Sustainable Bauxite Mining Guidelines

First Edition

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International Aluminium Institute (IAI) www.world-aluminium.org

Current IAI membership represents over 60% of global bauxite, alumina and aluminium production. Since its foundation in 1972, members of 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 IAI 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 liaise 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 promote appropriate research and other action concerning them;
- Encourage and assist continuous progress in the healthy, safe and environmentally sound production of aluminium;
- Collect statistical and other relevant information and communicate 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 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) http://aluminium.org.au/

AAC is the industry association representing the Australian aluminium industry. AAC's members are the companies operating in bauxite mining, alumina refining, aluminium metal production and semi-fabricated aluminium production and distribution. AAC 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) http://abal.org.br/

ABAL was founded in 1970 by the primary aluminium producing companies in Brazil. It was designed as a common forum to address aluminium industry related issues from a producer and processor perspective but also with regards to government and community concerns. Today, ABAL is comprised of primary aluminium producers, aluminium processing companies (representing around 80% of Brazilian domestic consumption), consumers of aluminium products, raw material suppliers, service suppliers and traders. ABAL aims 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, as well as watching over its institutional image and product.

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. To meet current and future demand, there has been – and will continue to be – an increase in the number of mines, some with less extensive ore bodies and with shorter predicted mine life. This changing nature of the industry means that it needs to assess cumulative impacts of both large- and small-operations and their required governance. The recent influx of new entrants has, in some situations, led to the emergence of poor 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 have developed these Guidelines.

The aluminium industry's objective is a sustainable bauxite mining industry with acceptably low social and environmental impacts during operation and post-closure. Sustainable bauxite mining is not a single "one-size fits all" prescriptive process but one that involves managing risks with best available technologies appropriate to the circumstances of the specific mine. This will be influenced by local climatic, geographic and environmental conditions as well as government policies, the 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 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 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 mine life, 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 alterations to mine plans 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, changes to mining 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 mine 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 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. Identify key stakeholders and have a formalised plan and schedule for interacting with them;
7. Consult with the community about the operation and ultimate closure of the mine;
8. Communicate to the community on progress against any agreed actions;
9. Understand the role, customs and decision-making practices of Indigenous Peoples impacted by the mine;
10. Consult with Indigenous Peoples prior to commencement of mining or mine construction;
11. Understand and plan to preserve key aspects of cultural heritage relevant to the mining area;
12. Survey prior to mining and protect any additional cultural heritage sites identified during mining;
13. Not used forced or child labour (as defined by ILO Conventions C138 and C182) and shall comply with related national laws;
14. Provide documented, fair working conditions to all employees appropriate to local standards;
15. Ensure the health and safety of all employees and contractors;
16. 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;
17. Ensure all transport through the community includes safety training;
18. Ensure that transport personnel adhere to speed restrictions and cover all vehicles appropriately;
19. Consider the need for economic mitigating measures or compensation for loss of land use and its other community values;
20. Avoid physical community displacement if possible;
21. If physical displacement cannot be avoided, then engage with the affected community and government to jointly develop a resettlement action plan; and
22. Seek approval from the government to implement any community relocation.

Health and safety

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

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

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1 Introduction

Aluminium is a comparatively young metal – its commercial use dates back only about 150 years – yet 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 1.1). In all sectors, it is valued for being light, strong, durable, flexible, impermeable, thermally and electrically conductive and non-corrosive.

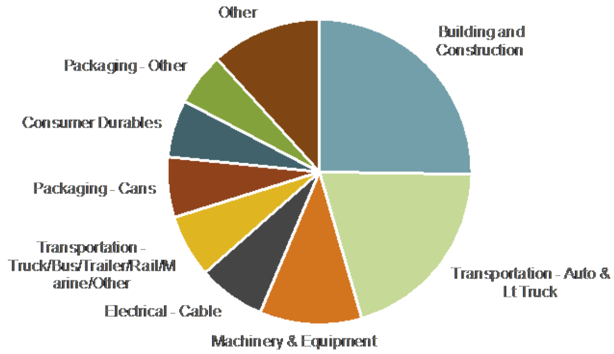
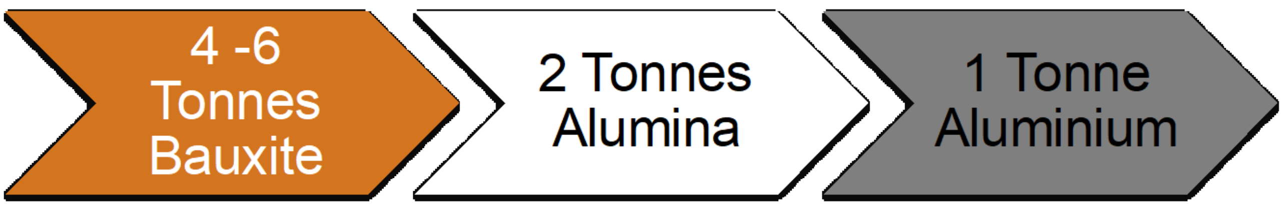


Figure 1.1 Semi-finished shipments share of demand by end-product, 2017 [1]

Bauxite is the primary ore used to make aluminium. Bauxite is non-hazardous. Around 85% of bauxite is refined into alumina (or alumina chemicals), which is then smelted into aluminium, 8% produces 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 are 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 metres 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, though for a shorter time. 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 mines (and other processes in the aluminium value chain) are independently owned and operated, in some cases becoming detached from mainstream aluminium producers.

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 (for example Malaysia, Fiji and New Caledonia) and the establishment of many new operations in both traditional (for example Guinea, Australia and India) and newly producing countries (Figure 1.2).

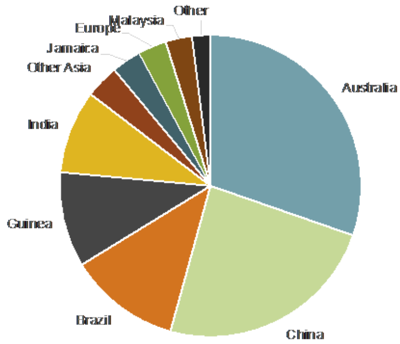


Figure 1.2 Bauxite production share by country, 2016 [2]

Sometimes this is done by operators with limited bauxite mining experience. This influx of new entrants has, in some situations, led to the emergence of poor mining and environmental practices, with some authorities imposing moratoria or bans on bauxite mining and shipping in response. To address unsustainable practices by parts of the newly emerging bauxite mining industry, a coalition of global and national aluminium associations and companies has developed these Sustainable Bauxite Mining Guidelines.

These Guidelines elaborate the aluminium industry's prime objective – to ensure bauxite mining is sustainable and achieves acceptably low social and environmental impacts during operation and post-closure. However, sustainable bauxite mining is not a single 'one-size fits all' prescription to bauxite mining – it involves managing each risk with best available technologies 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 bodies in Brazil (ABAL) and Australia (AAC), in addition to the current Aluminium Stewardship Initiative (ASI) (https://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 managers of bauxite mines, representatives of non-government organisations (NGOs), neighbouring communities and government regulators. A summary of the recommended Guidelines is in Section 8.

A draft of these Guidelines was presented at the Conference on Sustainable and Responsible Mineral Development (Kuantan, Malaysia December 2017) by Miles Prosser (AAC) and Marghanita Johnson (Grove Solutions, consultant supporting the preparation of these Guidelines). IAI wishes to thank the organisers of the conference, the Malaysian Chamber of Mines, for making this possible.

The IAI would like to acknowledge the contributing and reviewing companies for their contributions to these Guidelines.

- Alcoa
- Alufer
- Alumina Limited
- Companhia Brasileira de Alumínio
- Harita Group
- Hindalco
- Jamaica Bauxite Institute
- Mineração Rio do Norte
- Norsk Hydro
- Rio Tinto
- Rusal
- Société Minière de Boké (SMB) - Winning Consortium
- South32
- Spring Energy

The IAI acknowledges the contributions of Miles Prosser (AAC) and Milton Rego (ABAL) as well as the support of IAI Bauxite and Alumina Committee and IAI Communication and Promotion Committee.

2 Background

2.A Global supply and demand

Primary aluminium demand is strong and is forecast to grow at more than 4% per annum through until 2030 (Figure 2.1). The growth in primary aluminium will drive subsequent growth in the alumina and bauxite markets, also projected to be 4%. China currently represents over 50% of global primary aluminium demand and alumina production (Figure 2.2), with this trend expected to continue until 2030.

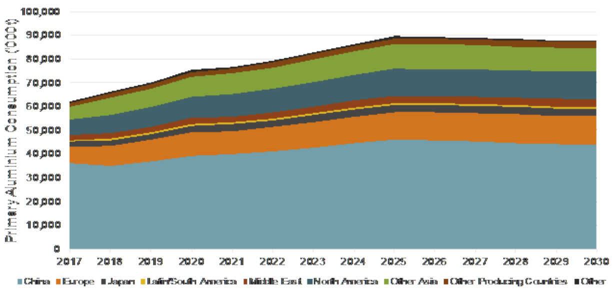


Figure 2.1 Primary aluminium consumption by region, 2017-2030 ('000t) [1]

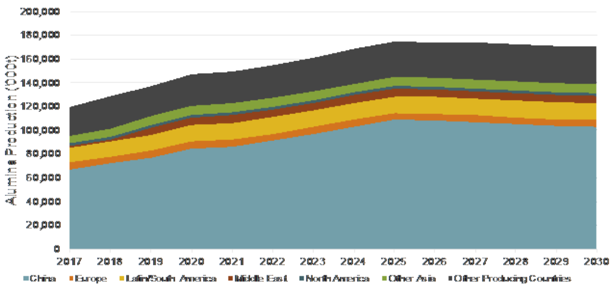


Figure 2.2 Global alumina production by region, 2017-2039 ('000t) [1]

As a result, with domestic bauxite availability and quality declining in key provinces, Chinese demand for bauxite imports to meet alumina production is forecast by several analysts to increase steeply from around 2020, resulting in a near doubling of estimates for bauxite imports to 120 Mt per annum by 2025 (Figure 2.3). China's increasing requirement for bauxite 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 new area of demand, thereby resulting in the entry of new producers and new countries into the bauxite market. Recently, there have been major swings in the bauxite supply source, with both Indonesia and Malaysia becoming the major supply country to the traded (export) bauxite market for short periods – in total, over 10 countries now export bauxite to China, leading to a widely diverse industry.

While, historically, Australia has been the world's largest bauxite miner, in 2016 it was second (88 Mt) in volume terms to China (94 Mt), alongside other major players, including Guinea, Brazil and Jamaica. Guinea has replaced Australia as the largest bauxite exporter. Guinea and Australia combined contributed 74% of Chinese bauxite imports in the first half of 2017 (Figure 2.4).

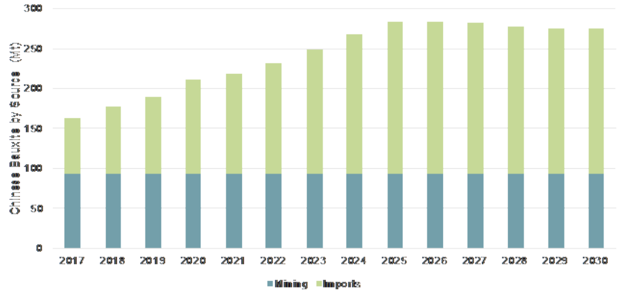


Figure 2.3 Chinese bauxite import forecast, 2017-2030 [1]

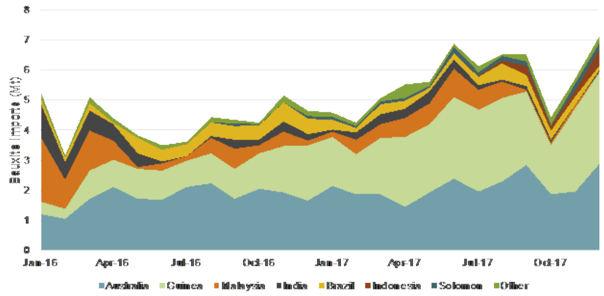


Figure 2.4 Monthly Chinese bauxite imports, 2016-2017 (Mt) [1]

Existing suppliers, as well as ‘committed’ and ‘probable’ projects, may meet demand to around 2020. However, from 2020-2025, projects in the ‘possible’ category are also required to meet these expected industry requirements. Beyond 2025, a supply/demand gap is predicted to emerge, with further new projects needed to meet forecast demand (Figure 2.5). This need may be met by emerging South-East Asia and African providers. Indeed, while demand has historically been met by a few large players in the market which have operated large-scale mines, future sustainable bauxite supply will rely on both these existing suppliers and new suppliers in the market. This may result in an increase in the number of small mines, with less extensive ore bodies and shorter mine lives which respond to opportunities in the market. This changing nature of the industry to meet future demand means that the cumulative impacts of these small operations needs to be assessed, including their required governance.

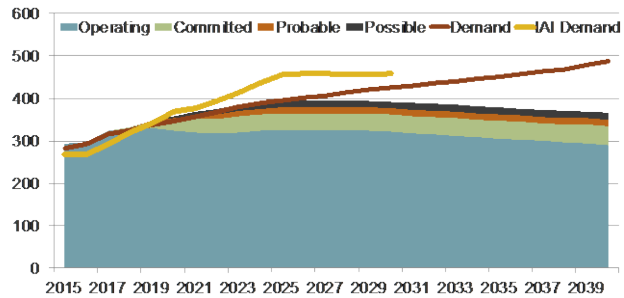


Figure 2.5 Current and predicated worldwide bauxite supply and demand, 2015-2039 (Mt) [3]

2.B 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 will become economically viable.

A total of 90% of the world's bauxite reserves are concentrated as large blanket deposits in tropical and sub-tropical regions – West Africa, Australia, South America and South East Asia (Figure 2.6). 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 metres, although it may be less than 1 metre and up to 40 metres in exceptional cases.

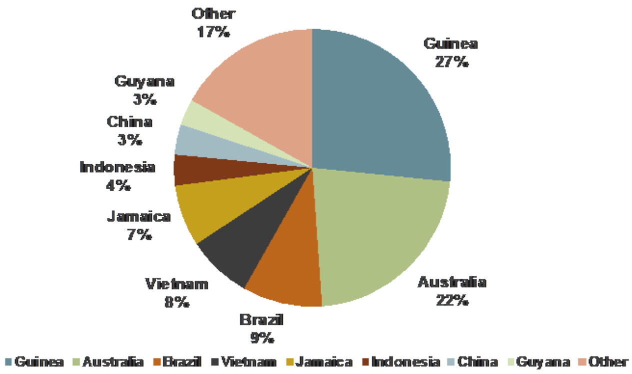


Figure 2.6 Global bauxite reserves [4]

Bauxite is predominately mined by surface (open cast) mining methods and therefore 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 quickly, efficiently and effectively as possible.

Because of this 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 may frequently require access to large tracts of land and water that are often the basis of livelihoods for these local communities. However, at the same time, it should be noted that mining related activities may also 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.

2.C 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, seedlings and cuttings 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);
- Breaking up the bauxite using methods such as ripping with very large bulldozers or, in some cases, drilling and blasting;
- Once the bauxite is loosened, loading it into trucks or rail wagons or on to conveyors, and transporting it 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 removal of waste materials through screening, crushing, washing and dewatering. The process produces a higher-grade ore product and tailings (mainly clays and fine sands);
- Transporting the bauxite to alumina refineries; and
- Once this removal is completed, rehabilitating the areas affected.

Figure 2.7 Bauxite stockpile at a South32 mine

3 Sustainable bauxite mining practices

3.A Key principles

The key 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 as well as 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 regarding safety, the environment, the economy and the community[5]. Principles of sustainable mining include[6]:

- Ethical business practices and sound governance;
- Sustainable development considerations in decision-making;
- Respect for human rights;
- Effective risk management;
- Effective health and safety performance;
- Observant environmental performance;
- Considerate conservation of biodiversity and land use planning;
- Responsible use and supply of materials;
- Attentive social contribution; and
- Engaging and transparent reporting.

Figure 3.1 Community engagement at Alufer, Bel Air, Guinea

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.

Incorporating all the elements of sustainable bauxite mining practices into operations is therefore vital. In turn, good governance, reduced environmental legacies, fewer safety incidents and increased community benefits result in not only better financial outcomes but also in enhanced company, country and industry reputation, competitiveness and credibility. Indeed, overcoming any 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 therefore strive to be a catalyst for local sustainable development.

3.B Key impacts during the phases of a mine’s life cycle

Sustainability requires that 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 therefore 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.

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.

Specific strategies to mitigate any negative environmental and social impacts of bauxite mining may include:

- Identifying culturally and environmentally significant areas and alterations to the mine plan to minimise impacts on these areas;
- Controlling dust levels by watering, covering vehicles and road maintenance as well as by imposing vehicle speed limits and load limits;
- Constructing settling ponds and other drainage control structures;
- Encouraging rehabilitation planning and implementation as early as possible 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 the provision of buffer zones, altered timing of operations, modification of equipment, changes to mining and blasting methods; and
- Establishing 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 regards 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 at Alcoa Juruti, Brazil*[7]**

In the heart of the Amazon, Alcoa's bauxite mining project in the pristine Juruti region of Brazil (Figure 3.2) 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 Brazil and in the world.

Figure 3.2 Aerial photos and bauxite mine stockpile at Alcoa, Juruti, Brazil

Alcoa's stated principles for its mine project at Juruti are to:

- 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 cost;
- Apply world-class technology and management systems; and
- Earn the right to operate the business day by day by living up to the foundations of Alcoa's sustainability structure.

The Juruti region is home to 47,000 people – 65% of these live in about 150 rural communities. Traditionally, the economy 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 and almost 70 additional meetings with community members and, as a result, implemented 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; this included 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:

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

The Sustainable Juruti Council brings together three representatives from the private sector, three representatives from 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. This includes monitoring Alcoa's bauxite mining operation, as well as the implementation of environmental control programmes and 'positive agenda' initiatives to provide a forum for discussion and collective action. The Council contains eight working groups – environment, health, education, security, infrastructure, culture and tourism, economy and labour and rural development, and citizenship. Each stakeholder group plays a unique and vital role in the Council, with the government serving an important regulatory and mediation role.

The positive agenda initiative 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 addressing 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 local municipal administration, with initiatives implemented through partnerships with local authorities, NGOs and the community. Examples of sustainable infrastructure initiatives include:

- Constructing 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 seek medical attention;
- Constructing 16 classrooms in eight municipal schools and an elementary school in the district;
- Constructing a legal complex, including the municipality's first courthouse and associated offices;
- Creating a new business training programme, in partnership with the Juruti Trade and Business Association, and a supplier development programme of the State of Para Federation of Industries;
- Creating three deep water wells to provide fresh, clean water to city residents; and
- Establishing 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.

In addition to this operational commitment to world-class environmental management and restoration, the Juruti project has developed a series of sustainability indicators to monitor local development within Juruti. This has been done through multiple stakeholder workshops and with input from over 600 community members through town hall meetings and online consultation. They provide important input to the work of both the Council, the positive agenda initiative and to the environmental control plans, the latter totalling 35 programmes which were part of the bauxite mine's installation licence. 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 8 years of operation, the bauxite mine is boosting the development of Juruti by improving governance, employing and training local labour, mitigating environmental impacts and leveraging community incomes. For example, from 2009-2017, after Alcoa's investment in partnership with the government and stakeholders:

- Enrolment in middle school increased more than 400%;
- The human development index (HDI) jumped from 0.389 to 0.592; and
- The number of formal jobs rose from 185 to 4,948.

Alcoa has also 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 has paid approximately US$17.6 million in royalties to ACORJUVE.

Rehabilitation of mined areas has also been successful on both environmental and social grounds. To date, Alcoa has purchased almost 400,000 rehabilitation seedlings, generating more than US$ 200,000 in local income. These are raised by the community who receive training and support from Alcoa. In the same sense of promoting shared results for the environment and for communities, Alcoa adopted a 'green locomotive' programme aiming to mitigate the carbon emissions generated by the operation of the railway locomotives by planting trees within degraded areas. This was a voluntary action additional to the rehabilitation of mined areas. The programme has resulted in the production of 10,000 seedlings, generating income for the Galileia community and revegetating 6 hectares of community land with species native to the Amazon forest.

Alcoa Juruti's approach of integrating mining with conservation has encouraged a consideration of the different land uses in the region in a diversified and flexible way. Alcoa believes that this is both feasible and necessary for sustainable mining.

4 Governance

4.A 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, particularly in developing countries. 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. Additionally, in the absence of an effective local government presence, the company may end up becoming a proxy local government authority. Bauxite mining companies may therefore 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.
- Good governance for bauxite mines should include:
- Having a set of values and a code of ethics applicable to employees, suppliers and relationships with authorities. This includes publishing and distributing these to all key stakeholders;
- Conducting employee training on ethical conduct;
- Complying with or exceeding 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 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: • Document the values, policies and procedures for their processes, including decision-making; • Comply with government regulations; and • Publish their performance, including details of significant non-conformance or penalties.

4.B Role of governments

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

4.C 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 EIA and a SIA prior to the commencement of mining will help identify the impacts the mine will have on the environment and community and allow mitigation plans to be implemented early to avoid these issues impacting the sustainable operation of the mine. They also identify the permits required for the bauxite mine. While permitting processes will vary considerably between countries, the operation of a bauxite mine typically requires more than just an environmental permit to operate, perhaps also requiring other permits, approvals or licences such as:

- Exploration permits;
- Feasibility study approvals;
- EIAs for permits;
- SIAs for permits;
- Land use permits;
- Import / export permits;
- Port usage permits;
- Water allocation licences;
- Effluence discharge permits;
- Tailings dam approvals;
- Sewerage treatment plant licences;
- Waste disposal licences;
- Permits or approvals for transport of bauxite permits;
- Radio frequency permits;
- Bulk fuel storage tank certification; and
- Mine closure plan approvals.

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.

Case study – overarching governance structure at South32

The global mining company South32 currently operates in three continents – Africa, South America and Australia. In the context of governance, they need to ensure that appropriate structures are in place, regardless of the location of a particular operation. South32 therefore uses a globally applicable sustainability policy as its overarching guidance for all operations:

> South32 affirms our commitment to Sustainable Development, defined as supporting the needs of the present without compromising the ability of future generations to meet their own needs.
>
> - We monitor the external environment for opportunities to invest and develop natural resources that deliver shared value for society.
> - We work to achieve positive social, environmental and economic outcomes as a result of our decisions.
> - We commit to respecting internationally recognised human rights relevant to our operations, in line with the International Council for Mining and Metals Sustainable Development Framework, the United Nations Guiding Principles on Business and Human Rights and the Voluntary Principles on Security and Human Rights.
> - We support employment and community practises which empower people to make choices and have control over their process of development as it affects their lives, beliefs, institutions, well-being and the lands they occupy or otherwise use.
> - We continually improve safety, health, environmental practice, management systems and controls to ensure we avoid, mitigate and manage impact.
> - We practise responsible stewardship for the commodities we extract as well as the natural resources we consume.
> - We actively initiate and partake in conservation and rehabilitation activities to ensure ecosystems continue providing value to future generations.
> - To meet the challenge of climate change, we work to reduce our greenhouse gas emissions. We monitor our impact to ensure we do not compromise the ecosystems which provide resilience against climate change for our host communities.
> - We uphold stringent health, safety, environment and governance standards in all jurisdictions in which we operate.
> - We publicly report our progress and encourage high standards of transparency and accountability in our business governance, risk and government interactions.

South32 also has a Code of Business Conduct which is founded on its values. This defines how to act when working for or on behalf of South32. It represents the commitments to uphold ethical business practices and meet or exceed applicable legal requirements. South32 believes that consistent and proper business conduct creates loyalty and trust with its stakeholders, with each other and, importantly, with the communities in which it operates. Its community standard is therefore designed to achieve the commitments of its sustainability policy related to engaging with host communities.

Further, in line with South32's code of business conduct, environmental responsibility can also be demonstrated through minimising environmental impacts and contributing to enduring benefits to biodiversity and ecosystem services. In particular, its environmental standard outlines specific commitments required of each operation and exploration activity.

Case study – role of governance in the Jamaican bauxite mining industry[8]

The Jamaican bauxite industry has a history stretching back more than 60 years to 1952, when bauxite was first exported – in the early years of bauxite mining Jamaica was the world's largest producer (Figure 4.1). Today it remains the worlds 6th largest producer. The Jamaican Government has a long history with the bauxite and alumina industries, as a part owner of mines and refineries.

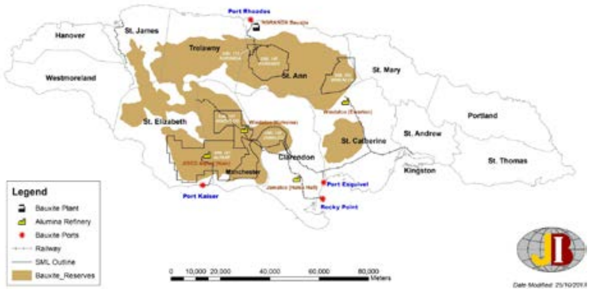


Figure 4.1 Location of Jamaican bauxite reserves

The Jamaican Bauxite Institute (JBI) is committed to the sustainable development of the bauxite industry in Jamaica, while ensuring protection of the environment for the greatest benefit of Jamaican people. This involves the JBI working with government agencies and being proactive in facilitating compatibility between the industry's operations and the environment. JBI has defined functions of:

- Monitoring and studying the bauxite and alumina industries;
- Ensuring productive use of bauxite land and reserves, before and after mining;
- Ensuring adequate pollution controls and other aspects of environmental management; and
- Undertaking research and development activities across industry issues.

In achieving the industry's goals of sustainability, the Jamaican government plays a major role in:

1) Legislation and enforcement of the:
   a) Mining Act and Regulations;
   b) National Environment and Planning Agency, where JBI has a memorandum of understanding;
2) Monitoring:
   a) Environmental monitoring and setting industry standards;
   b) Monitoring land use, before and after mining;
   c) Monitoring and certification of the rehabilitation or reclamation processes;
3) Direct investment in Bauxite Community Development Programme (BCDP)[9];
4) Encouraging dialogue through the formation of the Joint Bauxite Community Councils around mining, port and rail operations which:
   a) Assist in resolution of issues;
   b) Provide information channel about planned mining activities;
   c) Form a channel for identifying and developing ideas and proposals for BCDP; and
5) Forward thinking in improved mining practices which minimise impacts through technology improvements.

The goal of the BCDP is to reinvest earnings from the bauxite (and alumina) industry by implementing long-term sustainable projects in communities affected by bauxite mining and alumina operations. Ultimately, the programme is expected to lead to improvements in standards of living in the affected communities and to ensure that there is ‘life after bauxite’. Projects have included agriculture, the refurbishing of community facilities, repairs to numerous section of roadways in the five bauxite parishes, adult learning and vocational skills training, as well as the refurbishment and construction of classrooms and computer laboratories at basic, all-age and high schools and adult training centres.

The sustainability of communities which contain bauxite mines is dependent on the collaborative efforts of all stakeholders – community, government and mining companies. Understanding the role of these stakeholders and using defined governance structures such as the Jamaica’s Joint Bauxite Community Councils improves the outcomes which can be delivered.

5 Community assessment and contribution

5.A 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'. That is, unless the community is engaged and accepting of a mining operation, opposition and confrontation may ensue. Community opposition also has the potential to develop into disruptive actions which may directly interfere with mining activities or result in a government and / or 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 SIA to understand community needs, the impact of the mine on the community, and ensuring any significant risks identified are appropriately mitigated;
- Ensuring employment and contract labour 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 to enable a pathway into employment opportunities;
- Providing education support, for example scholarships;
- Assisting in the development of local suppliers of goods and services through a local procurement programme;
- Forming partnerships with governments and NGOs to help ensure community programmes such as community health, education and local business development are well designed and effectively delivered;
- Ensuring that people physically resettled by operations, where unavoidable, or people incurring economic displacement due to operations, are provided with appropriate mitigating measures or compensation; and
- Paying local, regional and national taxes, consistent with legal requirements, in a full and timely manner.

It is particularly important for the cumulative environmental and social impacts of these operations to be assessed where it is likely that there will be multiple smaller mines within a close geographic area. This may need to be undertaken by a regional body or aggregator of these mines. These small mines may increase in number as demand for bauxite 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.

Sustainable bauxite mines should:

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

Case study – community support at Companhia Brasileira de Alumínio, Brazil

In 2014, in consultation with local communities and other stakeholders, the Brazilian bauxite mining company Companhia Brasileira de Alumínio (CBA) identified the need to provide additional alternative incomes for family farmers and provide incentives for youth to stay in the region of São Sebastião da Vargem Alegre. CBA worked with Empresa de Assistência Técnica e Extensão Rural do Estado de Minas Gerais (Technical Assistance and Rural Extension Company in the State of Minas Gerais) and local producers to establish this.

It was determined that banana growing would be the best option. Bananas crop weekly, yet require start-up costs to establish and initial and ongoing farming training. As such, the partnership to implement this included an agricultural technician visiting the properties four times a month to ask questions and offer guidance to the beneficiaries. Training was also provided on the handling, harvesting and climate control of bananas. The programme initially aimed to increase income by R$200 per month for each of 27 families in the municipality. By 2015, with technical improvements and good use of funds, the rural producers acquired 10,400 seedlings. By the end of that year the first harvest took place – commercial production began a year later. In total, between 2014-2016 about 33,000 banana seedlings were planted (Figure 5.1).

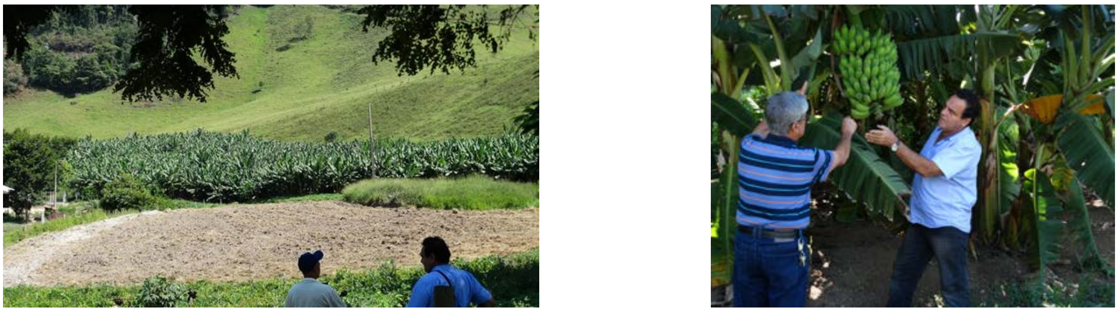


Figure 5.1 Community banana farming programme at Companhia Brasileira de Alumínio, Brazil

In addition to this, through an investment made by CBA in 2015, family farmers could acquire a chamber for climate control which allowed bananas which, when picked unripe, could reach the right maturity for sale. Local youth, often part of the families of the local producers, were trained in the safe operation of these chambers, thereby providing additional vocational education and employment.

The next stage of the project aims to include the cultivation of grapes to produce juice. Three producers are planting the fruit experimentally and one of them already produces quality juice. This diversification of product continues to increase the socio-economic impact and long-term sustainability of this programme.

Case study – understanding and contributing to communities at South32

In the context of community assessment and contribution, South32 ensures that they understand the local socio-economic context and appropriately identify and analyse stakeholders, social impacts and business risks to design their community engagement programmes. To achieve this, each operation:

- Completes a social baseline study which is updated every 5 years;
- Identifies and analyses stakeholders annually or more frequently where changes require;
- Completes a SIA and opportunity assessment and updates this where a significant change to the operation or community occurs; and
- Completes a community perception survey every 3 years.

For South32, facilitating regular, open and honest dialogue to understand the expectations, concerns and interests of stakeholders and incorporating these into business planning helps build strong mutually beneficial relationships by:

- Ensuring stakeholder engagement activities are planned, implemented, documented and evaluated. This plan should be reviewed and updated annually or more frequently where stakeholder or business changes require.
- Monitoring trends in host community issues to enable early warning of emerging issues.
- Implementing a locally appropriate community complaints and grievances process which:
- Acknowledges, investigates and documents all complaints;
- Completes appropriate remedial action;
- Communicates transparently with complainant; and
- Is readily accessible to all members of the host community.

South 32 works openly with the community and governments in order to contribute to building shared values for host communities and to supports the enhancement of their reputation. They do this by:

- Developing and implementing a 3-year regional community investment plan for each region which is reviewed and updated annually;
- Evaluating the effectiveness of this plan every 5 years;
- Ensuring the plan meets the requirements of the ethics and compliance standard;
- Ensuring that the plan recognises and, where appropriate, supports the role of government; and
- Communicating the plan’s criteria to stakeholders.

It is important to note that community investment plans should not:

- Intentionally favour individuals from one political, religious or ethnic group, except for positive discrimination activities (for example to assist historically disadvantaged groups in the community, particularly Indigenous groups);
- Contribute to any religious organisation for religious purposes; nor
- Provide a financial contribution to an individual/group of individuals, except for educational scholarship or bursary programmes.

In addition, exercising human rights due diligence to identify, prevent and mitigate adverse human rights impacts therefore enables South32 to respect human rights and meet its commitments.

5.B 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 contribute towards a positive impact on communities; and
- Address stakeholder expectations and concerns identified during the EIA and SIA 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
- NGOs and local community groups;
- Indigenous groups
- Local suppliers of goods and services and other local businesses;
- Industry organisations (for example 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 mine's life and includes:

- Exploration – focusing on identifying cultural heritage areas, land access and developing a common understanding of a future mine;
- Mine planning / design – starting to understand both risks and opportunities the mine may bring. This can be a time of high resource requirements from both sides, involving meetings, surveys and focus groups, often assisted by external facilitators;
- Operations – proactively managing relationships formed between the mine and community. Any agreements must be honoured and results of monitoring reported;
- Closure planning – liaising with communities, government and stakeholders about developing closure plans; and
- Closure – developing a final land-use for the rehabilitated mine in consultation with all interested parties.

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;
- Communicate on progress against any agreed actions.

Case study – community engagement at Rio Tinto Weipa, Australia[10]

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 5.2).

Figure 5.2 Rio Tinto staff meeting Traditional Owners at Rio Tinto Weipa, Australia

The Weipa community feedback system reflects the six overarching principles for a 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.

A Weipa community forum also 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 5.3).

Figure 5.3 Quarterly community forum at Rio Tinto Weipa, Australia

Case study – mining company integration within the community and contribution to economic and social infrastructure, SMB-Winning Consortium, Guinea

The Société Minière de Boké (SMB)-Winning Consortium is the first large scale bauxite mining project launched in Guinea since the 1970s. The Consortium observed the negative results in other countries and communities from a failure by mining companies to integrate their activities into the social and economic structure of the communities where they are involved. This was the catalyst and philosophy behind the Consortium setting out to build a co-operative community relationship, centred on providing communities with a share of the value arising from the mining activities in tangible forms across both infrastructure and social programmes.

Additionally, the local staff and community are educated and supported to understand how using workplace systems, health safety and environment procedures and organisational processes can help achieve the best outcome for all stakeholders including the Government, the State and the project itself. Supporting this education programme there is an awards programme which recognises and rewards staff and the community who demonstrate these desired behaviours. In 2017, the Consortium launched two awards:

- the “Pacific Development Award of the SMB-Winning Consortium General Commander” for the local staff; and
- the “Harmonious Development Award of the SMB-Winning Consortium General Commander” for the local community.

The awards are on top of, and significant as compared with, the mandatory contribution provisions of the Mining Code and Labour laws. The guiding principle for both awards are that both the staff and community will gain additional reward if the Project’s production is not affected by human interference. The awards are delivered both quarterly and annually. During unrest in Boké in April and May 2017, the Project was well protected by both the local staff and the local community, driven by their recognition of their mutual interest with the Project objectives.

Figure 5.4 Staff and the community, SMB-Winning Consortium, Guinea

Tangible infrastructure and social programmes established to date include:

- The construction of a 16 km all-weather road pavement linking local communities areas to the town of Boké, at a cost of approximately US$8 million spent over a two year construction period. On completion, the road will cut the local communities' transportation time from their home to the Boke town from 2 hours in the dry season to half an hour, and, importantly, the road will be accessible in the wet season, which was previously impossible. This community project will remove the transport barrier which has previously existed and allow access to public services, such as medical care and education.
- Sun Scholarship for Civil Servant Training for 20-30 Guinean civil servants per year to attend an intensive best practice training course in Singapore, and a mentor system to coach the candidates to implement their proposed projects back to Guinea. The scholarship is used to engage Nanyang Technological University Singapore, which is ranked 11th in the world and has track record of training People's Republic of China government officials. The budget for this scholarship programme is US$1 million per annum.
- Sponsorship of a study to establish a special economic zone (SEZ) in Boké which was completed in 2017. The Boké SEZ can leverage from the bauxite mine infrastructure to bring other industries, such as fruit processing and other light industries, to the region. The SEZ is expected to enhance the economy in Boké area, thus assist in stabilising the economic and social environment of the area and in this way will improve community support for the bauxite mine.
- Planning of a rail connection between Boffa and the Dapillon port. The rail project, on top of the basic function of bauxite transportation, will have the added function of unlocking the agriculture land and human resources potential of the landlocked Boffa area, further enhancing the economic development of the region.

Figure 5.5 Bauxite mining and associated activities, SMB-Winning Consortium, Guinea

5.C Indigenous Peoples consultation

Bauxite is often found in areas where there are populations of Indigenous Peoples[11] 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 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, on the same conditions as other employees, 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
- Consult with Indigenous Peoples prior to commencement of mining or mine construction.

Case study – Indigenous engagement at Rio Tinto Weipa, Australia

When bauxite reserves were first discovered in Weipa 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[12].

Figure 5.6 Operations at 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 agreements 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 Indigenous employment and training strategy was developed in collaboration with Traditional Owners, and defines its long-term commitment to increasing the participation, retention and advancement of local Aboriginal people in their 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.
- Kinection – this is a pre-employment work-ready training programme designed to equip local Aboriginal people with the skills needed to fill a traineeship requirement with Rio Tinto.
- 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, Rio Tinto Weipa's strong Aboriginal and Torres Strait Islander workforce reflects the recognition that its 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 25% of Weipa's employees who are Indigenous, of which 12% are local Aboriginal people. A key aspiration of local Traditional Owner groups is the sustainable long-term employment for local Aboriginal people and Rio Tinto is continuing to work closely with its community partners and Aboriginal agreements in order to achieve this.

5.D Cultural heritage assessment

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[13]:

- 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 5.7).

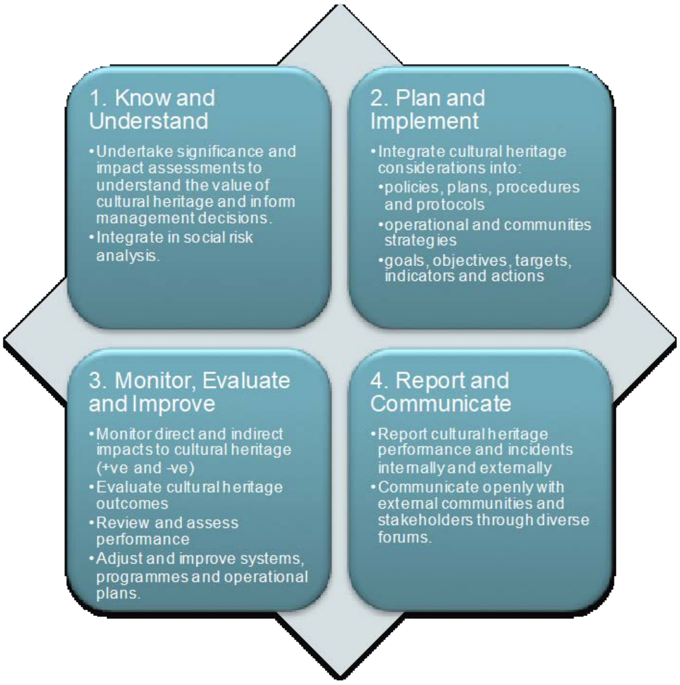


Figure 5.7 The four phases of cultural heritage management

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 at Rio Tinto Weipa, Australia*[10]**

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 5.8 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 5.8 Cultural heritage survey at Rio Tinto Weipa, Australia

The development of a new mining region therefore required an integrated and inclusive engagement approach by Rio Tinto to ensure that the Thanikiwithi 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, Rio Tinto worked with the Traditional Owners to introduce traffic control barriers to restrict people from driving on the river bank, including creating a designated parking lot with bollards. In addition, educational materials were developed to engage and inform all employees and the broader community of the significance of Vyces Crossing to the Thanikiwithi people. These include interpretive signage and information pamphlets which focus on communicating the site's cultural significance to those who use it. The materials also explain that continued access to the site depends on the goodwill of the Traditional Owners. An example of this can be seen in Figure 5.9 which shows an information brochure depicting its cultural significance. The Thanikiwithi Traditional Owners and Rio Tinto jointly produced the brochure and other educational materials about this region.

Figure 5.9 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 Rio Tinto's 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.

5.E 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.

For example, a sustainable bauxite mine should have employment policies and procedures which are at least consistent with the national labour and employment laws. This will include providing employees with clear documentation of their hours of work, wages, overtime, compensation and benefits. This documentation should be updated when any substantial changes occur. In addition, a bauxite mine should ensure that wages paid for a normal working week meet at least a legal or sector standard and are sufficient to meet the basic needs of employees, plus some discretionary income. This payment includes compliance with applicable national standards on working time (including overtime working 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, particularly those which may be life-threatening;
- Modification, substitution or elimination of these hazardous conditions or substances to reduce the risk;
- Training of employees and contractors;
- Documentation and reporting of accidents, 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.

5.F Transport and traffic management

While transport of bauxite and traffic management within the mine gate form a routine part of mine planning and mine safety, bauxite ultimately needs 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 this increased heavy vehicle interaction, there is an increased risk and severity of accidents. Controlling and monitoring mine vehicle traffic reduces risks and impacts on the surrounding communities. However, managing road hazards and other 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 public roads include[14]:

- Inadequate road configuration for the heavy vehicles;
- Interaction with non-vehicle road users such as pedestrians, cyclists and fauna;
- Unsafe speed or activities by other vehicles on roads; and
- Lack of driver training on the hazards.

Strategies to improve safety on public roads may include:

- Understanding who are the key stakeholders in the management of safety on local roads (for example 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 the bauxite is transported in covered vehicles and with appropriate load limits, or transported in a manner which prevents dusting – dust 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 the 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 to 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 understanding 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 implementing key actions to mitigate these risks.

Sustainable bauxite mines should:

- 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; and
- Ensure all transport through the community includes safety training;
- Ensure that transport personnel adhere to speed restrictions and cover all vehicles appropriately.

Case study – minimising the impact of transport at Spring Energy KotaSAS, Malaysia

Spring Energy commenced mining bauxite in KotaSAS in the Pahang State of Malaysia in late 2013. The bauxite mined there 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 kilometres away by public road. Spring Energy undertake 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 creating dust.

Figure 5.10 - Figure 5.13 show Spring Energy's implementation of these measures compared to non-implementation by some other operators in the region.

Figure 5.10 Vehicle wash at Spring Energy KotaSAS, Malaysia

Figure 5.11 Example of an unwashed vehicle on a public road

Figure 5.12 Well loaded and covered truck at Spring Energy KotaSAS, Malaysia

Figure 5.13 Example of a poorly loaded truck with a 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 5.14).

Figure 5.14 Water truck onsite at Spring Energy KotaSAS, Malaysia

5.G Land acquisition and community displacement

The location of bauxite deposits limits possible mine locations. If a mine is approved to be established close to an existing community, it may involve economic and or community displacement. While community displacement is rarer for bauxite mines, economic displacement because of changing land use may become 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 at the outset of land acquisition or mine approval processes who the current land owner is, who the key stakeholders are, nor where mitigating measures or compensation, if any, should be directed.

As the bauxite mining industry undergoes a change from a few large mines to more smaller mines, some of which may be much smaller scale and with shorter mine lives, this increases the challenges associated with land access. Further, 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 therefore 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; however, providing cash compensation to low income households generally leads to unsustainable spending, in turn 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. Nevertheless, there is no single formula for calculating compensation, if required, on land access. As such, 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.

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. As such, the mining company must ensure that the preferences of the different community stakeholders are understood and balanced with any pressure to be close to existing infrastructure. Further, 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 wherever possible;
- If physical displacement cannot be avoided, then engage with the affected community and government to jointly develop a resettlement action plan; and
- Seek approval from the government to implement any community relocation.

6 Health and safety

6.A Considerations

The main health and safety risks in bauxite mining are common across the mining sector, such as mobile equipment, working at heights, confined spaces and electrical safety. Such occupational health and safety aspects occur during all phases of the mine cycle and may be classified according to the following categories. These need to be considered under a health and safety plan:

- General workplace health and safety
- Hazardous substances
- Use of explosives
- Electrical safety and isolation
- Physical hazards
- Ionising radiation
- Fitness for work
- Travel and remote site health
- Thermal stress
- Noise and vibration
- Digging / vegetation clearance
- Work at height
- Hand tools
- Confined spaces
- Light vehicles and mobile equipment
- Dangerous chemicals
- Machine protection

The mine needs to take into account opportunities to both improve community health and wellness and mitigate any risks. 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. This system should include:

- A health and safety rights policy for all employees and contractors in order to recognise their rights in accordance with all relevant national standards;
- 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, manage, mitigate and monitor 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.

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 and weight management
- Smoking cessation
- Stress management
- Cholesterol management
- Diabetes education
- Vaccination and immunisations
- Heart health programmes
- Depression screening
- Work–life balance initiatives
- Sexual health education
- Vector-borne disease control programmes
- Drug and alcohol programmes
- Sanitation infrastructure initiatives

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 manage and minimise health and safety hazards and control such risks; and
- Understand the health needs of the local community and how these relate to the needs of the mine operation.

Case study – community health at Hindalco Durgmanwadi, India[17]

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

- Education – investment in primary and adult educational activities, including the construction and renovation of school buildings and the provision of school uniforms, books and other instruments;
- Healthcare – the mine also provides free medical services to the local community through their dispensary, and the medical team regularly conducts health check-up camps and distributes free medicines;
- Sustainable livelihood – formation of women's self-help groups in many villages and provision of vocational training to local women. The women now actively participate in economic activities such as forming a milk co-op dairy, mushroom cultivation, nursery raising, vermi compost (Figure 6.1), goat and rabbit rearing and handicrafts.
- Social projects – investment in social projects such as organic farming and providing smokeless chulas using a fuel stand and solar lamps to reduce the smoke. In addition, wheelchair cycles have been provided to disabled people, and fruit-bearing saplings have been distributed to villagers; and
- Infrastructure development – construction of roads, gutters, latrines and a water treatment plant as well as provision of irrigation schemes for farmers, street lights and house repairs in the local community and the renovation of a gravity water flow scheme.

Figure 6.1 Vermi compost at Hindalco Durgmanwadi, India

Case study – renewed health at Companhia Brasileira de Alumínio (CBA), Brazil

CBA operates in the municipalities of Poços de Caldas and Miraí in the Minas Gerais area of Brazil. The Poços de Caldas unit began operations in 1955 and the Miraí unit started operations in 2008. In September 2015, CBA established a renewed health programme to encourage their workers to adopt a healthier lifestyle (Figure 6.2). It is intended for people with a body mass index (BMI) above 30 and with chronic diseases such as diabetes and hypertension. The employees who participate in the programme get support from a health professional in monthly consultations who monitor treatment, especially weight loss and disease control.

Figure 6.2 Renewed health programme at Companhia Brasileira de Alumínio, Brazil

6.B Emergency preparedness

Responding effectively to emergencies is essential for bauxite mines in order to better protect employees, local communities and the wider region from harm. Major risks from bauxite mining include management of hydrocarbons and tailings dams, where there is onsite beneficiation. In particular, 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 especially 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 injury to people, property and the environment.

A structured approach, such as the use of a local emergency response planning group, is required in order to develop an emergency response plan (Figure 6.3). This helps companies work with local authorities and communities, or their representatives, to identify who does what in an emergency, advise on training, and establish possible community liaison functions. These emergency response plans define:

- Responsibilities, organisation and coordination for response to an emergency;
- Emergency situations;
- Evaluation of areas and effects;
- Communication and warning systems, including availability of suitable communication systems in remote areas;
- Evacuation procedures;
- Duration of emergency and follow-up; and
- Updates to the plan.

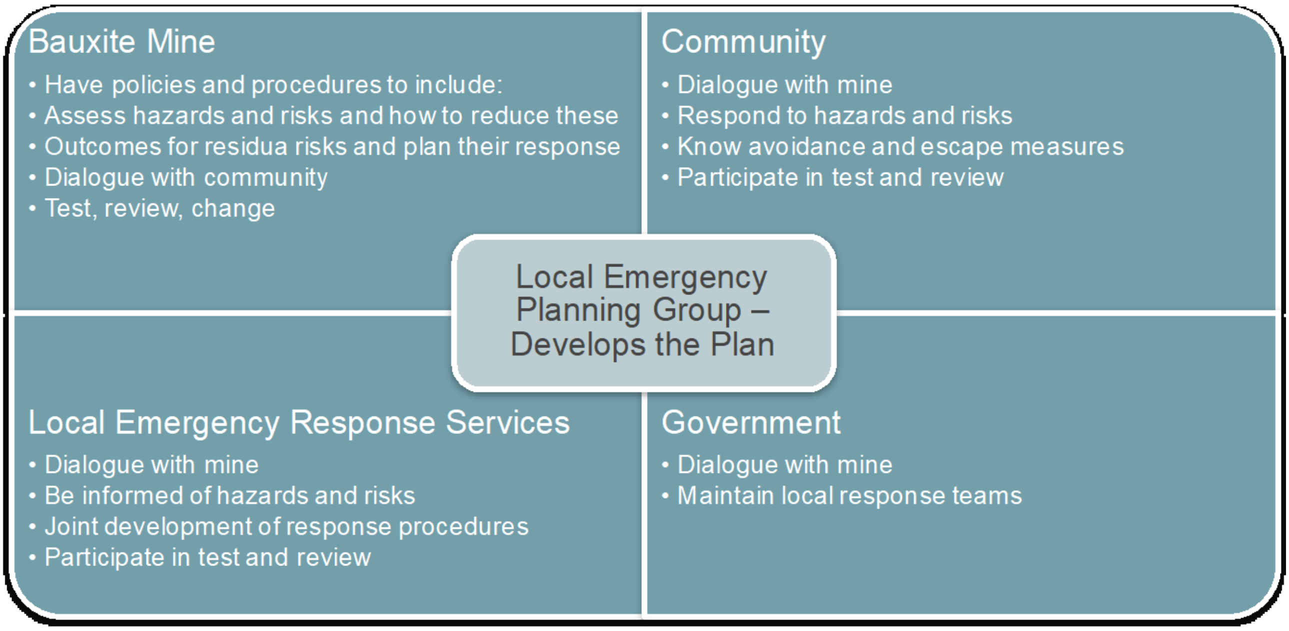


Figure 6.3 Local emergency planning co-ordinating group [15]

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

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

6.C Security considerations[16]

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:

- Identification of security hazards and assessment of risks – these 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 – this can depend on the environment; it 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 – in addition, the 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 also help develop appropriate risk mitigation measures;
- Local prosecuting authority and judiciary's capacity to hold accountable those responsible for human rights abuses and those responsible for violations of international humanitarian law in a manner that respects the rights of the accused; and
- Identification and understanding of 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 also 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. In particular, 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, including the need for adequate and effective training of personnel to uphold these policies; and
- Encourage host governments to make security arrangements transparent and accessible to the public, subject to any overriding safety and security concerns.

Mining companies should also 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, and 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 ensure that any private security personnel used are adequately trained to respect the rights of employees and the local community.

7 Environmental management and performance

7.A 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;
- Managing 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 & beyond; and
- Using energy and water efficiently.

Mines should therefore 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 (for example 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 the 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 also 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:

- Complete a pre-mining impact assessment;
- Have a documented EMS which identifies significant risks and mitigates against these; and
- Have a plan on how to report their performance publicly.

Case study – integrated environmental management at Hindalco Durgmanwadi, India[17]

The Durgmanwadi bauxite lease was granted in 1968 and the mine was developed in 1992 with a designed capacity of 660 KT per annum. By integrating the planning of the mine with environmental aspects, Hindalco could achieve improved environmental outcomes including:

- Using computerised mine planning – this allows for planning day-to-day mining activities based on the customer's quality requirements, while ensuring the minimum use of land;
- Conducting seismic studies before mining – this revealed that the entire plateau was rippable. Therefore, drilling and blasting (using explosives) were avoided and replaced by ripping and dozing which significantly reduced dust, noise and ground vibrations as well as the risk of accidents;
- Using a mobile crusher instead of a stationary crusher – this helped limit mining activities to small areas and reduced vehicle movement, resulting in reduced diesel consumption and nuisance dust along haul roads (Figure 7.1 - Figure 7.2);
- Immediate backfilling of overburden – this reduced its rehandling, as well as enabling faster rehabilitation of mined areas through revegetation and water body creation which resulted in faster restoration of the ecosystem;
- Collecting storm water in depleted areas – this was done by creating artificial ponds/water bodies and a filtration systems consisting of settling tanks and silt check dams which reduced the silt in the mine's drainage water and the siltation of riverbeds; and
- Installing atomised dust suppression systems on the mobile crusher and spraying of water on haul roads and dust generation points by mobile water tankers – this resulted in low dust levels in the mine.

Figure 7.1 Mobile crushing plant at Hindalco Durgmanwadi, India

Figure 7.2 Silt dams in series and settling of silt in tanks at Hindalco Durgmanwadi, India

In addition to the integration of mine and environmental planning with the use of an EMS certified to ISO14001, Hindalco showed environmental leadership by:

- Operating beyond legal standards;
- Increasing revegetation in lease area and beyond;
- Using parapet walls to protect overburden dumps from wash offs;
- Harvesting onsite rain water and establishing a waste water management programme;
- Enforcing road safety rules for bauxite trucks, including all the trucks to be covered with tarpaulins to avoid spills in roads and villages;
- Restricting mining operation and vehicular movements to day time only;
- Monitoring the environment quality of the air, water, soil quality and noise levels – this was conducted by a third party;
- Conducting an environment awareness programme to enhance the environment protection awareness in local villagers and school children; and
- Establishing clear procedures for sharing environmental information.

7.B Associated infrastructure management

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 a power station, workshops, warehouses, administration facilities, sewage treatment plants and waste disposal and fuel storage facilities;
- Permanent camps or construction camps for employees and contractors;
- Water supply infrastructure such as dams;
- Ports, ship loading and unloading facilities;
- Roads, both mine-only use and public use;
- 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:

- Using catch trays under transfer points;
- Positioning belt scraping with water sprays on conveyors to clean the belt. The water used for belt cleaning should then be returned to sedimentation ponds;
- Using variable speed drives on conveyors to minimise the potential for spillage;
- Installing belt drift switches on the conveyor that shut down the conveyor drives if a belt moves from the designed position; and
- 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 and railways, whether they are public or private, including consideration of community impacts.

Case study – infrastructure options at Pará State, Brazil[18]

Bauxite is an abundant raw material in Pará State, Brazil (Figure 7.3) and the region is now one of the most important bauxite mining areas in the world. There are multiple mines in the region, and these have approached the operational and community challenges of bauxite transport in different ways.

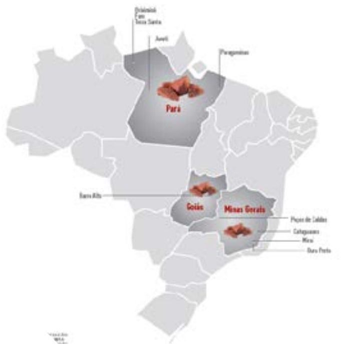


Figure 7.3. Bauxite mines in Brazil [19]

One of these, Mineração Rio do Norte (MRN), was one of the first large-scale industrial projects in the Amazon. MRN started operations in 1979 – today the plant's capacity is 18.3 million tons per year. MRN operates a 28 kilometre railroad (Figure 7.4) to transport bauxite from the wash plant to the local port of Trombetas. From there it is transported approximately 1,000 kilometres by ships also operated by MRN to the Vila do Conde Port in Barcarena to the Norsk Hydro Alunorte refinery, as well as to other export customers.

Figure 7.4 Railroad operations and Port of Trombetas at Mineração Rio do Norte, Brazil

Another bauxite mine, the Norwegian-owned Norsk Hydro mine in Paragominas, is located 64 kilometres from urban areas in the northeast of Pará State some 350 kilometres from the capital Belém. It started operations in 2007 and transports all its bauxite as a slurry along a 244 kilometre pipeline. This pipeline, with a capacity of 15 million tons per year, is a global pioneer in bauxite transportation. It also sends the ore to the municipality of Barcarena to feed the Norsk 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 and the local population is not exposed to moving railways or trucks.

Another mine, the Alcoa Juruti mine, in the west of Pará State, started operations in 2009 and has a current production capacity of 5.3 million tons a year. In addition to mining, other facilities at the project include a railroad approximately 55 kilometres long which was built by the company to transport the bauxite from the processing facilities to the port terminal on the banks of the Amazon river located 2 kilometres from the centre of the municipality.

7.C 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 therefore aim to reduce water use and improve or maintain water quality by minimising water consumption, maximising the reuse of water, avoiding contamination of any neighbouring bodies of water, and maintaining monitoring programmes to measure their performance.

Bauxite mines often use large quantities of water, especially in beneficiation plants and in dust suppression. Mines in high rainfall areas in particular may experience high runoff 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; and
- 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 (for example 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 are associated with increased turbidity in runoff and accidental hydrocarbon spills – it is of note that 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 the management of storm water include the separation of clean and dirty water, the minimisation of exposed erosion-prone and/or contaminated ground surfaces and the 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 at Alcoa operations, Western 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 TSS 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 so 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 (Figure 7.5), for example, 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 7.5 Drainage management at Alcoa operations, Western Australia

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 (for example 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[20]

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

1. Limited access to arable lands for farming due to the acquisition of lands for bauxite mining and related purposes; and
2. 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 (Figure 7.6) 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 7.6. 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 (Figure 7.7).

Figure 7.7. Greenhouse clusters at Watt Town (left), Tobolski (centre) and Clapham (right), St Ann, Jamaica

7.D Biodiversity

Bauxite is often found in areas which have high biodiversity, that is a high variety of plant and animal life. Minimising the adverse impacts to biodiversity is therefore fundamental to sustainable bauxite mining. The mitigation of impacts requires that both 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 (for example 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 buffer 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, 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 metres.

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 of 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.

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 the impact on habitats of high conservation value.

Case study – biodiversity at Mineração Rio do Norte, Brazil [21]

The MRN mine is located within the borders of the Amazon rainforest. Ongoing reforestation starts as soon as an area is depleted – this was first initiated at MRN in 1984, some 5 years after initial operations began. The oldest areas have now reached a profile resembling the original state; however, MRN has taken further actions 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 Master's 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 (Figure 7.8). The rehabilitation programme includes:

- Taking the collected epiphytes to MRN's tree nursery where they are classified and cultivated;
- Collecting species – since 2001 more than 63 thousand epiphytes of 123 species have been collected, including 83 species of orchids, 16 species of bromeliads and 24 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 7.8 Nursery and aerial view showing reforestation at Mineração Rio do Norte, Brazil

***Case study – jarrah dieback at Alcoa operations, Western Australia*[22]**

In the jarrah (*Eucalyptus marginata*) forest of Western Australia there is a plant disease called dieback. This is caused by the introduced soil-borne pathogen *Phytophthora cinnamomi* and 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, both in areas with or without mining activity.

Alcoa’s bauxite mining operations are located in these affected jarrah forests and some degraded sites are present within their operations. In 1979, the company made a commitment to support a rehabilitation programme within the areas surrounding its 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 its 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.

In addition, 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 7.9). Only local trees and local understorey plants are re-established.

Figure 7.9 Dieback rehabilitated area at Alcoa operations, Western Australia

7.E 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 impact on both air quality and noise pollution have the potential for major community impacts. However, with appropriate planning and controls, both dust and noise impacts may 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 a number of factors, including age and health (for example schools, day care centres, hospitals, nursing homes), status (for example sensitive or endangered species), proximity to the source, or the facilities they use (for example water supply well). Again, this needs to be done through ongoing environmental monitoring.

Figure 7.10 Environmental monitoring at Alufer Bel Air, Guinea

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), sulphur dioxide (SO_2) and oxides of nitrogen ($N0_x$). 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 $N0_x$ 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 (for example 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 the impact on sensitive people and other organisms; and
- Maintain safe human healthy working conditions for all employees and contractors.

Case study – dust management at Rio Tinto, Weipa, Australia[23]

Managing dust emissions at Rio Tinto's Weipa operations in Queensland is a major focus during the dry season. Dust emissions from operations, 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 TSP matter and dust deposition (Figure 7.11).

Figure 7.11 Dust monitors at Rio Tinto Weipa, Australia

The stations send SMS messages to a member of the site environment team if dust levels are approaching licence limits, allowing 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 at Hindalco Durgmanwadi, India[17]

Through combined environmental and mine planning, dust and noise emissions from Hindalco's Durgmanwadi mines were minimised (Figure 7.12). Initiatives included:

- The use of dozers for ripping – these eliminated the need for drilling and blasting, thereby minimising noise and dust;
- A spray suppression system – this minimises dust generation due to vehicular traffic and crushing;
- Accumulated water bodies in depleted pits – these improve the ground water table and provide water for dust suppression; and
- Endemic revegetation – this uses seedlings from the onsite nursery for creation of a green belt and rehabilitation of depleted areas, thereby also minimising dust emissions.

Figure 7.12 Dust suppression at all stages of operations at Hindalco Durgmanwadi, India

7.F 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 kilometres from the point of extraction to the shipping point or local refinery stockpile – additional data and context is provided in Bauxite Industry – Key Facts. 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 onsite generation of electricity (for example 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, the implementation of energy efficiency measures has the dual benefit of reducing operational greenhouse gas emissions whilst improving productivity and reducing costs, thereby making the bauxite mine more sustainable. Recommended energy conservation measures include the following:

- Correctly sizing motors and pumps and using 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 reduce 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 at Jamalco, Jamaica[24]

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. From this, Alcoa saved approximately US$1.5 million in energy costs in the first 5 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 and driven by two AC induction motors (Figure 7.13). As the conveying system is loaded with bauxite and begins its descent, 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, including:

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

Figure 7.13 Conveyor at Jamalco, Jamaica

Case study – towards carbon neutrality at Norsk Hydro Paragominas, Brazil

Since 2013, Norsk Hydro has been supporting a bilateral research programme to develop scientific knowledge and techniques to restore biodiversity at its Paragominas bauxite mine in the Brazilian Amazon. Working together with the University of Oslo and three Brazilian research institutions, the aim of the programme is to provide new, scientifically-grounded knowledge and methods to improve forest and ecosystem rehabilitation. In addition to supporting the aspirational long-term goal of restoring mined areas to prior forested conditions, the programme also aims to support Norsk Hydro's aspirational long-term goal of carbon neutrality.

The Paragominas is in what used to be an area of high biodiversity, most of which was deforested because of logging and cattle farming before the mining operations were established. Today, pristine forest covers only 15% of the area. Although Norsk Hydro was not responsible for this deforestation, when it commenced operations in 2011 it decided to continue the rehabilitation work started by the mine's former owner, Vale. The goal was to replant degraded areas and, if possible, restore the forest ecosystems and biodiversity to their original state. By 2016, Norsk Hydro had rehabilitated nearly 1700 ha (Figure 7.14).

Figure 7.14 Researchers at Norsk Hydro Paragominas, Brazil

One promising line of research involves applying a reforestation technique first developed by Alcoa known as *nucleation* which improves natural soil formation, enhances regrowth and increases biodiversity. To support this work, the company has established a nursery with the capacity to produce hundreds of thousands of seedlings and epiphytes per year – this contains wide genetic diversity which is crucial to successful forest restoration. Another important benefit of the nucleation technique is that it can reduce greenhouse gas emissions on degraded forest lands. As a result, in addition to Norsk Hydro's reforestation activities, the research is playing a significant role in supporting the company's action against climate change, as well achieving its goal of becoming carbon neutral from a lifecycle perspective by 2020.

7.G 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 (WMP) 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 WMP 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 (for example 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 belts (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 absorbents from workshops; and
- Liquid hazardous wastes (for example 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.

Sustainable bauxite mines should:

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

Case study – waste management approach in Africa

For mining projects in developing countries, including Guinea, developing a WMP can be challenging as certain wastes – including 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 movement of hazardous 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. There are a number of steps involved in this process:

- The starting point is procurement – this is done by eliminating or reducing waste production onsite by having a procurement policy to seek alternatives for chemicals, replacement parts, hazardous materials and packaging. This can reduce or eliminate wastes before they are produced;
- The next step is to identify and quantify as far as possible all the different wastes streams the project will produce at each phase. For instance, the amount of used tyres can be estimated from the number of vehicles maintained onsite and their reuse was planned as protective barriers, slope stability buttresses and road bollards. Remaining used tyres made available for recycling offsite or by local residents are cut to ensure they cannot be refitted to other vehicles.
- Next, 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 reuse offsite. For instance, where bottles and containers that have not contained hazardous materials are recycled 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 onsite 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, onsite disposal to landfill may be the only viable alternative to offset disposal. Here, the quantifying of the volumes of wastes remaining after reduction, reuse 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 of the mine's life.

Figure 7.15 Monthly site inspection at Alufer Bel Air, Guinea

7.H Tailings management

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[1]. 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.

Figure 7.16 Bauxite tailings at Alcoa Juruti, Brazil

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, as well as for any ongoing monitoring and maintenance post closure. Typically, bauxite tailings don't 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 to 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 may also 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.

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

[1] In Bahasa, the term for bauxite tailings would be "*limbah Vdak berbahaya dan beracun* "– non-LB3.

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. For example, storing water 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 therefore include:

- Defined responsibilities;
- Descriptions of the process and operation, including water management;
- Schedules and scopes of inspection and operational monitoring;
- Schedules and scopes of audits and stability assessments by specialists;
- Training requirements;
- Decommissioning plans; 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 should:

- 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 at Harita Group Ketapang, Indonesia[25]

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 7.17). 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 compounds 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.

Figure 7.17. Existing mine operation process at Harita Group Ketapang, Indonesia

While bauxite is predominantly made up of minerals such as gibbsite, böhmite and diaspore, it may also contain other minerals which are reactive in the Bayer process. For example 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 7.18) has a relatively low grade of bauxite (46.5%) and high silica (12%). Lateritic bauxite may be challenging to beneficiate due to bedrock types and lateritisation stage. In addition fine-grained gibbsite and interlocked kaolinite within bauxite are difficult to separate with existing beneficiation methods.

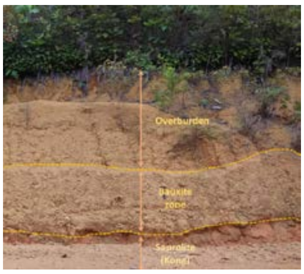


Figure 7.18. Lateritic bauxite profile at Harita Group Ketapang, Indonesia

The kaolinite clays are identical in size to the reactive silica and may cause caustic soda losses in the Bayer process, resulting in a high operating cost. Developing an integrated bauxite map may help future mine determine ‘wash or no wash’ and ‘crush or no crush’ decisions during operations, minimising waste and maximising mine efficiency. Using a combination of techniques (Figure 7.19) – 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, thereby reducing waste and improving the economics of the subsequent Bayer processing.

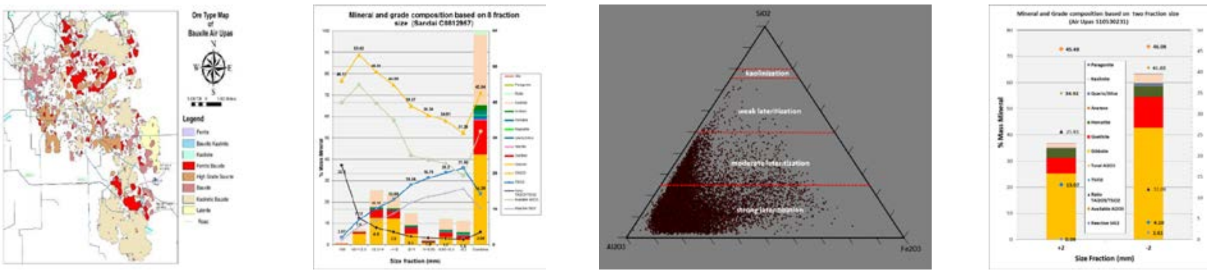


Figure 7.19 Combined bauxite mapping and analysis at Harita Group Ketapang, Indonesia

7.I 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, including:

- 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 a soil management plan describing how soils are to be classified, salvaged, stockpiled and respread.

Case study – topsoil management at Alcoa operations, Western Australia[26]

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.

Previously, fresh topsoil was returned using scrapers. However, it is challenging to apply thin layers of topsoil evenly using this method. To enable more efficient use of limited fresh topsoil, a recent development has been to spread thin (between 10-25 mm deep) layers of soil using a modified articulated truck (Figure 7.20)

Figure 7.20 Fresh topsoil spreading at Alcoa operations, Western Australia

In addition, botanical monitoring data from unmined and rehabilitated 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 – these 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 such species which do not regenerate easily from fresh topsoil or seed, Alcoa is able to ensure these 'recalcitrant' species are propagated from cuttings, tissue culture or from limited amounts of seed and then planted into newly restored areas (Figure 7.21). Often these are surrounded by a plastic mesh guard to discourage grazing by kangaroos. Currently, Alcoa produces and plants around 450,000 recalcitrant plants into newly restored areas each year, 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 forests.

Figure 7.21 Tissue culture produced plant at Alcoa operations, Western Australia

Case study – minimising soil erosion in the tropics at Alufer Bel Air, Guinea

Mining operations in tropical climates encounter challenges from soil erosion due to a combination of high overall rainfall levels during the wet season and intense daily rainfall events on lateritic soils that have low cohesion when exposed to rainfall runoff after vegetation clearing. Monthly rainfall in Guinea and elsewhere in tropical west Africa can be 500-600 mm with 20-25 days of rain per month.

The problems can be particularly acute during the construction and operation phases of the mine when vegetation stripping can expose large areas of surface soils before permanent drainage works and sedimentation basins are installed. Failure to plan and cost soil erosion prevention measures, both temporary and permanent, from the start of the mine's life can lead to:

- Severe delays and safety issues during construction;
- Exceedances of discharge water quality parameters (TSS, turbidity) during production;
- Reduction in slope stabilities;
- Loss of livelihoods from the silting-up of water courses or washing away of productive soils from agricultural land;
- Negative social impacts in the affected communities; and
- Additional replacement costs to import fertile topsoils or soil amendments for rehabilitation.

However, preventative measures can reduce the need for subsequent mitigation or compensation of soil erosion once it has occurred – prevention is better than cure. These measures need to be implemented as soon as clearing starts for a construction work area, and quick temporary measures are used initially before more permanent measures are installed. In deciding what and where to install measures, three principles are used to prevent rainfall and sheet flows from exacerbating erosion:

- Collecting surface drainage waters using crown/toe ditches, lateral diversion berms, side ditches and drainage channels;
- Reducing the flow energy using weirs, timber/stone rip-rap, cascades, flow breakers; and
- Dissipating to outflow areas by diverting the collected and depleted drainage waters to lower ground via protected outfall channels, sediment basins or sediment barriers.

Alufer's Bel Air mine in Guinea has applied these principles to develop temporary soil erosion control during the construction phase of the mine. Most temporary soil erosion measures can be constructed from boulders, stones, vegetation, branches and tree trunks cleared from the site and combined with sediment filter geotextiles. The quantities, location and sizing need to be determined by identifying potential flow channels and calculating peak and average flow rates from rainfall data and surface areas being drained. These installation works can also create local employment opportunities for local labour which can be trained in groups and deployed where needed (Figure 7.22).

Figure 7.22 Training in slope stabilisation at Alufer Bel Air, Guinea

As construction is further developed, these temporary measures can then be combined with permanent measures, such as stone rip-rap, top and toe ditches along slopes, sediment basins and armoured drainage ditches with flow breakers (Figure 7.23).

Figure 7.23 Combined temporary and permanent erosion control at Alufer Bel Air, Guinea

7.J 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 7.24).

Figure 7.24. Nursery crops at Alufer Bel Air, Guinea

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 large 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 at Alcoa operations, Western Australia*[26]**

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 7.1). 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 overstorey 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 http://www.dsd.wa.gov.au/alcoa's-bauxite-mine-rehabilitation-programme 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 < 2 ha). 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 stems/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 7.1. Example of a completion criteria for rehabilitation (2016 onwards) at Alcoa operations, Western Australia

Case study – rehabilitation and recovery at Companhia Brasileira de Alumínio, Brazil

Since 2008, CBA has developed an innovative model of soil restoration. This technique has been carried out in their mines in the Miraí region of Minas Gerais forest area in partnership with the federal Universities of Viçosa and Lavras, and covers areas with native forest and coffee and eucalyptus crops, as well as grazing lands.

After mining is finished, the topographic reformation begins. It consists of smoothing the soil so that it has the configuration as close as possible to the original, followed by its decompression, which will make the growth of the plants easier. The soil, rich in stored organic matter, is replaced, then a new drainage system is deployed and, finally, acidity, phosphatising and soil fertilisation are corrected, preparing it for planting.

All areas used for mining which are rehabilitated are already showing strong signs of growth, on average within 3 or 4 years (Figure 7.25). CBA are continually developing new practices to qualify the rehabilitation processes, achieving results for both the company and the universities. The projects evaluate the effectiveness of the rehabilitation and restoration in these areas, proposing solutions for their qualification through the analysis of bio-indicators such as soil seed bank, natural regeneration, seedling mortality, burlap production and decomposition (the layer formed by deposition and accumulation of dead organic matter). The initiative has so far concluded that the rehabilitation and restoration actions adopted by the company have enabled a fast recovery of the native vegetation layer and the natural enrichment of the mined areas over time.

Figure 7.25. Rehabilitated areas, Companhia Brasileira de Alumínio operations, Brazil

7.K 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 therefore 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 NGOs;
- 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, completion of mine rehabilitation, cap and cover tailings facilities, remediation of any contaminated sites, and implementation of post-closure monitoring and maintenance programmes; and
- 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 to 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 (for example for monitoring and maintenance) the closure plan needs to state how these obligations will be met (for example 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;
- A 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 at Alcoa operations, Western Australia*[27]**

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 7.26)

Alcoa's ongoing research and improvements to rehabilitation treatments suggest that future mine restoration achievements are going to be better than the high standards 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
Executive Director
Department of Conservation and Land Management
Dated 8th day of November 2005

Figure 7.26. Example certificate of acceptance at Alcoa operations, Western Australia

8 Summary of Guidelines

This summary of the Guidelines for Sustainable Bauxite Mining has been included as a checklist for regulators and operators. 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. Identify key stakeholders and have a formalised plan and schedule for interacting with them;
7. Consult with the community about the operation and ultimate closure of the mine;
8. Communicate to the community on progress against any agreed actions;
9. Understand the role, customs and decision-making practices of Indigenous Peoples impacted by the mine;
10. Consult with Indigenous Peoples prior to commencement of mining or mine construction;
11. Understand and plan to preserve key aspects of cultural heritage relevant to the mining area;
12. Survey prior to mining and protect any additional cultural heritage sites identified during mining;
13. Not used forced or child labour (as defined by ILO Conventions C138 and C182) and shall comply with related national laws;
14. Provide documented, fair working conditions to all employees appropriate to local standards;
15. Ensure the health and safety of all employees and contractors;
16. 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;
17. Ensure all transport through the community includes safety training;
18. Ensure that transport personnel adhere to speed restrictions and cover all vehicles appropriately;
19. Consider the need for economic mitigating measures or compensation for loss of land use and its other community values;
20. Avoid physical community displacement if possible;
21. If physical displacement cannot be avoided, then engage with the affected community and government to jointly develop a resettlement action plan; and
22. Seek approval from the government to implement any community relocation.

Health and safety

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

28. Complete a pre-mining impact assessment;
29. Have a documented EMS which identifies significant risks and mitigates against these;
30. Have a plan on how to report their performance publicly;
31. Include all infrastructure associated with the mine when assessing environmental and social impacts;
32. Have a plan for safe operation of roads, ports and railways, whether they are public or private, including consideration of community impacts;
33. Understand the social, cultural and environmental value of water in the mine catchment;
34. Develop targets on water use and water quality, and report on these;
35. Avoid, or at least minimise, turbid water leaving the site through effective sediment control;
36. Not be established or developed in World Heritage areas;
37. 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;
38. Use buffer areas to minimise the impact on habitats of high conservation value;
39. Understand where the nearest sensitive people and other organisms for noise and dust are located;
40. Control noise and dust at source to minimise the impact on sensitive people and other organisms;
41. Maintain safe human health working conditions for all employees and contractors;
42. Optimise their energy use to achieve environmental and economic benefits;
43. 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;
44. Comply with all regulations as a minimum;
45. Have a WMP based on the waste minimisation hierarchy;
46. 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;
47. Ensure these tailings management plans are subject to independent expert review; and

48. During and after use, independently monitor tailings dams on a regular basis using both internal and external experts.
49. Have a soil management plan describing how soils are to be classified, salvaged, stockpiled and respread;
50. Have a progressive rehabilitation plan, integrated with mining operations, which includes completion criteria;
51. Ensure completion criteria are agreed with regulators and, where appropriate, other stakeholders;
52. Have a closure plan, developed with local stakeholders and agreed with regulators; and
53. Establish appropriate financial provisioning for closure and ongoing monitoring and maintenance activities.

9 Bauxite industry – key facts

Data current as at February 2018.

Updated data can be found at http://bauxite.world-aluminium.org/home/.

<table>
<tr><th>Metric</th><th>Current Data</th><th>Source</th></tr>
<tr><td>Global Bauxite Production (2016)</td><td>275 Mt</td><td>USGS[2]</td></tr>
<tr><td>Global Bauxite Demand (2016)</td><td>270 Mt</td><td>IAI Mass Flow Model[3]</td></tr>
<tr><td>Globally Traded Bauxite (2016)
…of which, China Bauxite Imports</td><td>~ 75 Mt
~ 50 Mt</td><td>IAI Mass Flow Model</td></tr>
<tr><td>Land Area Currently Mined (2015)</td><td>~ 50 km^2</td><td>IAI estimate</td></tr>
<tr><td>Total Land Area Mined
(Total area disturbed since mining began to the end of 2015)</td><td>~ 1,500 – 2,000 km^2</td><td>IAI estimate</td></tr>
<tr><td>Land Area Rehabilitated
(Total area rehabilitated since mining began to the end of 2015)</td><td>~ 500 km^2</td><td>IAI estimate</td></tr>
<tr><td>Percentage Newly Mined Land Rehabilitated, by Area (2006-2016)</td><td>~ 70%</td><td>IAI estimate</td></tr>
<tr><td>Energy Use per Tonne Bauxite (2015)</td><td>Heavy oil 0.5 kg
Diesel oil 1.6 kg
Natural gas 0 m^3
Coal 0 kg
Electricity 1.5 kWh</td><td rowspan="3">IAI 2015 Life Cycle Inventory Data & Environmental Metrics (2017)[4]</td></tr>
<tr><td>Greenhouse Gas Emissions Per Tonne Bauxite (2015)</td><td>7 kg CO_2</td></tr>
<tr><td>Average Bauxite Transport Distances (2015)</td><td>Sea 2,804 km
Road 2 km
Rail 71 km
Conveyor 119 km</td></tr>
</table>

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2 https://minerals.usgs.gov/minerals/pubs/commodity/bauxite/
3 http://www.world-aluminium.org/media/filer_public/2017/10/24/global_mass_flow_model__2016.xlsx & http://www.world-aluminium.org/statistics/massflow/
4 http://www.world-aluminium.org/media/filer_public/2017/07/04/appendix_a_-_life_cycle_inventory.xlsx

10 Supporting material

10.A Selected 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 – a refined product of bauxite. Mined bauxite is refined into alumina which is then smelted into aluminium. It is also used in the manufacture of chemical products.
- Aluminium – a product of bauxite. Mined bauxite is refined into alumina which is then smelted into aluminium.
- Beneficiation – the processing of crude bauxite to produce product-grade bauxite. This is 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 – a process whose primary purpose is to benefit 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 grievances – community issues regarding bauxite production. Concerns can range from commonly occurring, relatively minor issues (complaints) to more entrenched or serious issues that can 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 – 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 – any element of a mine's activities, products or services that may interact with the environment.
- Environmental impact assessment (EIA) – any change to the environment, whether adverse or beneficial, which 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.
- 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. This can range from people living adjacent to or at a distance from activities.
- Human rights impact assessment – an assessment to identify, understand and manage any potential impacts of direct and indirect activities on the human rights of its stakeholders.
- Indigenous Peoples – those who are the descendants of the pre-colonial peoples of the Americas, Scandinavia, Australia and New Zealand; those marginalised ethnic minority groups or tribal

populations of Asian and African countries; those groups with a culture distinct from most of the population and who have historically occupied certain regions.

- ISO 14001 – an international standard that provides the requirements for an EMS.
- Opportunity – 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.
- Risk rating – the chance of something happening that will/may have an impact upon objectives. It is determined by consequence and probability.
- Risk register – the aspects and impacts identified in risk ratings collated together.
- Sensitive receptors – people or other organisms that may have a significantly increased sensitivity or exposure to contaminants by their age and health (for example schools, day care centres, hospitals, nursing homes), status (for example sensitive or endangered species), or proximity to the source or the facilities they use (for example water supply well). The location of sensitive receptors must be identified to evaluate the potential impact on health and the environment.
- Significant environmental aspect – 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 NGOs.
- 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 plans) and qualitative data (including community perceptions and attitudes which are sourced directly from stakeholders).
- Social impact assessment (SIA) – this 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 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 – 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 non-hazardous fine-grained waste material resulting from beneficiation.
- Total suspended particles – all suspended particles. To be suspended, these are typically 50 µm (0.05 mm diameter) in size or less.
- World Heritage areas – places identified by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) for their outstanding cultural or natural value to humanity.

10.B List of abbreviations

- AAC – Australian Aluminium Council
- ABAL – Brazilian Aluminium Association
- CBA – Companhia Brasileira de Alumínio
- EIA – Environmental impact assessment
- EMS – Environmental management systems
- IAI – International Aluminium Institute
- JBI – Jamaican Bauxite Institute
- MRN – Mineração Rio do Norte, Brazil
- NGO – Non-government organisation
- SIA – Social impact assessment
- TSP – Total suspended particulates
- TSS – Total suspended soils
- WMP – Waste management plan

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