstatement of access tracks needed for future forest management are complete. Applications for relinquishment are planned for sub-regions rather than for individual rehabilitated pits. Assessments against completion criteria follow an agreed process of inspections, completion of any remedial works and final sign-off.

Criteria and intent	3. Early establishment – first 5 years 3.1 Vegetation establishment 3.1.1 Establishment of overstorey (a) The overstory stocking of both jarrah and marri to meet standards.
Guidelines for acceptance	Rehabilitated areas must have a stocking rate which will meet designated land uses. Alcoa must submit 9-month monitoring data to Western Australia Department of Parks and Wildlife (DPaW) annually. A copy of the full completion criteria is available at: https://www.jtsi.wa.gov.au/what-we-do/manage-state-agreements/alcoa's-bauxite-mine-rehabilitation-program DPaW must review and advise Alcoa of acceptance or request corrective actions. Establishment of overstorey that have achieved the standard will be deemed acceptable unless DPaW writes to Alcoa within 3 months of self-certification unless otherwise agreed.
Standard	The average number of stems/ha within a pit (9-month monitoring data): • Min 600 eucalypt stems/ha (including min. 150 jarrah stems/ha and min. 200 marri stems/ha) • Max: 1400 eucalypt stems/ha • Target: 1000 eucalypt stems/ha (except haul roads and pits <2ha). No rehabilitated sites (>2ha in size) have areas >0.5ha (as identified from either 9-month monitoring or subsequent review of aerial imagery at ~5yrs of age) with < 100 stem/ha.

Corrective action	Alcoa to provide documentation and advice to DPaW, where self-certification has resulted in outcomes that do not meet the standard. Rehabilitated areas that do not meet the minimum standard will be replanted or reseeded by Alcoa with minimal delay (once conditions are suitable) to enable the minimum standard to be achieved. Rehabilitated areas that exceed the maximum standard will be inspected by DPaW and may be thinned by Alcoa to reduce tree density back to the identified acceptable range, as required

Table 1. Example of a Completion Criteria for Rehabilitation (2016 Onwards) at Alcoa operations, Western Australia

Case Study - Mine site reclamation and rehabilitation program at Companhia Brasileira de Alumínio (CBA), Brazil

Since 2008, CBA has been working on a land reclamation model that has established a new relationship between mining and the environment. Working in partnership with the Federal University of Viçosa (UFV), legacy mine sites are reclaimed into native Atlantic Forest land, pastureland, coffee and eucalyptus plantations. The reclamation process re-integrates the decommissioned mine site into the surrounding landscape using best-practice methods throughout the process to create a sustainable, natural environment. New and improved rehabilitation practices have not only been beneficial to the Company and the academic community, but they have also provided subject matter for masters and doctoral papers presented in national and international conferences and journals. They have also been especially beneficial to local farmers.

CBA's bauxite mine operations in Minas Gerais differ from typical open-pit mines. Ore is found in the crest and mid-slope areas and can easily be mined with limited excavation and without the need to form large pits. Bauxite mines can be reclaimed into native vegetation, cropland or pastureland.

The partnership with UFV spans three lines of research and development (R&D) to improve reclamation practices: Environmental Rehabilitation, Reforestation and Water Conservation.

Research in collaboration with the university's Soils Department develops and evaluates best-practice methods of soil management, planting crops and native vegetation, as part of the mine reclamation process. This line of research also deals with mechanisation and family farming. The first major outcome from this research, and the first initiative of its kind in the world, was the development of methods to reclaim mine sites into coffee farms. Coffee farms established by CBA in reclaimed mine land have 50% higher crop yields compared to other properties in the region.

At the Forest Restoration Laboratory, the second line of research is focused on reforestation with native species, both on legacy mine land and as offsets. Bioindicators monitored in these areas include natural regeneration, canopy closure, seedling diversity, leaf litter, soil seed bank, and fauna components. This line of research also develops and deploys restoration and monitoring methods such as nucleation, artificial perches, topsoil, green manure, direct seeding and other methods to improve Atlantic Forest restoration efforts. On another front, landscape ecology studies assess forest cover and connectivity between forest patches. Many bioindicators in forests planted by CBA are now comparable to or better than those of Atlantic Forest remnants in the region. In terms of biodiversity, 155 species have been identified in forests restored by CBA. This figure is 16% higher than the average for secondary forests in the region and 48% higher than recommended by the environmental authority (80 species).

The third line of research, Water Conservation, evaluates pre- and post-mine hydrological conditions and works to perfect drainage methods used at CBA for mining and reclamation. An important component of this research effort is a program to reduce surface runoff, which has demonstrated the benefits of CBA's rehabilitation methods in areas reclaimed into eucalyptus plantations. In these areas, surface runoff has been reduced by more than 67%, demonstrating increased water infiltration into the soil.

Figure 63. CBA reclamation and rehabilitation in Minas Gerais, Brazil

Case Study - Bagru Hill Bio-park, Hindalco, India

Hindalco's Bagru Hill mines in Jharkhand, India has been the site of major land reclamation and rehabilitation following decades of bauxite mining. After mining, an area of the mine was backfilled and reclaimed using waste material (mostly laterite) and topped with soil. A 5.5-hectare area has been restored and developed into a park with different themed garden zones that include among other things a Butterfly Garden and a Spice Garden.

The park has provided an opportunity to engage with the local community. There is a bamboo pavilion on site that acts as a hub and multi-function space for hosting group meetings, parties and community discussions. There is also a commercial fishery, duck farm and orchard in this park where the local community are actively involved. The fishery provides two yields per year to the villagers and the fish are sold in the local market once they reach a size of 2 kg. The fishery pond also houses a 150-capacity duck house. This sits on a raised platform allowing the duck waste to be utilised by the fish. The orchard has the dual purpose of increasing vegetation cover on the reclaimed land as part of the mine closure plan and also provides crops for the local communities. There is over 1,000 m^2 sized plantations of strawberries, 20,000 m^2 of pears and 4,300 m^2 of cashew trees with new saplings brought in annually to grow the orchard and increase the yields.

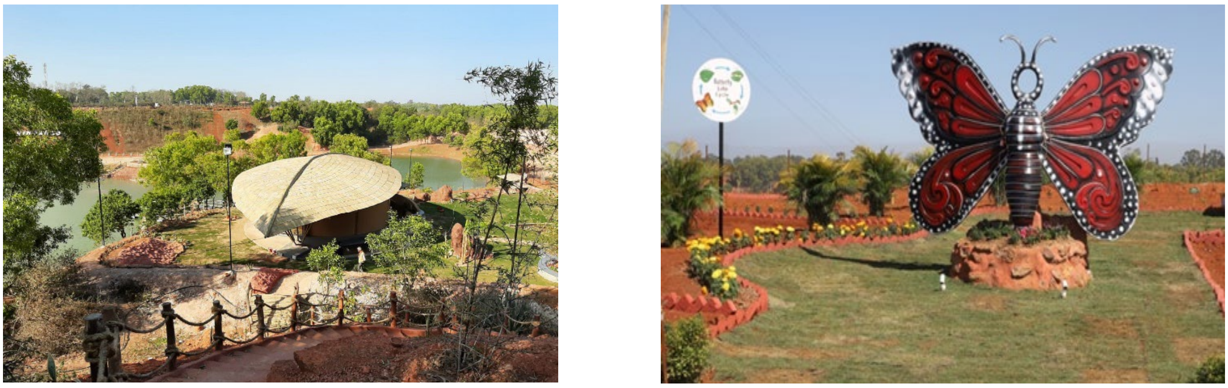


Figure 64. Rehabilitation of the mine includes multipurpose gardens, community spaces and commercial initiatives

The fishery, duck farm and orchard have supported the community directly with the produce that can be sold at local markets but also through training and skills development which has increased self-sufficiency and improved livelihoods in the local community. The villagers have been trained in fish and duck rearing and orchard management at the park and in turn taken these skills back to their community to set up their own initiatives.

Figure 65. Fishery and duck farming on reclaimed land at Bagru Hills (Hindalco)

Case study: Biodiversity Research Consortium, Hydro, Paragominas, Brazil

The Biodiversity Research Consortium is a partnership to build knowledge on rehabilitation of bauxite mined areas, promoting skills and capacity building in the Amazon region and enabling Hydro Paragominas to rehabilitate its mined areas and support Amazon biodiversity.

The BRC is an alliance between academia and the mining industry with a focus on scientific development, biodiversity conservation and rehabilitation of mined areas. It involves the integration of technical knowledge and operations expertise with academic rigour and fosters the role of education and science in delivering positive mine rehabilitation outcomes. The collaborative approach has promoted the exchange of information and knowledge across a broad network. It has also seen many researchers and students visit Hydro's Paragominas mine where over 26 research projects as part of the BRC have been approved. The projects cover a range of different environmental issues related to biodiversity and ecosystem services including greenhouse gas fluxes and carbon emissions, biodiversity surveys, monitoring and indicator development and restoration of tropical forests including soil restoration. From 2013 to 2020 approximately 220 researchers, across different levels and organisations, have been involved in the Consortium's activities.

Figure 66: Researchers and students working on projects at Hydro Paragominas

In 2021, almost 100 students were supported by BRC and after interruptions and delays to activities as a result of the Covid-19 pandemic, it is expected that activities will begin to return to normal and field activities and projects can continue in 2022.

Figure 67: Interacting with community, government and industry to disseminate information from the Consortium's activities

Another key area for the BRC is dissemination of the research and partnership. This involves regular presentations at mining events, interface with government and research institutes as well as community initiatives, such as the Paragominas Agricultural Fair to engage a variety of stakeholders in ongoing work.

Closure Planning

A bauxite mine's economically useful life will eventually be reached. Planning for mine closure is therefore fundamental to business planning and should be considered at the earliest stages of planning, including considering closure costs when making initial investment decisions. Closure planning involves continual testing of assumptions and preferences to match evolving social, economic and environmental conditions and expectations. As such, closure plans typically develop through several iterations:

- Closure planning is initially conceptual and progressively becomes more detailed;
- An initial closure plan may communicate an outcome and goals, whereas a detailed plan should include milestones, detailed methodologies of achieving these, and programmes for monitoring results; and
- Prior to and during the operational stage, closure plans should identify any studies and investigations that may be needed to improve technical knowledge relating to future closure works and to improve the accuracy of closure cost estimates.

A detailed closure plan should be in place before closure-related works commence and would usually include:

- A detailed description of the final self-sustaining land use post mining, developed in consultation with stakeholders such as regulators, other parties with interests over the mining tenure (including indigenous peoples), local communities and NGO's.
- A plan documenting how the mine is to transition from operations to closure including:
    - Engineering works to decommission and dismantle infrastructure, grade landforms for effective drainage, complete mine rehabilitation, cap and cover tailings facilities, remediate any contaminated sites, and implement post-closure monitoring and maintenance programmes;
    - Administrative arrangements relating to transferring assets, demobilising the labour force, relinquishing mining tenure and environmental licences, and relinquishing any other relevant agreements with third parties; and
    - Documentation of the resources, including financial, which are required implement closure activities, including ongoing monitoring and maintenance.

In cases where the mining lease is to be relinquished after closure, but the company has ongoing obligations (e.g., for monitoring and maintenance) the closure plan needs to state how these obligations will be met (e.g., financial surety in the form of a trust fund). There should be an agreed framework which ensures mines are not abandoned without penalty, and that this penalty is sufficient to complete the necessary closure works by a third party.

In particular, mine closure benefits from the active participation of regulators and local communities in planning and implementation of closure actions. Benefits include:

- Plans which are transparent and readily understood by all stakeholders;
- Lower risk of regulatory non-compliance;
- Timely identification and rectification of potential problems;
- Progressive reduction in potential liabilities; and
- Timely identification and implementation of beneficial opportunities for lasting community benefits.

Sustainable Bauxite Mines should:

- Have a closure plan, developed with local stakeholders and agreed with regulators; and
- Establish appropriate financial provisioning for closure and ongoing monitoring and maintenance activities.

Case Study – Mine Relinquishment, Alcoa, Australia

The first of Alcoa’s bauxite mines in Western Australia was at Jarrahdale, where mining operations commenced in 1963 and continued until rehabilitation was completed in May 2001. The 4090-ha mine produced some 168 million tons of bauxite from 1963 to late 1998 when the mine ceased production. Many of the key lessons in developing Alcoa’s current rehabilitation methods were developed at Jarrahdale – it was the first mine in Western Australia that the company had closed and rehabilitated to pre-agreed standards. Although the closure of Jarrahdale is seen as an end point, improvements in rehabilitation are ongoing at the two operating mines at Huntly and Willowdale. Alcoa’s mines in Western Australia are located in jarrah forest, in an area of high biodiversity and with a high value placed on the ecosystem – this creates additional expectations of high-quality restoration.

While the published rehabilitation objective at Alcoa’s WA bauxite mines is to “establish a stable, self-regenerating Jarrah forest ecosystem, planned to enhance or maintain water, timber, recreation, conservation and/or other nominated forest values”, achieving such a broad objective to the level expected by society, however, required the evolution of increasingly stringent, specific targets and operating standards. This in turn depended on the constant evolution of improved restoration technologies, requiring significant levels of ecological research.

Alcoa has a three-tiered hierarchy of objectives which cascade from broad completion criteria, through ‘working arrangements’ to specific internal targets. Completion criteria are the most generic level of formal performance indicators expected to be achieved by Alcoa before a mine can be decommissioned to state government standards. Effectively, these represent milestones in the biophysical processes of rehabilitation that provide confidence that a rehabilitated mine site will eventually reach the desired objective.

Substantial areas of Alcoa’s former mine at Jarrahdale have met these required completion criteria. This should allow these areas to be managed in an integrated manner with the surrounding unmined Jarrah forest. Therefore, although the rehabilitated areas are not identical to the pre-mined condition, all the sites at Jarrahdale have reached approximate compositional goals to unmined sites and have demonstrated processes of self-perpetuation. Key components of Alcoa’s strategy have included:

- Implementing a commitment to study the baseline native ecosystem and the restored ecosystem and to seek convergence in similarity of biodiversity and function;
- Facilitating specific applied knowledge gained from this research, such as the:
    - Use of direct- returned topsoil;
    - Sowing of seed of a wide range of native species;
    - Proximity of colonisation sources for other species;
    - Propagating and planting of species that are difficult to return by other means; and
    - Refining ratios of species to duplicate the forest structure and function.

In 2005, a total of 975 ha of rehabilitation at Alcoa’s now decommissioned Jarrahdale mine site was handed back to the State Government and a Certificate of Acceptance issued to Alcoa This represented the first large-scale relinquishment of rehabilitated land by a mining company in Australia. A second certificate of acceptance was issued for a further 380 ha of mine rehabilitation at the same site in 2007 (Figure 68).

Alcoa's ongoing research and improvements to rehabilitation treatments suggest, that 10 years from now, mine restoration achievements are going to be better than the high standard being achieved today. These refinements will also raise the level of environmental and rehabilitation performance that is expected by the community and will continue to drive ongoing improvement for the whole industry at a global level.

CERTIFICATE OF ACCEPTANCE

The Department of Conservation and Land Management issues this Certificate of Acceptance to Alcoa World Alumina Australia on recommendation from the Mining and Management Program Liaison Group. The certificate is for 975 hectares of State forest within the Wungong Catchment and is referred to as **Jarrahdale Area One,** the area coloured green on the map marked "A" attached to this certificate.

The Minister for the Environment's *Statement* 390 of 1995 (pursuant to Part IV of the Environmental Protection Act 1986). Procedure 4(6) Final rehabilitation completion criteria states.... *"where areas have met all appropriate criteria, a certificate of acceptance will be supplied to the proponent by the Department of Conservation and Land Management, on behalf of the State"*

Alcoa World Alumina Australia has met all of the appropriate criteria required by CALM for rehabilitating Jarrahdale Area One, which was cleared for bauxite mining purposes under the Alumina Refinery Agreement Act 1961.

The issue of this Certificate of Acceptance is formal acknowledgement that Alcoa World Alumina Australia has no residual liability or management responsibility for **Jarrahdale Area One** henceforth.

Keiran McNamara
Keiran McNamara
Executive Director
Department of Conservation and Land Management
Dated 8th day of November 2005

Figure 68. Example Certificate of Acceptance

Glossary and References

Glossary

- Activity - Actions performed by employees or contractors (such as changing a seal or landscaping a pit) or processes that take place (such as transporting caustic through a pipe or conveying bauxite).
- Alumina - Mined bauxite is refined into alumina (which is smelted into aluminium and the manufacture of chemical products).
- Aluminium - Mined bauxite is refined into alumina, and alumina is smelted into aluminium.
- Beneficiation - The processing of crude bauxite to produce product grade bauxite a process where oversized particles are removed by screening and fine particles are removed by washing.
- Broad based community support - Community support which is received from a broad spectrum of people.
- Community investment - Has the primary purpose of benefiting the communities in which bauxite mines operates. It should improve quality of life indicators and/or align with community priority and focus areas.
- Complaints and grievance - Community concerns can range from commonly occurring, relatively minor issues [complaints] to more entrenched or serious ones that have become a source of significant concern or resentment. The latter are sometimes referred to as grievances.
- Consequence -The outcome of an event expressed qualitatively or quantitatively, being loss, injury, disadvantage or gain. There may be a range in severity of possible outcomes associated with an event.
- Deposited matter – is any dust that falls out of suspension in the atmosphere.
- Environment - Surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelations.
- Environmental Aspect -An element of a mine’s activities, products or services that may interact with the environment.
- Environmental Impact - Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an activity, product or service.
- Event - The result of one or more activities that may lead to an environmental aspect.
- Frequency - A measure of the likelihood expressed as the number of occurrences of an event in a given time and is the frequency of the impact (as opposed to the event) occurring.
- Greenhouse gases - Gases such as carbon dioxide and methane which, when dispersed in the atmosphere, tend to trap heat.
- Host community - Persons or groups of people living and/or working in any areas that are economically, socially or environmentally impacted (positively or negatively) by mining activities. It can range from people living adjacent to or at a distance from our activities that may be impacted.
- Human rights impact assessment - An assessment to identify, understand and manage potential impacts of direct and indirect activities on the human rights of its stakeholders.
- ISO 14001 - An international standard that provides the requirements for an Environmental Management System (EMS).
- Likelihood - Used as a qualitative description of probability and frequency and is the likelihood of the impact (as opposed to the event) occurring.
- Opportunity - An opportunity is a beneficial social or environmental impact.
- Overburden - Rock and/or soil overlying the bauxite resource.
- Probability - The likelihood of a specific outcome, measured by the ratio of specific events or outcomes to the total of possible events or outcomes. A probability rating matrix is defined in the EHS risk assessment.
- Risk rating - The chance of something happening that will/may have an impact upon objectives. It is determined by consequence and probability.
- Risk Register - These aspects and impacts are collected together as ‘Risk Registers’.

- Sensitive Receptors - Sensitive receptors are people or other organisms that may have a significantly increased sensitivity or exposure to contaminants by their age and health (e.g., schools, day care centres, hospitals, nursing homes), status (e.g., sensitive or endangered species), proximity to the source or the facilities they use (e.g., water supply well). The location of sensitive receptors must be identified to evaluate the potential impact on health and the environment.
- Significant Environmental Aspect - A significant environmental aspect is an environmental aspect that has or may have a significant environmental impact.
- Social Aspect – An element of a mine's activities, products or services that may interact with the community, stakeholder groups, government, or non-government organisations.
- Social baseline study - The gathering and compilation of baseline data that describes the state of the social and economic environment and the characteristics of the populations living in the area around activities. The study includes quantitative data, including population, education, and health data, which can generally be derived from secondary sources including census reports, government statistics and reports, regional or community plan and qualitative data such as community perceptions and attitudes, which is sourced directly from stakeholders.
- Social Impact Assessment (SIA) - An SIA identifies and assesses the social impacts that are directly related to projects and operations. It proposes measures to enhance potential positive impacts (opportunities) and strategies to avoid, manage, mitigate, or offset potential negative project impacts. The SIA is informed by the Social Baseline Study and stakeholder engagement. The SIA must be verified through stakeholder engagement.
- Soil Erosion - The loss or degradation in the quality of surface soils resulting in a net negative impact when compared to baseline conditions.
- Stream Order - The stream order is a positive whole number used in geomorphology and hydrology to indicate the level of branching in a river system. For example, the smallest tributaries are referred to as first-order streams, while the Amazon, is a twelfth-order waterway.
- Tailings - Bauxite tailings are the fine-grained waste material resulting from beneficiation.
- Total Suspended Particles (TSP) – all suspended particles. To be suspended, these typically 50 µm (0.05 mm diameter) in size or less.
- World Heritage Areas - are places identified by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) for their outstanding cultural or natural value to humanity.

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