Business and Biodiversity Offsets Programme (BBOP)

BBOP Pilot Project Case Study

The Ambatovy Project

Ambatovy

BBOP
Business and Biodiversity Offsets Programme

Forest Trends, Conservation International and the Wildlife Conservation Society provided the Secretariat for BBOP during the first phase of the programme's work (2004 – 2008).

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THE AMBATOVY PROJECT

BBOP PILOT PROJECT

BUSINESS AND BIODIVERSITY OFFSETS PROGRAMME

CASE STUDY

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About this document

To help developers, conservation groups, communities, governments and financial institutions that wish to consider and develop best practice related to biodiversity offsets, the Business and Biodiversity Offsets Programme (BBOP) has prepared a set of Principles, interim guidance and resource documents[1], including pilot project case studies, of which this Document[2] is one. All those involved in BBOP are grateful to the companies who volunteered pilot projects in this first phase of its work.

The ability to test methods and learn from practical experience in a set of pilot projects has played an important role in the development of the BBOP Principles on Biodiversity Offsets and supporting materials during the first phase of the programme's work (2004 – 2008). The Ambatovy Project's four shareholders volunteered to undertake pilot projects during BBOP's first phase, with some joining at the outset, and some at later stages. While BBOP has offered some support and technical advice to the individual pilot projects through its Secretariat and Advisory Committee, each pilot project has been directed and managed by a team employed or contracted by the companies and city council leading the respective projects. Each of the case studies prepared by the pilot projects explains the approach taken and how close the Project has come to completing the design of the biodiversity offset concerned, and sets out the developer's current thinking on the most appropriate offset. This may change as the Project teams finalise their offset programme design and further implementation. The nature of the guidance used by the pilot projects has varied according to which drafts of the evolving BBOP Handbooks were available to them at the time. This and the individual circumstances and context of each pilot project have affected the extent to which they have used or adapted the BBOP guidance. Consequently, the case studies do not necessarily reflect the range of interim guidance currently presented in BBOP's Biodiversity Offset Design Handbook, Cost-Benefit Handbook and Implementation Handbook.

This Document has been provided by the Ambatovy Project subject to the limitations set out herein.

The Ambatovy Project is still working on the design of the proposed biodiversity offset discussed in this case study. Consequently, none of the suggested or projected activities based on fieldwork to date represent a commitment on the part of The Ambatovy Project, it shareholders or potential partners to proceed with the offset as described in draft form in this Document. Such commitment is the subject of continuing internal discussions. The information and data relating to possible offset sites, areas and activities are presented here to communicate the initial work that has been done on a potential offset design and to illustrate one possible approach to the design of a biodiversity offset intended to comply with the BBOP principles.

Where data supplied by external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by the Ambatovy Project for incomplete or inaccurate data supplied by others.

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1 The BBOP Principles, interim guidance and resource documents, including a glossary, can be found at **www.forest-trends.org/biodiversityoffsetprogram/guidelines/**. To assist readers, a selection of terms with an entry in the BBOP Glossary has been highlighted thus: biodiversity offsets. Users of the Web or CD-ROM version of this document can move their cursors over a glossary term to see the definition.

2 This case study was prepared by Pierre O. Berner, Steven Dickinson and Aristide Andrianarimisa.

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BBOP is embarking on the next phase of its work, during which BBOP hopes to collaborate with more individuals and organisations around the world, to test and develop these and other approaches to biodiversity offsets more widely geographically and in more industry sectors. BBOP is a collaborative programme, and we welcome your involvement. To learn more about the programme and how to get involved please:

See: **www.forest-trends.org/biodiversityoffsetprogram/**

Contact: **bbop@forest-trends.org**

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1. Executive Summary

The Ambatovy Project is a large-tonnage nickel project in Madagascar with an annual design capacity of 60,000 tonnes of nickel and 5,600 tonnes of cobalt. The Project is comprised of two companies Ambatovy Minerals SA and Dynatec Madagascar SA each owned in the same proportion by Sherritt Incorporated, Sumitomo Incorporated, Kores and SNC Lavalin. The Project was permitted in December 2006. Construction began in early 2007 and production is due to begin by the end of 2010, reaching full capacity by 2013. The Project's expected LIFECYCLE is 27 years, although operation beyond this is likely.

The Ambatovy Project has six components: the mine, the slurry pipeline, the processing plant (including refinery), the tailings management facility, the harbour extension and the resettlement site. The Project covers a large territory extending over two of Madagascar's twenty-two regions. The mine is located at an elevation of approximately 1,000 m above sea level, on Madagascar's eastern escarpment, near the town of Moramanga. The industrial complex (plant, tailings management facility and harbour) is located 130 km to the northeast of the mine site, in the seaport city of Toamasina. A 218 km slurry pipeline carrying a water laterite slurry, which contains the ore, links the mine and plant. The proposed off-site offset of Ankerana, which constitutes the key component of the multifaceted offset programme, is situated in a very remote area between the mine site and Toamasina.

The Ambatovy Project's vision states that it will operate a sustainable nickel / cobalt mining and processing enterprise that delivers outstanding environmental and social records. The Project developed an environmental strategy aiming at honouring the Project's vision, by producing positive CONSERVATION OUTCOMES on biodiversity through an offset programme. The offset programme aims at achieving NO NET LOSS on biodiversity, and preferably NET GAIN. The business benefit is essentially linked to risk management and aims to sustain 'a good citizen project' status in a host country recognised to constitute a BIODIVERSITY HOTSPOT but suffering from chronic poverty.

The Ambatovy offsets programme is multifaceted with many components. The programme has been adopted voluntarily to go above and beyond the Project's impacts management strategy. The Programme includes:

1. **The Ankerana offset:** the off-site offset area covers 11,600 hectares (ha) of endangered forest, with similar ABIOTIC and BIOTIC conditions to those found at the mine site; the Project aims to ensure its long term protection through legal arrangements, financing and community consensus.
2. **Two azonal forest sites:** two on-site (mine) azonal forest conservation areas occur partially over the ore body footprint; the Project aims to ensure their long term protection through legal and managerial commitments.
3. **The mine area conservation forest:** the conservation forest area around the mine footprint is 4,900 ha; the Project aims to ensure its long term conservation as part of the priority species management programme and maintenance of the ecological services for the local communities.
4. **The Analamay-Mantadia forest corridor:** the Project is spearheading the establishment of a forest corridor between the mine area forests and the nearby Ankeniheny-Zahamena Corridor; the forest corridor aims at long term landscape level CONNECTIVITY for the protection of mine area biodiversity through partnerships with government, NGOs and local communities.

5. **The Torotorofotsy Ramsar wetland ecosystem:** the Project is supporting the site management plan design and implementation in conjunction with government and local NGOs; these efforts aim to ensure the permanency of legal and managerial commitments in partnership with government and a local NGO.

6. **The pipeline right of way reforestation programme:** the programme aims at enhancing FOREST CONNECTIVITY in targeted areas of the Ankeniheny-Zahamena Corridor through expanded reforestation activities along the slurry pipeline right of way by conducting targeted reforestation in partnership with government and local NGOs.

7. **The mine footprint replacement forest:** the Project aims to create a replacement, multifunctional forest on the footprint during progressive reclamation with an established, integrated managerial structure by mine closure.

The Ambatovy offset programme design approach was tailored according to the guidelines provided by the BBOP Secretariat and Advisory Committee. It includes the following steps:

Step 1. **Reviewing the offset project scope and activities:** the offset project was outlined in the ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA), to go above and beyond the expected regulatory requirements, and was presented during stakeholder consultation; the Project became a pilot project in 2006 before obtaining its operating permit.

Step 2. **Reviewing the legal policy context for its biodiversity offset programme:** key elements comprise the MECIE decree (*Mise en Compatibilité des Investissements avec l'Environnement,* Decree N° 2004-167 modified), the Madagascar Action Plan (MAP) 2007 – 2012, the regional and communal development plans and the EQUATOR PRINCIPLES.

Step 3. **Initiating stakeholder participation:** PARTICIPATION has been pursued since the ESIA stage, engaging the Project's shareholders, government, financiers, NGOs and local communities in the design of the offset programme and integrating their feedback.

Step 4. **Determining the need for an offset based on residual adverse effects:** the Project's principal impacts on natural systems and biodiversity were assessed by the project ESIA. DIRECT IMPACTS were predicted to occur at the mine area through the phased clearing of the 1,336 ha mine footprint within an ecologically sensitive semi-pristine forest mosaic. The KEY BIODIVERSITY COMPONENTS in the mine area and upper slurry pipeline portion include significant numbers of fauna (16 lemurs, 62 birds, 123 herpetofauna), fish and 376 flora species, three structurally distinct HABITAT TYPES and a landscape-level habitat assemblage with functional interactions between its forest habitats. A very substantial MITIGATION programme was implemented through the Ambatovy Project's Biodiversity Management Plan (BMP). The Project's most significant RESIDUAL IMPACTS occur at the mine site, including both direct impacts through the clearing of the 1,336 ha footprint (and associated biodiversity) and indirect residual impacts from edge effects on the environmental buffer (790 ha). Other key Project components are located in areas that are already heavily and historically degraded and thus have negligible negative impacts on biodiversity.

Step 5. **Methods to calculate LOSSES / GAINS and quantify residual losses:** the Project used the BENCHMARK and HABITAT HECTARES methodology to determine the scale of the offset needed to achieve the CONSERVATION GAINS that will achieve no net loss of biodiversity. The Project will generate a total loss of 1,168 habitat hectares that any offset will be required to compensate; this result will be refined with complementary fauna quantitative data acquired in early 2009. Socioeconomic losses and compensations from the offset programme will be determined during 2009.

Step 6. Reviewing potential offset locations and activities to assess biodiversity gains which could be achieved: preliminary surveys of offset candidate sites were undertaken in 2005 with the objective of identifying potential IN-KIND type offsets. The Ankerana forest site has many similarities with the Ambatovy mine site forests, supporting the hypothesis that Ankerana can be considered 'in-kind' relative to the Ambatovy azonal habitats.

Step 7. Calculating offset gains and select appropriate offset locations and activities: additional work to verify Ankerana's similarities is required and planned for 2009, including detailed quantification of potential offset gains. Gains from other offset programme components will also be calculated and integrated.

Step 8. Recording the offset design and entering the offset implementation process: the Ankerana offset design and other components of the offset programme have not yet been finalised, thus the implementation process has not formally begun. The Project will finalise the offset programme design, using BBOP guidance, during the course of 2009.

The team plans to complete the design of the offset programme implementation plan by the end of 2009, with the Ankerana and other offset sites' gain calculated in 2010, and thus the final offset design completed at that point. The Project will have the responsibility of ensuring the management of the Ankerana site, while actual site protection and local management will likely be entrusted to an NGO. For Ankerana, the annual operational costs are in the process of being established and are estimated to be in the range US$ 250,000 – 300,000 per annum. Since the offset programme is still in the design phase, the actual conservation outcomes to date are limited. They represent what the Project has achieved thus far and the benefits the Project has already enjoyed and include securing the temporary protection of Ankerana until the Ministerial decree for its protection is finalised; integrating Ankerana into the national protected areas network; coordination between government organisations, NGOs, local communities and the private sector; local community awareness and reforestation activities. At the mine site, forest and TAXA-specific conservation management plans were developed for flora and fauna, (e.g., lemurs, Mantella frog species and fish). Although these programmes were developed as part of the Biodiversity Management Plan, their importance is reinforced by their aim of ensuring the conservation of azonal habitat and associated species, thus ensuring that all key biodiversity components present on the IMPACT SITE are present at the offset.

A summary of the Ambatovy Project pilot project BBOP programme is presented in Table 1.

Table 1: Summary of the Ambatovy pilot Project

Company name	Ambatovy Minerals SA & Dynatec Madagascar SA (AMSA / DMSA)
Project name	Ambatovy Project – Madagascar
Sector & project description	Ambatovy is a large-tonnage nickel Project with an annual design capacity of 60,000 tonnes of nickel, 5,600 tonnes of cobalt and 190,000 tonnes of ammonium sulphate. Production is scheduled to begin in 2010, with full capacity expected to be achieved by 2013. The Project's assessed reserve life is 27 years, with potential for extension beyond this. The main impacts to biodiversity are located at the mine footprint with the clearing of near-primary forest. The Project has designed and implemented a Biodiversity Management Programme to mitigate and monitor the residual impacts associated to development, whilst pursuing its impact AVOIDANCE and reduction approach. The mitigation measures cover flora, fauna and aquatics.
Country	Republic of Madagascar (Alaotra Mangoro and Atsinanana regions, eastern Madagascar).
Shareholders	Sherritt International Corporation, Sumitomo Corporation, Kores, and SNC Lavalin Incorporated.
Principal biodiversity components affected by Project	The key biodiversity components, mostly confined to the mine area and upper slurry pipeline portion, can be summarised as follows: • Priority species: – 16 lemurs species, including *Prolemur simus* (IUCN CR), *Propithecus d. diadema* (IUCN EN), *Indri indri* (IUCN EN), *Eulemur rubriventer* (IUCN VU), *Daubentonia madagascarensis* (IUCN NT), *Hapalemur griseus* (VU), *Allocebus trichotis* (IUCN DD); – 62 birds species, including *Tyto soumagnei, Anas melleri* and *Ardea humbloti*, *Sarothura watersi* (IUCN EN); – 123 herpetofauna species, including *Mantella aurantiaca* (IUCN CR), *M. crocea* (IUCN EN) and *Sanzinia madagascariensis* (IUCN VU); – 5 fish species of which *Rheoles alaotrensis* (IUCN VU) and at least two new *Ratsirakia* species; – 24 insect species, which are considered rare at a national level; – 376 plants including *Asteropeia mcphersonii* (IUCN VU), *Leptolaena multiflora* (IUCN EN), *Dalbergia baroni* (IUCN VU) and 330 species of concern, which are considered rare in Madagascar; • Three structurally distinct habitat types: zonal, transitional and azonal forests (the latter including seasonal ponds and upper watershed stream systems) and their fauna and flora communities; and • The landscape-level habitat assemblage with the functional interaction between the zonal, transitional and azonal forests.
Scale of impact	The main anticipated residual impacts on biodiversity caused by the Project will occur at the mine site and in the upper portion of the slurry pipeline through the progressive clearing of the mine footprint (approximately 1,336 ha), located within an ecologically sensitive natural forest mosaic of the eastern mid-altitudinal forest corridor. Stringent impact avoidance and minimisation strategies were applied in the design phase of the Project. Residual impacts on biodiversity at the other Project components are insignificant due to human-induced degradation in these areas but will nonetheless be offset. These include pipelines, the processing plant, the tailings area and a pier extension project. The 218 km of buried slurry pipelines will involve the clearing of a mix of native and non-native secondary vegetation resulting from historical slash and burn with comparatively little biodiversity value. However, two sections of the pipeline cross sensitive habitats: the first 2 km of zonal, near-primary forest accounted for in the mine footprint and the crossing of the Ankeniheny-Zahamena Corridor at Vohimana, where the pipeline has been routed to avoid residual primary forest fragments.

	The processing plant occupies 2.6 km^2 of the Toamasina industrial zone. The associated tailings system of 14 km^2 will be located in a highly degraded agricultural matrix. An existing pier at the harbour will be extended by over 300 m to accommodate the Project's logistical needs. The processing plant, tailings and pier extension have been assessed in the Environmental and Social Impact Assessment (ESIA) to have negligible residual impacts on biodiversity. As the Project is developing the ESIA is being revisited to ensure that no residual impact to biodiversity is being neglected. Any further residual impacts identified will be accounted for in the biodiversity offset calculation.
Description of offset	The Ambatovy offsets programme is multifaceted with many components. The Ambatovy Project is committed to achieve positive conservation outcomes through designing and implementing its multifaceted programme, that includes: 1. **Ankerana offset:** establishing an 11,600 ha endangered forest off-site offset, with similar abiotic and biotic conditions to those found at the mine site and ensuring long term protection through legal arrangements and community consensus. 2. **Azonal forest sites:** establishing two on-site (mine) azonal forest habitats conservation areas that occur partially over the mine footprint and ensuring long term protection through legal and managerial commitments. 3. **Mine area conservation forest:** establishing a 4,900 ha conservation forest area around the footprint and ensuring long term conservation as part of the priority species management programme and maintenance of the ecological services for the local communities. 4. **Analamay-Mantadia forest corridor:** spearheading the establishment of a forest corridor between the mine area forests and the nearby Ankeniheny-Zahamena Corridor and securing long term landscape level connectivity for the protection of mine area biodiversity through partnerships with government, NGOs and local communities. 5. **Torotorofotsy Ramsar:** supporting the site management plan design and implementation in conjunction with government and local NGOs and ensuring permanency of legal and managerial commitments with its partnerships. 6. **Pipeline right of way reforestation:** enhancing forest connectivity in targeted areas of the Ankeniheny-Zahamena Corridor through expanded reforestation activities along the slurry pipeline right of way and conducting targeted reforestation in partnership with government and local NGOs. 7. **Mine footprint replacement forest:** creating a replacement, multifunctional forest on the footprint during progressive reclamation with an established, integrated managerial structure by mine closure. While the design and implementation of the several components of the Ambatovy offset programme has progressed, the predicted conservation outcomes from these various offset components have not yet been fully calculated. Meanwhile, Ambatovy has focused on its proposed Ankerana offset as the most significant component of its offset. However, the high degree of social sensitivity around Ankerana has led the project to undertake community involvement before the planned biodiversity assessment at the site. The impact of the first pipeline section will be included in the offset calculation for the mine site. The second section of pipeline will be offset by reforestation not only of the pipeline footprint but also of broader areas with the aim of reconnecting the forest corridor.
Links to further information	**http://www.sherritt.com** and **http://www.sherritt.mg**

2. Project Context

2.1 Policy context

Investment projects in Madagascar must be compatible with Malagasy environmental regulations. This principle is embedded in the MECIE (*Mise en Compatibilité des Investissements avec l'Environnement*) decree (Decree N° 2004-167 modified). The application of this decree is enforced by the environmental regulator, ONE (*Office National de l'Environnement*), which has developed stringent guidelines and protocols on how to elaborate, review, permit and monitor Environmental and Social Impact Assessments (ESIA). Although the terms of reference for an ESIA in Madagascar typically require stringent mitigation of impacts, biodiversity offsets are not included in the text.

The Government of Madagascar became aware of biodiversity offset mechanisms through interactions with environmental NGOs in 2005 (WWF, Conservation International – CI, Wildlife Conservation Society – WCS). Subsequently, the BBOP Secretariat attended a presidential audience to discuss biodiversity offsets in June 2006 during which the concept of offsets as a complementary mechanism to reduce impacts on Madagascar's heritage was well received by the President of Madagascar. Biodiversity offsets were subsequently referred to in the Madagascar Action Plan (MAP) 2007 – 2012:

- *Commitment # 7 "Cherishing the Environment"*
- *Challenge # 3 "Develop the Environmental Reflex at All Levels"*
- *Priority Projects and Activities # 3 "Develop a policy for mining companies and logging companies for* ***biodiversity offsets*** *and other mechanisms and incentives for environmental protection"*

The ESIA for the Ambatovy Project (MINEVEF/ONE Permit # 47/06 dated December 1st, 2006) established that the Project, and specifically the mine component, would be located in a sensitive biodiversity area and that the mitigation of residual impacts would require both on-site and off-site compensation measures. While on-site measures at the mine are commitments made in the ESIA, the Ambatovy offset programme goes above and beyond compliance with legal obligations. The offset programme is believed to deliver positive conservation outcomes under a vision of no net loss of biodiversity, and possibly net gain. This would enable the Project to honour its stringent biodiversity policy developed and endorsed by its shareholders:

- *"… to cause no net harm to biological diversity where we operate, to mitigate unavoidable impacts, and to practice responsible closure procedures;*
- *… to assure the conservation of habitats, flora and fauna, using all reasonable actions and technologies;*
- *… to ensure responsible attention to the maintenance and, where possible, enhancement of biodiversity in the best interest of our business, the communities in which we operate, and the world at large."*

The Project's principal financial lenders have subscribed to the Equator Principles (**http://www.equator-principles.com/index.shtml**). In this context, full regulatory compliance and the implementation of a thorough impact management strategy is expected. In addition, the lenders also require the Project's general compliance with the IFC Performance Standards and specifically Performance Standard 6 (Biodiversity Conservation and Sustainable Natural Resource Management). In the context of biodiversity offsets, paragraph 8 of Standard 6 is particularly relevant and requires the design of mitigation measures to achieve no net loss of biodiversity where feasible. These measures may include a combination of actions, such as:

- Post-operation restoration of habitats
- Offset of losses through the creation of ecologically comparable area(s) that is managed for biodiversity
- Compensation to direct users of biodiversity

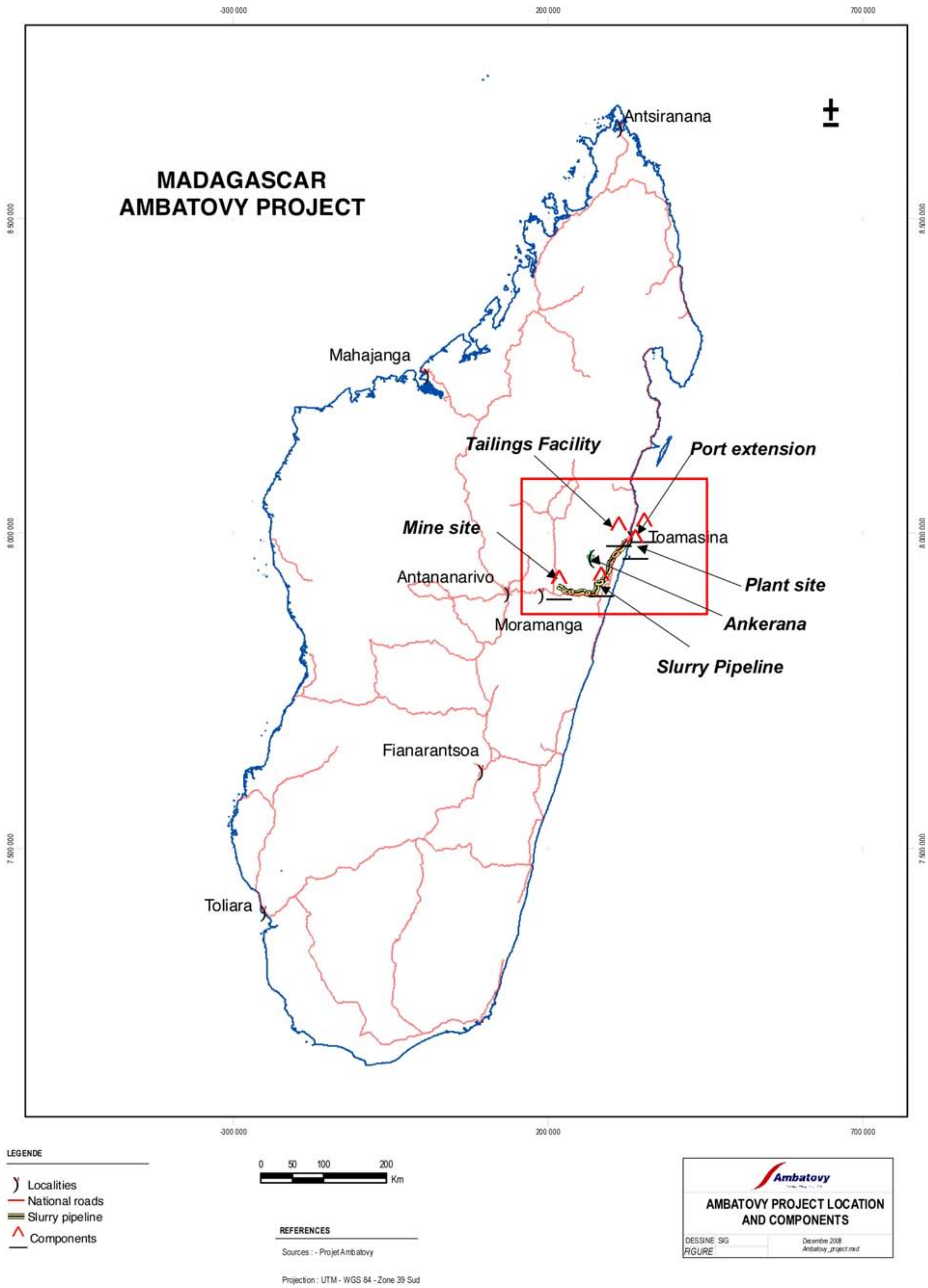
The Project is thus designed to comply with the IFC Performance Standards for major projects.

2.2 Regional context

The Ambatovy Project has six components, including the mine, the slurry pipeline, the processing plant (including refinery), the tailings management facility, the harbour extension and resettlement sites (see Figure 1). The Project covers a large territory extending over two of Madagascar's twenty-two regions (Alaotra-Mangoro and Toamasina). The mine is located at an elevation of approximately 1,000 m above sea level (m.a.s.l.), near the town of Moramanga. The industrial complex (plant, tailings management facility and harbour) is located 130 km to the northeast of the mine site, in the seaport city of Toamasina. A slurry pipeline carrying a water laterite slurry, which contains the ore, links the mine and plant. The proposed Ankerana offset, constituting the key component of the multifaceted offset programme, is situated in a very remote area between the mine site and Toamasina.

As presented in the Project ESIA, the principal biodiversity sensitivities of the Project are concentrated in the forested mine area and within the upper portion of the slurry pipeline, while social issues are relevant for all components. Biodiversity resources within the mine region have strong intrinsic and USE VALUES and communities there largely depend on these biodiversity resources for their LIVELIHOODS. However, in light of current agricultural practices and population growth, natural resource and biodiversity utilisation by local communities is far from sustainable in the mine region; the depletion is such that this natural capital will not be available to future generations unless fundamental changes take place. The socioeconomic impacts on the local communities from the Project's offset programme will need to be considered. The mitigation of these impacts needs to be designed in the context of national, regional and communal plans that address long-term issues of sustainable resource use in the regions in which the Project operates.

Figure 1: Project location map



2.3 Shareholders involved in offset design

- **Shareholders:** the Project is jointly owned by Sherritt Incorporated, Sumitomo Incorporated, Kores and SNC Lavalin. Each partner has played an important role in the Project's environmental programme, including regulatory compliance, impact mitigation, risk management and design of a comprehensive biodiversity offset programme. The Ambatovy vision, besides the goal of generating attractive economic results, is to contribute significantly to the host country and to deliver outstanding safety, social and environmental performance.
- **Government:** the general offset principle is captured in the MAP (see *Policy Context* section above) and specific governmental entities have been involved in the offset design, including the Ministry of Environment, Water, Forests and Tourism (MEWFT) and the Malagasy Forest Service, which have actively participated in securing the proposed offset site at Ankerana via a community-led zoning process.
- **Lenders:** the Ambatovy Project is one of the largest capital investment projects in the world and it is financially supported by a number of lender banks, most of which have adopted the EQUATOR PRINCIPLES. Lenders includes the African Development Bank (AFDB), Export Development Canada (EDC), Export-Import Bank of Korea (K-EXIM), the European Investment Bank (EIB), the Japan Bank for International Cooperation (JBIC) and various commercial banks such as Société Générale and BNP Paribas. The consideration of Performance Standard 6 in the Project's Biodiversity Management Plan, including the taxa-specific plans, reflects this.
- **NGOs:** environmental NGOs in Madagascar are aware of the offset concept and are encouraging the Ambatovy Project to continue moving its offset programme forward in an effort to ensure NO NET LOSS on biodiversity and, preferably, net gain. However, it is worth noting that some STAKEHOLDERS voice concerns about the Project's ability to deliver no net loss of biodiversity and are closely scrutinising the Project's offset initiative. Given this, the Project has been actively working to enhance its offset programme in collaboration with NGOs such as CI, WCS and ERI (Eco Regional Initiative). A number of other NGOs working with the Ambatovy Project on impact mitigation have also provided valuable input to the offset design process (e.g., *Groupe d'Etudes et de Recherche des Lémuriens*, Henry Doorly Zoo and its Madagascar Biodiversity Program, Madagasikara Voakajy, Missouri Botanical Garden, Mitsinjo, University of Antananarivo Biology department, the South African Institute of Aquatic Biology, WWF and others).
- **Local communities:** the Project continues to engage stakeholders, including local communities, to ensure that any offset is compatible and integrated with regional and local land and resource management visions.

3. Project Summary

3.1 General project description

The Ambatovy Project is a large-tonnage nickel project with an annual design capacity of 60,000 tonnes of nickel and 5,600 tonnes of cobalt. Additionally, the Project will produce 190,000 tonnes of fertiliser (ammonium sulphate) as a by-product from the refinery, a product much needed in this part of the world.

The Project was permitted in December 2006 and construction began in early 2007. Production is due to begin at the end of 2010, reaching full capacity by 2013. Based on proven nickel and cobalt ore reserves, the Project's expected lifecycle is 27 years, although operation beyond this is likely, as stored low-grade ore could become an economic commodity in the future.

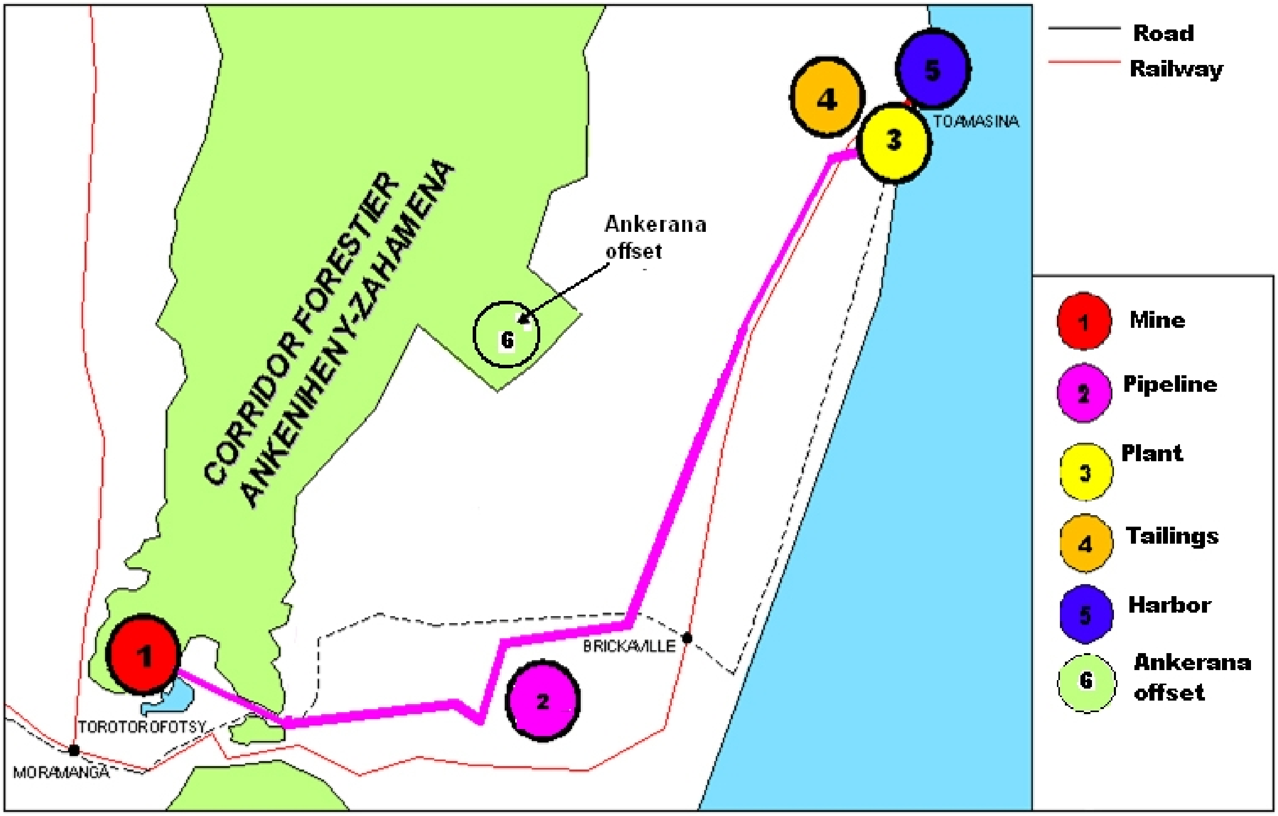
The locations of the main Project components are shown in Figure 2, and the key features are summarised below:

- The Ambatovy mine lies within the mid-altitude forests, at the westerly limit of the residual eastern rain forest known as the Ankeniheny-Zahamena Corridor. The near-primary forests of the mine area have undergone considerable human-induced pressures including hunting and gathering, selective logging, slash and burn agriculture, uncontrolled fires and species collection for trade;
- The slurry pipeline, buried over the majority of its route, will pass through 2 km of near-primary forest surrounding the mine, crosses a Ramsar site (avoiding the wetlands by following an old railroad spur) and traverses the Ankeniheny-Zahamena forest corridor by avoiding residual forest fragments whenever possible. It then continues to the coast through hilly terrain of the former eastern rain forest destroyed by extensive slash and burn agriculture;
- The industrial complex, including the processing plant and the refinery, the tailings and the harbour, is located within an anthropogenic coastal landscape in a suburban setting. The plant and harbour lay within the industrial zones of Toamasina; and
- The proposed Ankerana offset site, which is equidistant between the mine and Toamasina, is a large, mountainous dome covered with primary forest, encroached only by slash and burn agriculture in surrounding valleys where frontier dwellings exist. The pristine character of the site is a result of its remoteness and the low density of surrounding human populations.

The Project's principal impacts on natural systems and biodiversity will occur at the mine area, through the phased clearing of the mine footprint within an ecologically sensitive natural forest mosaic. The sensitivity of this mosaic arises from the considerable local heterogeneity in terms of geology, geomorphology, substrate, topography and meso-climate.

It is widely documented that the average annual deforestation rate calculated over the period between 2000 and 2005 was 0.35%. In total, between 1990 and 2005, Madagascar lost 6.2% of its forest cover, approximately 854,000 ha. The current annual loss of the residual eastern rain forest is equivalent to 14,000 ha per year. The total mine footprint to be cleared (1,336 ha) represents only 0.03% of the residual eastern rain forest, estimated in 2008 at 4,012,100 ha. In consideration of the large forest loss in eastern Madagascar, the INTRINSIC VALUE of the offset area at Ankerana (11,600 ha) will increase over time as such forest estates and their associated biodiversity become rarer.

Figure 2: Project components map



While the bulk of the residual biodiversity impact will arise in the mine area and in the upper portion of the pipeline, the Project's offset calculation considers residual impacts from each project component including the entire slurry pipeline, the processing plant, the tailings and the harbour extension. The intention is that all residual impacts will be offset.

Approximately 90% of the pipeline's 218 km right of way will require the clearance of secondary, non-sensitive and mostly non-ligneous vegetation, which has resulted from historical slash and burn and has comparatively little biodiversity value. Disturbed land will ultimately be rehabilitated using species appropriate to current land use in the different pipeline sectors (including provision of fuel wood species to reduce pressure on native forests). However, two sections of the pipeline cross sensitive habitats:

- The first 2 km of zonal, near-primary forest at the mine area; these losses are integrated to the mine footprint loss calculations; and
- The Ankeniheny-Zahamena forest corridor area, which led to 16.5 ha of zonal forest being cleared, despite planning and routing efforts to avoid the residual primary forest fragments present there.

The processing plant, currently under construction, covers 2.6 km^2 of Toamasina's industrial zone. The tailings management facility has a footprint of 14 km^2 and is located in a highly degraded, fire-driven agricultural matrix, where irreversible, human-induced depletion of the original biodiversity occurred during historical forest clearance. The harbour expansion requires the construction of an extended pier (over 300 m) to accommodate the unloading of equipment during the construction and the importation of raw material (coal, sulphur, limestone and diesel) and the loading of nickel and cobalt briquette bags and ammonium sulphate during operation. At the Project's industrial complex (plant, tailings management facility and harbour), most of the biodiversity values were lost many years ago through extensive habitat conversion. The Project's ESIA notes that the industrial complex will have negligible residual impacts on biodiversity, which will nonetheless be traded up through the Project's offset programme.

Specific aspects of the biological environment assessed in the ESIA are being revisited through expanded BASELINE STUDIES to ensure that residual impacts are fully documented and included in the biodiversity offset calculation.

The KEY BIODIVERSITY COMPONENTS in the mine area and upper slurry pipeline portion can be summarised as:

- Priority species, with home ranges overlapping (and or potentially overlapping) the mine footprint:
  - 16 lemurs species, including Prolemur simus (IUCN CR), Propithecus d. diadema (IUCN EN), Indri indri (IUCN EN), Eulemur rubriventer (IUCN VU), Daubentonia madagascarensis (IUCN NT), Hapalemur griseus (VU), Allocebus trichotis (IUCN DD);
  - 62 birds species, including Tyto soumagnei, Anas melleri and Ardea humbloti, Sarothura watersi (all IUCN EN);
  - 123 herpetofauna species, including *Mantella aurantiaca* (IUCN CR), *M. crocea* (IUCN EN), *Sanzinia madagascariensis* (IUCN VU);
  - 5 fish species of which *Rheoles alaotrensis* (IUCN VU) and at least two new *Ratsirakia* species;
  - 24 insects species, which are considered rare at a national level;
  - 376 plants including *Asteropeia mcphersonii (IUCN VU), Leptolaena multiflora (IUCN EN), Dalbergia baroni* (UCN VU) and the 330 species of concern which are considered rare in Madagascar;
- Three structurally distinct HABITAT TYPES: zonal, transitional and azonal forests (the latter including seasonal ponds and upper watershed stream systems) and their fauna and flora communities; and
- The landscape-level habitat assemblage with the functional interaction between the zonal, transitional and azonal forests.

Section 7.3 presents more detail in the form of a Key Biodiversity Components Matrix (KBCM) and the steps followed in its completion. The full KBCM (December 2008 iteration) is provided in Appendix 1. Earlier iterations (February and April 2008) are presented in Appendices 2 and 3 respectively.

3.2 Ambatovy offset programme

The Ambatovy Project offset programme is a multifaceted endeavour to achieve measurable CONSERVATION OUTCOMES resulting in no net loss and preferably a NET GAIN of biodiversity. It has been adopted voluntarily to go above and beyond the Project's impacts management strategy. The Ambatovy Project intends to implement its diversified offset portfolio, as presented in Table 2.

Table 2: Ambatovy Project offset programme

#	Offset component	Design	Implementation
1	Ankerana	Establishing a large off-site offset site at Ankerana, encompassing similar ABIOTIC and BIOTIC conditions to those found at the mine site. The site is located 71 km to the northeast of the mine site and would involve conservation of 11,600 ha of endangered forest, including a multiple use area of 7,000 ha and a core conservation area of 4,600 ha, within which there is a large tract of azonal forest.	Ensure long term protection of the Ankerana offset site through the stringent legal arrangements and strong community consensus. Community motivation and consent is the highest priority of the Ambatovy Project offset implementation in its early phase and needs to be obtained before the BIODIVERSITY INVENTORIES are conducted (perceived as external intrusions by the local communities if ill prepared). Adhere to BBOP principles and guidelines for offset processes. Monitoring of efficacy of BBOP tools used and offset programme evaluation in 2011 and option analysis.
2	Azonal forest sites	Protecting, for the long term, two on-site conservation sites of the azonal forest habitats that occur partially over the mine footprint that would otherwise be lost to deforestation.	Ensure permanency of on-site conservation azonal sites through legal and managerial commitments. Ensure permanency of surrounding mine area forests (see offset component #3) with same measures as mentioned above. Ensure connectivity of mine area forests with surrounding protected areas (see offset component #4).
3	Mine area conservation forest	Ensuring long term conservation of the forest surrounding the mine footprint as part of the priority species management programme and maintenance of the ecological services for the local communities. The area consists of the establishment of 4,900 ha of buffer forest around the footprint.	Conduct multifunctional zoning based on existing models in Madagascar and ensure management of leased lands and in areas of targeted community transfer. It is believed that site that would otherwise be lost given regional deforestation rates.
4	Analamay-Mantadia forest corridor	Promoting the landscape level connectivity of the mine area forests with the nearby Ankeniheny-Zahamena Corridor to secure long term protection of mine area biodiversity as part of the Durban Vision implementation.	Enter into formal partnerships with government, NGOs and local communities to design and develop implementation plans for the Analamay-Mantadia Corridor, that take present and future community needs into account.
5	Torotorofotsy Ramsar	Supporting the Torotorofotsy Ramsar site management plan design and implementation in conjunction with government and local NGO.	In partnership with government and local NGO, ensure permanency of legal and managerial commitments. In a first phase, complete zoning and management plan for Ramsar site. Development of pragmatic viable resources uses to maintain ecological functions of wetland area while community needs are met.
6	Pipeline right of way reforestation	Enhancing FOREST CONNECTIVITY in targeted areas of the Ankeniheny-Zahamena Corridor through expanded reforestation activities along the slurry pipeline right of way.	In partnership with government and local NGOs conduct targeted reforestation of the Ankeniheny-Zahamena Corridor (CAZ) with the aim of re-establishing forest connectivity.
7	Mine footprint replacement forest	Creating a replacement, multifunctional forest on the entire footprint during progressive reclamation with an established, integrated managerial structure by mine closure.	Design and implement management plans for engineering, water management, erosion control, early vegetation establishment, targeted species reforestation, induced and facilitated secondary successions and sylviculture treatments.

4. How the Ambatovy Project is Applying the BBOP Principles

During the ESIA in 2004 and 2005, the Ambatovy Project initiated its offset programme based on an improved understanding of RESIDUAL IMPACTS and the need for developing compensatory conservation activities. In 2006, Ambatovy became a BBOP PILOT PROJECT and refined its initial offset vision and the design approach was tailored according to the guidelines provided by the BBOP Secretariat and Advisory Committee.

The BBOP PRINCIPLES ON BIODIVERSITY OFFSETS were finalised in December 2008[3], following several years of groundwork including the development of draft guidance and tools. The Project's offset initiative was developed alongside, and is generally well-aligned with, the BBOP Principles. The Project's alignment with the BBOP Principles is illustrated in more detail in Section 7. The Project applies the BBOP Principles as follows:

1. No net loss:

The Project's aim is to achieve measurable conservation outcomes that deliver NO NET LOSS of biodiversity and a possible net gain through a mix of complementary offset and mitigation activities, including:

- An offset site at Ankerana that contains a core conservation area designed to compensate for the Project's residual impacts on azonal forest biodiversity.
- Protection of viable tracts of azonal forest habitats through the set-aside of two specific on-site azonal forest habitat conservation zones within the forests surrounding the mine footprint (see next point).
- Implementation of a 'no species EXTINCTION' commitment and protection of forests surrounding the mine footprint to ensure the long-term viability of priority species populations impacted by the Project. This approach would include the on-site azonal forest habitat conservation zones and mechanisms to control current human pressure on these areas.
- Design and implementation of protection measures for an existing residual forest corridor linking forests surrounding the mine area and the Mantadia National Park to ensure landscape-level forest connectivity.
- Targeted reforestation of the Ankeniheny-Zahamena Corridor, in partnership with government and local NGOs, to re-establish forest connectivity between Mantadia National Park and the Man and the Biosphere Private Reserve.
- Development of the Ramsar Torotorofotsy Management Plan in partnership with government and local NGOs, and contribution to its subsequent implementation.
- Progressive rehabilitation at the mine site to produce a multifunctional replacement forest with reinstated biodiversity values to be included in the offset calculation.

To date, the Project's offset planners have used BBOP guidance and methodologies to assess the impact on biodiversity and to identify potential sites for biodiversity offsets. BBOP methodologies will also be followed to

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3 The full text of the BBOP Principles is available in the BBOP document "Business, Biodiversity Offsets and BBOP: An Overview" – see **www.forest-trends.org/biodiversityoffsetprogram/guidelines/overview.pdf**.

determine the scale of the offset required to deliver no net loss, to verify that no net loss has been achieved and to define implementation measures that will ensure the long-term sustainability of the offset.

2. Additional conservation outcomes:

The Project is designing and implementing conservation activities that are predicted to deliver ADDITIONALITY, as summarised below for each of the Project's components:

- The proposed Ankerana offset site is currently being integrated within the recently established SAPM (National Protected Areas System) under the Durban Vision. However, there is a significant shortfall in the financial and human resources to offer protection to all these areas and the Durban Vision can only be implemented if an array of different partners commits to developing the required financial and human resources. Through the proposed offset, the Project will play a role in that development process.
- Historically the azonal forest habitats of Ambatovy and Analamay have suffered significant anthropogenic impacts (e.g., from hunting and gathering, destructive honey collection, fire, charcoal, slash and burn, and the pet trade). The long-term survival of this habitat in the absence of the Project is far from proven. This is clearly seen in the baseline data for the mine area: of the total area of 1,347 ha of azonal forest habitat in the mine area, only 60% is of prime quality, the rest being significantly degraded before the project was established. While the mine development is predicted to impact 590 ha of prime quality azonal forest habitat, 212 ha (26.4% of the total prime quality habitat) will be preserved through the Project's on-site azonal habitat conservation initiative. The likelihood of successful conservation of a viable portion of the unique azonal forest habitat at Ambatovy is therefore significantly increased by the presence of the Project.
- Similarly, the zonal forests surrounding the mine footprint have experienced historic anthropogenic impacts such as forest structure modification (logging), species composition modification though canopy openings (invaders, heliophytes), FOREST FRAGMENTATION through clear cutting, and plain, irreversible loss of forest areas. The Project has committed to preserving the residual forests of the mine area by, for example, implementing forest community transfer[4] to avoid further anthropogenic losses. Such additionality, if clearly established, will be included in the offset calculations once data and a model for the rate of regional deforestation are available.
- In the long-term, the forests of the mine area and Mantadia National Park are likely to become isolated unless the existing forest corridor that links these areas is managed and protected. The loss of this corridor would cause landscape-level forest fragmentation and jeopardise the long-term viability of populations of critical species that the project has committed to protect at the mine area. As of December 2008, the forest corridor has not been included in the first zoning approximation of the Durban Vision. The Project and its partners plan to create a westerly extension of the Durban Vision zoning to incorporate this area in the protection zone of the Ankeniheny-Zahamena Corridor. Forest loss avoidance via the successful management and protection of the corridor will be taken into account in offset calculations based on a fair assessment of the resulting additionality.
- The Ramsar Torotorofotsy site is experiencing considerable pressure from inward migration, the drainage of wetlands and subsequent conversion to rice paddies, wildfires, slash and burn activities in the forested watersheds, hunting and the pet trade. The National Committee on Ramsar (CONARAMS) has given a local NGO (Mitsinjo) the mandate to design and implement a management plan. Ambatovy has joined this effort as a partner and will work with Mitsinjo and others to enhance the management plan. The first step

4 The targeted forest areas are jointly managed with local communities, using a defined management programme that meets conservation and sustainable use requirements.

will be to establish a functional zoning that results in the avoidance of BIODIVERSITY LOSS, which will be taken into account in offset calculations, again based on a fair assessment of the resulting additionality.

- Reforestation activities to reconnect residual patches of primary forests at the perimeter of the slurry pipeline right of way within the Ankeniheny-Zahamena Corridor will contribute to an overall corridor defragmentation. The areas to be reforested sit outside of the SAPM and will be accounted for in the offset GAIN calculation as clearly additional outcomes.

3. Adherence to the mitigation hierarchy:

Given the Project's setting (high regional biodiversity and endemicity), rigorous biodiversity management is necessary to meet its policy of 'no net harm to biodiversity'. Before considering biodiversity offsets, the Ambatovy Project implemented appropriate avoidance and minimisation measures according to the MITIGATION HIERARCHY, for example:

- **AVOIDANCE:** analysis of pipeline route alternatives, including the study of 21 major re-routes to avoid ecologically, socially and culturally sensitive areas; avoidance of other sensitive areas during the development of other Project components whenever possible. Also, set-aside of an area of the ore body that would otherwise be mined as the foundation of the on-site azonal habitat conservation initiative.
- **Minimisation:** reduction of the surface area subject to impacts through appropriate design and implementation.
  - Early (2004 / 05) impact mitigation through the rehabilitation of 50 km of exploration roads and platforms in the mine area.
  - Mitigation of impacts following forest clearance through biodiversity rescue and management programs (lemurs, small mammals, herpetofauna and fish).
  - Management of surges in total suspended solids to protect water quality and aquatic biodiversity in seven affected watersheds downstream of the mine site using large retention dams (at a cost of US$ 40 million).
- **Restoration / rehabilitation:** planned progressive rehabilitation of the mine site footprint to create a replacement forest with reinstated biodiversity values and reduce the net residual impact.

4. Limits to what can be offset:

The Ambatovy Project currently believes that all its direct residual impacts on biodiversity are OFFSETABLE. No habitat or species (flora and fauna) ENDEMIC to the mine footprint alone have been identified during the thorough investigations to date. Nevertheless, given the high levels of biodiversity and endemicity around the Project, field studies will continue as the mine is developed and forest clearance progresses.

In contrast, the Project believes that there are limits to offsetting certain social impacts. For local communities, there were few legal and cultural constraints on the exploitation of natural resources and biodiversity prior to the arrival of the mine. In light of forest clearance during development of the mine and the Project's commitment to conserve the surrounding forests by introducing a zoned approach to forest use, the local communities' existing way of life, including unsustainable use of biodiversity, will undoubtedly be disrupted. The Ambatovy Project believes that this disruption cannot be entirely offset and also that, in light of dwindling forest resources and population growth, it is desirable from a BIODIVERSITY CONSERVATION perspective to seek to break the cycle of unsustainable use by local communities and replace it with a more sustainable model.

The present unfettered community exploitation of resources may reflect a lack of community empowerment and choice. Hence, the changes envisioned by the Project (sustainable, participatory forest use) may ultimately be viewed by local communities as a positive transformation relative to the current situation.

The same concept applies to the Ankerana offset site where the Project believes that the pre-project socioeconomic conditions should not be, and ultimately cannot be, maintained. While this change can also not be offset, the Project believes the change to sustainable use of natural resources will ultimately be to the benefit of both local communities and biodiversity.

5. Landscape context:

The spatial spread of the Project has driven the integration of planned conservation activities with regional and landscape-level environmental and social initiatives. At the mine, the landscape approach currently consists of maintaining forest connectivity between the on-site azonal habitat conservation zones (and rehabilitated areas as these progress) and the surrounding forests. Moreover, forest connectivity between the mine area and the Ankeniheny-Zahamena Corridor will be maintained through landscape-level designs and interventions in line with the Durban Vision to increase the surface areas of protected areas in Madagascar; the development of this programme is at an early stage and aims to be conducted in collaboration with Conservation International. At Ankerana, the offset design is based on a phased and spatially concentric, landscape-level approach. Long-term community needs have been identified and participative zoning has been completed.

6. Stakeholder participation:

The Project is committed to stakeholder PARTICIPATION and has made significant progress with local communities and NGOs. Examples include interaction during the integration of the Ambatovy Project offset programme with national, regional and local plans and community involvement at the heart of the zoning project at the proposed Ankera offset site. In the latter example, a functional, participatory forest zoning process is being implemented by the community with assistance from the Forest Services and the help of local NGOs. This will result in areas identified for multiple-use at the periphery of the offset site being transferred to the community as stipulated by Malagasy law and promoted in the regional plan.

7. Equity:

While the Ambatovy Project is committed to BBOP Principles 6 and 7, insufficient data are currently available to apply the latter strictly. As data become available, the Project will develop its cost-benefit model and analysis using key elements of the BBOP BIODIVERSITY OFFSET COST-BENEFIT HANDBOOK[5] and in consultation with stakeholders. The Project is currently in the process of establishing a strategy to implement the socio-environmental action programme, including assessing natural resources usages by the local communities at the Ankerana and mine sites, further to which dollar value of the losses will be determined and compensation options identified and provided.

8. Long-term outcomes:

The Ambatovy offset programme for the mine region, comprising on-site azonal habitat conservation, community-based forest management, forest connectivity of mine area, Ramsar wetland management, forest

5 Available at **www.forest-trends.org/biodiversityoffsetprogram/guidelines/cbh.pdf**.

corridor rehabilitation and the proposed Ankerana offset, is being designed for long-term success following its implementation. Four activities will support the long-term outcomes:

- Strong community involvement throughout the planning, designing and implementation phases with the development of complementary sustainable activities in the surrounding agricultural matrix and in the multiple use area of the forests surrounding the critical habitats (core areas). Appropriate joint activities are being identified as the result of ongoing stakeholder interaction and data gathering.
- Development of financial strategies, mechanisms, and commitments as the operational phase of the Project begins (2011), based on the analysis of stakeholder needs and the Project's predicted economic operating environment. In light of the ongoing financial crisis and the resulting economic uncertainties, ADAPTIVE MANAGEMENT strategies will play a key role in securing long-term financing for the Ambatovy offset programme.
- Identification of long-term governmental legal and political commitment to protect the conservation sites in the mine region and the proposed offset site at Ankerana. A high level of commitment is expected as elements of the mine area and the proposed offset site have been designed to fall under the future Malagasy protected area system (SAPM), which itself is a part of the Presidential Durban commitment and which is expected to attract significant outside funding as a result of a global concern for biodiversity.
- Determining the institutional arrangements for managing the offset sites into the long-term. It has not yet been decided how the Ankerana site will be managed, with all options remaining open, i.e., managed by governmental institutions, by an NGO, by the community, by the company or a combination of any of the foregoing. The on-site conservation zones forests will be managed by the Project, the FOREST CONNECTIVITY programme will likely be community-based, while the Ramsar site has a defined management structure.

9. Transparency:

The Ambatovy Project's intention to offset its residual impacts on biodiversity is a commitment developed in the ESIA, which has undergone thorough public consultation, hearings and a public information process. Consequently, the Project's strategic environmental and social commitments are in the public domain and its offset activities have been, and are being, scrutinised by the Malagasy environmental authorities, regional and international NGOs, the local communities and the lender banks. Since becoming a BBOP Pilot Project, Ambatovy has committed to ensuring that design (and ultimately implementation) activities are completed in a transparent fashion. Transparency allows the Project to ensure stakeholders are well informed and able to offer insightful feedback that contributes to the optimisation of conservation outcomes.

10. Science and traditional knowledge:

In order to evaluate residual impacts on biodiversity and quantify the required offset, the Project has applied established and developing scientific methodologies. In parallel, traditional knowledge is being utilised (for example, species identification in time and space, identification of species' utilisation by humans (medicinal) and animals (fruit trees), and land use patterns (plant-substrate relationships)).

5. Current Status of the Project and Offset

5.1 Project chronology and status (as of December 2008)

- 1960: Genim, a French company, conducts exploration drilling and identifies the Ambatovy and Analamay nickel cobalt ore bodies; environmental considerations of the early feasibility study were very limited and did not consider vegetation anomalies nor the importance of nearby wetland (e.g. using Torotorofotsy for tailings disposal);
- 1970: Under the President of Madagascar, Didier Ratsiraka, a partnership with North Korea leads to the analysis of a bulk sample that confirmed the existence of nickel and cobalt but which led to no further development; environmental considerations were absent during exploration (e.g. no rehabilitation of test pit, which remains unvegetated today);
- 1994 – 1997: Phelps-Dodge conducts exploration drilling and develops a feasibility study and an ESIA (not submitted to ONE); vegetation anomaly recognised and quantified (vegetation map), biological inventories created; management principles for surrounding forests conceptualised; importance of azonal habitats recognised;
- 1998 – 2003: Restoration of exploration roads and platforms undertaken in light of Project development uncertainties;
- 2003 – 2006: Dynatec conducts exploration drilling and develops a feasibility study and an ESIA; Final Investment Decision taken by the investors (Dynatec and partners); on-site and offset conservation ideas captured in the ESIA; Ambatovy becomes BBOP pilot Project; ESIA was permitted by ONE on December 1st, 2006; and
- 2007 – 2008: Elaboration of the Ambatovy Project thematic Environmental and Social Plans (18 plans: air, noise, water etc and biodiversity); implementation of Biodiversity Action Plan (and others), development of priority TAXA-specific draft management plans (lemur, Mantella species, fish and flora). Confirmation of shareholders and loans and start of construction.

5.2 Offset chronology and status (as of December 2008)

- 2004 – 2005: Concept of biodiversity offset integrated with other Project activities, with a preliminary survey of proposed offset site undertaken and documented in the ESIA; proposed offset site selection based on geological, substrate, altitude and forest structure similarity (relative to principal IMPACT SITE);
- 2006: Ambatovy Project selected as a BBOP Pilot Project at Pretoria meeting;
- 2007: Participation in BBOP meetings (London and Bainbridge) and contribution to development of BBOP handbooks and guidelines; concepts for Ankerana site management programme developed and zoning initiated;

- 2008:
  - Preparation of interim report outlining technical aspects of the offset process (e.g. benchmark selection, confirmation of impacts, preliminary loss calculations and completed Key Biodiversity Components Matrix (KBCM);
  - Preparation of supplementary report with revised benchmark selection and loss calculations, including updated KBCM with quantitative species data;
  - Preparation of complementary field work (terrestrial fauna) in response to gap analysis; inclusion of other Project components (pipeline, tailings, plant and harbour) in overall assessment of residual impacts;
  - Implementation of Ankerana site management programme:
    - Stakeholder consultations (local communities, NGOs and government including Office National l'Environnement (ONE,) Forestry Department, Gendarmerie, District of Brickaville, local mayors and police forces);
    - Reforestation work on periphery area of proposed offset; this focused mainly on planting wood for construction uses to avoid primary forest logging in the offset area;
    - Population awareness campaigns around the proposed offset, conducted by field teams and partners. The objectives of the campaigns were to define the offset site boundary and explain existing laws that prohibit forest clearance;
    - Support provided to the mixed brigade (includes local communities, NGOs, local administrative staff and the police force) which manages forestry resource exploitation through out the local communes;
    - Financial and logistic support to update the five year Communal Development Plans for impacted communes; and
    - Technical committee meeting with SAPM focusing on integration of the proposed offset site with the national protected areas network.
- Conceptualised and pending (for 2009):
  - The offset design work, following guidance in the BBOP BIODIVERSITY OFFSET DESIGN HANDBOOK has to date quantified biodiversity losses as presented below. The next phase of work will be to calculate offset gains and continue with the design of the offset and offset activity plan;
  - The proposed Ankerana offset site has undergone only preliminary characterisation. Detailed baseline ecological characterisation is planned for 2009 focusing on ecosystems, habitats, fauna, flora and socioeconomic attributes. This information will underpin the calculation of offset gains;
  - Socio-environmental losses will be defined and subsequently an appropriate compensation calculation strategy and programme will be designed; and
  - Continued interaction with stakeholders to refine and enhance the offset activity plan.

In summary, the Project is committed to designing and financing a long-term offset programme that aims at achieving NO NET LOSS on biodiversity and preferably NET GAIN. Substantial progress has been made by calculating the residual impacts on biodiversity and identifying potential offset mechanisms. Ambatovy will continue to work closely with stakeholders on the offset design and plan the financial mechanisms to secure the offsets in the long-term, using adaptive management in response to the insecurities of the global financial crisis. The following pages of this case study detail the actions conducted and those that are planned for the future.

6. Business Case for a Biodiversity Offset

The vision of the Ambatovy Project is stated as follows: The Ambatovy partnership will develop and operate a sustainable nickel / cobalt mining and processing enterprise that significantly contributes to our host country, delivers outstanding safety, environmental and social records and generates attractive economic returns.

The environmental strategy designed to honour the Project's vision to deliver outstanding environmental records consists of:

- Ensuring full regulatory compliance and conformity with international loan agreements;
- Minimising residual impacts through the stringent application of the mitigation hierarchy;
- Reducing environmental risks through dynamic management guided by Malagasy know-how and stakeholder consultation; and
- Producing positive CONSERVATION OUTCOMES on biodiversity through the offset programme that aims at achieving no net loss on biodiversity, and possibly net gain, in order to sustain 'a good citizen project' status in a host country recognised as constituting a biodiversity hotspot.

The business benefit of its offset programme is essentially linked to risk management. As a world class mining project, Ambatovy and its shareholders believe in demonstrating good environmental management practices to secure its license to operate. To Ambatovy, a license to operate consists of the permanent support of civil society, local communities, national and international NGOs and governmental authorities in the manner social and environmental affaires are managed. Because Madagascar's biodiversity is universally considered of utmost importance by national and international STAKEHOLDERS producing positive conservation outcomes that offset the residual impacts on biodiversity is a critical component of this license to operate.

It is recognised by the Project's shareholders that the Ambatovy offset programme has provided additional confidence to the lender banks in securing access to capital. This has created reputational benefits to the shareholders that can result in easier access to land, human and financial resources for future projects in Madagascar and elsewhere in the world. It is expected that this approach will result in competitive advantage for the shareholders in relation to other governments.

Conversely, bad environmental practice is bound to produce higher operating costs, expensive permit delays, liabilities, and lost revenues. Consequently, engaging in good environmental practice will maximise the overall long-term economic return to shareholders, stakeholders and government.

It is worth mentioning that the Malagasy governmental policy, through the Madagascar Action Plan, refers to biodiversity offsets. The Ambatovy offset programme under the BBOP guidance is thus aligned with Madagascar's endeavour to protect its unique biodiversity heritage.

In summary, Ambatovy believes that its offset programme will bring about the following advantages:

- Continuing access to land and capital;
- Increasing investor confidence and loyalty;
- Reducing risks and liabilities;
- Strengthening relationships with local communities, government regulators, environmental groups and other stakeholders;
- Building trust on a credible reputation for environmental and biodiversity related management performance and winning a ‘social license to operate’;
- Increasing ‘regulatory goodwill’ which leads to faster permitting;
- Influencing emerging environmental regulation and policy;
- Developing more cost effective means of complying with increasingly stringent environmental regulations;
- Taking advantage of ‘first mover’ benefits in the marketplace Madagascar;
- Maximising strategic opportunities in the new markets and businesses emerging as biodiversity offsets become more widespread; and
- Improving staff loyalty.

7. The Offset Design Process

7.1 Guidance and methodologies used

The Ambatovy biodiversity offset programme has been developed as an iterative process calling upon BBOP principles and guidance. Additional inputs towards the development of the Project's offset programme came from a number of recent good practice guides, including *Good Practice Guidance for Mining and Biodiversity* (International Council on Mining and Metals 2006), *Planning for Integrated Mine Closure: Toolkit* (International Council on Mining and Metals 2008), *Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management* (International Finance Corporation 2006) and Biodiversity Offsets: Views, Experience, and the Business Case (ten Kate *et al*. 2004).

The BBOP guidance supports the development of either single or COMPOSITE OFFSET sites to compensate for residual impacts on biodiversity. The Ambatovy offsets programme is multifaceted because it is a large project with many components (see Section 3.2). While the design and implementation of the several components of the Ambatovy offset programme has progressed, the predicted conservation outcomes from these various offset components have not yet been fully calculated. Meanwhile, Ambatovy has focused on its proposed Ankerana offset as the most significant component of its offset. The proposed Ankerana offset design is based on the guidance in the draft BBOP Biodiversity Offset Design Handbook revised in December 2008 (available at **www.forest-trends.org/biodiversityoffsetprogram/guidelines/odh.pdf**). However, the high degree of social sensitivity around Ankerana has led the project to undertake community involvement before the planned biodiversity assessment at the site.

7.2 Roles and responsibility

The Ambatovy offset programme is designed, implemented and financially supported by the Ambatovy Project. The offset commitment was reiterated by Sherritt Incorporated, the Project's operator, in November 2008 during a clarification meeting with the BBOP Secretariat and representatives of Forest Trends, CI and WCS. The offset programme is managed and monitored by the Project's environmental department. Since Ambatovy became a BBOP Pilot Project, the BBOP Secretariat and members of the BBOP Advisory Committee have also monitored progress. Senior Project representatives attend all BBOP meetings and provide updates and feedback to the BBOP Secretariat. The Project's BBOP team includes:

- A focal point (Pierre O. Berner, Environmental Director, Ambatovy Project);
- A full time consultant responsible for supporting the offset programme management implementation (Steven Dickinson of Golder Associates / Ambatovy Project);
- An ecological assessment consultant responsible for the benchmark, loss and gain calculations (Aristide Andrianarimisa of WCS); and
- Environmental superintendent (monsieur Alphonse) leading a technical environmental and social field team responsible for social and environmental management at the proposed Ankerana offset site. This team led consultations with local stakeholders, including local communities, local forestry and police authorities and local NGOs. A legal team is supporting the superintendent to ensure the legal protection status of the Ankerana site.

7.3 The offset design process

7.3.1 Step 1: Review project scope and activities

The nature, scope and geographical location of the Ambatovy offset programme was outlined in the ESIA as a COMPENSATION measure that would go above and beyond the expected regulatory commitments. The basic Ambatovy offset concept was presented and discussed in the many stakeholder public information meetings associated with the ESIA review. As Ambatovy was accepted as a BBOP Pilot project in 2006, a more structured approach was developed, which led to the multifaceted programme outlined in Section 3.2.

7.3.2 Step 2: Review the legal framework and / or policy context for a biodiversity offset

The key elements of the legal framework and policy context for the Ambatovy Project's biodiversity offset programme comprise the MECIE decree, the Madagascar Action Plan (MAP) 2007 – 2012, the regional and communal development plans and the EQUATOR PRINCIPLES. Further information on these and other regulatory requirements is provided in Section 2.1.

7.3.3 Step 3: Initiate a stakeholder participation process

As noted previously, the Ambatovy Project obtained its permit from the Malagasy regulatory authorities in December 2006, based on a large ESIA that involved public information, consultation and enquiry throughout the development and review process. Subsequently stakeholder consultations have been central to discussions on integrating the offset programme with national, regional and local plans. At the Ankerana offset site, the community buy-in process is progressing well and precedes the hard-core biological assessment that can only be conducted after full community participation is demonstrated.

The offset stakeholder participation process can be summarised as:

- Confirming key stakeholders (the JV partners, government, financiers, NGOs and local communities, see Section 2.3);
- Engaging stakeholders in the offset design process by presenting and discussing the offset's objectives and the proposed implementation process;
- Engaging communities in the offset design process by assessing the impact the offset will bring about and agreeing on an acceptable MITIGATION strategy; and
- Integrating stakeholder feedback into the design process, especially with respect to land use in the multiple use areas (site zoning); this part of the process is in its initial stage and will continue throughout the offset zoning processes.

7.3.4 Step 4: Determine the need for an offset based on residual adverse effects

This section describes how the Ambatovy offset planning team:

1. Assessed the likely impacts on biodiversity caused by the Ambatovy Project;
2. Prepared a Key Biodiversity Components Matrix (KBCM);
3. Applied the mitigation hierarchy;
4. Determined residual impacts; and
5. Checked whether these residual impacts could be offset.

7.3.4.1 Assessing biodiversity impacts

Biodiversity impacts are presented in the Project's 2006 ESIA. The ESIA BASELINE and impact analysis (including CUMULATIVE IMPACTS) followed World Bank (IFC, International Finance Corporation) standards. A formal summary is available at:
http://www.sherritt.com/doc08/files/coal/abatovy/EAAmbatovy_EnglishSummary.pdf.

Details of the biodiversity impacts are available in Volume J of the full ESIA report (full document available in French or English, on CD, through the Ambatovy Project or the Malagasy Ministry for Environment).

The Project's main impacts will occur at the mine site, through the progressive clearing of the mine footprint (total footprint of 2,126 hectares, of which 1,336 ha will result from clearance and the balance resulting from indirect (edge effect) impacts around the cleared area) located within an ecologically sensitive natural forest mosaic of the eastern mid-altitudinal forest corridor. Stringent impact avoidance and minimisation strategies were applied in the design phase of the Project, so RESIDUAL IMPACTS on biodiversity from the other key Project components, most of which lie in heavily degraded areas, are of less significance (but will nonetheless be offset). These include pipelines, the processing plant and refinery, tailings management facility and pier extension (see Section 3 for a summary of associated impacts).

As the Project has evolved, specific aspects covered in the ESIA are currently being revisited to ensure that no residual impacts to biodiversity have been neglected. Any further residual impacts identified will be included in the biodiversity offset calculation.

7.3.4.2 Key Biodiversity Components Matrix (KBCM)

Key biodiversity components

KEY BIODIVERSITY COMPONENTS were identified for the impact area, including mainly species and habitats, but also landscapes / ecosystems. The completed key biodiversity components matrix (KBCM) conveys the essence of the character of the site by identifying a range of its highest biodiversity values. The KBCM can help ensure that the offset generates additional conservation outcomes for these key biodiversity values, and the matrix can also contribute to the design of the BENCHMARK that will help with the calculations of residual BIODIVERSITY LOSS caused by the Project (see Appendix 1) and the gain that will be achieved through the offset. Both intrinsic and NON-USE VALUES of key species and habitats / ecosystems were assessed according to their significance level and IRREPLACEABILITY. The KBCM based on the current data is in Appendix 1. The Project will conduct additional surveys and improve analysis of existing data during 2009.

The key biodiversity components listed here will subsequently be considered during the offset site selection[6] and characterisation stage.

7.3.4.3 Applying the mitigation hierarchy

Prior to consideration of biodiversity offsets, the Ambatovy Project implemented appropriate avoidance, minimisation and restoration measures through its Biodiversity Management Plan (BMP) to avoid species EXTINCTION and EXTIRPATION (all IUCN EN and CR species), avoid sensitive areas where possible and minimise impacts on flora, fauna and aquatic resources.

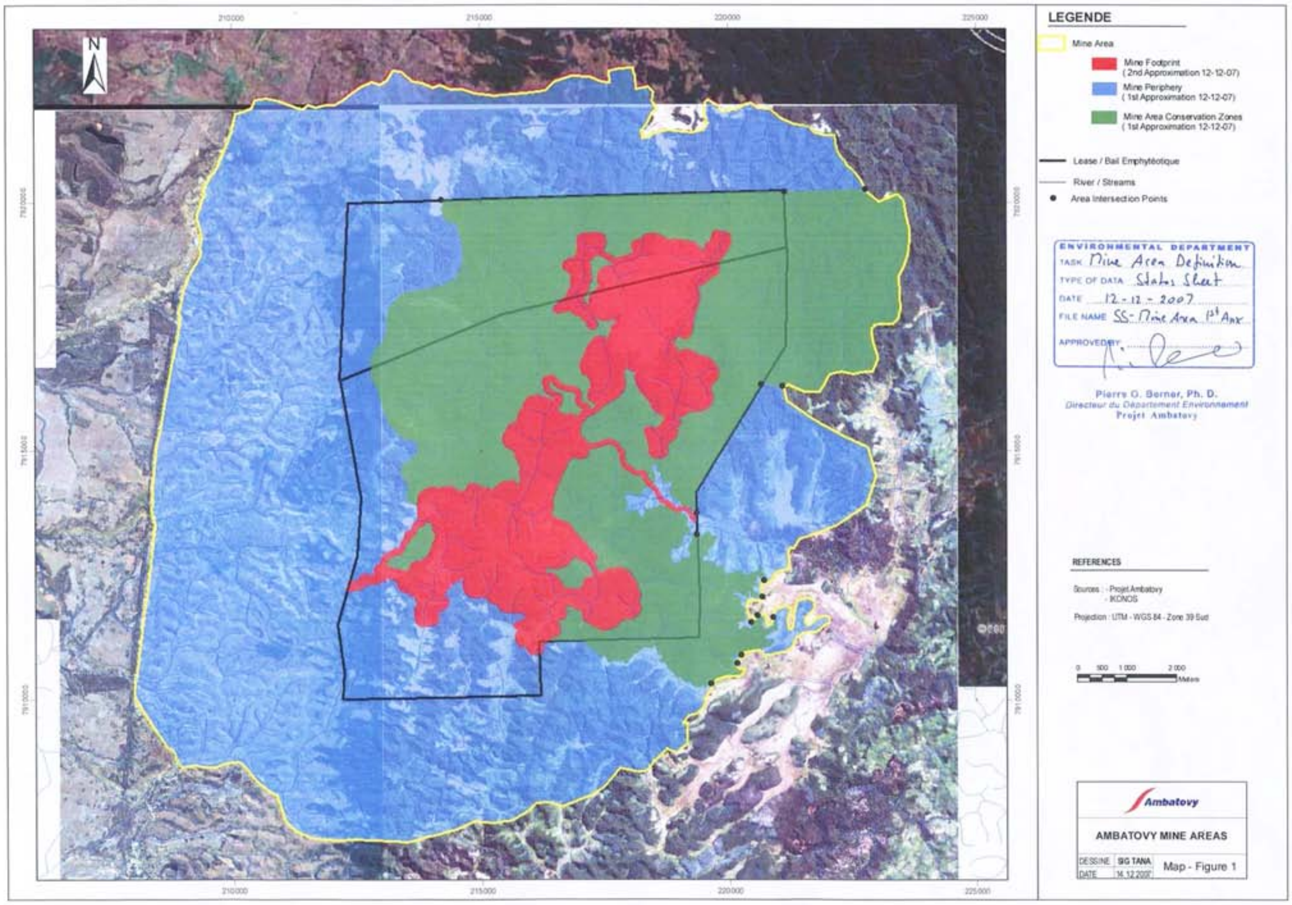
6 A rapid assessment of the Ankerana site provided preliminary species-level data. The potential offset site is located within the same biogeographical setting as the impact area, so it is anticipated that more detailed assessments will also reveal the presence of the key biodiversity components at Ankerana.

Specific avoidance strategies include the use of conservation barriers to physically isolate the on-site azonal conservation areas from construction activities in surrounding areas and ensure that modification of the mine footprint follows a strict environmental protocol (see Appendix 4: Protocol for Mine Area Modification).

A very substantial minimisation programme was implemented through the BMP. Significant activities include:

- Directional and paced forest clearance to optimise the natural migration of terrestrial fauna. Clearance procedures are provided to the forest clearing team manager as part of Forest Clearing Biodiversity Action List procedure; the proper implementation of the actions is monitored on a daily basis by the mine environmental team and any deviation reported for immediate corrective action.
- Repetition of full biological surveys in the clearing perimeter and surrounding areas prior to any forest clearance in order to inventory fauna taxa present, particularly priority species (IUCN Endangered [EN] and Critically Endangered [CR] categories) but also including lemurs, other mammals, birds, reptiles and amphibians. The surveys facilitate the development of taxa-specific mitigation measures. For example, a representative sample of individuals from all lemur species are captured and fitted with radio collars and subcutaneous microchips in order to monitor their ability to migrate from an area as it is cleared and the receiving populations' behaviour on arrival of displaced groups in their territory. For plants, a list of species of concern (SOC) was drawn up during ESIA baseline studies in collaboration with the Project's botanical expert partner. Pre-clearance work involves identifying whether SOC are present in the clearing perimeters and searching for these SOC outside the mine footprint (in protected areas) to avoid potential species extinction. For fish in streams, a spatial and genetic survey (endemicity assessment) was conducted to determine whether the species present were ENDEMIC to the mine footprint. Until genetic results became available, fish from impacted streams were recovered and temporarily maintained in aquaculture systems; subsequent management actions are currently being undertaken.
- Monitoring of fauna during and after clearance. For example, lemur spatial dispersion is monitored during forest clearance to assess their capacity to (i) migrate (avoid immediate impacts); (ii) settle in their new home range (a medium-term impact) and (iii) reproduce and maintain population viability (a long-term impact). Biomedical health is assessed in parallel to behavioural assessments with the aim of improving analysis of trends in the Project's long-term lemur population viability assessment programme.
- Salvaging activities focused on fauna likely to require human aid to migrate towards refuge areas (the conservation zones shown in green on Figure 3). A crew of 80 technical agents was trained by experts to identify and salvage all small mammals, stranded lemurs, nocturnal birds and herpetofauna. Systematic salvage of these taxa was undertaken for all mine, pipeline and plant site clearings, under the supervision of external experts (e.g. biologists from the University of Antananarivo) and the Ambatovy biodiversity team. Taxa were logged and relocated / monitored in refuge areas. Limited salvaging of flora was also conducted. Some SOCs required ex situ conservation, with individuals translocated to a dedicated on-site area while searches for the SOC in areas outside the footprint were completed; cells from these SOC were collected for micro-propagation and cryoconservation as a back-up. To date all SOC surveys have lead to the identification of off-site VIABLE POPULATIONS, and the Project and its botanical partners remain confident that this will be the case for all remaining SOCs. In the event that SOC are not found, then the aforementioned mitigation will be applied.

Figure 3: Mine area, showing conservation zones (green) that constitute on-site offset area (including azonal, transitional and zonal forests)



The mine restoration programme includes progressive footprint rehabilitation through erosion control, reforestation with targeted species and facilitated secondary successions. The aim is to produce a multifunctional replacement forest with biodiversity values that can be included in the offset calculation (by reducing the residual impact on biodiversity that will require offsetting). The pipeline restoration programme will focus on targeted reforestation of the right of way.

7.3.4.4 Determining residual impacts

The Project's most significant residual impacts will occur at the mine site. Residual impacts caused by the other key Project components are limited as these components are located in areas that are already heavily and historically degraded. Nonetheless, these less significant residual impacts will also be included in the offset calculations.

The Project's residual impacts are summarised below.

Direct negative impacts

- The total loss of habitats as progressive clearance of the mine footprint (1,336 hectares, excluding the environmental buffer) proceeds in an ecologically sensitive natural forest mosaic. Following clearance some areas will be built on and / or eventually mined. In the areas lost to DIRECT IMPACT the HABITAT TYPES were identified (azonal, transitional and zonal forests, ephemeral ponds and streams) and the quality of each determined (good or degraded). Flora, fauna and aquatic taxa assemblages were associated where feasible with these habitat types and quality. Finally, habitat surface areas were calculated using ESIA habitat maps and GIS. Taxa assemblages and forest structural characteristics were determined for each habitat where possible. Available fauna data were generally qualitative, although pre-clearance survey data from both the mine footprint and surrounding conservation areas were used, providing updated lemur densities and abundance.

- Clearance of 16.5 ha of fragmented and degraded primary forest during installation of the 218 km buried slurry pipeline (a total clearance permit for approximately 70.5 hectares was granted as 98% of the pipeline route passes through secondary, non-sensitive vegetation (e.g. non-native eucalyptus) resulting from historic slash and burn). Two sections of the pipeline do, however, cross sensitive habitats: the first 2 km passes through zonal, near-primary forest and the pipeline also crosses the Ankeniheny-Zahamena Corridor (CAZ). Losses associated with the pipeline's first 2 km have been included in the mine losses using the same approach for determining residual impacts as applied to the mine footprint.

Indirect negative impacts

INDIRECT IMPACTS through edge effects (dust, noise, plant desiccation, invasion of natural heliophytes), will potentially affect 790 ha of forest surrounding the mine footprint. This area was defined on the basis of a 100 m zone surrounding polygon features (e.g. mine pits and ancillary facilities) and a 50 m zone around linear features such as roads (except the main access road) and pipelines (see Appendix 4: Mine Footprint Definition, 2nd Approximation, December 12, 2007). The degree to which these areas will be affected remains unclear; as a precautionary approach the full 790 ha has been included in the total loss calculations. This may be modified as information on the degree of impact becomes available through monitoring.

Low or negligible negative impacts for biodiversity

The processing plant is being constructed on a 150 ha (1.5 km^2) area of the Toamasina industrial zone. The 1,400 ha (14 km^2) tailings management facility will be located in a highly degraded fire-driven agricultural matrix. An existing pier at the harbour will be extended by over 300 m. The residual biodiversity impacts associated with the processing plant, tailings facility and pier extension are expected to be negligible. The habitat classes for the plant site and tailings facility location would be defined as highly impacted and degraded and have been omitted from the loss calculations for the time being. However, the Project will consider how to trade-up these areas by conserving higher priority biodiversity elsewhere; one suggestion is to simply add the surface areas lost (i.e., 15.5 km^2) and apply a MULTIPLIER to determine the area of higher BIODIVERSITY CONSERVATION priority land as part of the offset. The Project will seek assistance from the BBOP Advisory Committee before making a decision.

Socioeconomic impacts

The Project will conduct loss calculations for the socio-environmental aspects in 2009. The aim of the offset programme is to compensate for all AMENITY and LIVELIHOOD related losses experienced by local communities as a result of the biodiversity offset. Potential compensation measures include the introduction of improved agricultural techniques to increase crop yield and the provision of jobs related to environmental protection.

At present, a number of positive socioeconomic impacts are also apparent:

- Over 80 members of the local community at the mine are permanently employed in biodiversity management-related jobs (in total, over 8,000 jobs for Malagasies will be generated by the Project); the biodiversity jobs include ongoing training.

- 14 community members have been hired as park rangers at the mine site to protect the mine forests.
- A public awareness programme is underway to raise community understanding of their natural heritage and their role in its protection.
- Reinforcement of the local forestry service's capacity to protect forests (and their fauna and flora) around the mine footprint; the work at the Torotorofotsy wetland will also improve the forest service's capacity there.
- Over 50 local expert biologists have been hired (on a project-by-project basis) to bring their knowledge to the Project's activities and to promote the development and use of Malagasy skills).

7.3.4.5 Offsetable nature of residual impacts

The Project is ensuring that its residual impacts are OFFSETABLE by focusing on the avoidance of species, habitat and ecosystem loss and checking that the particular biodiversity components affected can be found in the surrounding area and beyond, so that their populations will not be unduly affected by the Project and will benefit viably from the offset activities. The Project has ensured that species of concern (SOC) were present outside of the mine footprint and is using taxa-specific management programs to define the relevant conservation management activities:

- The Flora Management Programme aims to ensure that SOC – flora species that were only identified on the mine footprint during the ESIA baseline – are not lost. These species remain listed as SOC until viable populations are located outside the mine's footprint in protected areas. Surveys and viability assessments are being conducted by experts in flora taxonomy and ecology from Missouri Botanical Garden – Madagascar.
- The Lemur Management Programme aims to confirm that the mine's construction and operation activities are not leading to a long-term reduction in the viability of priority species' populations present in the mine area. The programme focuses on IUCN EN and CR species, but includes all 16 species as a BEST PRACTICE measure due to the unique nature of lemurs. The programme includes two principal phases, a short-term three year assessment (covering the 2007 – 2010 construction phase) to begin identifying any trends in lemur groups and populations in the footprint and receiving areas located in the conservation forests. The second phase (from 2010 to end of the mine's life), aims to identify any long-term viability trends and to develop appropriate mitigation measures, such as off-site relocation programs, recruitment boosting (e.g. captive breeding and release), reduction of slash and burn activities and strict control of hunting (bushmeat).
- The Mantella Management Programme aims to ensure that there are no measurable adverse impacts on the ability of the mine area forests to support the established *Mantella aurantiaca* (IUCN CR) and *Mantella crocea* populations (IUCN EN). Any reduction in their population sizes is also to be avoided. The programme was implemented in November 2007, although the species are located in areas that will not be mined for 10 years or more. The Project is defining populations present on the footprint and in the conservation zones and comparing them to regional population sizes. Various mitigation measures are possible including footprint reduction or shifting (i.e., modifying the footprint to avoid breeding areas), relocation (based on successful trials) and increasing population recruitment.
- The Fish Management Programme aims to avoid the extinction of fish species and to maintain population viability at pre-Project levels. Endemicity assessments have been conducted as the species present were only previously described to the genus level. Mitigation measures will be applied accordingly and may include, for example, the creation of conservation streams and relocation.

7.3.5 Step 5: Choose methods to calculate loss / gain and quantify residual losses

The Project is using methodologies described in the BBOP Biodiversity Offset Design Handbook to assess the Project's impact on biodiversity, to identify appropriate activities and sites for the biodiversity offset, and to determine the scale of the offset needed to achieve the CONSERVATION GAINS that will achieve NO NET LOSS. The methodologies combine consideration of biodiversity of equivalent or higher value and site selection to ensure that all key biodiversity components are represented at the offset and have two key features: 'benchmarks' and 'HABITAT HECTARES':

- BBOP defines a 'benchmark' as reference point against which the losses of biodiversity due to the Project and gains through the proposed offset can be quantified and compared consistently and transparently. A benchmark usually comprises a number of representative and characteristic 'ATTRIBUTES' used to represent the type, amount and quality of biodiversity which will be lost / gained. Comparison of the observed level (or 'score') of each BENCHMARK ATTRIBUTE at the impact site (before and as predicted after the impact) against the level at the benchmark can help to quantify the loss of biodiversity to be caused by the Project. Similarly, comparing the observed level (or 'score') of each benchmark attribute at the offset site (before the offset and as predicted after the offset intervention) against the level at the benchmark can help to quantify the gain in biodiversity caused by the offset. A benchmark can be based on an area of land that provides a representative example, in a good condition, of the type of biodiversity that will be affected by the proposed development project.
- 'Habitat hectares' are units of measurement that take into account the area affected and the quality or CONDITION of the biodiversity impacted (determined by the quantities of a number of chosen attributes related to the structure, composition and function of that habitat). The habitat hectares METRIC was originally developed in Victoria, Australia to focus on HABITAT STRUCTURE, particularly native vegetation, and thus to provide proxies for composition and function. It has since been adapted by BBOP to cover both flora and fauna, and to include some aspects of composition and function as benchmark attributes. The habitat hectares approach is described in more detail in Section 7.3.5.1 below.

The Project's proposed benchmark meets specific predetermined criteria with respect to surface area, habitat quality and connectivity (see below). It is ideally located as it is in the mine area conservation zones, thus ensuring its long term protection. The long-term presence of the benchmark is important as it will enable background environmental degradation arising from external factors (such as climate change) to be quantified and subsequently addressed at the offset site.

Lists of key biodiversity components were identified in the impact area; these include species and habitat types (structural). Complementary faunal data will be collected by the Project in 2009 to integrate more species attributes into the habitat hectares loss calculation, as current calculations are limited to quantitative information for only three priority lemur species.

The Project has calculated its habitat hectares loss values for forest habitats. Scores for streams and ephemeral pools were calculated in April 2008, but have been temporarily excluded subject to re-assessment during the next iteration of the loss calculations.

Two habitat hectares calculation scenarios were assessed in April 2008: without and with post-impact MITIGATION. It is important to note that both potentially relate to real situations since restoration performance is not well documented for Madagascar or the Ambatovy region. 'Post-impact mitigation' significantly decreases the habitat hectares loss value and will ultimately be included in the final (definitive) offset calculations. However, care is necessary to avoid overestimating the potential for rehabilitation success as this can result in the underestimation of the number of habitat hectares that the offset must deliver. Only the 'without post-impact mitigation' scenario is reported here as further analysis (modelling) is required to accurately calculate losses based on the 'with post-impact mitigation' scenario.

7.3.5.1 The habitat hectares approach

This section:

- Introduces the 'HABITAT HECTARES' approach;
- Describes how the 'benchmark' was defined for forest habitats; and
- Explains how the Project's residual impacts on biodiversity have been calculated using the benchmark.

The habitat hectares approach

Biodiversity loss was calculated using the habitat hectares approach, summarised as:

1. Completion of the Key Biodiversity Component Matrix (KBCM), which corresponds to conducting a biodiversity assessment of species, habitats and ecosystems components and determining intrinsic (significance and irreplaceability) and use (socioeconomic and cultural) values;
2. Completion of a table to review the application of the MITIGATION HIERARCHY to the key biodiversity components;
3. Selecting attributes for the key biodiversity components using available or complementary data and assigning 'weights' to each. For example:
    - Forest structural attributes can be selected and compared (weighed) against each other, e.g. tree species richness is considered to be the most important attribute at Ambatovy and therefore has a higher WEIGHTING than attributes related to forest physical structure.
    - Taxa attributes such as quantitative fauna data (e.g. density) from priority species can also be integrated and therefore allow key fauna data into the weighing of attributes; this reflects more accurately the importance of species biodiversity in the habitat hectares scores.
4. Defining and selecting a BENCHMARK for selected habitats;
5. Calculating biodiversity loss at the IMPACT SITES by comparison to the benchmark, for each habitat CONDITION classes in light of impact levels;
6. Completion of a table to record and compare whether POTENTIAL OFFSET SITES could deliver conservation gains for key biodiversity components; and
7. Calculating the habitat hectares gained at the offset site.

Using the previously cited information, habitat hectare scores were determined for all habitats (e.g., forests, streams and ephemeral ponds). Calculation of the forest habitat hectare loss at Ambatovy requires the following condition information:

- Habitat types, namely azonal, transitional and zonal forests and respective surface areas (see Figure 4 showing the mine area habitat map);
- Habitat condition class and respective surface areas (see Figure 4), namely:
    – Quasi pristine primary forest (see definition in benchmark section hereafter, *Forest habitats*, 3rd and 4th bullets);
    – Disturbed / degraded primary forest; and
    – Heavily fragmented and degraded primary forest.
- Impact types, namely high (cleared footprint) and medium (environmental buffer) and respective surface areas (see Figure 5).

Figure 4: Mine area habitat map

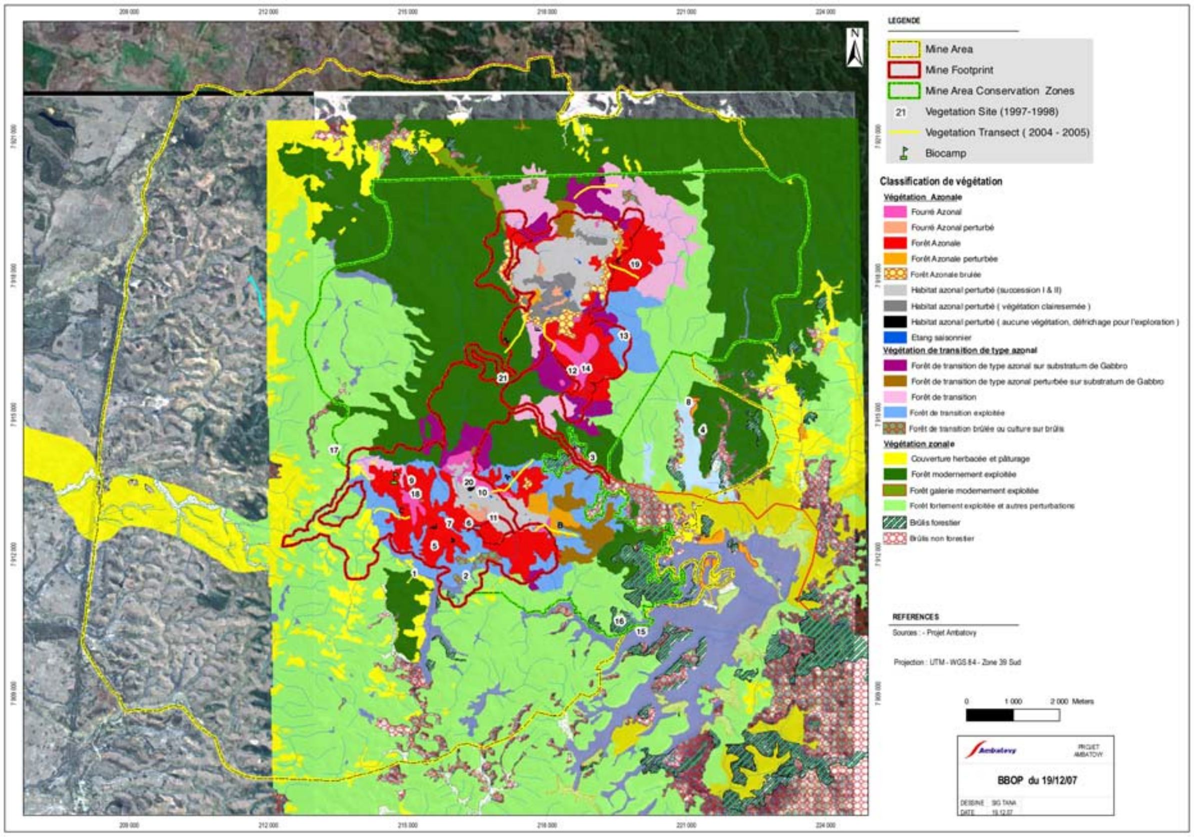
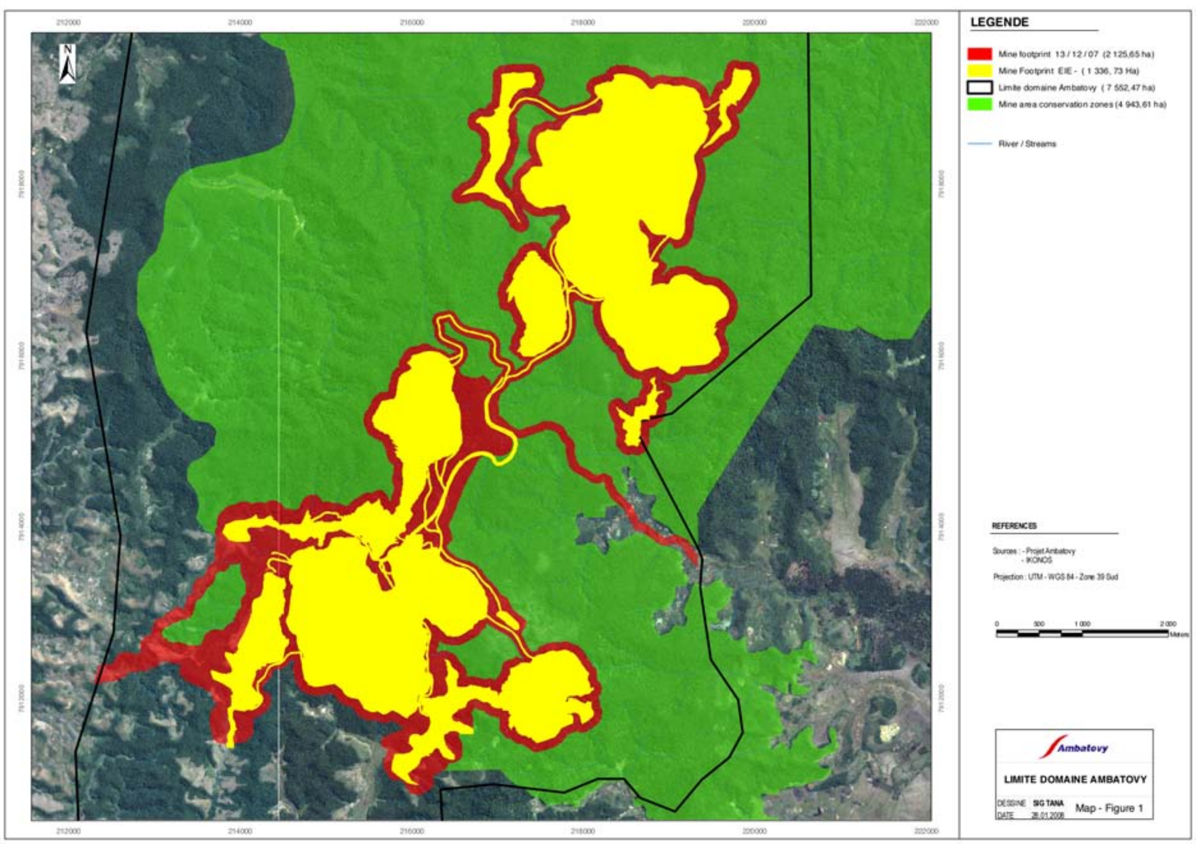


Figure 5: Mine footprint and environmental buffer map



The Ambatovy forest habitat loss scores were determined by merging data from the three existing habitat types, since the selected forest attributes did not exhibit a statistical difference and faunal movement from intensive fauna surveys in the pre-clearing perimeters showed the same occupancy pattern for the three habitat types. Knowledge of the condition class is particularly important, since it reflects the biodiversity loss at stake, thus highlighting the application of multipliers in degraded habitats that are subsequently subject to negative impacts. The importance of multipliers was highlighted, for example, when considering degraded azonal forests which constitute 44.6% of the azonal habitat loss, but equivalent to only 29.3 habitat hectares of the total 620 habitat hectares score for the azonal habitat. High impact areas corresponded to 100% forest clearance with earthworks, medium impacts corresponded to the potential edge effects on the forest environmental buffer (50 m for linear features and 100 m for polygons), while low impacts did not apply to the impact areas. The habitat hectares score provided above is for the 'without post-impact' mitigation scenario.

The habitat hectare gain for the proposed offset site has not yet been calculated, as detailed forest structure and quantitative species attribute data are still being acquired, with field surveys for flora / forest structure and aquatics planned in July 2009 and terrestrial fauna in November 2009. As the proposed Ankerana site is considered to be an 'IN-KIND' offset (relative to the impact site), the same benchmark will be used to calculate gains.

Benchmark

Based on the BBOP definition of a benchmark, the following criteria were used to define and identify a candidate site:

- Forest habitats:
  - Minimal critical size: in the Ambatovy forests, a benchmark is required that captures the progressive structural changes between the existing three vegetation types, and the faunal movement between them throughout the seasons. A contiguous area of quasi pristine 'azonal', 'transitional' and 'zonal' forests, each of which must be a minimum of 40 ha is proposed. This area of 120 ha includes the core area of original habitat with a 100 m wide buffer around it and appears to be the minimum required as a home range for lemurs and to represent an adequate assemblage of vegetation.
  - CONNECTIVITY: the contiguous forest area (minimum size – 120 ha) must be connected to other forest habitats.
  - Human disturbance: there must be no sign that the site has ever been cleared by humans (in both core and buffer areas). However other evidence including tree stumps, historical records, soil charcoal, archaeological remains and signs of selective logging (defined as less than 12.5% of crown cover loss) over the last 20 years do not exclude a site from consideration as a benchmark (such evidence is widespread and unavoidable in the region). Any small degraded areas within the larger benchmark area are mapped and excluded from the benchmark calculations (and surface area).
  - Natural disturbances: a site that has experienced a natural fire in the last 20 years, at a level of 10% of its surface area (in both its core and buffer area) is excluded. Also, no evidence of cyclonic events is acceptable (above 10% loss of canopy crown cover in the last 20 years).
- Streams and ephemeral pools:
  - The benchmark must be the mostly pristine habitat.
  - The stream locations where benchmark data were acquired must be surrounded by quasi-pristine and natural habitat, unaffected by any major human-induced disturbance and under pristine forest cover.

    - Since many natural ephemeral pools occur in hollow rocky ground, benchmark data must be taken where the rock outcrops are of natural origin and not the result of forest clearance or other human disturbance.
- Assumptions:
  - Within the azonal and transitional habitats, the highest ENDEMISM is associated with the lowest human impact.
  - No sylviculture or tree enrichment has been carried out in Ambatovy.

The benchmark site is presented in Figure 6.

Quantifying biodiversity residual impacts calculations using the benchmark

Benchmark

A scoping exercise was undertaken to determine from the KBCM and other studies which biodiversity components would be most appropriate as attributes of the benchmark. The data quality associated with each of these components available in the ESIA was checked. The selected attribute types are:

- Species:
  - 3 lemurs: *Propithecus d. diadema, Indri indri, Allocebus trichotis (*the attributes of species such as *Prolemur simus* and *Daubentonia madagascariensis* will be re-examined in the next iteration of the offset calculations); and
  - 2 fish: *Ratsirakia sp and Rheocles sp* (suspended for the moment and to be re-examined in the next iteration).
- Communities / habitats:
  - Forest (three habitats, azonal, transitional and zonal);
  - Streams (suspended for the moment and to be re-examined in the next iteration); and
  - Ephemeral pools (suspended for the moment and to be re-examined in the next iteration).

Impact assessment and mitigation hierarchy application:

An impact assessment of the biodiversity components was subsequently conducted based on the anticipated impacts, of which the principal impact is forest clearance and subsequent habitat loss. The corresponding mitigation strategies for each biodiversity component are presented below:

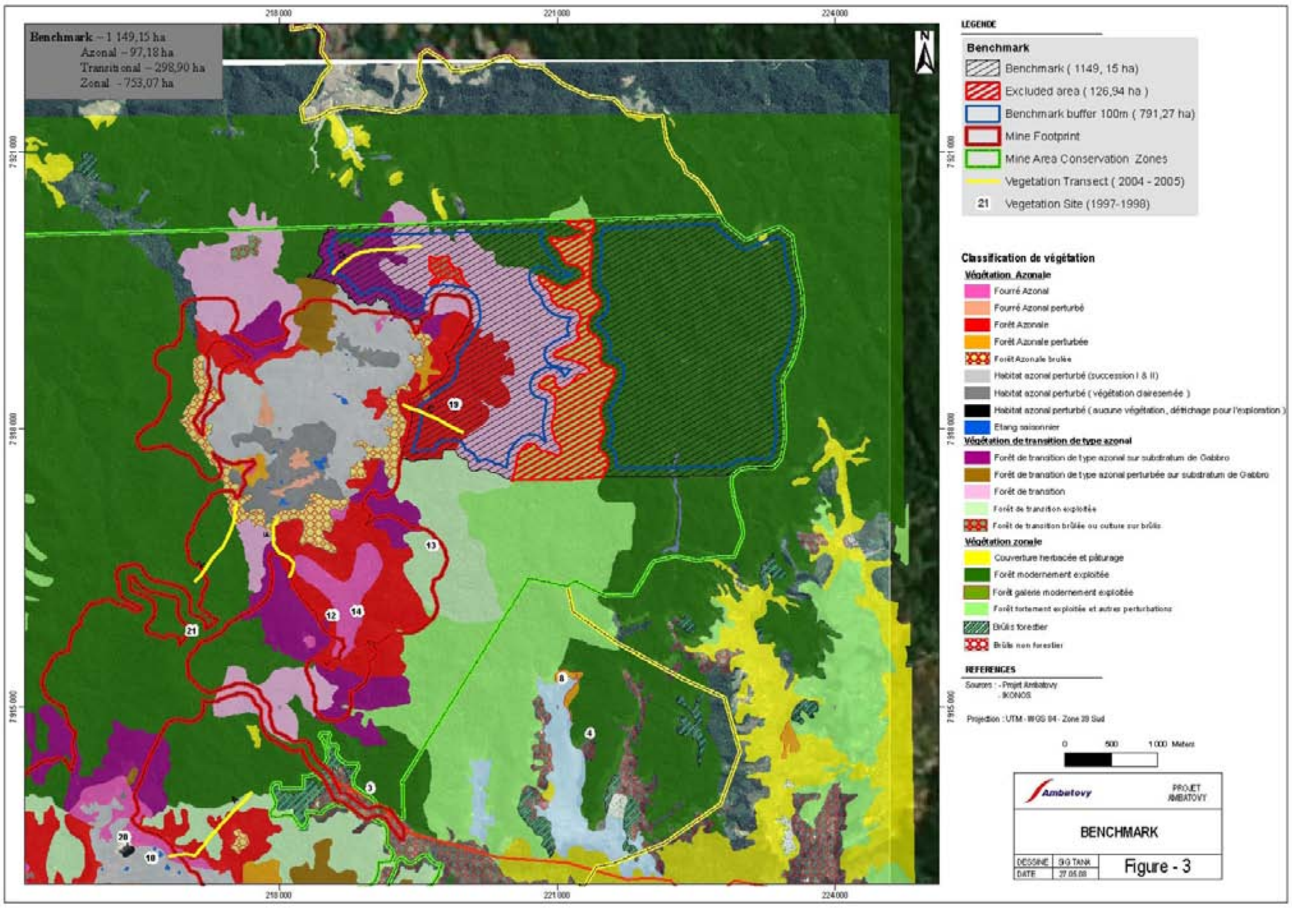
- Species: lemurs are displaced from their habitats by forest clearance. The Project's mitigation measure is to monitor (through radio collars and telemetry) their ability to migrate from the clearance area towards the refuge areas (see Figure 3, conservation zones). The mitigation measures include assisting stranded individuals from all 16 known species identified on-site and limited off-site relocation to protected areas (e.g. Propithecus diadema) following IUCN translocation guidelines.
- Habitats: the main mitigation strategy for the three forest habitats is offsetting due to their fixed location. AVOIDANCE will also be applied to the azonal habitat since 26.4% of this habitat will be protected in the form of the mine area conservation zones (see Figure 4).

The December 2008 iteration of the impact assessment and mitigation strategies is presented in Appendix 1.

Benchmark and attributes

A benchmark site was selected (see Figure 6) in line with the BBOP definition and Project-specific criteria noted above. The benchmark includes a forest tract of 1,149.15 ha, composed of quasi pristine azonal, transitional and zonal forests, at least two streams and several ephemeral ponds.

Figure 6: BBOP benchmark site map



A limited number of ATTRIBUTES were selected as SURROGATES for both forest habitat structure and function based on the following characteristics:

- Sensitive INDICATORS to habitat quality;
- Simple and practical to measure and quantify;
- Reliable and repeatable in assessments; and
- Reflect outstanding biodiversity values (e.g. species of conservation concern, or CULTURAL VALUE).

Due to data limitations (e.g., difficulties faced in obtaining quantitative data for fauna at the impact site), the present loss calculations are limited to forest structural attributes (streams, number of tree species, canopy height, basal area and Diameter to Breast Height, Dbh) and the attributes of selected fauna species (lemur density). Future iterations will include additional attributes as appropriate data become available.

The December 2008 iteration results are presented in Table 3, with WEIGHTING assigned to forest habitat and species attributes according to their relative importance for biological diversity.

Table 3: Summary of attribute weighting (December 2008)

Attributes	Unit	Weighting (%)	Justification
Stems [(a)]	number / ha	15	Reflects forest density, an important ecological attribute for fauna, especially lemurs.
Number of tree species (per ha)	number / ha	20	Provides overall floral diversity and habitat heterogeneity. Higher numbers are better.
Canopy height	m	5	Indicator of forest maturity and canopy continuity. For azonal habitat lower canopy height is better.
Basal area [(b)]	m^2 / ha	5	Indicator of habitat CONDITION. Higher value is better as it is an indication of mature forest.
Dbh	m	5	Indicator of habitat condition. Higher value is better as it is an indication of mature forest.
Propithecus diadema density [(c)]	individual number / ha	20	IUCN CR [(d)] status, species very sensitive to human activities in their habitat.
Allocebus density	Individual number / ha	10	Nocturnal species sparsely distributed and appears to be sensitive to forest structure.
Indri indri density	Individual number / ha	20	Madagascar's largest lemur species sparsely confined to eastern rain forest, IUCN EN status, and also has a cultural value (the most taboo lemur species).
Total		**100**	

(a) Number of trees with diameter ≥10 cm, with measurements taken at 1.3 m above the ground.

(b) Basal area is calculated as π x (diameter at breast height / 2)^2.

(c) Lemur species density is estimated based on line transect samples within a surface area, S = 2 x (Width x Length) in which density D = individual number / S.

(d) Was recently lowered to EN.

The selection and weighting of the attributes is examined below.

- Selected attributes are divided in two groups:
  - Forest structure, as a general surrogate for forest dependent biodiversity; and
  - Lemur species, as an 'umbrella species' fauna group considered to be the most sensitive to human disturbance in Ambatovy (bush meat, slash and burn, logging); the species selected include both diurnal and nocturnal species.
- Weighting: 60% and 40% importance were chosen for forest structure and faunal assemblage species, respectively. Attributes that express biological diversity (e.g., tree SPECIES DIVERSITY and stem number) are weighted with higher importance, as are species with CR rather than EN status. Since the mine is located in a BIODIVERSITY HOTSPOT area, IUCN species of concern have been chosen as the main attributes to reflect the principles of 'IRREPLACEABILITY' and no loss of NON-OFFSETABLE components.
- TAXA selection: lemurs were selected over other fauna groups, due to their wide presence in forest habitats. Fish, amphibians and reptiles are restricted to specific habitats at Ambatovy, for example microhabitats for herpetofauna. Therefore any impact occurring away from these specific microhabitats (which are yet to be defined) might not reflect the Project's impact on these taxa. The possibility of considering some of the herpetofauna and pond invertebrate species will be explored after new data has

been collected in 2009. The inclusion of fish components for stream habitats will also require further analysis and consideration.

- VULNERABILITY: although this attribute was integrated in the April 2008 calculations (see Appendix 5), it is excluded from the present iteration of the loss calculations. The taxa groups should be considered together, not only at the species level, so that the same weight can be given to all taxa (lemurs, birds, herpetofauna, etc). This would allow the Project to consider not only specific species, but also the taxonomic groups that are important for monitoring purposes. In fact species EXTIRPATION can sometimes be linked to group effects or intra-species interactions; therefore, it is best to consider taxa group vulnerability rather than that of specific species. It is thus assumed that vulnerability considered as an attribute makes more ecological sense than that considering specific species alone. However, the use of vulnerability attributes requires further detailed analysis, to be conducted in 2009.

Calculating biodiversity loss at the impact site

The attributes presented above are for the mine and pipeline components.

As described in the previous sections, the pipeline's impact on forest habitat is very limited since routing avoided relic forest fragments present in the first 32 km (after which the area crossed is entirely exotic secondary vegetation resulting from slash and burn activities). Only the first 2 km of the pipeline cross quasi primary forest, and these losses were included in the mine loss calculations. The pipeline's losses thus correspond to the forest fragments (16.5 ha) that could not be avoided: the habitat hectares could be calculated for this as the area impacted could be compared to the zonal forest BENCHMARK ATTRIBUTES. The pipeline's forest fragments are classed as Ecological Vegetation Class (EVC) 3: 'heavily fragmented and degraded primary forest'. Instead of using the 'basal area' attribute, 'volume' was considered since these forests are heavily exploited by the local communities for fire wood. Volume can also be used in the future socioeconomic compensation analyses. The pipeline's aquatic components include the crossing of more than 400 streams with variable levels of ecological integrity and sensitivity. However, pipeline-related impacts to the aquatic environment are considered temporary, which cannot be captured by the habitat hectare methodology. The Project will therefore use methodological options for integrating temporary impacts in the next iteration of the loss calculations.

The locations of the processing plant and tailing management facility have an EVC of 4 (essentially heavily degraded, with no remaining integrity, based on ESIA data). The habitat hectares calculation for this fourth category has not yet been undertaken for these areas. However the Project is committed to 'TRADING UP' these areas and will work with BBOP to define an appropriate methodology for doing so. The harbour has been used as an industrial port for some time and little biodiversity of any significant conservation value is found there now.

The mine area includes two Ecosystem Vegetation Classes (EVC): 'quasi pristine primary forest' and 'disturbed primary forest'. The pipeline has only one EVC: 'heavily fragmented and degraded primary forest'.

For each EVC the Project will have either a:

- 'High impact' corresponding to total forest clearance with or without grubbing (removal of stumps, roots, and vegetable matter). A total area of 1,336 ha will fall in this impact category.
- 'Medium impact' corresponding to the environmental buffer around the mine footprint (100 m) and linear features (pipeline / roads, with a 50 m buffer), which will be indirectly affected by forest clearance (impacts are mainly through edge effects such as light, dust and unauthorised disturbances.

Results of the HABITAT HECTARES scores for each HABITAT TYPE at the mine and along the pipeline are presented in Tables 4 to 7.

Table 4: Azonal habitat (December 2008)

AZONAL FOREST	… of Condition Class 1: Quasi pristine primary forest	…of Condition Class 2: Disturbed primary forest	TOTAL HABITAT HECTARE LOSS
Total areas	**590.74**	**475.55**	**620**
High impact	528.86	427.22	
Medium impact	61.88	48.33	

Table 5: Transitional habitat (December 2008)

TRANSITIONAL FOREST	… of Condition Class 1: Quasi pristine primary forest	…of Condition Class 2: Disturbed primary forest	TOTAL HABITAT HECTARE LOSS
Total areas	**126.37**	**328.22**	**239**
High impact	53.38	222.68	
Medium impact	72.99	105.54	

Table 6: Zonal habitat (December 2008)

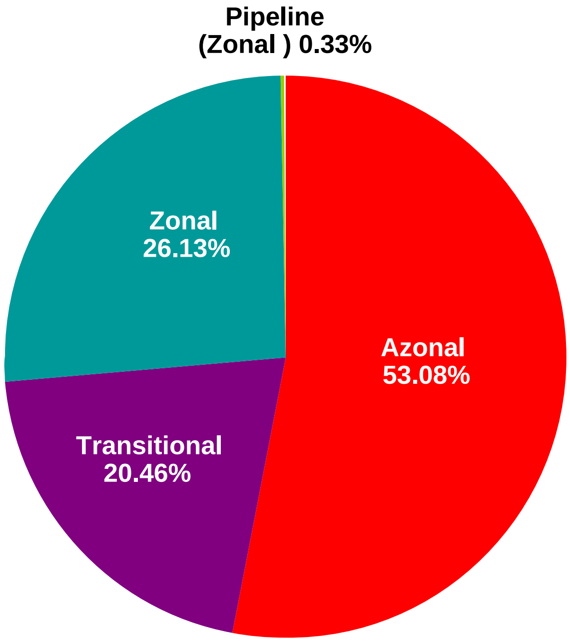
ZONAL FOREST	… of Condition Class 1: Quasi pristine primary forest	…of Condition Class 2: Disturbed primary forest	TOTAL HABITAT HECTARE LOSS
Total areas	**412.74**	**124.97**	**305**
High impact	256.9	14.94	
Medium impact	155.84	110.03	

Table 7: Pipeline zonal habitat (December 2008)

PIPELINE	…of Condition Class 3: Heavily fragmented and degraded primary forest	TOTAL HABITAT HECTARE LOSS
Total area	**71.04**	**4**
High impact	16.5	
Medium impact	4.95	

The forest habitat percentage hectares loss for the mine (and pipeline) components is shown in Figure 7.

Figure 7: Forest habitat percentage hectares loss for the mine component (the pipeline affects only a small portion of the zonal habitat)



Based on the current iteration, calculations show that:

- The project will generate a total loss of **1,168** habitat hectares that any offset will be required to compensate.
- In the mine area, the azonal forest habitat hectares score is the highest, with a total loss of 620 habitat hectares, representing over half of the entire forest habitat lost.
- The pipeline terrestrial biodiversity losses are minimal at 3.83 habitat hectares (0.33% of the total loss).
- The Project's offset programme must focus its offset efforts on the azonal forest and associated biodiversity components, whilst ensuring that the other two habitats (transitional and zonal) habitat hectares losses are also compensated. Early analysis of trends in lemur species distribution (based on ESIA and construction mitigation management data) indicates that none of the three habitats has distinctly higher species richness. Instead it appears that the combination of the three habitats underpins high lemur species richness at Ambatovy. The azonal and other forest habitats that will be cleared during mine construction are not required for the survival of critically endangered or endangered species, since each lemur species found at Ambatovy is also present outside the mine area. However, the azonal forest habitats, including the forest assemblage composed of the azonal, transitional and zonal habitats, appear to favour the presence of lemur species biodiversity, with 16 species identified in the mine area compared with 6 to 10 species (depending on location) in the forest corridor (Schmid and Alonso 2005)

Post-impact mitigation

By excluding post-impact MITIGATION, the results remain conservative. When rehabilitation (as a mitigation measure) is considered, the habitat hectares losses are decreased by 50% within a 30 year period and there is a trend in the decrease of the habitat hectares loss using this mitigation strategy. It is important to note that the absence of a temporal parameter that integrates post-impact mitigation in the habitat hectares calculation may mask a project's success over time in reducing habitat hectares loss.

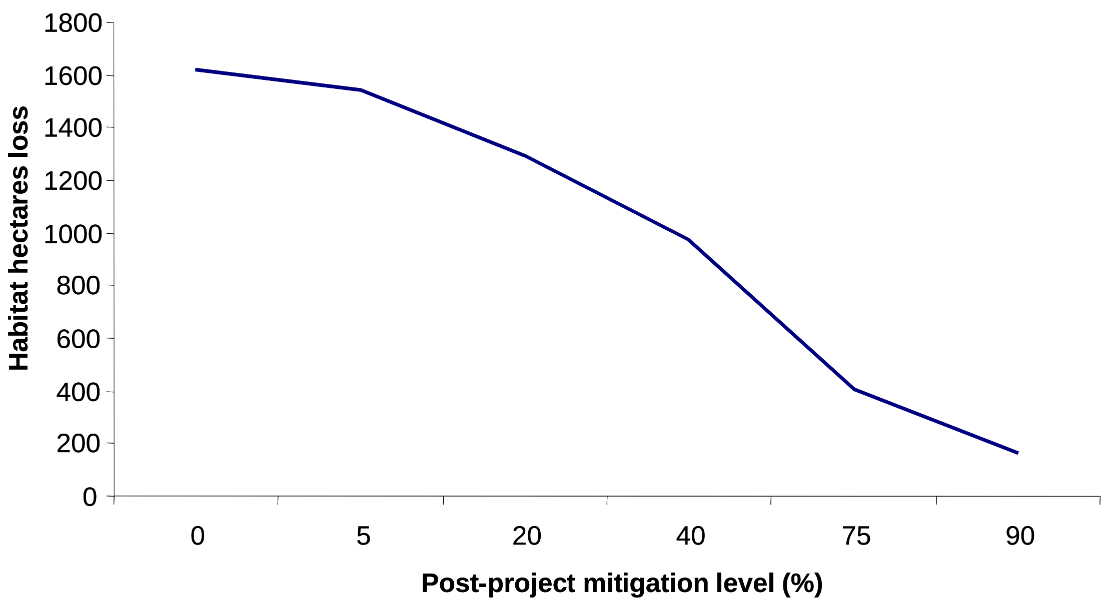
Table 8: Biodiversity loss calculations scenarios at impact site and effect of post-impact remediation

Percentage of attributes rehabilitated	Year	Habitat type – forest
		HABITAT HECTARES loss
0%	0 (without mitigation)	1,168
5%	0 – 7	1,110
20%	7 – 15	934
40%	15 – 30	701
75%	30 – 60	292
90%	60 – 120	117

For the forest habitat, the results show a significant difference for the varying levels of post-impact mitigation. However, in order to obtain a more realistic assessment of the post-impact condition, the Project considered the influence of forest rehabilitation on the habitat hectares loss numbers over time. Although the temporal factor is not considered in the habitat hectares loss calculations, a basic simulation was designed that integrated basic forest regeneration activities and specific ecosystem dynamics in the context of the Ambatovy forests. There are four essential steps in forest regeneration:

1. Erosion control (involves engineering, addition of organic matter and water control).
2. Planting of heliophytes species (including native and potentially some non-natives).
3. Planting of native tolerant species to increase ground cover.
4. Assisted natural succession of native species.

The inclusion of post-impact rehabilitation based on these activities shows a distinct decrease in the habitat hectares loss score over time, due to forest regrowth patterns and increases in the values of attributes (Pearson correlation R2 = -0.98 $p < 0.001$, n = 6; see Graph 1).



Graph 1: Post-impact mitigation influence on biodiversity loss for forest habitats at IMPACT SITE

It is important to note reforestation of the azonal forest area will create zonal type forest, with some azonal influences arising from the use of backfill originating in the azonal areas (which has specific geochemistry and broken ferricrete crust and pisolitic iron). Complete restoration to azonal habitat is deemed impossible due to its strong links with the removed ground structure and geochemistry.

To improve the basic simulation discussed above, the Project will collect available rehabilitation data for Madagascan lateritic soils and the eastern domain. This will enable the refinement of reforestation predictions. Based on Madagascan forestry experience, it is estimated that at 30 years forests will begin to offer a habitat that can be exploited by lemurs and other important taxa, for both food and shelter. The closure biodiversity programme will include monitoring of priority taxa in these rehabilitated areas to define the rate of recolonisation. Irrespective of improvements in the model, continuing care in integration of rehabilitation data in the loss calculations will be necessary due to:

1. Limitations in the availability of specific information on Malagasy forests rehabilitation success rates;
2. The specificity of the Ambatovy mine site forests and overall associated uncertainties; and
3. The risk that lower success rates may occur despite improved confidence in predictions.

Consequently, the Project may decide to take a more precautionary approach and retain conservative habitat hectares scores to ensure that NO NET LOSS is not undermined by an undersized offset design.

7.3.6 Step 6: Review potential offset locations and activities and assess the biodiversity gains which could be achieved at each

Identifying offset options

Preliminary surveys of offset candidate sites were undertaken in 2005 (see Appendix 6, Survey for Off-site Azonal Outcrops (in French)) with the objective of identifying potential in-kind type offsets. The surveys were based on geological, substrate, altitude and forest structure similarities (see Figure 9, showing correlation between the EVC (azonal, transitional and zonal), substrate and topography) and comprised:

- A desk study using geological maps to identify ultramafic outcrops and satellite imagery for remaining forest cover.
- Aerial (plan) reconnaissance survey to confirm the presence of forest cover and rapid visual integrity assessment; the survey had to be conducted by air, due to the absence of road infrastructure and general remoteness of the areas. Two potential candidate sites (of 14 initially identified – see Figure 8) were chosen based on forest integrity and surface area.
- Aerial (helicopter) reconnaissance survey and walk over ground survey of potential candidate sites (Vohimenakely and Ankerana). Vohimenakely, located northwest of Zahamena National Park appeared to have azonal characteristics but was very small (<10 ha) and highly disturbed. Thus, this location has some potential for off-site purposes, but it is not highly regarded because of its small size and relatively poor condition. Ankerana, located northeast of Mantadia National Park is the best potential off-site azonal vegetation area among those visited. It had the general appearance of Analamay, although the presence of ferricrete could not be confirmed from the air. It appeared a reasonable size (>500 ha) and with no signs of disturbance (see Photograph 1).
- A ground-level vegetation survey at selected candidate site (Ankerana) to determine if it has similar habitat and floristic (see Photograph 2) characteristics as at Ambatovy and Analamay. The preliminary comparison of the Ankerana area with Ambatovy / Analamay is presented in Appendix 7. Ankerana had previously and independently been identified by the Missouri Botanical Garden – Madagascar (a Project partner) as a

potential conservation area based on its floral assemblages. Overall, many similarities were noted in the physical, climatic and biological characteristics compared to Ambatovy / Analamay, supporting the hypothesis that Ankerana can be considered 'IN-KIND' relative to the Ambatovy azonal habitats. Additional work to verify these similarities is required and planned for 2009.

Figure 8: Ankerana offsite offset area location and other candidate sites surveyed by the Project, in relation to the Ambatovy mine area

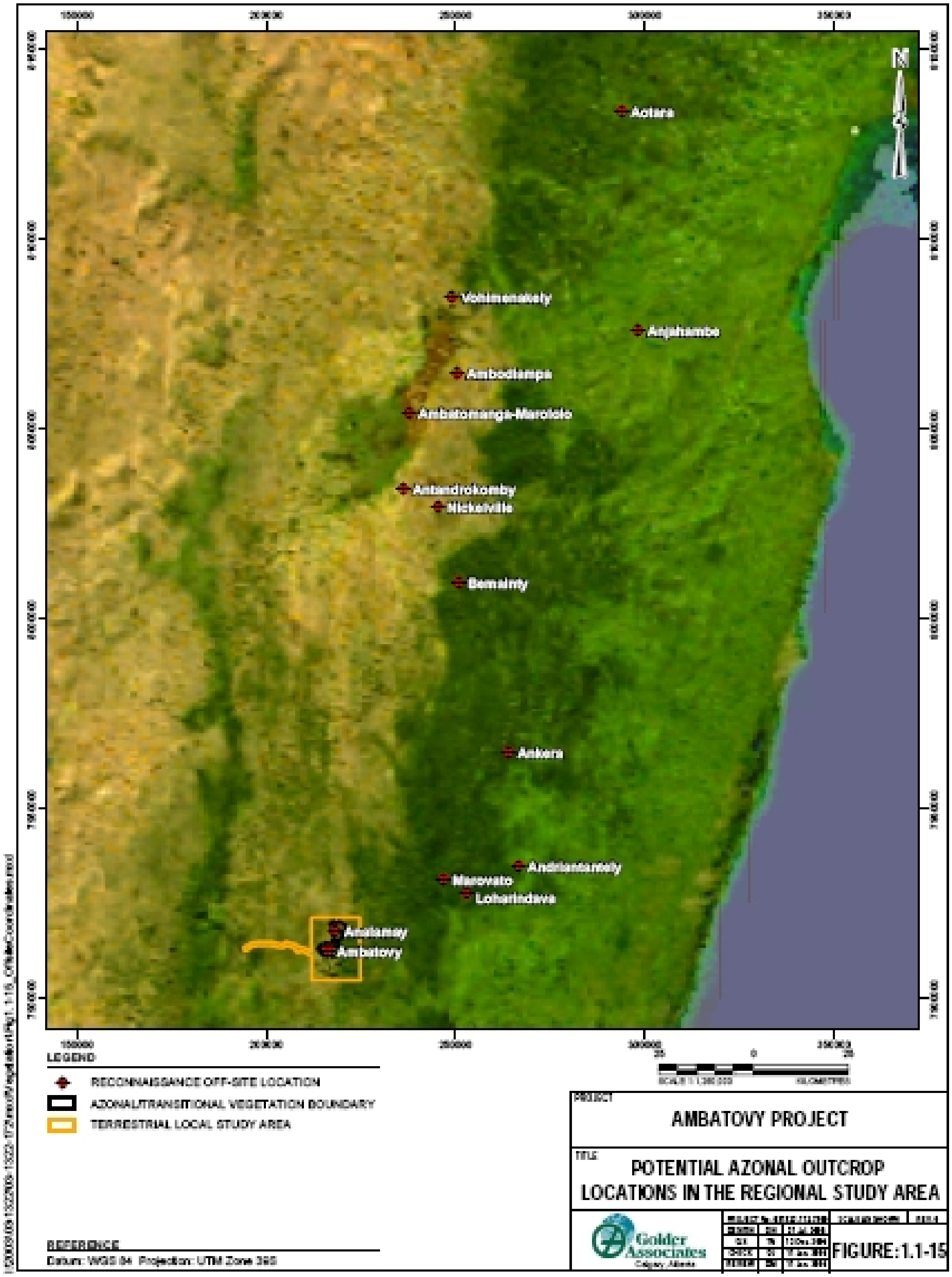
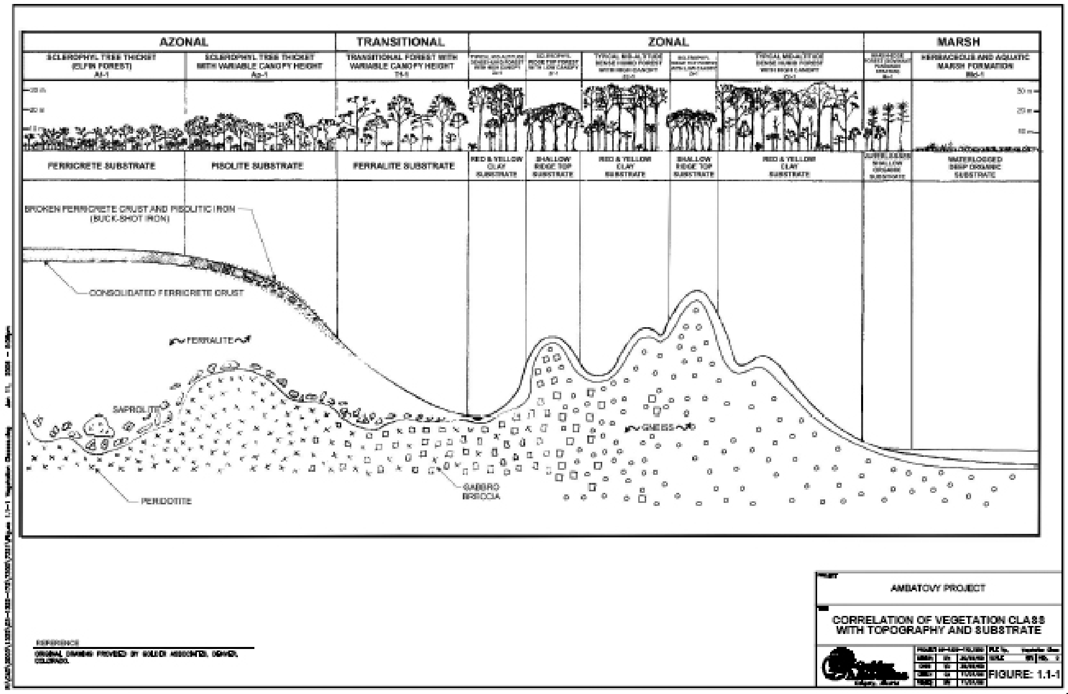


Figure 9: Correlation between EVC (azonal, transitional and zonal), substrate and topography



Photograph 1: Ankerana aerial view

Photograph 2: Ankerana azonal habitat

Quantifying gains of offset options

The detailed quantification of potential offset GAINS has not yet been conducted. Rough estimates of gains have been prepared based on mapping data and the surface areas that would be protected:

1. Ankerana offset site (see Figure 10): the Ankerana offset has a total surface area of approximately 11,600 ha, consisting of a 4,600 ha core conservation area and a 7,000 ha multiple use buffer area surrounding the core. The site lies within the area planned for inclusion in the Malagasy protected area system (SAPM). Consequently, the Project funding is being designed to ensure that any biodiversity offset offers conservation ADDITIONALITY. The field surveys to characterise species, habitats and ecosystems at the proposed offset site will be conducted in 2009, allowing calculation of the habitat hectares gains. Based on the preliminary survey conducted during the ESIA, the Project is confident that the KEY BIODIVERSITY COMPONENTS identified at Ambatovy (species, habitats and ecosystem) can be found at Ankerana, although Ambatovy species assemblages may not all be present at Ankerana. It is important to note that this issue justifies the conservation of the two on-site azonal forest tracts (the mine area conservation zones). The forest will form part of the on-site offset component. The on-site offset includes all forest habitats present on the mine footprint, including two azonal forest areas (one being the Project's BENCHMARK site). Therefore it is acceptable to assume that all key biodiversity components are present in the on-site offset.

2. On-site azonal habitat conservation sites (see Figure 4): the azonal forest surface area equals 212.33 ha (26.4% of the total prime quality habitat; the azonal habitat remaining outside the mine footprint is all pristine).

3. Management of mine area forests (see Figure 3): the Ambatovy offset programme includes the 4,900 ha conservation zones forest around the mine footprint; the azonal conservation zones noted above are located within this area. The Project aims to reinforce the legally protected status of these forests to ensure their continued protection following mine closure. Their current protection is ensured by the mine Forest Management Plan, since most of the forest areas are within the mine lease where the Project has exclusive management rights. The Project is also currently discussing with Conservation International the regional integration of its on-site offset.

4. Mine area / Ankeniheny-Zahamena Corridor link (see Figure 11): the forest corridor between the mine area conservation zones forest and the rest of the eastern rain forest corridor is a key component in ensuring CONNECTIVITY between these two areas. The corridor concept has been integral to the Project's species management strategies (particularly for lemurs). The exact boundaries have not yet been defined, but are likely to enclose about 2,500 ha. The Project is also currently discussing with CI the regional integration and protection of this forest corridor to ensure its connection with the relic Ankeniheny-Zahamena Corridor and the SAPM protected areas (e.g. Mantadia National Park).

5. Torotorofotsy Ramsar site management (see Figure 11): the total surface area of this site's watershed is 8,500 ha of which 1,100 ha is wetland. However, results of recent surveys led by Ambatovy indicate that the ecological integrity of the overall area has been several degraded, resulting in reduced gains for biodiversity. The true gains will be quantified based on analysis of the survey results.

6. FOREST CONNECTIVITY CAZ (see Figure 11): the total area of zonal forest lost to the pipeline right of way will be reforested (so a gain of 16.5 ha, the first 2 km reforested route being integrated with the mine). The exact surface area to reforest for the CAZ connection has yet to be determined, but may be around 200 ha.

7. Footprint rehabilitation: the total surface area of the mine footprint will be rehabilitated, of which a majority will be reforested (approximately 1,336 ha).

Figure 10: Ankerana map

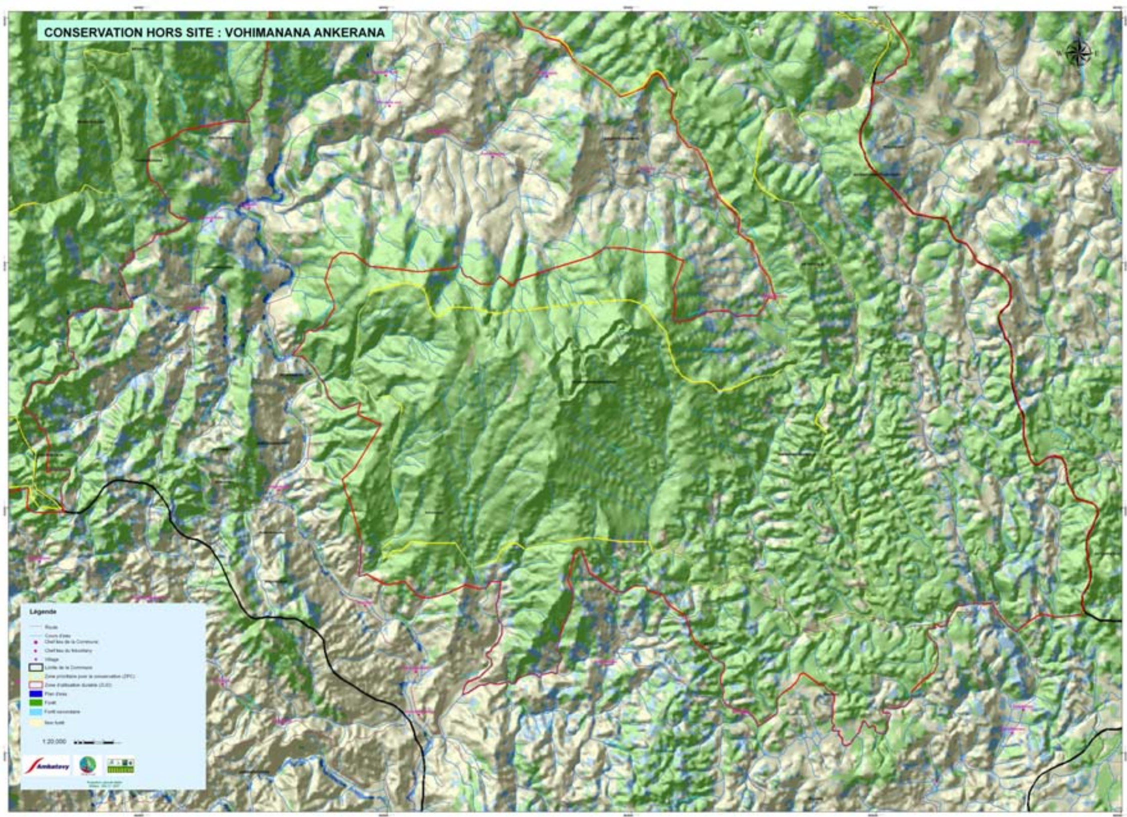
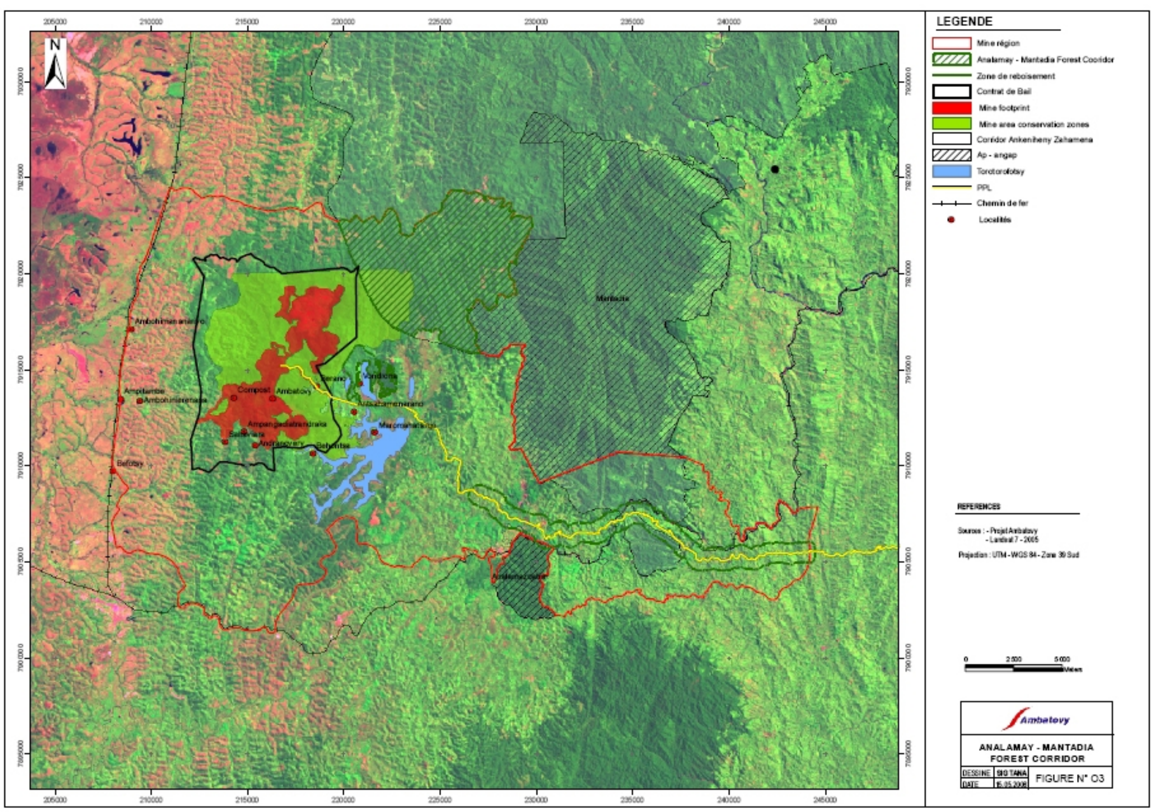


Figure 11: Mine area and Analamay-Mantadia forest corridor, allowing link between on-site offset and forest corridor



Comparative analysis of offset options

A comparative analysis of offset options was conducted during the site selection process (as noted above). Results are presented in Appendix 6 (in French).

7.3.7 Step 7: Calculate offset gains and select appropriate offset locations and activities

Finalising offset sites and activities

The habitat hectares gain score for the offset sites has yet to be calculated, as detailed forest structure and species attribute quantitative data need to be obtained for the Ankerana and other offset sites. This will take place as soon as the stakeholder consultation process is completed. As the Ankerana site is considered ‘in-kind’ with the Ambatovy azonal habitats, the same benchmark will be used to calculate gains. A detailed BASELINE STUDY of the Ankerana offset will be conducted in 2009 to check the offset site for the presence and suitability for all the key biodiversity components identified at the impact site and to support the gain score calculations.

The plan for the Ankerana offset will include a core conservation area, surrounded by a multiple use area to ensure social integration of the offset and thus its sustainability in the context of local community support.

The principle of pursuing an offset was established in 2004. However, the offset was not fully established before the Project’s impacts began occurring in May 2007 (the date that mine forest clearance began). The Project must thus still determine whether the temporal loss is critical or not (i.e. that any biodiversity component cannot be offset because of impacts in the period before the offset is created). However, the Project is confident that this is not the case for any of the taxa present; especially for very sensitive species such as *Mantella aurantiaca* and *Mantella crocea* (whose habitats will not be disturbed for at least 10 years, when Analamay will be cleared for mining). With respect to lemurs, a short-term and long-term trend assessment programme (Lemur Viability Assessment Programme) is underway for all priority species (IUCN CR and EN species). However, even though the temporal loss will not compromise the success of the offset, the offset design does plan to take it into account. Conventionally, this could be done through application of a MULTIPLIER and TIME DISCOUNTING (the concept that 1 habitat hectare delivered accruing in 10 years time has only a fraction of that value at the present time). The Project will explore and define a methodology and apply it to the next iteration of loss and gain calculations in 2009, taking into consideration that the main impacts will be spread over a period of approximately 20 years, while the offset could be in place much earlier.

7.3.8 Step 8: Record the offset design and enter the offset implementation process

The Ankerana offset design and other components of the offset have not yet been finalised, thus the implementation process has not formally begun. The Project will finalise the offset design, using BBOP guidance, during the course of 2009. A summary of the management plan will be presented in subsequent case study revisions. However, a brief description of the progress made to date is presented below:

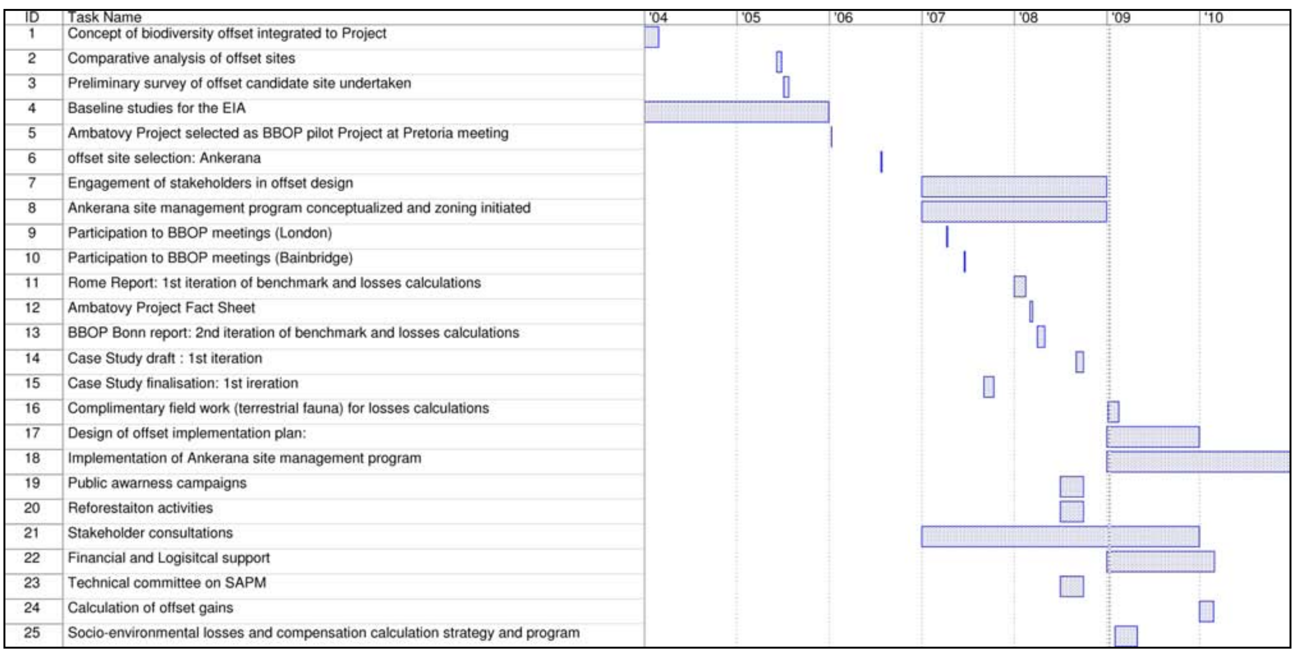
- Stakeholder consultations: the Project has pursued stakeholder consultations, ensuring through a participatory process that the offset can be integrated into national, regional and local plans and that feedback is taken into account in the offset design and the development of multiple use zones.
- Legal protection: the Ankerana forest was under temporary protection status until the end of 2008. The Project requested that this protection status be prorogated (continued) until the final Ministerial Protection Decree is finalised and made law (planned for July 2009).

- Boundary definition: delimitation of the Ankerana offset boundaries (see Figure 10). The mapping has been presented to the local communities, regional authorities and partner NGOs. Several awareness campaigns have enabled presentation of this information to remote habitations around the proposed offset site. The campaigns will be repeated twice per year at key periods i.e. before and during the traditional clearing period (with police enforcement against passing the boundary). Results if the campaigns to date indicate that Ankerana has been extremely isolated for a long time and people had no idea of forest laws restricting forest clearance.
- Zoning: the current land uses have been described and will be integrated with the offset design in 2009.
- Reforestation activities: continuation of reforestation on the periphery of the proposed offset; this has focused mainly on planting construction wood to avoid primary forest logging in the core offset area.
- Support (financial and logistic) for updating of the Marserana commune's five year Communal Development Plan. This commune covers the offset area. Discussions with a second commune, Andahamana have begun; this commune includes a small fraction of the offset area and will also be assisted with updating of its five year plan.
- Integration of Ankerana with the SAPM: a technical committee meeting with SAPM was used to discuss the integration of the offset site into the national protected areas network.

8. Implementation Plan and Long-term Management

The team plans to complete the design of the offset implementation plan by the end of 2009, with the Ankerana and other offset sites' gain calculated in early 2010 and thus the final offset design completed at that point. The Ministerial Protection Decree should be ready by June 2009, thus allowing the Project to legally implement the management of the core and multiple use buffer area of the Ankerana part of the offset. While the ESIA stated the Project's commitment to establish a biodiversity offset at Ankerana, no timing commitment was made. The offset establishment is therefore assumed to be in line with the Project's temporal goals. The Project is establishing the offset to last the Project's lifetime of 30 years and beyond. The establishment of a Ministerial Protection Decree is underway and the financing mechanisms are being discussed. Actions and timings are summarised in Figure 12.

Figure 12: Actions and timings (2004-onwards)



The Project will have the responsibility of ensuring the management of the Ankerana site. Actual site protection and local management will likely be entrusted to an NGO. The exact mode of financing has not yet been defined precisely. An in depth financial assessment will be conducted to determine the most viable means of ensuring long term financial revenue to support site protection.

9. Summary of Offset Process Costs

The Ambatovy Project BBOP programme component is part of the Project's Biodiversity Programme (itself part of the Environmental Programme). Specific activities are designed, budgeted and implemented. Offset design and early implementation cost estimates are presented in Table 9.

Table 9: Summary of estimated costs

Human resources	Staff	Tasks	Costs (man days per annum*)	Cost for 2008, 2009 (USD)
Project focal point : Pierre Berner (Ambatovy Project Environmental Director)	1	Ensure communication / meetings (international) with BBOP committee and management of overall Ambatovy BBOP programme.	24	
Superintendent responsible for Ankerana site: monsieur Alphonse (Ambatovy Project)	1	Ankerana off-site offset management. Spearheading legal protection status programme with governmental and local STAKEHOLDERS. Supervising financial arrangements for programme's long term viability.	36	
Superintendent responsible for Special Programs: Irene Daso (Ambatovy Project)	1	Support Project focal point. Liaising with local and international stakeholders (e.g. CI).	12	
Environmental Coordinator for Ankerana (Sylvain Be Totozafy)	1	Ensuring local stakeholder involvement. Supervising Ankerana zoning (core / buffer / inhabited areas). Awareness campaigns.	132	
Technical support team Ankerana management: Environmental Forest Technician (to be filled) Environmental Community Agent (to be filled) Guest house manager (to be filled)	3	Ankerana Forest and community management.	264 (currently one staff member)	
BBOP programme management: Steven Dickinson (Golder Associates)	1	Managing overall BBOP design, including benchmark / loss / gain calculations.	36	
BBOP design ecological assessment: Aristide Andrianarimisa (WCS)	1	Conducting benchmark / loss / gains calculations and overall ecological assessments.	140	

Human resources	Staff	Tasks	Costs (man days per annum*)	Cost for 2008, 2009 (USD)
BBOP external auditing progress reports: Jon Ekstrom (TBC)	(1)	Carry out a technical peer review of the Ambatovy offset (e.g. benchmark, losses and gain calculation).	2	
TOTALS	**9**		**646**	**560,000**

* based on 2008 man days

The average annual operational costs are in the process of being established and are estimated to be in the range US$ 250,000 – 300,000 per annum.

10. Project Outcomes

Actual outcomes

Since the offset is still in the design phase, the actual CONSERVATION OUTCOMES to date are limited. They represent what the Project has achieved thus far and the benefits its shareholders already enjoyed, including:

- Legal protection status: the extension of the temporary protection of Ankerana has been secured until the Ministerial Decree for protection is finalisation;
- Integration of Ankerana into the national protected areas network;
- Coordination between government organisations, NGOs, local communities and the private sector;
- Public awareness;
- Reforestation activities; and
- Forest and TAXA-specific conservation management plans: specific taxa conservation management programs were developed for flora, lemurs, Mantella species and fish. Although these programs were developed as part of the Biodiversity Action Plan, their importance is reinforced by their aim of ensuring the conservation of azonal habitat and associated species, thus ensuring that all KEY BIODIVERSITY COMPONENTs present on the impact site are present at the offset.

Anticipated outcomes

The benefits anticipated as the final outcome of the offset include:

- Averted loss of forest habitat:
  - The offset is designed to result in no net loss of biodiversity and will strive to attain a NET GAIN.
  - The initial objective was to secure the Ankerana site, but with additional insight the Project is presently aiming to extend the expanse of protected areas it will be managing indirectly (Ankerana) or directly (e.g. the on-site mine area conservation zones).
  - The Project aims to also spearhead the creation of the Analamay-Mantadia forest corridor enabling connectivity between the mine area conservation areas and the SAPM.
- Community benefits: The creation of the offset will be conducted though integration of a socioeconomic and cultural component, which is the key to its long-term viability. A socio-environmental compensation programme will be designed during 2009 and subsequently to support social integration and ensure this. The programme will assess the compensation options available. Its partnerships with NGOs and agencies such USAID, PACT and ERIE will provide valuable insights. Specific activities that will be explored include fuel wood reforestation using native species, planting in suitable locations that avoid biodiversity impacts of biofuel crops (e.g., Jatropha plant), aquaculture and improved crop yield techniques. The programs will be integrated with social programs, especially complementary educational and family planning programs that contribute to reductions in human pressure on natural resources and forests. Other programs that will be critical to the overall success of the offset include fire management, hunting / bushmeat management and forest resource management.

- Improved communication: information available to international NGOs did not reflect the full scale of works conducted in the field by the Project. The reason was linked to rather limited communication efforts by the Project, which was subsequently ramped up. The high velocity of Project implementation has been generally overwhelming for most NGOs, who felt they needed a deeper involvement with the Project. Such aspects were discussed in detail with CI, Forest Trends and WCS in November 2008. The Project will present and implement its communication strategy on biodiversity management and BBOP activities in 2009. The offset programme is not yet mentioned as a standalone project on the Sherritt web site, however it is mentioned on the Environmental Assessment documents (page 12), available at: **http://www.sherritt.com/doc08/subsection.php?submenuid=operations&category=operations/metals_ambatovy**.
- A specific web page will ultimately describe in detail the biodiversity offset process and activities, including this case study and subsequent, updated versions of it.
- Stakeholder confidence: the Project hopes to increase and consolidate the confidence of the public (government, NGOs, authorities and the public at large) and private partners, (banks) and demonstrate its commitment to sustainability. This is strongly linked to both the communication effort and compliance activities. The governmental authorities and local communities are aware of, and have taken part in, the offset activities. Project partners and lender banks have monitored the progress of the offset programme through quarterly audits and bi-annual biodiversity audits.
- Significant scientific knowledge will be obtained through biological surveys (which underpin the loss and gain calculations), especially at Ankerana, where studies have been limited despite the description of these ultramafic outcrops as biodiversity hotspots. The Project intends to prepare external publications of its biodiversity management programs, especially for MITIGATION in high biodiversity areas, possibly setting a precedent for other mining projects in Madagascar. A publication, likely a monograph of both the impact and offset sites, will be produced in collaboration with scientific partners. An article on the Project was provided to the CBD newsletter *Business 2010* in April 2008 (**www.cbd.int/doc/newsletters/news-biz-2008-04/**).
- Forest restoration: the reforestation activities include targeted reforestation with native species to improve connectivity around the Ankerana offset site and between it and the remaining forest corridor; similar programs exist around the mine and the pipeline component.
- Taxa-specific conservation: species taxa conservation management programs will be developed for key taxa such as lemurs, *Mantella* spp., flora and fish, on the same basis as those developed at the mine site.

11. Lessons Learned

The main lesson learned to date (during the offset conceptualisation and design stages) is that a commitment to implement a biodiversity offset can generate substantial interest and respect from third parties for the Project developer in tandem with delivering real and measurable benefits for biodiversity. The 'NO NET LOSS' offset represents a strong and positive vision that allows the Project to present its mitigation programme elegantly and coherently to third parties.

The main difficulties encountered to date have been:

- While beneficial, the BBOP guideline development process has been lengthy, dense and not always readily applicable to the Ambatovy Project. However, the Project feels privileged to continue with its contribution to the improvement of the offset design tools though its feedback.
- The integration of biodiversity offsets at the ESIA stage is also crucial if baseline data collection is to:
  - Prioritise target species with high biodiversity value for the Key Biodiversity Components Matrix;
  - Target sampling stations to ensure that a benchmark is identified;
  - Ensure loss and gain sites are adequately covered; and
  - Ensure that quantitative data is gathered for the HABITAT HECTARES calculations.

Ideally, the offset calculations for LOSSES and GAINS should have been completed before Project construction began, in order to alleviate the risk of being confronted with a low gains score. Greater targeting of baseline data collection during the ESIA would have helped reduce the cost and time associated with subsequent filling of data gaps.

11.1 Limitations

Limitations and issues identified during the habitat hectare calculations are presented below.

11.1.1 Available data

- The main limitation for the Ambatovy Project offset design is that only azonal forests were sufficiently sampled for habitat structure ATTRIBUTES. Fewer data exist for zonal and transitional habitats. In addition, more accurate improved diversity and abundance data were required for species (especially lemurs and other taxa) in both the benchmark and impact areas. Obtaining these data in 2009 should improve precision of the habitat hectares loss calculation.
- No available data exist at present for the selected attributes at the proposed Ankerana offset site. This means that offset gains cannot yet be calculated.
- Some of the existing data were not sufficiently habitat specific to meet the requirements of the habitat hectares calculations. The fauna data did not allow the species identified to be clearly linked to either the three ecological vegetation classes (azonal, transitional and zonal) or the habitat CONDITION classes. The January 2009 fauna surveys will aim to resolve this.

11.1.2 Averaging

Averaging of attribute values was necessary in the habitat hectares calculation in order to avoid overly conservative results and to reflect the reality of conditions on the ground. However, it is commonly recognised that by calculating averages of vegetation parameters within a large area, habitat heterogeneity and its variations, which are the key elements for microclimate and ecological processes, are masked (Whittaker *et al.* 1974; Parkes *et al.* 2003). This approach thus limits the impact of variability on the calculation. While the variation is small-scale, considering its effects is important.

11.2 Recommendations

1. Integrate a temporal parameter to the post-Project impact in the habitat hectares calculation in order to show the Project's success through time in reducing habitat hectares loss. This aspect is important for time discounting (i.e. delay of offset creation and delivery of ultimate habitat hectares gain, see Step 7).

2. Averaging of contiguous HABITAT TYPES as far as habitat classes is optimal as it best reflects the reality of conditions in the impact area.

3. Tools are based merely on numerical data that might not always have a biological and / or ecosystem health significance. It is important to assess how to integrate biodiversity qualitative data (like ENDEMISM, only presence / absence etc.) with the habitat hectares calculation.

4. There is a need for a 'Weighting Guideline' to guide the operator in weighting attributes, since this will ultimately affect the scoring.

5. SPECIES DIVERSITY and other fauna attributes should be used (e.g., lemur and herpetofauna) as often as possible to better reflect true biodiversity values (as opposed to forest structural SURROGATES).

6. The Project should design its data acquisition programs at the ESIA stage (baseline collection) to ensure it meets the habitat hectares calculation requirements in an optimal fashion (e.g. fauna, flora, aquatics sample sites linked with all main vegetation types likely to be impacted, as well as their condition classes – for example, good / disturbed).

12. Next Steps

The next steps for the Ambatovy offset team are presented below:

1. Habitat hectares loss scores:

a. Integrate the IMPACT SITE and benchmark terrestrial fauna data being gathered in January 2009, integrate *Mantella aurantiaca* and *M. crocea* data that is being acquired for these two key species as part of the Mantella Management Programme during 2009, re-evaluate the fish and aquatic (stream and ponds) data to adequately integrate with the KBCM; this will imply reassessing the weighting of the attributes generally, giving more importance to the species attributes to better reflect BIODIVERSITY LOSS values.

b. Re-calculate habitat hectares loss scores for the impact site, for each forest habitat type (azonal, transitional and zonal), aquatic ecosystems (streams and ponds) and condition class.

2. Habitat hectares gain scores:

a. Prepare and implement the habitat, flora, fauna and aquatics BASELINE data collection at the proposed Ankerana offset site.

b. Calculate habitat hectares gains scores for the variety of POTENTIAL OFFSET SITES (e.g. contiguous with the mine footprint, the Analamay-Mantadia Corridor and the Ankerana offset site), for each forest habitat type (azonal, transitional and zonal), aquatic ecosystems (streams and ponds) and condition class.

3. Socio-environmental losses and compensation calculations:

a. Apply cost-benefit model and analysis using key elements of the BBOP BIODIVERSITY OFFSET COST-BENEFIT HANDBOOK to determine the ecosystems services to the local communities in and around Ankerana as well as the mine site (COMPOSITE OFFSET).

b. Determine socio-environmental compensations required, including compensations options; the Project will distinguish between legal and illegal activities specifically (the latter being obviously recognised by local legislation as unsustainable).

c. Design and implement a compensation programme.

4. Offset management programme:

a. In light of both the biodiversity and socio-environmental inputs, the Project will finalise the design of the Ankerana (and mine site) management programs.

b. The Project will implement and monitor the implementation of the programs.

5. Legal protection status:

a. The Project will pursue the finalisation of the Ministerial Protection Decree for Ankerana and creation of a protection status for the mine area conservation zones forests; the status of other offset programme components (Analamay-Mantadia Corridor, Ramsar site) will also be pursued in collaboration with the Project's partners (CI).

b. The Ankerana offset jurisdictional protection status is being finalised with Malagasy authorities with its integration in the National Park network, in order to ensure the long-term protection status of the site from a legal perspective.

6. Other activities:

a. The Project will be pursuing the implementation of its MITIGATION HIERARCHY strategy, namely through the Biodiversity Action Plan and the taxa-specific management programmes for lemurs, Mantella, fish and flora.

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Appendix 1: Key Biodiversity Components Matrix (KBCM) and Habitat Hectares Score, December 2008 Iteration

Key Biodiversity Components Matrix

Biodiversity Component	Biodiversity Assessment								Justification (Insert comments here explaining data entered in columns A to I)
	Intrinsic, 'non use' Values						Use Values		
	Significance			Irreplaceability (mark only one)			Socioeconomic Values	Cultural Values	
	Global	National	Local	Site Endemic	Localized	Widespread			
Species									
MAMMALS									
Prosimans (primates)									
Allocebus trichotis	DD				X		Ecotourism, illegal bush meat, CITES I	Tabou	
Avahi laniger	LC				X		Ecotourism, illegal bush meat, CITES I		
Cheirogaleus crossleyi	DD				X		Ecotourism, illegal bush meat, CITES I		
Cheirogaleus major	LC				X		Ecotourism, illegal bush meat, CITES I		
Daubentonia madagascariensis	NT					X	Ecotourism, illegal bush meat, CITES I		
Eulemur fulvus fulvus	NT				X		Ecotourism, illegal bush meat, CITES I, pet trade		
Eulemur rubriventer	VU				X		Ecotourism, illegal bush meat, CITES I		
Hapalemur griseus griseus	VU				X		Ecotourism, illegal bush meat, CITES I		
Indri indri	EN				X		Ecotourism, illegal bush meat, CITES I	Tabou	Existence of illegal bush meat for all t
Lepilemur microdon	DD				X		Ecotourism, illegal bush meat, CITES I		
Lepilemur mustelinus	DD				X		Ecotourism, illegal bush meat, CITES I		
Microcebus lehilahytsara	DD				X		Ecotourism, illegal bush meat, CITES I		
Microcebus rufus	LC				X		Ecotourism, illegal bush meat, CITES I		
Prolemur simus	CR				X		Ecotourism, illegal bush meat, CITES I		Ecological services: main seeds dispe
Propithecus d. diadema	EN				X		Ecotourism, illegal bush meat, CITES I		Ecological services: main seeds dispe
Varecia v. variegata	CR				X		Ecotourism, illegal bush meat, CITES I		
Carnivores									
Cryptoprocta ferox	VU					X	Ecotourism, illegal bush meat		
Fossa fossana	NT					X	illegal bush meat		
Galidia elegans	LC					X	illegal bush meat		
Small mammals									
Brachytarsomis albicauda	NE				X		illegal bush meat		symbiotic to Allocebus trichotis
Eliurus minor	LC				X		illegal bush meat		
Eliurus tanala	LC				X		illegal bush meat		
Eliurus webbi	LC				X		illegal bush meat		
Microgale cowani	LC				X		illegal bush meat		
Microgale drouhardi	LC				X		illegal bush meat		
Microgale majori	LC				X		illegal bush meat		
Microgale thomasi	LC				X		illegal bush meat		
Myotis goudoti	LC					X	illegal bush meat		
BIRDS									
Accipiter henstii	NT					X	pet trade, CITES II		
Accipiter madagascariensis	NT					X	pet trade, CITES II		
Acridotheres tristis	NE					X			
Agapornis cana cana	LC					X	pet trade, CITES II		
Alectroenas madagascariensis	LC					X			
Anas melleri	EN					X			
Ardea humbloti	EN					X			
Asio madagascariensis	LC					X	pet trade, CITES II		
Atelornis pittoides	LC					X			
Aviceda madagascariensis	LC					X	pet trade, CITES II		
Berneria zosterops	LC					X			
Bernieria cinereiceps	NT					X			
Brachypteracias squamigera	VU					X			
Buteo brachypterus	LC					X			
Calicalicus madagascariensis	LC					X			
Canirallus kioloides	LC					X			
Caprimulgus enarratus	LC					X			
Caprimulgus madagascariensis	LC					X			
Circus m. macrosceles	VU					X			
Copsychus albospecularis	LC					X			
Coracopsis nigra nigra	LC					X	pet trade, CITES II		
Coracopsis vasa vasa	LC					X	pet trade, CITES II		
Coua caerulea	LC					X			
Coua reynaudii	LC					X			
Coua serriana	LC					X			
Crossleyia xanthophrys	NT					X			
Cyanolanius madagascarinus	LC					X			
Dromaeocercus brunneus	LC					X			
Eurystomus glaucurus	LC					X			
Falco eleonorae	LC					X	pet trade, CITES II		
Falco newtoni newtoni	LC					X	pet trade, CITES II		
Foudia madagascariensis	LC					X			
Foudia omissa	LC					X			
Gallinago macrodactyla	NT					X			
Hypsipetes madagascariensis	LC					X			
Leptopterus chabert	LC					X			
Lonchura nana	LC					X			
Lophotibis cristata	NT					X			
Margaroperdix madagascariensis	LC					X			
Milvus migrans	LC					X	pet trade, CITES II		
Mystacornis crossleyi	LC					X			
Nectarinia notata	LC					X			
Neodrepanis coruscans	LC					X			
Neomixis flavoviridis	NT					X			
Neomixis tenella	LC					X			
Neomixis viridis	LC					X			
Nesillas typica	LC					X			
Newtonia brunneicauda	LC					X			
Ninox superciliaris	LC					X	pet trade, CITES II		
Otus rutilus rutilus	LC					X	pet trade, CITES II		
Oxylabes madagascariensis	LC					X			
Philepitta castanea	LC					X			
Ploceus nelicourvi	LC					X			
Polyboroides radiatus	LC					X	pet trade, CITES II		
Rallus madagascariensis	VU					X			
Sarothrura insularis	NE					X			
Sarothrura watersi	EN					X			
Tylas eduardi	LC					X			
Tyto soumagnei	EN					X	CITES I		
Vanga curvirostris	LC					X			
Xenopirostris polleni	NT					X			
Zosterops maderaspatana	LC					X			

Key Biodiversity Components Matrix

Biodiversity Component	Biodiversity Assessment								Justification (Insert comments here explaining data entered in columns A to I)
	Intrinsic, 'non use' Values						Use Values		
	Significance			Irreplaceability (mark only one)			Socioeconomic Values	Cultural Values	
	Global	National	Local	Site Endemic	Localized	Widespread			
Species									
REPTILES									
Amphiglossus melenopleura	NE					X			
Amphiglossus minutus	NE					X			
Amphiglossus mouroundavae	NE					X			
Amphiglossus punctatus	NE					X			
Brookesia superciliaris	NE					X	pet trade, CITES II		
Brookesia therezieni	NE					X	pet trade, CITES II		
Brookesia thieli	NE					X	pet trade, CITES II		
Calumma brevicornis	NE					X	pet trade, CITES II		
Calumma cf nasuta	NE					X	pet trade, CITES II		
Calumma crypticum	NE					X	pet trade, CITES II		
Calumma gastrotaenia	NE					X	pet trade, CITES II		
Calumma malthe	NE					X	pet trade, CITES II		
Calumma nasuta	NE					X	pet trade, CITES II		
Calumma parsoni	NE					X	pet trade, CITES II		
Ebenavia inunguis	NE					X	pet trade, CITES II		
Exallodontophis albignaci	NE				X				
Furcifer lateralis	NE					X	pet trade, CITES II		
Furcifer willsii	NE	rare				X	pet trade, CITES II		
Geodipsas laphystia	NE					X			
Itycyphus perineti	NE					X			
Leioheterodon madagascariensis	NE					X			
Liophidium nov. sp. 1	NE				X				
Liophidium nov. sp. 2	NE					X			
Liophidium rhodogaster	NE					X			
Liophidium torquatus	NE					X			
Liopholidophis dolicocercus	NE					X			
Liopholidophis epistibes	NE					X			
Liopholidophis infrasignatus	NE					X			
Liopholidophis pinguis	NE					X			
Liopholidophis thieli	NE					X			
Lygodactylus guibei	NE					X			
Lygodactylus miops	NE					X			
Mabuya gravenhorstii	NE					X			
Madagascarophis colubrinus	NE					X			
Micropisthodon ochraceus	NE	rare				X			
Paroedura gracilis	NE					X			
Phelsuma lineata bifasciata	NE					X	pet trade, CITES II		
Phelsuma lineata lineata?	NE				X		pet trade, CITES II		
Phelsuma madagascariensis	NE					X			
Phelsuma pronki	NE	high extinction risk			X		pet trade, CITES II		
Phelsuma pusilla hallmanni	NE					X			
Phelsuma quadriocellata bimaculata	NE				X		pet trade, CITES II		
Phelsuma quadriocellata quadriocellata	NE					X	pet trade, CITES II		
Pseudoxyrhopus microps	NE					X			
Pseudoxyrhopus tritaeniatus	NE					X			
Sanzinia madagascariensis	VU					X	bushmeat, CITES I		
Stenophis arctifasciatus	NE					X			
Typhlops sp.	NE					X			
Uroplatus phantasticus	NE					X	pet trade, CITES II		
Uroplatus pieschmanni	NE					X	pet trade, CITES II		
Uroplatus sikorae	NE					X	pet trade, CITES II		
Zonosaurus aeneus	NE					X			
Zonosaurus madagascariensis	LC					X			
AMPHIBIANS									
Aglyptodactylus madagascariensis	LC					X			
Anodonthyla boulengeri	LC					X			
Blommersia blommersae	LC					X			
Blommersia grandisonae	LC					X			
Boophis albilabris	LC					X			
Boophis boehmei	NE					X			
Boophis brachychir	NE					X			
Boophis burgeri	NE					X			
Boophis cf.burgeri	NE					X			
Boophis cf.miniatus	NE					X			
Boophis cf.sibilans	NE					X			
Boophis erythrodactylus	LC					X			
Boophis goudoti	LC					X			
Boophis guibei	LC					X			
Boophis idae	LC					X			
Boophis luteus	LC					X			
Boophis madagascariensis	LC					X			
Boophis marojezensis	LC					X			
Boophis nov. sp.	NE					X			
Boophis pyrrhus	NE					X			
Boophis reticulatus	LC					X			
Boophis sibilans	DD					X			
Boophis viridis	LC					X			
Gephyromantis cf. leucocephala	NE					X			
Gephyromantis asper	NE					X			
Gephyromantis boulengeri	LC					X			
Gephyromantis cf.boulengeri	NE					X			
Gephyromantis plicifer	NT					X			
Guibemantis albolineatus	DD					X			
Guibemantis cf. bicalcaratus	NE					X			
Guibemantis cf.albolineatus	NE					X			
Guibemantis depressiceps	LC					X			
Guibemantis flavobrunneus	NE					X			
Guibemantis liber	LC					X			
Guibemantis tornieri	LC					X			
Heterixalus betsileo	LC					X			
Mantella aurantiaca	CR				X		pet trade, CITES II		
Mantella baroni	NE					X	pet trade, CITES II		
Mantella crocea	EN				X		pet trade, CITES II		
Mantidactylus argenteus	LC					X			
Mantidactylus betsileanus	LC					X			

Key Biodiversity Components Matrix

Biodiversity Component	Biodiversity Assessment								Justification (Insert comments here explaining data entered in columns A to I)
	Intrinsic, 'non use' Values						Use Values		
	Significance			Irreplaceability (mark only one)			Socioeconomic Values	Cultural Values	
	Global	National	Local	Site Endemic	Localized	Widespread			
Species									
Mantidactylus cf. betsileanus	NE					X			
Mantidactylus femoralis	LC					X			
Mantidactylus guttulatus	LC					X			
Mantidactylus melanopleura	LC					X			
Mantidactylus opiparis	LC					X			
Mantidactylus sp. C	NE					X			
Mantidactylus sp. H	NE					X			
Mantidactylus zipperi	LC					X			
Paradoxophyla palmata	NE					X			
Platypelis barbouri	LC					X			
Platypelis cf.barbouri	NE					X			
Platypelis grandis	LC					X			
Platypelis pollicaris	DD					X			
Platypelis sp. (aff. *mavomavo)*	NE					X			
Platypelis sp.nov	NE	new undescribed species				X			
Platypelis tuberifera	LC					X			
Plethodontohyla inguinalis	LC					X			
Plethodontohyla mihanika	LC					X			
Plethodontohyla notosticta	LC					X			
Plethodontohyla nov. sp.	NE				X				
Plethodontohyla sp.	NE					X			
Rhombophryne alluaudi	LC					X			
Rhombophryne coronata	VU					X			
Rhombophryne coronata	VU					X			
Scaphiophryne marmorata	VU					X			
Scaphiophryne spinosa	NE					X			
Spinomantis aglavei	LC					X			
Spinomantis phantasticus	NE					X			
Stumpffia sp. "*kibomena*"	NE				X				
FISH									
Ratsirakia sp nov 1 (Mangoro catchment)	NE	new undescribed species			X				
Ratsirakia sp nov 2 (Berano catchment)	NE	new undescribed species			X				
Rheocles alaotrensis	VU				X				
Rheocles spp ? (Berano catchment)	NE	potential new species			X				
Rheocles spp ? (Mangoro catchment)	NE	potential new species			X				
INSECTS									
Amblyopone sp. mad-01	NE	rare			X				
Amblyopone sp.2	NE	rare			X				
Artitropa hollandi	NE	rare				X			
Cerapachys lividus	NE	rare			X				
Cerapachys sp. mad-38	NE	rare			X				
Cerapachys sp.6	NE	rare			X				
Cerapachys sp.7	NE	rare			X				
Coeliades fidia	NE	rare				X			
Colotis lucasi	NE	rare				X			
Fulda imorina	NE	rare				X			
Heteropsis andasibe	NE	rare			X				
Heteropsis paradoxa	NE	rare				X			
Hovala sp. 2	NE	rare			X				
Malaza carmides	NE	rare				X			
Mystrium mysticum	NE	rare			X				
Mystrium rogeri	NE	rare			X				
Proceratium sp.1	NE	rare			X				
Smerina manoro	NE	rare				X			
Strabena consobrina	NE	rare			X				
Strabena dyscola	NE	rare			X				
Strabena modestissima	NE	rare				X			
Strabena niveata	NE	rare				X			
Strabena perroti	NE	rare				X			
Vitsika sp.1	NE	rare			X				
FLORA									
Adenia acuta		rare			X				
Aerangis citrata		rare			X		ornemental		
Aerangis fastuosa		rare			X		ornemental		
Aerangis macrocentra		rare			X		ornemental		
Aerangis sp.		rare			X		ornemental		
Aerangis stylosa		rare			X		ornemental		
Aeranthes adenopoda		rare			X		ornemental		
Aeranthes angustidens		rare			X		ornemental		
Aeranthes antennophora		rare			X		ornemental		
Aeranthes ecalcarata		rare			X		ornemental		
Aeranthes fasciola		rare			X		ornemental		
Aeranthes longipes		rare			X		ornemental		
Aeranthes nidus		rare			X		ornemental		
Aeranthes peyrotii		rare			X		ornemental		
Aeranthes sp.		rare			X		ornemental		
Aloe leandrii		rare			X		medicinal value		
Amyrea sp		patrimonial value				X			as defined by MBG
Angraecum calceolus		rare			X		ornemental		
Angraecum caricifolium		rare			X		ornemental		
Angraecum chaetopodum		rare			X		ornemental		
Angraecum chloranthum		rare			X		ornemental		
Angraecum compactum		rare			X		ornemental		
Angraecum danguyanum		rare			X		ornemental		
Angraecum filicornu		rare			X		ornemental		
Angraecum finetianum		rare			X		ornemental		
Angraecum germinyanum		rare			X		ornemental		
Angraecum graminifolium		rare			X		ornemental		
Angraecum humblotianum		rare			X		ornemental		
Angraecum lecomtei		rare			X		ornemental		
Angraecum linearifolium		rare			X		ornemental		
Angraecum mauritianum		rare			X		ornemental		
Angraecum panicifolium		rare			X		ornemental		
Angraecum pinifolium		rare			X		ornemental		

Key Biodiversity Components Matrix

Biodiversity Component	Biodiversity Assessment								Justification
	Intrinsic, 'non use' Values						Use Values		*(Insert comments here explaining data entered in columns A to I)*
	Significance			Irreplaceability *(mark only one)*					
	Global	National	Local	Site Endemic	Localized	Widespread	Socioeconomic Values	Cultural Values	
Species									
Angraecum rhynchoglossum		rare			X		ornemental		
Angraecum rostratum		rare			X		ornemental		
Angraecum sedifolium		rare			X		ornemental		
Angraecum setipes		rare			X		ornemental		
Angraecum sp.		rare			X		ornemental		
Angraecum teretifolium		rare			X		ornemental		
Angraecum urschianum		rare			X		ornemental		
Angraecum viguieri		rare			X		ornemental		
Antirhea borbonica		rare			X				
Asparagus similens						X		Magical	against demonic possessions
Aspidostemon conoideum		rare			X				
Asplenium nidus		patrimonial value				X			as defined by MBG
Asplenium sp		patrimonial value				X			as defined by MBG
Asteropeia mcphersonii	VU	rare			X		timber for construction, bark = medicinal		
Astrotrichilia parvifolia		rare			X				
Baroniella acuminata		rare			X				
Baroniella linearis		rare			X				
Bathioramnus sp		patrimonial value				X			as defined by MBG
Benthamia sp.		rare			X		ornemental		
Biophytum sp. nov.		rare			X		ornemental		
Brexia montana		rare			X				
Bulbomolossus sp1		patrimonial value				X			as defined by MBG
Bulbomolossus sp2		patrimonial value				X			as defined by MBG
Bulbophyllum alexandrae		rare			X		ornemental		
Bulbophyllum analamazoatrae		rare			X		ornemental		
Bulbophyllum ankaizinense		rare			X		ornemental		
Bulbophyllum aubrevillei		rare			X		ornemental		
Bulbophyllum auriflorum		rare			X		ornemental		
Bulbophyllum baronii		rare,patrimonial value			X		ornemental		
Bulbophyllum complanatum		rare			X		ornemental		
Bulbophyllum coriophorum		rare			X		ornemental		
Bulbophyllum francoisii		rare			X		ornemental		
Bulbophyllum leandrianum		rare			X		ornemental		
Bulbophyllum longiflorum		rare			X		ornemental		
Bulbophyllum lyperocephalum		rare			X		ornemental		
Bulbophyllum molossus		rare			X		ornemental		
Bulbophyllum multiflorum		rare			X		ornemental		
Bulbophyllum occlusum		rare			X		ornemental		
Bulbophyllum occultum		rare			X		ornemental		
Bulbophyllum oxycalyx		rare			X		ornemental		
Bulbophyllum pachypus		rare			X		ornemental		
Bulbophyllum peyrotii		rarepatrimonial value			X		ornemental		
Bulbophyllum platypodum		rare			X		ornemental		
Bulbophyllum rhizomatosum		rare			X		ornemental		
Bulbophyllum sandrangatense		rare			X		ornemental		
Bulbophyllum sp. indet.		rare			X		ornemental		
Bulbophyllum sulfureum		rare			X		ornemental		
Burasaia sp. nov A		rare			X				
Byttneria heteromorpha		rare			X				
Caesalpinia delphinensis		rare			X				
Calantica sp nov.		rare			X				
Calophyllum mulvis						X		Magical	against thunder
Canarium sp. 2 (egregium)		rare			X				
Carallia brachiata						X		Magical	astrology
Carex sphaerogyna		rare			X				
Cassinopsis sp. nov.		rare			X				
Ceropegia cf. racemosa		rare			X				
Chassalia bojeri		rare			X				
Chassalia leptothyrsa		rare			X				
Chassalia stenantha		rare			X				
Cheirostylis gymnochiloides		rare			X		ornemental		
Cirrhopetalum longiflorum		rare			X		ornemental		
Claoxylon lancifolium		rare			X				
Claoxylopsis purpurascens		rare			X				
Cleistanthus sp. 1		rare			X				
Coffea liaudii		rare			X				
Coffea mangoroensis		rare, patrimonial value			X				
Colea fusca		rare			X				
Colea sp nov. A		rare			X				
Combretum sp. nov.		rare			X				
Coptosperma sp. nov. '17'		rare			X				
Coptosperma sp. nov. '36'		rare			X				
Craterispermum laurinum		rare			X				
Croton alceicornu		rare			X				
Croton droguetioides		rare			X				
Croton lepidotoides		rare			X				
Croton sp. cf. jennyanum		rare			X				
Croton sp. nov. cf nitidulus 'cinereum'		rare			X				
Cryptocarya myristicoides		rare			X				
Cryptocarya pervillei		rare			X				
Cryptocarya spathulata		rare			X				
Cryptopus brachiatus		rare			X		ornemental		
Cryptopus paniculatus		rare			X		ornemental		
Cyathea cf tsaratananensis							CITES II		
Cyathea dregei						X	CITES II		
Cyathea hildebrandtii		rare			X				
Cynanchum moramangense		rare			X				
Cynorkis angustipetala		rare			X		ornemental		
Cynorkis aurantiaca		rare			X		ornemental		
Cynorkis fastigiata		rare			X		ornemental		
Cynorkis flexuosa		rare			X		ornemental		
Cynorkis gibbosa		rare			X		ornemental		
Cynorkis graminea		rare			X		ornemental		
Cynorkis jumelleana		rare			X		ornemental		
Cynorkis lilacina		rare			X		ornemental		
Cynorkis lowiana		rare			X		ornemental		
Cynorkis purpurascens		rare			X		ornemental		

Key Biodiversity Components Matrix

Biodiversity Component	Biodiversity Assessment								Justification (Insert comments here explaining data entered in columns A to I)
	Intrinsic, 'non use' Values						Use Values		
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	Global	National	Local	Site Endemic	Localized	Widespread			
Species									
Cynorkis ridleyi		rare			X		ornemental		
Cynorkis sp.		rare			X		ornemental		
Cynorkis uncinata		rare			X		ornemental		
Cyperus longifolius		rare			X				
Dalbergia baronii	VU					X	timber for furniture (rose wood)		
Danais andribensis		rare			X				
Danais humblotii		rare			X				
Danais ligustrifolia		rare			X				
Danais pauciflora		rare			X				
Danais pubescens		rare			X				
Dicoryphe laurina		rare			X				
Dilobea thouarsii		patrimonial value				X			as defined by MBG
Diospyros sp		patrimonial value				X			as defined by MBG
Diporidium louvelii		rare			X				
Disperis oppositifolia		rare			X		ornemental		
Distephanus aff. garnieriana		rare			X				
Dombeya biumbellata		rare			X				
Dombeya megaphylla		rare			X				
Dombeya sp		patrimonial value				X			as defined by MBG
Dombeya spectabilis		rare			X				
Dracaena sp. 3		rare			X				
Dracaena sp2		patrimonial value				X			as defined by MBG
Dypsis sp. nov. 2 (aff. hildebrandtii)		rare			X				
Elaphoglossum sp. 'B'		rare			X				
Embelia nummulariifolia		rare			X				
Erica sp. 'senescens'		rare			X				
Erythroxylum "sp. 2		rare			X				
Erythroxylum ferrugineum		rare			X				
Erythroxylum sp. 1		rare			X				
Erythroxylum sp. 3		rare			X				
Erythroxylum sp. 4		rare			X				
Erythroxylum sp. 5		rare			X				
Erythroxylum sp. 6		rare			X				
Erythroxylum sp. 7		rare			X				
Erythroxylum sp. 8		rare			X				
Eugenia alaotrensis		rare			X				
Eugenia arthroopoda		rare			X				
Eugenia goviala		rare			X				
Eugenia sp. Nov 3		rare			X				
Eugenia sp. Nov 4		rare			X				
Eugenia sp. Nov. 1		rare			X				
Eugenia sp. Nov. 2		rare			X				
Euphorbia rangovalensis		rare			X				
Exacum bulbilliferum		rare			X				
Filicium sp		patrimonial value				X			as defined by MBG
Gaertnera aff. Pauciflora		rare			X				
Gaertnera madagascariensis		rare			X				
Gaertnera obovata		rare			X				
Gaertnera obovata		rare			X				
Gaertnera phanerophlebia		rare			X				
Gaertnera phyllostachya		rare			X				
Gallienia sclerophylla		rare			X				
Gastropis sp		patrimonial value				X			as defined by MBG
Gastrorchis francoisii		rare			X		ornemental		
Gastrorchis humblotii		rare			X		ornemental		
Gastrorchis pulchra		rare			X		ornemental		
Gouania mauritiana						X		Magical	against evil spirits
Grammangis ellisii		rare			X		ornemental		
Grammangis sp. indet.		rare			X		ornemental		
Gravesia setifera		rare			X				
Gravesia setifera vel. sp.aff.		rare			X				
Gravesia sp. nov. cf. baronii		rare			X				
Gravesia tanalensis		rare			X				
Gussonea gilpinae		rare			X		ornemental		
Habenaria sp. indet.		rare			X		ornemental		
Helichrysum sp. nov. aff. ambondrombeense		rare			X				
Homalium axillare		rare			X				
Homalium maringitra		rare			X				
Homolliella sericea		rare			X				
Homolliella sp. nov. 'pauciflora' ined.		rare			X				
Hyperacanthus sp. indet.		rare			X				
Hyperacanthus sp. nov. ined. 'mangoroensis'		rare			X				
Hyperacanthus thouvenotii		rare			X				
Inula speciosa		rare			X				
Ixora trichocalyx		rare			X				
Jasminum sp		patrimonial value				X			as defined by MBG
Jumellea arborescens		rare			X		ornemental		
Jumellea brachycentra		rare			X		ornemental		
Jumellea francoisii		rare			X		ornemental		
Jumellea gracilipes		rare			X		ornemental		
Jumellea lignosa		rare			X		ornemental		
Jumellea punctata		rare			X		ornemental		
Jumellea sagittata		rare			X		ornemental		
Jumellea sp.		rare			X		ornemental		
Jumellea teretifolia		rare			X		ornemental		
Keraudrenia macrantha		rare			X				
Khaya madagascariensis		rare			X				
Korthalsella commersonii		rare			X				
Lemurella virescens		rare			X		ornemental		
Lemyrea sp.		rare			X				
Leptolaena multiflora	EN					X	imber for construction, bark = medicinal		
Leptolaena sp2		patrimonial value				X			as defined by MBG
Liparis bulbophylloides		rare			X		ornemental		
Liparis hildebrandtiana		rare			X		ornemental		
Liparis jumelleana		rare			X		ornemental		
Liparis longicaulis		rare			X		ornemental		
Liparis sp		rare			X		ornemental		

Key Biodiversity Components Matrix

Biodiversity Component	Biodiversity Assessment								Justification (Insert comments here explaining data entered in columns A to I)
	Intrinsic, 'non use' Values						Use Values		
	Significance			Irreplaceability (mark only one)			Socioeconomic Values	Cultural Values	
	Global	National	Local	Site Endemic	Localized	Widespread			
Species									
Ludia madagascariensis		rare			X				
Ludia sp. nov. 1.aff. scolopioides		rare			X				
Ludia sp. nov. 2		rare			X				
Ludia sp. nov. 3		rare			X				
Ludwia sp		patrimonial value				X			as defined by MBG
Macaranga racemosa		rare			X				
Mailardia sp		patrimonial value				X			as defined by MBG
Margaritaria sp. nov. A		rare			X				
Medinilla cf. oblongifolia		rare			X				
Medinilla chermezonii		rare			X				
Medinilla lophoclada		rare			X				
Medinilla mandrakensis		rare			X				
Medinilla micrantha		rare			X				
Medinilla sp nov 2.		rare			X				
Medinilla sp. nov. 1		rare			X				
Meineckia orientalis		rare			X				
Melicope discolor		rare			X				
Melicope sp. nov.		rare			X				
Memecylon faucherei		rare			X				
Memecylon sp. nov. aff. vaccinioides		rare			X				
Mendoncia sp. nov. 1		rare			X				
Microcoelia gilpinae		rare			X		ornemental		
Microcoelia macrantha		rare			X		ornemental		
Molinaea sp. nov		rare			X				
Morinda retusa		rare			X				
Morinda sp. nov.		rare			X				
Mussaenda arcuata		rare			X				
Neobathia sp		patrimonial value				X			as defined by MBG
Nervilia bicarinata		rare			X		ornemental		
Noronhia emarginata		rare			X				
Noronhia gracilipes		rare			X				
Noronhia louvelii		rare			X				
Noronhia sp nov. A		rare			X				
Noronhia sp. nov E		rare			X				
Noronhia sp. nov. C		rare			X				
Oberonia disticha		rare			X		ornemental		
Ochrocarpos orthocladus		rare			X				
Oeonia oncidiiflora		rare			X		ornemental		
Oeonia rosea		rare			X		ornemental		
Oeonia volucris		rare			X		ornemental		
Oeoniella polystachys		rare			X		ornemental		
Olax emirnensis						X		Magical	against bad luck
Oldenlandia lancifolia		rare			X				
Oldenlandia trinervia		rare			X				
Oncostemum cauliflorum		rare			X				
Oncostemum evonymoides		rare			X				
Oncostemum filicinum		rare			X				
Oncostemum humbertianum		rare			X				
Oncostemum laevigatum		rare			X				
Oncostemum linearisepalum		rare			X				
Oncostemum neriifolium		rare			X				
Oncostemum nitidulum		rare			X				
Oncostemum oliganthum		rare			X				
Oncostemum paniculatum		rare			X				
Oncostemum sp nov aff. triflorum		rare			X				
Oncostemum sp. cf. leprosum		rare			X				
Oncostemum sp. nov. D		rare			X				
Oncostemum triflorum		rare			X				
Paederia mandrarensis		rare			X				
Pauridiantha paucinervis		rare			X				
Pellaea sp		patrimonial value				X			as defined by MBG
Peltiera nitida		rare			X				
Pentopetia cotoneaster		rare			X				
Pentopetia longipetala		rare			X				
Pentopetia pinnata		rare			X				
Phaius pulchellus		rare			X		ornemental		
Phaius pulcher		rare			X		ornemental		
Phylica emirnensis		rare			X				
Phyllanthus moramangicus		rare			X				
Phyllarthron sp		patrimonial value				X			as defined by MBG
Phylloxylum sp		patrimonial value				X			as defined by MBG
Platylepis polyadenia		rare			X		ornemental		
Plectrantus sp		patrimonial value				X			as defined by MBG
Podocarpus sp		patrimonial value				X			as defined by MBG
Polyscias sp. nov. 'abrahamiana'		rare			X				
Polyscias sp. nov. 'ambatovyensis'		rare			X				
Polyscias sp. nov. 'anjozorobensis'		rare			X				
Polystachya aurantiaca		rare			X		ornemental		
Polystachya concreta		rare			X		ornemental		
Polystachya cornigera		rare			X		ornemental		
Polystachya cultriformis		rare			X		ornemental		
Polystachya fusiformis		rare			X		ornemental		
Polystachya humberti		rare			X		ornemental		
Polystachya mauritiana		rare			X		ornemental		
Polystachya rosea		rare			X		ornemental		
Polystachya rosellata		rare			X		ornemental		
Polystachya sp.		rare			X		ornemental		
Polystachya tsinjoarivensis		rare			X		ornemental		
Pseudopteris sp		patrimonial value				X			as defined by MBG
Psorospermum nervosum		rare			X				
Psorospermum sp. nov. A. aff. rienanense		rare			X				
Psorospermum sp. nov. B.		rare			X				
Psychotria sp		patrimonial value				X			as defined by MBG
Psychotria taxifolia		rare			X				
Pycreus ferrugineus		rare			X				
Pyrenacantha humblotii		rare			X				
Pyrenacantha laetevirens		rare			X				

Key Biodiversity Components Matrix

Biodiversity Component	Biodiversity Assessment – Intrinsic, 'non use' Values – Significance: Global	National	Local	Irreplaceability (mark only one): Site Endemic	Localized	Widespread	Use Values: Socioeconomic Values	Cultural Values	Justification (Insert comments here explaining data entered in columns A to I)
Species									
Pyrostria analamazaotrensis		rare			X				
Rhodolaena bakeriana		patrimonial value				X			as defined by MBG
Rhynchospora sp. nov. 1		rare			X				
Saldinia coursiana		rare			X				
Saldinia mandracensis		rare			X				
Saldinia myrtilloides		rare			X				
Saldinia proboscidea		rare			X				
Saldinia sp		patrimonial value				X			as defined by MBG
Sarcolaena sp		patrimonial value				X			as defined by MBG
Schismatoclada concinna		rare			X				
Schismatoclada psychotrioides		rare			X				
Scleria madagascariensis		rare			X				
Scolopia taimbarina		rare			X				
Scolopia thouvenoti		rare			X				
Secamone glaberrima		rare			X				
Secamone sp. aff. Perrieri		rare			X				
Secamone sp. nov. 1		rare			X				
Selaginella lyalii		patrimonial value				X			as defined by MBG
Senecio vel. sp. aff. multidenticulatus		rare			X				
Stenandrium amoenum		rare			X				
Syzigium sp. 1		rare			X				
Syzigium sp. 2		rare			X				
Syzigium sp. 3		rare			X				
Syzygium bernieri		rare			X				
Syzygium condensatum		rare			X				
Syzygium emirnense		rare			X				
Syzygium lugubre		rare			X				
Syzygium onivense		rare			X				
Syzygium parkeri		rare			X				
Tacca sp		patrimonial value				X			as defined by MBG
Tambourissa capuronii		rare			X				
Tambourissa sp nov. aff. mandrarensis		rare			X				
Tambourissa sp. nov. A		rare			X				
Tambourissa trichophylla		rare			X				
Tarenna alleizettei		rare			X				
Tarenna sp. nov. aff spiranthera		rare			X				
Terminalia sp		patrimonial value				X			as defined by MBG
Terminalia sp		patrimonial value				X			as defined by MBG
Tragia perrieri		rare			X				
Tricalysia sp. ined. 'analamazaotrensis'		rare			X				
Tristellateia grandiflora		rare			X				
Vepris sp1		patrimonial value				X			as defined by MBG
Vepris sp2		patrimonial value				X			as defined by MBG
*Vigueranthus sp_*		patrimonial value				X			as defined by MBG
Viguieranthus sp.						X		Magical	sorcellery
Viscum multicostatum		rare			X				
Viscum radula		rare			X				
Viscum sp. Nov. 1		rare			X				
Viscum sp. Nov. 2		rare			X				
Vitex coursii		rare			X				
Vitex oscitans		rare			X				
Xylopia sp		patrimonial value				X			as defined by MBG
Communities/Habitats									
Azonal thicket	X				X		medecinal, bushmeat		
Disturbed azonal thicket	X				X		medecinal, bushmeat		
Azonal forest	X				X		medecinal, bushmeat		
Disturbed azonal forest	X				X		medecinal, bushmeat		
Brunt azonal forest	X								
Disturbed azonal habitat (sucessions I and II)	X				X				
Disturbed azonal habitat (sparse vegetation)	X								
Transitional forest of azonal influence on gabbro sustratum	X				X		timbers, medecinal, bushmeat, water ressources		
Distrubed transitional forest of azonal influence on gabbro sustra	X				X		timbers, medecinal, bushmeat, water ressources		
Transitional forest	X				X		timbers, medecinal, bushmeat, water ressources		
Exploited transitional forest	X				X		timbers, medecinal, bushmeat, water ressources		
Moderately exploited zonal forest		X			X	X	ers, medecinal, bushmeat, water ressources		
Moderately exploited zonal gallery forest		X			X	X	ers, medecinal, bushmeat, water ressources		
Heavily exploited zonal forest (with other disturbances), mine and pipeline							timber, medecinal, bushmeat		
Ephemeral ponds	X				X				
Streams	X				X		water resources		
Whole Landscapes/Ecosystems									
Edaphic mid-altitudinal eastern humid forest on laterite profil abo	X				X		timbers, medecinal, bushmeat, water ressources		

Key to Global Significance Criteria

Further detailed information is available at **http://www.iucnredlist.org/info/categories_criteria2001**.

EXTINCT (EX)

A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

EXTINCT IN THE WILD (EW)

A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR)

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild.

ENDANGERED (EN)

A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild.

VULNERABLE (VU)

A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild.

NEAR THREATENED (NT)

A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC)

A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD)

A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE)

A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

CALCULATING BIODIVERSITY LOSS AT IMPACT SITE
(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: **Azonal thicket**

Total Habitat Hectares Lost: **620.00**

1. ***To the left, label each pre-project site condition class found.***
   (Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. ***Fill in the area of …***
   (enter "0" for non-relevent condition classes and impact levels)

	… of Condition Class 1: Quasi pristine primary forest	…of Condition Class 2: Disturbed primary forest	…of Condition Class 3:
Each Site Class…	**590.74**	**475.55**	**0**
Post-Project, High Impact Sites…	528.86	427.22	0
Post-Project, Medium Impact Sites…	61.88	48.33	0
Post-Project, Low Impact Sites…	0	0	0

3. ***For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…***

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	BENCHMARK: Weight	BENCHMARK: Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Quasi pristine primary forest Condition/ Level	Condition Class 1: Net Loss	Condition Class 2: Disturbed primary forest Condition/ Level	Condition Class 2: Net Loss	Condition Class 3: 0 Condition/ Level	Condition Class 3: Net Loss	Habitat Hectares Lost	Rationale (enter comments explaining data in columns B to Q)
Steams	1015	stems number/ha	0.15	NT	Pre-Project	911		285				89.19445714	
					Post-Project, High Impact Sites	0	911	0	285		0		
					Post-Project, Medium Impact Sites	911	0	285	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Number of tree species	41	Tree species/ha	0.2	NT	Pre-Project	43		18				148.4436098	No mitigation Year _0
					Post-Project, High Impact Sites	0	43	0	18		0		
					Post-Project, Medium Impact Sites	43	0	18	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Canopy height	11.5	Meter	0.05	NT	Pre-Project	8.98		5.45				30.77179043	
					Post-Project, High Impact Sites	0	8.98	0	5.45		0		
					Post-Project, Medium Impact Sites	8.98	0	5.45	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Basal area	19.6	m2/ha	0.05	NT	Pre-Project	19.42		3.55				30.06911276	
					Post-Project, High Impact Sites	0	19.42	0	3.55		0		
					Post-Project, Medium Impact Sites	19.42	0	3.55	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Dbh	9.74	cm	0.05	NT	Pre-Project	13.29		9.95				57.90240452	
					Post-Project, High Impact Sites	0	13.29	0	9.95		0		
					Post-Project, Medium Impact Sites	13.29	0	9.95	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Propithecus diadema density	0.033	number/ha	0.2	NT	Pre-Project	0.033		0				105.772	
					Post-Project, High Impact Sites	0	0.033	0	0		0		
					Post-Project, Medium Impact Sites	0.033	0	0	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Allocebus density	0.025	number/ha	0.1	NT	Pre-Project	0.0248		0				52.886	
					Post-Project, High Impact Sites	0	0.0248	0	0		0		
					Post-Project, Medium Impact Sites	0.0248	0	0	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Indri indri density	0.013	number/ha	0.2	NT	Pre-Project	0.013		0				104.9645802	
					Post-Project, High Impact Sites	0	0.013	0	0		0		
					Post-Project, Medium Impact Sites	0.013	0	0	0		0		
					Post-Project, Low Impact Sites		0		0		0		

LOSS AT IMPACT SITE

(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 2: **Transitional Forests**

Total Habitat Hectares Lost: **239**

1. To the left, label each pre-project site condition class found.

(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. Fill in the area of …

(enter "0" for non-relevent condition classes and impact levels)

	… of Condition Class 1: Quasi pristine primary forest	…of Condition Class 2: Disturbed primary forest	…of Condition Class 3: *[Fill in name here]*
Each Site Class…	**126.37**	**328.22**	
Post-Project, High Impact Sites…	53.38	222.68	
Post-Project, Medium Impact Sites…	72.99	105.54	
Post-Project, Low Impact Sites…			

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK: Reference Level #	Units/ Bands	Weight	Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Quasi pristine primary forest Condition/ Level	*Net Loss*	Condition Class 2: Disturbed primary forest Condition/ Level	*Net Loss*	Condition Class 3: Condition/ Level	*Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Stems	1273	stems/ha	0.15	NT	Pre-Project	1045		880				29.6630597	
					Post-Project, High Impact Sites		1045		880		0		
					Post-Project, Medium Impact Sites	1045	0	880	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Number of Tree species	138	Tree species/ha	0.2	NT	Pre-Project	138		55				28.42585507	
					Post-Project, High Impact Sites		138		55		0		
					Post-Project, Medium Impact Sites	138	0	55	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Canopy height	8.55	m	0.05	NT	Pre-Project	8.48		10.1				15.79959298	
					Post-Project, High Impact Sites		8.48		10.1		0		
					Post-Project, Medium Impact Sites	8.48	0	10.1	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Basal area	24.87	m2/ha	0.05	NT	Pre-Project	23.88		17.2				10.26298834	
					Post-Project, High Impact Sites		23.88		17.2		0		
					Post-Project, Medium Impact Sites	23.88	0	17.2	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Dbh	7.65	cm	0.05	NT	Pre-Project	12.26		9.18				17.63817778	
					Post-Project, High Impact Sites		12.26		9.18		0		
					Post-Project, Medium Impact Sites	12.26	0	9.18	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Propithecus diadema density	0.033	number/ha	0.2	NT	Pre-Project	0.033		0.033				55.212	
					Post-Project, High Impact Sites		0.033		0.033		0		
					Post-Project, Medium Impact Sites	0.033	0	0.033	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Allocebus density	0.0248	number/ha	0.1	NT	Pre-Project	0.0248		0.0248				27.606	
					Post-Project, High Impact Sites		0.0248		0.0248		0		
					Post-Project, Medium Impact Sites	0.0248	0	0.0248	0		0		
					Post-Project, Low Impact Sites		0		0		0		
Indri indri density	0.0131	number/ha	0.2	NT	Pre-Project	0.013		0.013				54.79053435	
					Post-Project, High Impact Sites		0.013		0.013		0		
					Post-Project, Medium Impact Sites	0.013	0	0.013	0		0		
					Post-Project, Low Impact Sites		0		0		0		

LOSS AT IMPACT SITE
(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 3: **Zonal Forests**

Total Habitat Hectares Lost: **305.13**

1. To the left, label each pre-project site condition class found.
(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. Fill in the area of …
(enter "0" for non-relevent condition classes and impact levels)

	… of Condition Class 1: Quasi pristine primary forest	…of Condition Class 2: Disturbed primary forest	…of Condition Class 3: [Fill in name here]
Each Site Class…	**412.74**	**124.97**	
Post-Project, High Impact Sites…	256.9	14.94	
Post-Project, Medium Impact Sites…	155.84	110.03	
Post-Project, Low Impact Sites…			

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK Reference Level #	Units/ Bands	Weight	Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Quasi pristine primary forest Condition/ Level	Condition Class 1: Net Loss	Condition Class 2: Disturbed primary forest Condition/ Level	Condition Class 2: Net Loss	Condition Class 3: Condition/ Level	Condition Class 3: Net Loss	Habitat Hectares Lost	Rationale (enter comments explaining data in columns B to Q)
Stems	1065	Stem number/ha	0.15	NT	Pre-Project	1207		970				45.71409859	
					Post-Project, High Impact Sites		1207		970		0		
					Post-Project, Medium Impact Sites	1207	0	970	0		0		
					Post-Project, Low Impact Sites		1207		970		0		
Number of tree species	72	Tree species/ha	0.2	NT	Pre-Project	107		30				77.60138889	
					Post-Project, High Impact Sites		107		30		0		
					Post-Project, Medium Impact Sites	107	0	30	0		0		
					Post-Project, Low Impact Sites		107		30		0		
Canopy height	9.9	meter	0.05	NT	Pre-Project	10.5		12.65				14.57798485	
					Post-Project, High Impact Sites		10.5		12.65		0		
					Post-Project, Medium Impact Sites	10.5	0	12.65	0		0		
					Post-Project, Low Impact Sites		10.5		12.65		0		
Basal area	22	m2/ha	0.05	NT	Pre-Project	33.3		21.65				20.177775	
					Post-Project, High Impact Sites		33.3		21.65		0		
					Post-Project, Medium Impact Sites	33.3	0	21.65	0		0		
					Post-Project, Low Impact Sites		33.3		21.65		0		
Dbh	14.91	cm	0.05	NT	Pre-Project	13.77		15.44				12.84548156	
					Post-Project, High Impact Sites		13.77		15.44		0		
					Post-Project, Medium Impact Sites	13.37	0.4	15.44	0		0		
					Post-Project, Low Impact Sites		13.77		15.44		0		
Propithecus diadema density	0.033	number/ha	0.2	NT	Pre-Project	0.033		0.033				54.368	
					Post-Project, High Impact Sites		0.033		0.033		0		
					Post-Project, Medium Impact Sites	0.033	0	0.033	0		0		
					Post-Project, Low Impact Sites		0.033		0.033		0		
Allocebus density	0.0248	number/ha	0.1	NT	Pre-Project	0.025		0				25.89717742	
					Post-Project, High Impact Sites		0.025		0		0		
					Post-Project, Medium Impact Sites	0.025	0	0	0		0		
					Post-Project, Low Impact Sites		0.025		0		0		
Indri indri density	0.0131	number/ha	0.2	NT	Pre-Project	0.013		0.013				53.9529771	
					Post-Project, High Impact Sites		0.013		0.013		0		
					Post-Project, Medium Impact Sites	0.013	0	0.013	0		0		
					Post-Project, Low Impact Sites		0.013		0.013		0		

LOSS AT IMPACT SITE

(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 4: **Pipeline degraded zonal forests** **Total Habitat Hectares Lost:** **3.83**

1. To the left, label each pre-project site condition class found.
(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. Fill in the area of …
(enter "0" for non-relevent condition classes and impact levels)

	… of Condition Class 1:	…of Condition Class 2:	…of Condition Class 3: Heavily fragmented and degraded primary forest
Each Site Class…			**71.04**
Post-Project, High Impact Sites…			16.5
Post-Project, Medium Impact Sites…			4.95
Post-Project, Low Impact Sites…			

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK Reference Level #	Units/ Bands	Weight	Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: 0 Condition/ Level	*Net Loss*	Condition Class 2: 0 Condition/ Level	*Net Loss*	Condition Class 3: Heavily fragmented and degraded primary forest Condition/ Level	*Net Loss*	Habitat Hectares Lost	Rationale (enter comments explaining data in columns B to Q)
Stems	1065	Stems/ha	0.15	NT	Pre-Project					104		0.241690141	
					Post-Project, High Impact Sites		0		0		104		
					Post-Project, Medium Impact Sites		0		0	104	0		
					Post-Project, Low Impact Sites		0		0		104		
Number of tree species	72	Tree species/500m2	0.2	NT	Pre-Project					45		2.0625	
					Post-Project, High Impact Sites		0		0		45		
					Post-Project, Medium Impact Sites		0		0	45	0		
					Post-Project, Low Impact Sites		0		0		45		
Canopy height	9.9	m	0.05	NT	Pre-Project					4.139		0.344916667	
					Post-Project, High Impact Sites		0		0		4.139		
					Post-Project, Medium Impact Sites		0		0	4.139	0		
					Post-Project, Low Impact Sites		0		0		4.139		
Volume	34.17	m3/ha	0.05	NT	Pre-Project					14.502		0.350136084	
					Post-Project, High Impact Sites		0		0		14.502		
					Post-Project, Medium Impact Sites		0		0	14.502	0		
					Post-Project, Low Impact Sites		0		0		14.502		
Dbh	14.91	cm	0.05	NT	Pre-Project					14.978		0.828762575	
					Post-Project, High Impact Sites		0		0		14.978		
					Post-Project, Medium Impact Sites		0		0	14.978	0		
					Post-Project, Low Impact Sites		0		0		14.978		
Propithecus diadema density	0.033	number/ha	0.2	NT	Pre-Project					0		0	
					Post-Project, High Impact Sites		0		0		0		
					Post-Project, Medium Impact Sites		0		0	0	0		
					Post-Project, Low Impact Sites		0		0		0		
Allocebus density	0.0248	number/ha	0.1	NT	Pre-Project					0		0	
					Post-Project, High Impact Sites		0		0		0		
					Post-Project, Medium Impact Sites		0		0	0	0		
					Post-Project, Low Impact Sites		0		0		0		
Indri indri density	0.0131	number/ha	0.2	NT	Pre-Project					0		0	
					Post-Project, High Impact Sites		0		0		0		
					Post-Project, Medium Impact Sites		0		0	0	0		
					Post-Project, Low Impact Sites		0		0		0		

Appendix 2: Key Biodiversity Components Matrix (KBCM) and Habitat Hectares Score, February 2008 Iteration

Key Biodiversity Components Matrix

Biodiversity Component	Biodiversity Assessment								Justification *(Insert comments here explaining data entered in columns A to I)*
	Intrinsic, 'non use' Values						Use Values		
	Significance			Irreplaceability *(mark only one)*			Socioeconomic Values	Cultural Values	
	Global	National	Local	Site Endemic	Localized	Widespread			
Species									
Prolemur simus	CR				X		Ecotourism, bush meat		Ecological services: main seeds disperseurs
Propithecus d. diadema	CR				X		Ecotourism, bush mea	Tabou	Existence of illegal bush meat for all these lemur species
Indri indri	EN				X		Ecotourism, bush mea	Tabou	
Allocebus trichotis	EN				X		Ecotourism, bush meat		
Daubentonia madagascarensis	EN					X	Ecotourism, bush mea	Tabou	
Tyto soumagnei	EN				X		Ecotourism		
Platypelis sp. nov			X		X		Rational exportation		There's annual quota for those species under CITES exporation. However, there are lacks of study on population density
Scaphiophryne marmorata	VU				X		Rational exportation		
Rhombophryne coronata	VU				X		Rational exportation		
Mantella aurantiaca	CR				X		Rational exportation		
Mantella crocea	EN				X		Rational exportation		
Mantidactylus plicifer	NT				X		Rational exportation		
Pararhadinaea sp.nov			X	X			Rational exportation		
Sanzinia madagascariensis	VU				X		Rational exportation, bush meat		
Aloe leandri			X		X				
Ratsirakia sp			X		X		Bush meat		
Rheocles sp			X		X		Bush meat		
Asteropeia micraster	EN								
Leptolaena multiflora	EN								
Dalbergia baroni	VU								
Cyathea dregei	NE								Cites II
Cyathea cf tsaratananensis	NE								Cites II
Eulemur rubriventer	VU				X		Bush meat		
Communities/Habitats									
Azonal forest	X				X		medecinal, bushmeet,		
Transitional forest	X				X		timbers, medecinal, bushmeet, water ressources		
Zonal forest		X				X	ecinal, bushmeet, water ressources		
Azonal fauna	X				X				
Azonal flora	X				X				
Whole Landscapes/Ecosystems									
Edaphic mid-altitudinal eastern humid for		X			X		forest & water ressources		

For 'Key to Global Significance Criteria' see Appendix 1 above.

CALCULATING BIODIVERSITY LOSS AT IMPACT SITE

(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: **Azonal forest**

Total Habitat Hectares Lost: **859**

1. To the left, label each pre-project site condition class found.

(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. Fill in the area of …

(enter "0" for non-relevent condition classes and impact levels)

	… of Condition Class 1: Good forest	…of Condition Class 2: Disturbed	…of Condition Class 3: Ponds
Each Site Class…	**793.02**	**549.17**	**0**
Post-Project, High Impact Sites…	615	447.04	0
Post-Project, Medium Impact Sites…	0	0	0
Post-Project, Low Impact Sites…	0	0	0

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	BENCHMARK: Weight	BENCHMARK: Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Good forest — Condition/ Level	Condition Class 1: Good forest — *Net Loss*	Condition Class 2: Disturbed — Condition/ Level	Condition Class 2: Disturbed — *Net Loss*	Condition Class 3: Ponds — Condition/ Level	Condition Class 3: Ponds — *Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Steams	586	steam/ha	0.2	NT	Pre-Project	739		263				195.2411331	Good: P.5; Disturbed: P. 20
					Post-Project, High Impact Sites		*739*	0	*263*		*0*		
					Post-Project, Medium Impact Sites		*739*		*263*		*0*		
					Post-Project, Low Impact Sites		*739*		*263*		*0*		
Number of tree species	41	Tree species/500m2	0.25	NT	Pre-Project	58		15				258.3878049	after 30 years estimated approximately about 40% to 60% of the structure attribute value will be restored on the impact site
					Post-Project, High Impact Sites	0	*58*		*15*		*0*		
					Post-Project, Medium Impact Sites		*58*		*15*		*0*		
					Post-Project, Low Impact Sites		*58*		*15*		*0*		
Canopy height variation	9.54	Meter	0.15	NT	Pre-Project	4.43		2.02				57.0357044	
					Post-Project, High Impact Sites	0	*4.43*		*2.02*		*0*		
					Post-Project, Medium Impact Sites		*4.43*		*2.02*		*0*		
					Post-Project, Low Impact Sites		*4.43*		*2.02*		*0*		
Basal area	5.45	m2/ha	0.15	NT	Pre-Project	7.07		1.18				134.1896477	
					Post-Project, High Impact Sites	0	*7.07*		*1.18*		*0*		
					Post-Project, Medium Impact Sites		*7.07*		*1.18*		*0*		
					Post-Project, Low Impact Sites		*7.07*		*1.18*		*0*		
Dbh	9.74	m	0.15	NT	Pre-Project	9.64		7.26				141.2850678	
					Post-Project, High Impact Sites	0	*9.64*		*7.26*		*0*		
					Post-Project, Medium Impact Sites		*9.64*		*7.26*		*0*		
					Post-Project, Low Impact Sites		*9.64*		*7.26*		*0*		
Height to crown	6.13	m3	0.1	NT	Pre-Project	4.98		3.13				72.78850245	
					Post-Project, High Impact Sites	0	*4.98*		*3.13*		*0*		
					Post-Project, Medium Impact Sites		*4.98*		*3.13*		*0*		
					Post-Project, Low Impact Sites		*4.98*		*3.13*		*0*		

Appendix 3: Key Biodiversity Components Matrix (KBCM) and Habitat Hectares Score, April 2008 Iteration

BIODIVERSITY LOSS calculations scenarios at IMPACT SITE, and post-Project remediation effects on biodiversity loss calculations scenarios at impact site, Ambatovy Project

Percentage of attributes rehabilitation	Year	Habitat types		
		Forest	Streams/Rivers	Ephemeral pools
0%	0 (without mitigation)	1620	1.16	0.64
5%	0-7	1539	1.1	0.61
20%	7-15	1296	0.93	0.51
40%	15-30	972	0.69	0.38
75%	30-60	405	0.29	0.16
90%	60-120	162	0.12	0.06

Detailed calculations can be found below.

Habitat hectares lost – no mitigation

CALCULATING BIODIVERSITY LOSS AT IMPACT SITE
(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: **Forest**

Total Habitat Hectares Lost: **1620**

1. To the left, label each pre-project site condition class found.
(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. Fill in the area of …
(enter "0" for non-relevent condition classes and impact levels)

	… of Condition Class 1: Good forest	…of Condition Class 2: Disturbed	…of Condition Class 3: Ponds
Each Site Class…	**1587.963**	**497.7**	**0**
Post-Project, High Impact Sites…	1587.963	497.7	0
Post-Project, Medium Impact Sites…	0	0	0
Post-Project, Low Impact Sites…	0	0	0

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	BENCHMARK: Weight	BENCHMARK: Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Good forest Condition/ Level	Condition Class 1: Good forest *Net Loss*	Condition Class 2: Disturbed Condition/ Level	Condition Class 2: Disturbed *Net Loss*	Condition Class 3: Ponds Condition/ Level	Condition Class 3: Ponds *Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Stems	1118	stems/ha	0.1	NT	Pre-Project	1004.75		735.57				175.4906165	Good forest is the average of : P.5, 6, 9, 12, 14, & 18; Disturbed forest average of : P. 10 &20
					Post-Project, High Impact Sites		*1004.8*	0	*735.57*		*0*		
					Post-Project, Medium Impact Sites		*1004.8*		*735.57*		*0*		
					Post-Project, Low Impact Sites		*1004.8*		*735.57*		*0*		
Basal area	22.16	Square meters/ha	0.05	NT	Pre-Project	23.22		14.57				99.55773885	No mitigation Year _0
					Post-Project, High Impact Sites	0	*23.22*		*14.57*		*0*		
					Post-Project, Medium Impact Sites		*23.22*		*14.57*		*0*		
					Post-Project, Low Impact Sites		*23.22*		*14.57*		*0*		
Mean tree height canopy	9.98	Meter	0.025	NT	Pre-Project	9.07		9.5				47.92328259	
					Post-Project, High Impact Sites	0	*9.07*		*9.5*		*0*		
					Post-Project, Medium Impact Sites		*9.07*		*9.5*		*0*		
					Post-Project, Low Impact Sites		*9.07*		*9.5*		*0*		
Top height tree	14.54	Meter	0.025	NT	Pre-Project	13.57		15.17				50.03226773	
					Post-Project, High Impact Sites	0	*13.57*		*15.17*		*0*		
					Post-Project, Medium Impact Sites		*13.57*		*15.17*		*0*		
					Post-Project, Low Impact Sites		*13.57*		*15.17*		*0*		
Tree species density	83.63	number/ha	0.1	NT	Pre-Project	85.08		36.86				183.4857277	
					Post-Project, High Impact Sites	0	*85.08*		*36.86*		*0*		
					Post-Project, Medium Impact Sites		*85.08*		*36.86*		*0*		
					Post-Project, Low Impact Sites		*85.08*		*36.86*		*0*		
Propithecus diadema Density	0.033		0.1	NT	Pre-Project	0.033		0				158.71055	
					Post-Project, High Impact Sites		*0.033*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.033*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.033*		*0*		*0*		
Propithecus diadema vulnerability index	123.3		0.05	NT	Pre-Project	123.3		123.3				104.3221485	
					Post-Project, High Impact Sites		*123.3*		*123.3*		*0*		
					Post-Project, Medium Impact Sites		*123.3*		*123.3*		*0*		
					Post-Project, Low Impact Sites		*123.3*		*123.3*		*0*		
Allocebus trichotis density	0.025	number/ha	0.1	NT	Pre-Project	0.025		0				160.3136869	
					Post-Project, High Impact Sites		*0.025*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.025*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.025*		*0*		*0*		
Allocebus trichotis vulnerability index	142.4		0.05	NT	Pre-Project	142.4		142.4				104.2548391	
					Post-Project, High Impact Sites		*142.4*		*142.4*		*0*		
					Post-Project, Medium Impact Sites		*142.4*		*142.4*		*0*		
					Post-Project, Low Impact Sites		*142.4*		*142.4*		*0*		
Prolemur simus density	0.007	number/ha	0.1	NT	Pre-Project	0.007		0				169.8818697	
					Post-Project, High Impact Sites		*0.007*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.007*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.007*		*0*		*0*		
Prolemur simus vulnerability index	4.13		0.05	NT	Pre-Project	4.13		4.13				104.2894121	
					Post-Project, High Impact Sites		*4.13*		*4.13*		*0*		
					Post-Project, Medium Impact Sites		*4.13*		*4.13*		*0*		
					Post-Project, Low Impact Sites		*4.13*		*4.13*		*0*		
Indri indri density	0.013	number/ha	0.1	NT	Pre-Project	0.013		0				157.7474504	
					Post-Project, High Impact Sites		*0.013*		*0*		*0*		
					Post-Project, Medium Impact Sites		*0.013*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.013*		*0*		*0*		
Indri indri vulnerability index	31.12		0.05	NT	Pre-Project	31.12		31.12				104.275906	
					Post-Project, High Impact Sites		*31.12*		*31.12*		*0*		
					Post-Project, Medium Impact Sites		*31.12*		*31.12*		*0*		
					Post-Project, Low Impact Sites		*31.12*		*31.12*		*0*		
Deforestation rate		Percentage	0.1	NT	Pre-Project	0.8		14.05				0	
					Post-Project, High Impact Sites		*0.8*		*14.05*		*0*		
					Post-Project, Medium Impact Sites		*0.8*		*14.05*		*0*		
					Post-Project, Low Impact Sites		*0.8*		*14.05*		*0*		

Habitat hectares lost – 5% mitigation

CALCULATING BIODIVERSITY LOSS AT IMPACT SITE
(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: **Forest**

Total Habitat Hectares Lost: **1539**

1. ***To the left, label each pre-project site condition class found.***
(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. ***Fill in the area of …***
(enter "0" for non-relevent condition classes and impact levels)

	… of Condition Class 1: Good forest	…of Condition Class 2: Disturbed	…of Condition Class 3: Ponds
Each Site Class…	**1587.963**	**497.7**	**0**
Post-Project, High Impact Sites…	1587.963	497.7	0
Post-Project, Medium Impact Sites…	0	0	0
Post-Project, Low Impact Sites…	0	0	0

3. ***For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…***

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	BENCHMARK: Weight	BENCHMARK: Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Good forest Condition/ Level	Condition Class 1: Good forest *Net Loss*	Condition Class 2: Disturbed Condition/ Level	Condition Class 2: Disturbed *Net Loss*	Condition Class 3: Ponds Condition/ Level	Condition Class 3: Ponds *Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Stems	1118	stems/ha	0.1	NT	Pre-Project	1004.75		735.57				166.7160857	Good forest is the average of : P.5, 6, 9, 12, 14, & 18; Disturbed forest average of : P. 10 &20
					Post-Project, High Impact Sites	50.2375	*954.51*	36.7785	*698.79*		*0*		
					Post-Project, Medium Impact Sites		*1004.8*		*735.57*		*0*		
					Post-Project, Low Impact Sites		*1004.8*		*735.57*		*0*		
Basal area	22.16	Square meters/ha	0.05	NT	Pre-Project	23.22		14.57				94.57985191	No mitigation Year _0
					Post-Project, High Impact Sites	1.161	*22.059*	0.7285	*13.842*		*0*		
					Post-Project, Medium Impact Sites		*23.22*		*14.57*		*0*		
					Post-Project, Low Impact Sites		*23.22*		*14.57*		*0*		
Mean tree height canopy	9.98	Meter	0.025	NT	Pre-Project	9.07		9.5				45.52711846	
					Post-Project, High Impact Sites	0.4535	*8.6165*	0.475	*9.025*		*0*		
					Post-Project, Medium Impact Sites		*9.07*		*9.5*		*0*		
					Post-Project, Low Impact Sites		*9.07*		*9.5*		*0*		
Top height tree	14.54	Meter	0.025	NT	Pre-Project	13.57		15.17				47.53065434	
					Post-Project, High Impact Sites	0.6785	*12.892*	0.7585	*14.412*		*0*		
					Post-Project, Medium Impact Sites		*13.57*		*15.17*		*0*		
					Post-Project, Low Impact Sites		*13.57*		*15.17*		*0*		
Tree species density	83.63	number/ha	0.1	NT	Pre-Project	85.08		36.86				174.3114413	
					Post-Project, High Impact Sites	4.254	*80.826*	1.843	*35.017*		*0*		
					Post-Project, Medium Impact Sites		*85.08*		*36.86*		*0*		
					Post-Project, Low Impact Sites		*85.08*		*36.86*		*0*		
Propithecus diadema Density	0.033		0.1	NT	Pre-Project	0.033		0				150.7750225	
					Post-Project, High Impact Sites	0.00165	*0.0314*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.033*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.033*		*0*		*0*		
Propithecus diadema vulnerability index	123.3		0.05	NT	Pre-Project	123.3		123.3				99.10604103	
					Post-Project, High Impact Sites	6.165	*117.14*	6.165	*117.14*		*0*		
					Post-Project, Medium Impact Sites		*123.3*		*123.3*		*0*		
					Post-Project, Low Impact Sites		*123.3*		*123.3*		*0*		
Allocebus trichotis density	0.025	number/ha	0.1	NT	Pre-Project	0.025		0				152.2980025	
					Post-Project, High Impact Sites	0.00125	*0.0238*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.025*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.025*		*0*		*0*		
Allocebus trichotis vulnerability index	142.4		0.05	NT	Pre-Project	142.4		142.4				99.04209716	
					Post-Project, High Impact Sites	7.12	*135.28*	7.12	*135.28*		*0*		
					Post-Project, Medium Impact Sites		*142.4*		*142.4*		*0*		
					Post-Project, Low Impact Sites		*142.4*		*142.4*		*0*		
Prolemur simus density	0.007	number/ha	0.1	NT	Pre-Project	0.007		0				161.3877762	
					Post-Project, High Impact Sites	0.00035	*0.0067*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.007*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.007*		*0*		*0*		
Prolemur simus vulnerability index	4.13		0.05	NT	Pre-Project	4.13		4.13				99.07494151	
					Post-Project, High Impact Sites	0.2065	*3.9235*	0.2065	*3.9235*		*0*		
					Post-Project, Medium Impact Sites		*4.13*		*4.13*		*0*		
					Post-Project, Low Impact Sites		*4.13*		*4.13*		*0*		
Indri indri density	0.013	number/ha	0.1	NT	Pre-Project	0.013		0				149.8600779	
					Post-Project, High Impact Sites	0.00065	*0.0124*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.013*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.013*		*0*		*0*		
Indri indri vulnerability index	31.12		0.05	NT	Pre-Project	31.12		31.12				99.06211074	
					Post-Project, High Impact Sites	1.556	*29.564*	1.556	*29.564*		*0*		
					Post-Project, Medium Impact Sites		*31.12*		*31.12*		*0*		
					Post-Project, Low Impact Sites		*31.12*		*31.12*		*0*		
Deforestation rate		Percentage	0.1	NT	Pre-Project	0.8		14.05				0	
					Post-Project, High Impact Sites	0.04	*0.76*	0.7025	*13.348*		*0*		
					Post-Project, Medium Impact Sites		*0.8*		*14.05*		*0*		
					Post-Project, Low Impact Sites		*0.8*		*14.05*		*0*		

Habitat hectares lost – 20% mitigation

CALCULATING BIODIVERSITY LOSS AT IMPACT SITE
(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: **Forest**

Total Habitat Hectares Lost: **1296**

1. ***To the left, label each pre-project site condition class found.***
(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

	... of Condition Class 1:	...of Condition Class 2:	...of Condition Class 3:
	Good forest	Disturbed	Ponds

2. ***Fill in the area of …*** *(enter "0" for non-relevent condition classes and impact levels)*

Each Site Class…	**1587.963**	**497.7**	**0**
Post-Project, High Impact Sites…	1587.963	497.7	0
Post-Project, Medium Impact Sites…	0	0	0
Post-Project, Low Impact Sites…	0	0	0

3. ***For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…***

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	BENCHMARK: Weight	BENCHMARK: Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Good forest Condition/ Level	Condition Class 1: Good forest Net Loss	Condition Class 2: Disturbed Condition/ Level	Condition Class 2: Disturbed Net Loss	Condition Class 3: Ponds Condition/ Level	Condition Class 3: Ponds Net Loss	Habitat Hectares Lost	Rationale (enter comments explaining data in columns B to Q)
Stems	1118	stems/ha	0.1	NT	Pre-Project	1004.75		735.57				140.3924932	Good forest is the average of : P.5, 6, 9, 12, 14, & 18; Disturbed forest average of : P. 10 &20
					Post-Project, High Impact Sites	200.95	*803.8*	147.114	*588.46*		*0*		
					Post-Project, Medium Impact Sites		*1004.8*		*735.57*		*0*		
					Post-Project, Low Impact Sites		*1004.8*		*735.57*		*0*		
Basal area	22.16	Square meters/ha	0.05	NT	Pre-Project	23.22		14.57				79.64619108	No mitigation Year _0
					Post-Project, High Impact Sites	4.644	*18.576*	2.914	*11.656*		*0*		
					Post-Project, Medium Impact Sites		*23.22*		*14.57*		*0*		
					Post-Project, Low Impact Sites		*23.22*		*14.57*		*0*		
Mean tree height canopy	9.98	Meter	0.025	NT	Pre-Project	9.07		9.5				38.33862607	
					Post-Project, High Impact Sites	1.814	*7.256*	1.9	*7.6*		*0*		
					Post-Project, Medium Impact Sites		*9.07*		*9.5*		*0*		
					Post-Project, Low Impact Sites		*9.07*		*9.5*		*0*		
Top height tree	14.54	Meter	0.025	NT	Pre-Project	13.57		15.17				40.02581418	
					Post-Project, High Impact Sites	2.714	*10.856*	3.034	*12.136*		*0*		
					Post-Project, Medium Impact Sites		*13.57*		*15.17*		*0*		
					Post-Project, Low Impact Sites		*13.57*		*15.17*		*0*		
Tree species density	83.63	number/ha	0.1	NT	Pre-Project	85.08		36.86				146.7885821	
					Post-Project, High Impact Sites	17.016	*68.064*	7.372	*29.488*		*0*		
					Post-Project, Medium Impact Sites		*85.08*		*36.86*		*0*		
					Post-Project, Low Impact Sites		*85.08*		*36.86*		*0*		
Propithecus diadema Density	0.033		0.1	NT	Pre-Project	0.033		0				126.96844	
					Post-Project, High Impact Sites	0.0066	*0.0264*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.033*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.033*		*0*		*0*		
Propithecus diadema vulnerability index	123.3		0.05	NT	Pre-Project	123.3		123.3				83.45771876	
					Post-Project, High Impact Sites	24.66	*98.64*	24.66	*98.64*		*0*		
					Post-Project, Medium Impact Sites		*123.3*		*123.3*		*0*		
					Post-Project, Low Impact Sites		*123.3*		*123.3*		*0*		
Allocebus trichotis density	0.025	number/ha	0.1	NT	Pre-Project	0.025		0				128.2509495	
					Post-Project, High Impact Sites	0.005	*0.02*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.025*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.025*		*0*		*0*		
Allocebus trichotis vulnerability index	142.4		0.05	NT	Pre-Project	142.4		142.4				83.40387129	
					Post-Project, High Impact Sites	28.48	*113.92*	28.48	*113.92*		*0*		
					Post-Project, Medium Impact Sites		*142.4*		*142.4*		*0*		
					Post-Project, Low Impact Sites		*142.4*		*142.4*		*0*		
Prolemur simus density	0.007	number/ha	0.1	NT	Pre-Project	0.007		0				135.9054958	
					Post-Project, High Impact Sites	0.0014	*0.0056*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.007*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.007*		*0*		*0*		
Prolemur simus vulnerability index	4.13		0.05	NT	Pre-Project	4.13		4.13				83.43152969	
					Post-Project, High Impact Sites	0.826	*3.304*	0.826	*3.304*		*0*		
					Post-Project, Medium Impact Sites		*4.13*		*4.13*		*0*		
					Post-Project, Low Impact Sites		*4.13*		*4.13*		*0*		
Indri indri density	0.013	number/ha	0.1	NT	Pre-Project	0.013		0				126.1979604	
					Post-Project, High Impact Sites	0.0026	*0.0104*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.013*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.013*		*0*		*0*		
Indri indri vulnerability index	31.12		0.05	NT	Pre-Project	31.12		31.12				83.42072484	
					Post-Project, High Impact Sites	6.224	*24.896*	6.224	*24.896*		*0*		
					Post-Project, Medium Impact Sites		*31.12*		*31.12*		*0*		
					Post-Project, Low Impact Sites		*31.12*		*31.12*		*0*		
Deforestation rate		Percentag e	0.1	NT	Pre-Project	0.8		14.05				0	
					Post-Project, High Impact Sites	0.16	*0.64*	2.81	*11.24*		*0*		
					Post-Project, Medium Impact Sites		*0.8*		*14.05*		*0*		
					Post-Project, Low Impact Sites		*0.8*		*14.05*		*0*		

Habitat hectares lost – 40% mitigation

CALCULATING BIODIVERSITY LOSS AT IMPACT SITE
(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: Forest

Total Habitat Hectares Lost: 972

		... of Condition Class 1: Good forest	...of Condition Class 2: Disturbed	...of Condition Class 3: Ponds
1. To the left, label each pre-project site condition class found. *(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)*				
2. Fill in the area of … *(enter "0" for non-relevent condition classes and impact levels)*	**Each Site Class…**	**1587.963**	**497.7**	**0**
	Post-Project, High Impact Sites…	1587.963	497.7	0
	Post-Project, Medium Impact Sites…	0	0	0
	Post-Project, Low Impact Sites…	0	0	0

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK: Reference Level #	Units/ Bands	Weight	Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Good forest – Condition/ Level	Condition Class 1: Good forest – *Net Loss*	Condition Class 2: Disturbed – Condition/ Level	Condition Class 2: Disturbed – *Net Loss*	Condition Class 3: Ponds – Condition/ Level	Condition Class 3: Ponds – *Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Stems	1118	stems/ha	0.1	NT	Pre-Project	1004.75		735.57				105.2943699	Good forest is the average of : P.5, 6, 9, 12, 14, & 18; Disturbed forest average of : P. 10 &20
					Post-Project, High Impact Sites	401.9	*602.85*	294.228	*441.34*		*0*		
					Post-Project, Medium Impact Sites		*1004.8*		*735.57*		*0*		
					Post-Project, Low Impact Sites		*1004.8*		*735.57*		*0*		
Basal area	22.16	Square meters/ha	0.05	NT	Pre-Project	23.22		14.57				59.73464331	No mitigation Year _0
					Post-Project, High Impact Sites	9.288	*13.932*	5.828	*8.742*		*0*		
					Post-Project, Medium Impact Sites		*23.22*		*14.57*		*0*		
					Post-Project, Low Impact Sites		*23.22*		*14.57*		*0*		
Mean tree height canopy	9.98	Meter	0.025	NT	Pre-Project	9.07		9.5				28.75396955	
					Post-Project, High Impact Sites	3.628	*5.442*	3.8	*5.7*		*0*		
					Post-Project, Medium Impact Sites		*9.07*		*9.5*		*0*		
					Post-Project, Low Impact Sites		*9.07*		*9.5*		*0*		
Top height tree	14.54	Meter	0.025	NT	Pre-Project	13.57		15.17				30.01936064	
					Post-Project, High Impact Sites	5.428	*8.142*	6.068	*9.102*		*0*		
					Post-Project, Medium Impact Sites		*13.57*		*15.17*		*0*		
					Post-Project, Low Impact Sites		*13.57*		*15.17*		*0*		
Tree species density	83.63	number/ha	0.1	NT	Pre-Project	85.08		36.86				110.0914366	
					Post-Project, High Impact Sites	34.032	*51.048*	14.744	*22.116*		*0*		
					Post-Project, Medium Impact Sites		*85.08*		*36.86*		*0*		
					Post-Project, Low Impact Sites		*85.08*		*36.86*		*0*		
Propithecus diadema Density	0.033		0.1	NT	Pre-Project	0.033		0				95.22633	
					Post-Project, High Impact Sites	0.0132	*0.0198*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.033*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.033*		*0*		*0*		
Propithecus diadema vulnerability index	123.3		0.05	NT	Pre-Project	123.3		123.3				62.59328907	
					Post-Project, High Impact Sites	49.32	*73.98*	49.32	*73.98*		*0*		
					Post-Project, Medium Impact Sites		*123.3*		*123.3*		*0*		
					Post-Project, Low Impact Sites		*123.3*		*123.3*		*0*		
Allocebus trichotis density	0.025	number/ha	0.1	NT	Pre-Project	0.025		0				96.18821212	
					Post-Project, High Impact Sites	0.01	*0.015*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.025*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.025*		*0*		*0*		
Allocebus trichotis vulnerability index	142.4		0.05	NT	Pre-Project	142.4		142.4				62.55290347	
					Post-Project, High Impact Sites	56.96	*85.44*	56.96	*85.44*		*0*		
					Post-Project, Medium Impact Sites		*142.4*		*142.4*		*0*		
					Post-Project, Low Impact Sites		*142.4*		*142.4*		*0*		
Prolemur simus density	0.007	number/ha	0.1	NT	Pre-Project	0.007		0				101.9291218	
					Post-Project, High Impact Sites	0.0028	*0.0042*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.007*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.007*		*0*		*0*		
Prolemur simus vulnerability index	4.13		0.05	NT	Pre-Project	4.13		4.13				62.57364727	
					Post-Project, High Impact Sites	1.652	*2.478*	1.652	*2.478*		*0*		
					Post-Project, Medium Impact Sites		*4.13*		*4.13*		*0*		
					Post-Project, Low Impact Sites		*4.13*		*4.13*		*0*		
Indri indri density	0.013	number/ha	0.1	NT	Pre-Project	0.013		0				94.64847026	
					Post-Project, High Impact Sites	0.0052	*0.0078*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.013*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.013*		*0*		*0*		
Indri indri vulnerability index	31.12		0.05	NT	Pre-Project	31.12		31.12				62.56554363	
					Post-Project, High Impact Sites	12.448	*18.672*	12.448	*18.672*		*0*		
					Post-Project, Medium Impact Sites		*31.12*		*31.12*		*0*		
					Post-Project, Low Impact Sites		*31.12*		*31.12*		*0*		
Deforestation rate		Percentag e	0.1	NT	Pre-Project	0.8		14.05				0	
					Post-Project, High Impact Sites	0.32	*0.48*	5.62	*8.43*		*0*		
					Post-Project, Medium Impact Sites		*0.8*		*14.05*		*0*		
					Post-Project, Low Impact Sites		*0.8*		*14.05*		*0*		

Habitat hectares lost – 75% mitigation

CALCULATING BIODIVERSITY LOSS AT IMPACT SITE
(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: **Forest**

Total Habitat Hectares Lost: **405**

		... of Condition Class 1:	...of Condition Class 2:	...of Condition Class 3:
1. To the left, label each pre-project site condition class found. *(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)*		**Good forest**	**Disturbed**	**Ponds**
2. Fill in the area of … *(enter "0" for non-relevent condition classes and impact levels)*	**Each Site Class…**	**1587.963**	**497.7**	**0**
	Post-Project, High Impact Sites…	1587.963	497.7	0
	Post-Project, Medium Impact Sites…	0	0	0
	Post-Project, Low Impact Sites…	0	0	0

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	BENCHMARK: Weight	BENCHMARK: Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Good forest – Condition/ Level	Condition Class 1: Good forest – *Net Loss*	Condition Class 2: Disturbed – Condition/ Level	Condition Class 2: Disturbed – *Net Loss*	Condition Class 3: Ponds – Condition/ Level	Condition Class 3: Ponds – *Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Stems	1118	stems/ha	0.1	NT	Pre-Project	1004.75		735.57				43.87265413	Good forest is the average of : P.5, 6, 9, 12, 14, & 18; Disturbed forest average of : P. 10 &20
					Post-Project, High Impact Sites	753.5625	*251.19*	551.6775	*183.89*		*0*		
					Post-Project, Medium Impact Sites		*1004.8*		*735.57*		*0*		
					Post-Project, Low Impact Sites		*1004.8*		*735.57*		*0*		
Basal area	22.16	Square meters/ha	0.05	NT	Pre-Project	23.22		14.57				24.88943471	No mitigation Year _0
					Post-Project, High Impact Sites	17.415	*5.805*	10.9275	*3.6425*		*0*		
					Post-Project, Medium Impact Sites		*23.22*		*14.57*		*0*		
					Post-Project, Low Impact Sites		*23.22*		*14.57*		*0*		
Mean tree height canopy	9.98	Meter	0.025	NT	Pre-Project	9.07		9.5				11.98082065	
					Post-Project, High Impact Sites	6.8025	*2.2675*	7.125	*2.375*		*0*		
					Post-Project, Medium Impact Sites		*9.07*		*9.5*		*0*		
					Post-Project, Low Impact Sites		*9.07*		*9.5*		*0*		
Top height tree	14.54	Meter	0.025	NT	Pre-Project	13.57		15.17				12.50806693	
					Post-Project, High Impact Sites	10.1775	*3.3925*	11.3775	*3.7925*		*0*		
					Post-Project, Medium Impact Sites		*13.57*		*15.17*		*0*		
					Post-Project, Low Impact Sites		*13.57*		*15.17*		*0*		
Tree species density	83.63	number/ha	0.1	NT	Pre-Project	85.08		36.86				45.87143191	
					Post-Project, High Impact Sites	63.81	*21.27*	27.645	*9.215*		*0*		
					Post-Project, Medium Impact Sites		*85.08*		*36.86*		*0*		
					Post-Project, Low Impact Sites		*85.08*		*36.86*		*0*		
Propithecus diadema Density	0.033		0.1	NT	Pre-Project	0.033		0				39.6776375	
					Post-Project, High Impact Sites	0.02475	*0.0083*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.033*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.033*		*0*		*0*		
Propithecus diadema vulnerability index	123.3		0.05	NT	Pre-Project	123.3		123.3				26.08053711	
					Post-Project, High Impact Sites	92.475	*30.825*	92.475	*30.825*		*0*		
					Post-Project, Medium Impact Sites		*123.3*		*123.3*		*0*		
					Post-Project, Low Impact Sites		*123.3*		*123.3*		*0*		
Allocebus trichotis density	0.025	number/ha	0.1	NT	Pre-Project	0.025		0				40.07842172	
					Post-Project, High Impact Sites	0.01875	*0.0063*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.025*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.025*		*0*		*0*		
Allocebus trichotis vulnerability index	142.4		0.05	NT	Pre-Project	142.4		142.4				26.06370978	
					Post-Project, High Impact Sites	106.8	*35.6*	106.8	*35.6*		*0*		
					Post-Project, Medium Impact Sites		*142.4*		*142.4*		*0*		
					Post-Project, Low Impact Sites		*142.4*		*142.4*		*0*		
Prolemur simus density	0.007	number/ha	0.1	NT	Pre-Project	0.007		0				42.47046743	
					Post-Project, High Impact Sites	0.00525	*0.0018*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.007*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.007*		*0*		*0*		
Prolemur simus vulnerability index	4.13		0.05	NT	Pre-Project	4.13		4.13				26.07235303	
					Post-Project, High Impact Sites	3.0975	*1.0325*	3.0975	*1.0325*		*0*		
					Post-Project, Medium Impact Sites		*4.13*		*4.13*		*0*		
					Post-Project, Low Impact Sites		*4.13*		*4.13*		*0*		
Indri indri density	0.013	number/ha	0.1	NT	Pre-Project	0.013		0				39.43686261	
					Post-Project, High Impact Sites	0.00975	*0.0033*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.013*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.013*		*0*		*0*		
Indri indri vulnerability index	31.12		0.05	NT	Pre-Project	31.12		31.12				26.06897651	
					Post-Project, High Impact Sites	23.34	*7.78*	23.34	*7.78*		*0*		
					Post-Project, Medium Impact Sites		*31.12*		*31.12*		*0*		
					Post-Project, Low Impact Sites		*31.12*		*31.12*		*0*		
Deforestation rate		Percentage	0.1	NT	Pre-Project	0.8		14.05				0	
					Post-Project, High Impact Sites	0.6	*0.2*	10.5375	*3.5125*		*0*		
					Post-Project, Medium Impact Sites		*0.8*		*14.05*		*0*		
					Post-Project, Low Impact Sites		*0.8*		*14.05*		*0*		

Habitat hectares lost – 90% mitigation

CALCULATING BIODIVERSITY LOSS AT IMPACT SITE
(Quantifcation of Biodiversity Loss Through Project Impact, via Habitat Hectares)

Habitat Type 1: **Forest**

Total Habitat Hectares Lost: **162**

1. To the left, label each pre-project site condition class found.
(Three or less. e.g. "pristine", "good", "degraded", or "good", "poor", etc.)

2. Fill in the area of …
(enter "0" for non-relevent condition classes and impact levels)

	… of Condition Class 1: **Good forest**	…of Condition Class 2: **Disturbed**	…of Condition Class 3: **Ponds**
Each Site Class…	**1587.963**	**497.7**	**0**
Post-Project, High Impact Sites…	1587.963	497.7	0
Post-Project, Medium Impact Sites…	0	0	0
Post-Project, Low Impact Sites…	0	0	0

3. For each relevant condition class and impact level below, please fill in the condition/level of the attribute in question…

Attribute	BENCHMARK: Reference Level #	BENCHMARK: Reference Level Units/ Bands	BENCHMARK: Weight	BENCHMARK: Trad'ble/ Non? (T/NT)	Pre/Post-Project Conditions	Condition Class 1: Good forest — Condition/ Level	Condition Class 1: Good forest — *Net Loss*	Condition Class 2: Disturbed — Condition/ Level	Condition Class 2: Disturbed — *Net Loss*	Condition Class 3: Ponds — Condition/ Level	Condition Class 3: Ponds — *Net Loss*	Habitat Hectares Lost	Rationale *(enter comments explaining data in columns B to Q)*
Stems	1118	stems/ha	0.1	NT	Pre-Project	1004.75		735.57				17.54906165	Good forest is the average of : P.5, 6, 9, 12, 14, & 18; Disturbed forest average of : P. 10 &20
					Post-Project, High Impact Sites	904.275	*100.48*	662.013	*73.557*		*0*		
					Post-Project, Medium Impact Sites		*1004.8*		*735.57*		*0*		
					Post-Project, Low Impact Sites		*1004.8*		*735.57*		*0*		
Basal area	22.16	Square meters/ha	0.05	NT	Pre-Project	23.22		14.57				9.955773885	No mitigation Year _0
					Post-Project, High Impact Sites	20.898	*2.322*	13.113	*1.457*		*0*		
					Post-Project, Medium Impact Sites		*23.22*		*14.57*		*0*		
					Post-Project, Low Impact Sites		*23.22*		*14.57*		*0*		
Mean tree height canopy	9.98	Meter	0.025	NT	Pre-Project	9.07		9.5				4.792328259	
					Post-Project, High Impact Sites	8.163	*0.907*	8.55	*0.95*		*0*		
					Post-Project, Medium Impact Sites		*9.07*		*9.5*		*0*		
					Post-Project, Low Impact Sites		*9.07*		*9.5*		*0*		
Top height tree	14.54	Meter	0.025	NT	Pre-Project	13.57		15.17				5.003226773	
					Post-Project, High Impact Sites	12.213	*1.357*	13.653	*1.517*		*0*		
					Post-Project, Medium Impact Sites		*13.57*		*15.17*		*0*		
					Post-Project, Low Impact Sites		*13.57*		*15.17*		*0*		
Tree species density	83.63	number/ha	0.1	NT	Pre-Project	85.08		36.86				18.34857277	
					Post-Project, High Impact Sites	76.572	*8.508*	33.174	*3.686*		*0*		
					Post-Project, Medium Impact Sites		*85.08*		*36.86*		*0*		
					Post-Project, Low Impact Sites		*85.08*		*36.86*		*0*		
Propithecus diadema Density	0.033		0.1	NT	Pre-Project	0.033		0				15.871055	
					Post-Project, High Impact Sites	0.0297	*0.0033*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.033*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.033*		*0*		*0*		
Propithecus diadema vulnerability index	123.3		0.05	NT	Pre-Project	123.3		123.3				10.43221485	
					Post-Project, High Impact Sites	110.97	*12.33*	110.97	*12.33*		*0*		
					Post-Project, Medium Impact Sites		*123.3*		*123.3*		*0*		
					Post-Project, Low Impact Sites		*123.3*		*123.3*		*0*		
Allocebus trichotis density	0.025	number/ha	0.1	NT	Pre-Project	0.025		0				16.03136869	
					Post-Project, High Impact Sites	0.0225	*0.0025*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.025*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.025*		*0*		*0*		
Allocebus trichotis vulnerability index	142.4		0.05	NT	Pre-Project	142.4		142.4				10.42548391	
					Post-Project, High Impact Sites	128.16	*14.24*	128.16	*14.24*		*0*		
					Post-Project, Medium Impact Sites		*142.4*		*142.4*		*0*		
					Post-Project, Low Impact Sites		*142.4*		*142.4*		*0*		
Prolemur simus density	0.007	number/ha	0.1	NT	Pre-Project	0.007		0				16.98818697	
					Post-Project, High Impact Sites	0.0063	*0.0007*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.007*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.007*		*0*		*0*		
Prolemur simus vulnerability index	4.13		0.05	NT	Pre-Project	4.13		4.13				10.42894121	
					Post-Project, High Impact Sites	3.717	*0.413*	3.717	*0.413*		*0*		
					Post-Project, Medium Impact Sites		*4.13*		*4.13*		*0*		
					Post-Project, Low Impact Sites		*4.13*		*4.13*		*0*		
Indri indri density	0.013	number/ha	0.1	NT	Pre-Project	0.013		0				15.77474504	
					Post-Project, High Impact Sites	0.0117	*0.0013*	0	*0*		*0*		
					Post-Project, Medium Impact Sites		*0.013*		*0*		*0*		
					Post-Project, Low Impact Sites		*0.013*		*0*		*0*		
Indri indri vulnerability index	31.12		0.05	NT	Pre-Project	31.12		31.12				10.4275906	
					Post-Project, High Impact Sites	28.008	*3.112*	28.008	*3.112*		*0*		
					Post-Project, Medium Impact Sites		*31.12*		*31.12*		*0*		
					Post-Project, Low Impact Sites		*31.12*		*31.12*		*0*		
Deforestation rate		Percentag e	0.1	NT	Pre-Project	0.8		14.05				0	
					Post-Project, High Impact Sites	0.72	*0.08*	12.645	*1.405*		*0*		
					Post-Project, Medium Impact Sites		*0.8*		*14.05*		*0*		
					Post-Project, Low Impact Sites		*0.8*		*14.05*		*0*		

Appendix 4: Mine Footprint Status Sheet, 2nd Iteration

Ambatovy ENVIRONMENTAL DEPARTMENT

ENVIRONMENTAL PROGRAM STATUS SHEET

MINE FOOTPRINT DEFINITION

(2nd APPROXIMATION – December 12, 2007[1])

1. Mine Footprint Definition:

- The mine footprint is a large track of land (21.26 km^2) that includes all perimeters and linear structures used for the mine construction, commissioning, operation and closure (retention and sedimentation ponds, mine pits, waste stock piles, low grade ore stock piles, camps, OPP, roads, pipelines, etc.).
- The mine footprint is nested within both the mine lease and mine area.
- Although the basic mine footprint has been validated through the EIA permitting in 2006, it is assumed that the mine footprint will undergo certain spatial modifications during the lifecycle of the mine, given the spatial dynamics of such a vast mining operation. However, spatial modification of the mine footprint will alter the residual impact evaluation of the EIA and imply a revision of the mitigation measures designed under the original footprint. Hence, stringent protocols for mine footprint modification are needed to ensure that the EIA commitments are not breached.
- The initial boundaries of the mine footprint were set as the result of existing construction and mining engineering plans presented in the Ambatovy Project's feasibility study. For the EIA, a 300 meter wide arbitrary safety buffer was added from the outside edge of the original engineering footprint. This 300 meter buffer was not understood to constitute an area for potential mine footprint expansion but was proposed as a safety zone (EIA, Volume B-2 Project Description, Section 2.2).
- The mine footprint presented in the first approximation Mine Footprint Status Sheets is the same as the footprint presented in the EIA including the arbitrary 300 meter safety buffer (see Mine Area Status Sheet 1st Approximation, 12-12-07).

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[1] This 2nd Approximation Mine Footprint definition supersedes the 1st Approximation Mine Footprint

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Projet Ambatovy

- Over the last year, while our understanding regarding the best possible management of the residual biodiversity in the mine periphery progressed (area within mine area that surrounds the mine footprint, see Mine Area Status Sheet 1st Approximation, 12-12-07), it came into sight that the 300 meter safety buffer covers an area too large to be excluded from the periphery. The concept of a narrower environmental buffer acting as a safeguard against edge effects was thus introduced.
- In light of this need, a 2nd approximation Mine Footprint was developed based on an updated engineering construction footprint onto which an environmental buffer had been added. The 2nd approximation mine footprint, tailored for environmental management (rather than safety management), is defined as follows:
  - The 2nd approximation mine footprint is defined by the union of the outer boundary of the original Knight Piedsol (KP) footprint of the EIA and the outer boundaries of the properly permitted 2006 construction clearings perimeters referred to as clearings 1, 2, 3 and 4 to which an environmental buffer is added.
  - The environmental buffer is set at a width of 100 meters wherever it is adjacent to areas of large clearings and reduced to 50 meters where it is adjacent to linear clearings such as mine roads (except main access road) and pipeline corridors.
  - In summary, the 2nd approximation mine footprint developed for the environmental management of the mine periphery includes all areas that that have currently been planned to be cleared plus a forest buffer considered to be potentially impacted by the edge effect (dust, noise, plant desiccation, invasion of natural heliophytes).

Note: The mine footprint second approximation boundaries are mapped in Map-Figure 2. Corresponding Shape Files are available for internal use.

2. Protocol for mine area modification:

- If the need for a boundary modification of the Mine Footprint is recognized by the Ambatovy Project, the following procedure must be followed:
  - A short written note with a justification and a map that shows the suggested modification is provided to the Environmental Manager.
  - If the modification does not constitute an expansion to the EIA mine footprint as defined in the 1st Approximation Mine Footprint Status Sheet, the modification proposal will be discussed between the environmental manager, the mine superintendent and concerned parties.
  - If the proposed changes are accepted, a new approximation of the Mine Area Status Sheet as well as an updated map attachment will

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be prepared, validated by the Environmental Manager and properly distributed.

- If the modification does constitute an expansion to the EIA mine footprint as defined in the 1st Approximation Mine Footprint Status Sheet, the modification proposal will be submitted to the regulator for discussion and procedures will be established on a case-by-case base, depending of the size and the nature of the footprint expansion. An EIA addendum could be requested.
- If the proposed changes are accepted by the regulator and the Project, a new approximation of the Mine Area Status Sheet as well as an updated map attachment will be prepared, validated by the Environmental Manager and properly distributed

3. Distribution:

- A validated, scanned version of this Mine Footprint Status Sheet including a accompanying map were distributed on December 14th , 2007 to:
  - Ambatovy Project Managing Director
  - Ambatovy Project Deputy Managing Director
  - Ambatovy Project Managers
  - Communication Manager
  - Environmental Superintends
  - Targeted Ambatovy Project Staff (GIS, Mine Superintendents)
  - Missouri Botanical Garden Madagascar (management of species of concerns)

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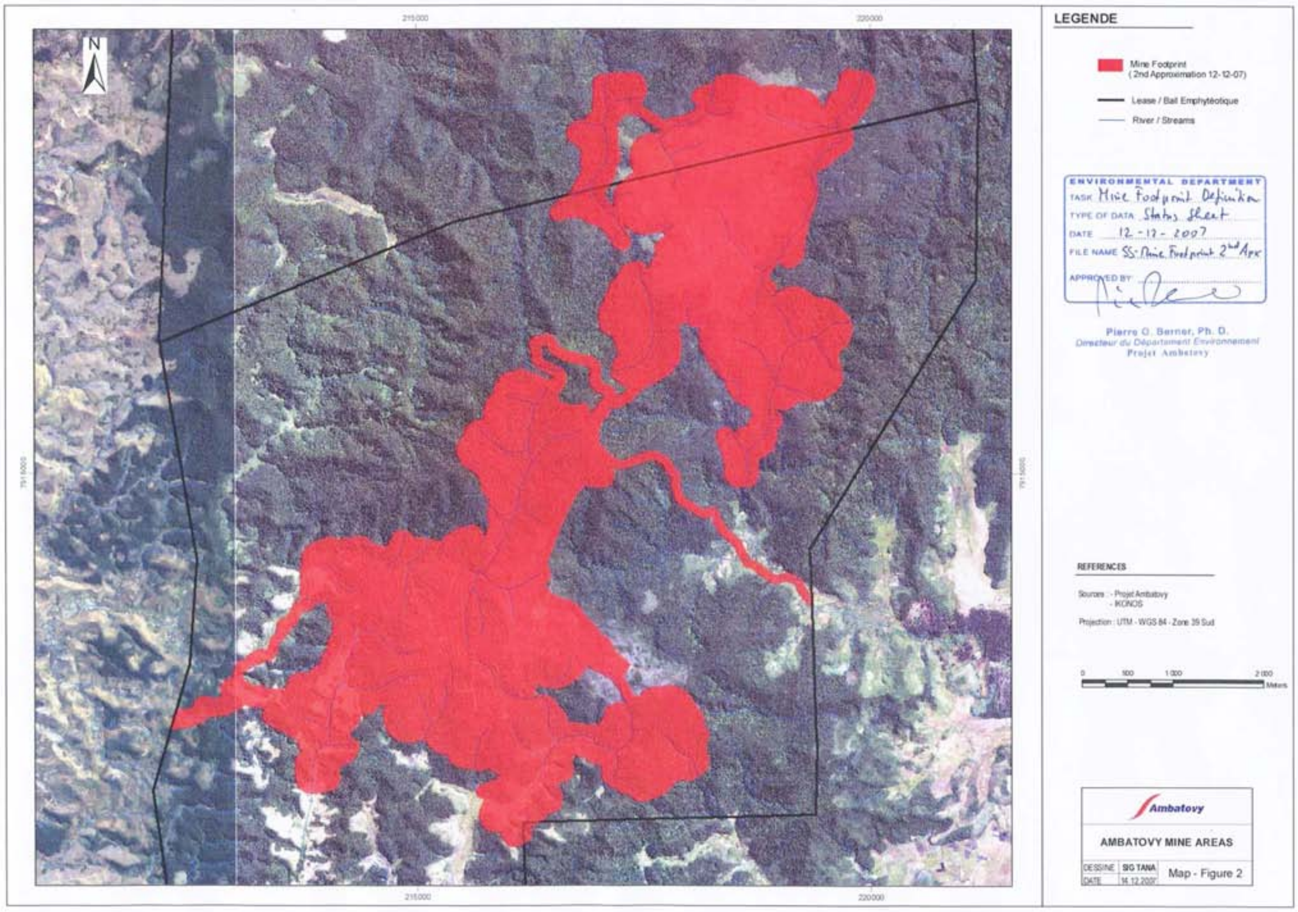

215000
220000
N
LEGENDE
Mine Footprint (2nd Approximation 12-12-07)
Lease / Bail Emphytéotique
River / Streams
ENVIRONMENTAL DEPARTMENT
TASK Mine Footprint Definition
TYPE OF DATA Status Sheet
DATE 12-12-2007
FILE NAME SS-Mine Footprint 2nd Apx
APPROVED BY
Pierre O. Berner, Ph. D.
Directeur du Département Environnement
Projet Ambatovy
REFERENCES
Sources : - Projet Ambatovy
- IKONOS
Projection : UTM - WGS 84 - Zone 39 Sud
0 500 1 000 2 000 Meters
Ambatovy
AMBATOVY MINE AREAS
DESSINE SIG TANA
DATE 14.12.2007
Map - Figure 2

Appendix 5: Vulnerability Index

VULNERABILITY can be expressed based on:

- Geographical range (largely, more restricted),
- Level of habitat types dependence (more ubiquiste to stenocene species etc.), and
- Abundance indices (rare to common) (Kattan 1992; Rabinowitz *et al.* 1986).

The approach used allows the offset planner to attribute an index score in each cell of the matrix in order to represent the vulnerability level of each species based on above parameters. For a community, the percentage of species constituting its total number could be included in a cell in order to indicate how vulnerable a community is. The original concept of the vulnerability matrix following (Rabinowitz *et al*. 1986) is presented below, where Vi is the vulnerability index.

		Range (geographical distribution)			
		Large		**Restricted**	
	Habitat type dependence level	**Ubiquiste**	**Stenocene**	**Ubiquiste**	**Stenocene**
Abundance	Common	Vi=8	Vi=6	Vi=4	Vi=2
	Rare	Vi=7	Vi=5	Vi=3	Vi=1

In order to ensure that the matrix is properly used as part of the calculation of loss and gain of biodiversity, the following points must be taken into consideration:

- Since the BENCHMARK approach is based on the principle that higher values are better in the habitat hectares calculations, higher index values should be given with increased vulnerability (e.g. Vi= 1 becomes Vi = 8 etc…).
- The BBOP '*Key Biodiversity Component Matrix (KBCM) 'Irreplaceability' level (Widespread, Localised, SITE ENDEMIC*) will be used instead of '*Range' (geographical distribution*); and
- The KBCM '*Significance level*' *Global* column will consider (CR, EN, VU, NT) instead of using '*habitat type dependence level*'.

Thus the Vulnerability matrix concept proposed for BBOP is:

	Irreplaceability :	***Widespread***		***Localised***		***Site endemic***	
	Abundance level:	**Common**	**Rare**	**Common**	**Rare**	**Common**	**Rare**
IUCN Status	**LC**	1	4	11	16	21	26
	NT	2	5	12	17	22	27
	VU	3	6	13	18	23	28
	EN	7	8	14	19	24	29
	CR	9	10	15	20	25	30

There are several ways to obtain ATTRIBUTES from the species Vulnerability matrix:

1. Fit all KBCM fauna and flora species into the matrix and assign a Vi number (1 to 30) and then simply compare to the total number of species in the community considered with how many have specific Vi numbers.
2. Determine the % of species with specific Vi numbers. For example, for all tree species assume that 30% of those recorded in the benchmark have a Vi of 19 (EN, rare, localised), equating to 30% x 19 = 57. This can be repeated for other Vi indices and finally a sum for the entire matrix table can be generated (for example 560). This value of 560 can then be compared with values for tree species from the impact site etc.
3. Taking a smaller community group, e.g. all lemur species, and proceed as above, assigning each species a Vi score and then multiplying it with species biological data (e.g. density / ha) in order to obtain a sum for each site. The higher the total Vi score is, the higher is the vulnerability of this group (note that the density in the excel table is set at 1 until further data is collected during subsequent at Ambatovy).

The Vulnerability matrix developed by Ambatovy is presented below. This matrix was developed in April 2008, as part of the second iteration of the benchmark and loss assessment[7].

Table A5.1: Fauna and flora species Vulnerability matrix (April 2008)

	Irreplacebility :	***Widespread***								***Localised***								***Site endemic***															
	Abundance level:	**Common**				**Rare**				**Common**				**Rare**				**Common**				**Rare**											
	Nocturnal/diurnal	**Diurnal**		**Nocturnal**		**Diurnal**		**Nocturnal**		**Diurnal**		**Nocturnal**		**Diurnal**		**Nocturnal**		**Diurnal**		**Nocturnal**		**Diurnal**		**Nocturnal**									
	Ability to move away from impact	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**	**Y**	**N**
IUCN Status	**LC**	1	4	7	10	13	16	19	22	41	46	51	56	61	66	71	76	81	86	91	96	101	106	111	116								
	NT	2	5	8	11	14	17	20	23	42	47	52	57	62	67	72	77	82	87	92	97	102	107	112	117								
	VU	3	6	9	12	15	18	21	24	43	48	53	58	63	68	73	78	83	88	93	98	103	108	113	118								
	EN	25	26	27	28	29	30	31	32	44	49	54	59	64	69	74	79	84	89	94	99	104	109	114	119								
	CR	33	34	35	36	37	38	39	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120								

A worked example of the application of the matrix to the Ambatovy KBCM is presented below (extract of Ambatovy Project BBOP Bonn report (April 2008)).

Table A5.2: Key Biodiversity Components Matrix (KBCM) Vulnerability scores (April 2008)

	Ambatovy KBCM Species	**IUCN**	**Widespread**	**Localised**	**Site endemic**	**Rare**	**Diurnal/Noct: D/N**	**Moves: Y/N**	**Vulnerabilty indices'**
Lemurs	*Prolemur simus*	CR		X		X			65
	Propithecus d. diadema	CR		X					
	Indri indri	EN		X					
	Allocebus trichotis	EN		X		X			74
	Daubentonia madagascarensis	EN	X						
	Eulemur rubriventer	VU		X					
Birds	*Tyto soumagnei*	EN		X					
Herptiles	*Platypelis sp. nov*	NE		X					
	Scaphiophryne marmorata	VU		X					
	Rhombophryne coronata	VU		X					
	Mantella aurantiaca	CR		X					
	Mantella crocea	EN		X					
	Mantidactylus plicifer	NT		X					
	Pararhadinaea sp.nov	NE			X				
	Sanzinia madagascariensis	VU		X					
Fish	*Ratsirakia sp*	NE			?				
	Rheocles sp	NE			?				
Plants	*Aloe leandri*	NE			X				
	Asteropeia micraster	EN		X					
	Leptolaena multiflora	EN	X						
	Dalbergia baroni	VU	X						
	Cyathea dregei	NE	X						
	Cyathea cf tsaratananensis	NE		?					

7 Ambatovy Project BBOP Bonn report (April 2008), with revised Benchmark selection and losses calculations, including KBCM matrix update with species quantitative data).

Note that the results of the Biodiversity Assessment in relation to intrinsic NON-USE VALUES and USE VALUES are presented in the KBCM sheet of the April 2008 report.

December 2008 iteration: the Project believes that the use of the Vulnerability attributes still requires more in depth analysis, which will be conduced in 2009: the justifications for excluding the vulnerability index in the December 2008 calculations are that:

- This attribute should be calculated by taxonomic group not by single species as was done in the April 2008 report: this index is a product of the combination of the IUCN status and that of relative abundance;
- Abundance is already considered in the other attributes for each species. Calculating the vulnerability index by taxonomic group (not single species) will give a greater 'overall scope' of the vulnerability and irreplaceability:
  - The index will provide a more scientific approach to determining the group requiring most effort for on-site conservation relative to other selected species.
  - It gives first same value (weight) for the various taxonomic groups. In fact not only species must avoid EXTIRPATION, but also the overall ecosystem characteristics should be offset. Among the latter is the community composition that can be tackled through a biodiversity vulnerability index. Furthermore, a gain on the vulnerability index by a taxonomic group will be more significant for biodiversity and ECOSYSTEM SERVICES than a gain for a single species.

Appendix 6: Survey for Off-site Azonal Outcrops

Volume J

Section 1.1

Attachment 2

Survey for off-site azonal outcrops

DYNATEC PROJET NICKEL COBALT

CONSERVATION HORS-SITE D'HABITATS AZONALS SUR GISEMENTS ULTRAMAFIQUES ET CONSTATS PRELIMINAIRES DU SITE RETENU D'ANKERA

RAPPORT FINAL

Pierre O. BERNER

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Aro RATOVONOMENJANAHARY

PARTIE I : IDENTIFICATION D'UN SITE ULTRAMAFIQUE ÉQUIVALENT

1. SITUATION DE BASE

- Les gisements latéritiques nickélifères d'Ambatovy et Analamay résultent d'une érosion de longue haleine d'une ancienne intrusion de roche mère ultra mafique.

- Dus aux conditions paléoclimatiques fluctuantes impliquant des séquences d'épisodes de réactions d'oxydation et de réduction de la couche latéritique ferrugineuse superficielle, une croûte ferralitique caractéristique s'est développée sur les plateaux d'Ambatovy et d'Analamay.

- En fonction des conditions chimiques et mécaniques particulières du substrat ainsi qu'une exposition substantielle aux pluies orographiques, une végétation forestière atypique a évolué sur ces stations. Cette forêt azonale se caractérise par une structure dense et une architecture rabougrie des arbres ainsi qu'une composition floristique qui se différencie de celle de la forêt zonale des alentours, notamment en terme d'abondance d'espèces.

- Ainsi, il existe une forte corrélation spatiale entre la roche mère ultramafique, le profil latéritique nickélifère résultant de son érosion, la couche ferralitique issue des processus d'oxydo-réduction sous un régime de nappe phréatique historiquement variable et le type de végétation azonale qui s'est adapté à ce substrat particulier. Par conséquent, l'exploitation du gisement latéritique nickélifère causerait un impact sévère sur la forêt azonale et la nécessité d'explorer les possibilités d'une mitigation compensatoire hors site est indispensable.

2. ENJEUX

- En considérant l'empreinte minière développée par le bureau d'études Knight Piésold Consulting équivalent à environ 13 km^2, proposée dans l'étude de faisabilité du projet Nickel Cobalt, la surface résiduelle de la forêt azonale sera relativement restreinte et morcelée.

- Par conséquent, les prospects d'une mitigation de ce type de forêt sur site offrent la possibilité d'une mise sous protection relativement restreintes dans l'espace, correspondant à environ 20% du total de la forêt azonale et il est ainsi souhaitable d'explorer les options d'une conservation d'une formation végétale sur substrat ultramafique similaire hors site.

- Notons d'emblée qu'une compensation hors site ne pourra, dans les meilleurs des cas, que protéger des habitats similaires et ne pourra jamais entièrement remplacer la perte de l'habitat sacrifié à la mine. En effet, une protection sur site est toujours à privilégier sur une compensation hors site. En outre, la définition d'un « habitat similaire » se réfère en l'occurrence à des aspects de substrat, de structure forestière de la forêt azonale et de son abondance d'espèces moins que des aspects de diversité biologique d'espèces endémiques locales puisque celle-ci varie pour chaque habitat ultrabasique isolé dans l'espace.

3. MÉTHODOLOGIE

- Identification des sites ultrabasiques de la côte est de Madagascar selon les données géologiques existantes de la littérature (Ministère de l'Energie et des Mines, Faculté des Sciences de l'Université d'Antananarivo, Ecole Supérieure des Polytechniques, etc.).

- Superposition de ces zones identifiées à la carte de couverture forestière de Conservation International (CI) et recoupement d'informations forestières avec le Missouri Botanical Garden (MBG).

- Identification des sites qui présentent les conditions géologiques et écologiques d'intérêt pour la compensation hors site et consultation ad hoc subséquente pour recueillir des informations par des professionnels familiarisés à ces sites (Steve Goodman, George Schatz, Chris Birkinshaw, Frank Hawkins, Raymond Rabevohitra, Michel Louys, etc.).

- Achat de cartes Ikonos des sites retenus et vérification de la couverture végétale et des tendances locales de l'occupation des sols.

- Survol des sites avec un Maule MX-7, prise de photos de la couverture végétale et identification des accès pour des éventuelles reconnaissances terrestres futures.

- Identification des sites d'intérêt pour une reconnaissance terrestre rapide à partir des constats du survol.

- Reconnaissance sur terrain des sites retenus avec relevés floristiques et faunistiques rapides.

- Analyse des données et formulation de recommandations en matière de site compensatoire.

4. RESULTATS

4.1 TYPE DE GISEMENT ULTRABASIQUE

Les gisements de roches basiques (gabbros et plus rarement diorites) offrent une grande variété tant par leur constitution que par leur âge, qui est soit post-tectonique soit syntectonique.

- Les gabbros post-tectoniques : Quatre types de gisement dominent à Madagascar
  - Les gabbros crétacés (datant de 90 Millions d'années) qui se caractérisent par de gros massifs intrusifs arrondis avec auréole de métamorphisme de contact. C'est le cas d'*Ambarany* et de *Fonjay*, situés dans la région de Morafenobe de la Province de Majunga.
  - Les gabbros crétacés subvolcaniques se rencontrent surtout dans le secteur d'*Ankilizato.*
  - Les gabbros crétacés qui se sont différenciés des péridotites aux syénites et recoupent les schistes cristallins. Il s'agit du massif d'*Antampombato* (Ambatovy-Moramanga, Province de Toamasina), d'âge 86 Millions d'années.
  - A l'Est de Manakara (Province de Fianarantsoa), le massif de la *Manama* montre une différenciation gabbroï-syénitique, il est aussi d'âge récent.
- Les gabbros anciens syntectonique comportent des formes franches à structure grenue ou ophitique (gabbro de l'Itsindro) et toute une série où un métamorphisme croissant conduit à des orthoamphibolites. Cette transformation se fait par une transformation progressive des pyroxènes en amphibole hornblende accompagnée parfois d'une recristallisation des plagioclases.

D'autre part, tous les massifs de gabbros montrent généralement des phénomènes de différenciation plus ou moins prononcés à partir d'un magma péridotitique qui se traduit par la présence de péridotites, pyroxénolites, gabbros et si l'évolution est très poussée, de termes acides.

4.2 LES PRINCIPAUX GISEMENTS ULTRABASIQUE MALGACHE

LES GABBROS POST-TECTONIQUE

Les gabbros post-tectoniques se rencontrent surtout dans les zones sédimentaires et assez rarement dans le massif cristallin.

- **Fonjay** : De forme elliptique, ce gisement s'étale sur près de 8 Km sur 13 Km. Il est en grande partie constitué de gabbro grenu. Au centre, une masse circulaire de dolérite forme une intrusion ultime subvolcanique.
- **Ambarany** : Les axes de ce gisement sont approximativement de 12 Km et 15 Km. Il s'est mis en place avec une phase majeure qui a introduit une grande masse de gabbro à augite. Une phase ultérieure a fourni des filons doléritiques. Tous ces filons recoupent le gabbro et sa bordure sédimentaire.
- **Gabbro d'Ankilizato** : Plusieurs intrusions gabbroïques et basaltiques traversent les marnes du jurassique. Elles forment des intrusions stratoïdes avec parfois alternance de gabbros et de basaltes. Le grand affleurement occupe un plateau avec basalte reposant sur des gabbros. A l'Est d'Ankilizato, plusieurs intrusions s'allongent sur 20 Km.

- **Massif d'Antampombato** : Il s'agit d'une intrusion très différenciée où une venue initiale de péridotite a donné lieu à une assimilation des parois et à une séparation par gravité de péridotite, pyroxénolites, gabbro, syénite quartzique, syénite calcoalcaline. Etendue sur 10 Km sur 5 Km, le massif intrusif dans les schistes cristallins, a été daté à 86 millions d'années (crétacé supérieur). Les péridotites sont nickélifères et leur partie superficielle altérée s'est transformée en argile latéritique nickélifère d'intérêt économique.

- **Massif de Manama** : Situé à 90 Km à l'Ouest de Manakara, ce massif a des dimensions approximatives de 16 Km sur 10 Km. C'est une zone très accidentée et boisée. Il correspond à une grande intrusion incontestablement post-tectonique qui n'a pas été datée et pour laquelle on peut penser à un âge analogue à celui d'Antampombato (86 millions d'années). Il est constitué par une ceinture syénitique et des zones concentriques successives de gabbros feldspathiques et de gabbros à olivine pour aboutir à une zone centrale troctolitique.

- **Gabbros de l'Itsindro** : Situé à 170 Km au sud sud-ouest d' Antananarivo, entre Ambositra et Ambatofinadrahana, le massif se développe le long de la vallée de l'Itsindro, affluent de la Mania. Il est constitué de gabbros à structure grenue ou ophitique, peu importante, de pyroxénolites et de péridotites (wehrlites). Il y a une différentiation très locale ayant produit des wehrlites. Il s'étale sur 40 Km sur 10Km.

- **Massif de l'Ankera** : Le relief est accentué avec une altitude au sommet de 1190 m. Ce massif montre le début de l'évolution métamorphique. A 60 Km au sud-ouest de Toamasina, il forme une masse quasi circulaire de 10 Km de diamètre avec une ceinture externe d'orthoamphibolites large de 1 à 2 Km. Le gabbro englobe des amas de pyroxénolites. La partie centrale est constituée de gabbros avec une bordure transformée en amphibolites. La partie orientale, estimée à 7Km sur 2 Km renferme des lentilles ou amas très irréguliers d'ultrabasites pyroxéniques. Le gabbro initial a été transformé en orthoamphibolites feldspathique et le pyroxène a entièrement disparu.

- **Massif d'Andriantantely** : Situé à 25 Km au sud de l'Ankera, le massif de 20Km sur 6 Km présente une transformation très poussée. Il est surtout constitué d'ortho pyroxénites et d'orthoamphibolites avec toutefois des amas de gabbros résiduels à hypersthène ou à olivine et plus rarement de pyroxénolites. Les déformations s'accompagnent de recristallisation. Une autre évolution transforme les gabbros riches en hypersthène en charnockites.

- **La série Basique Ultrabasique d'Andriamena** : Localisée dans la province de Majunga, cette série qui s'étend de part et d'autre de la moyenne Betsiboka offre des gisements très complexes. Les intrusions ont été ultérieurement très plissées, étirées, fracturées et reprises dans un nouveau cycle métamorphique. Il reste des amas résiduels de péridotites, pyroxénolites et gabbros mais la plupart de ces roches ont été transformées en orthoamphibolites ou en charnockites. Les pyroxénolites et surtout les péridotites sont intéressantes car elles renferment des concentrations de chromite. Le gisement de chromite d'Andriamena comprend, en milieu d'une masse de gabbros et d'anorthosites, un amas formé de pyroxénolites passant à la base à des péridotites qui renferme une grosse lentille de chromite.

- **Massif de l'Ankara-Bebeloka** : Situé à 50 Km dans l'ouest de Soanierana Ivongo de la province de Toamasina, il est essentiellement constitué d'amphibole-pyroxénites à grenat résultant du métamorphisme de gabbros. Des amas de pyroxénolites de dimensions notables et d'autres beaucoup plus réduits de péridotites traduisent l'évolution initiale par différentiation.

- **Massifs gabbroï-charnockitiques de Soavinadriana-Betafo** : Ces massifs correspondent à des intrusions de gabbros qui ont été ultérieurement transformés en charnockites. Ce sont de grosses masses dont les axes font de 10 à 20 Km renfermant des noyaux gabbroïques intacts à partir desquels se sont formées des charnockites gabbroïques puis granitiques et enfin syénitique.

- **Anorthosites : Ankafotra, Saririaka, Volovolo** (région de Bekily et Ampanihy) : Les anorthosites sont des gabbros essentiellement formés de plagioclases basiques.

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- **Massif de Vangoa** : Situé à 20 Km au Nord Est de Miandrivazo, il présente un complexe anorthosito-gabbroïque s'étendant sur 20Km sur 10 Km, inclus dans des schistes cristallins. Le centre est occupé par un ensemble de gabbros anorthosiques grenus qui renferme des enclaves de pyroxénolites souvent à gros cristaux d'hypersthène et d'ilménite. La périphérie est formée de gabbros présentant une structure spéciale dite orbiculaire où, autour d'un centre grenu, se développent des enveloppes concentriques. Ces gabbros renferment des parties lenticulaires constituant d'anorthosites normales.

LES LENTILLES DE PERIDOTITES

Les péridotites se présentent le plus souvent en petites lentilles injectées dans la stratification des schistes cristallins et prises dans les plissements, d'allongement décamétriques à hectométriques, généralement associées à des pyroxénolites parfois avec bordures d'orthoamphibolites et très rarement de serpentines.

- **La lentille d'Ambohitsara** : constituée de péridotites plus ou moins sérpentinisées s'allonge sur 900 m avec une épaisseur moyenne d'une centaine de mètre. Elle plonge de 70° dans des schistes cristallins pyroxéno-amphiboliques avec une bordure de pyroxénolites passant à des orthoamphibolites. La péridotite de surface est transformée en serpentine nickélifère sur quelques mètres.

- **La lentille d'Ampitambe** dans la boucle du confluent Ampasary (Nord-ouest de Mananjary) a une composition complexe avec noyaux de péridotites encadrés de pyroxénolites variées. Elle s'allonge sur 2 Km.

- **Massif de péridotites de Valozoro** : situé à 35 Km au Sud-est d'Ambositra, avec des affleurements spectaculaires de serpentine à garniérite, est formé par un dôme de péridotite (harzburgite) subcirculaire d'un diamètre de 700 m, intrusif dans des micaschistes précambrien, dont la partie superficielle est sur plusieurs mètres transformée en serpentine nickélifère.

Coupe de Valozoro :

(4)- Zone superficielle d'argiles latéritiques (1 à 5m), contenant des boules et blocs de 0,20 à 1,5m de diamètre, constitués soit de serpentine très riche en nickel, soit de harzburgite stérile, soit de harzburgite à croûte périphérique de serpentine riche ;
(3)- Zone d'altération très homogènes (0 à 10m), constituée de serpentine argileuse, souvent riche en nickel ;
(2)- Zone de transition à serpentine dure et pauvre ;
(1)- Harzburgite massive.

Source : Gîtes minéraux de Madagascar - Henri Besairie -Edition 1966

- **Nickelville** : (X= 629 ; Y= 920), 18 Km à l'Est d'Ambatondrazaka

Coupe géologique :

(5)- Argiles latéritiques (1 à 10m), lessivées et remaniées ;
(4)- Serpentines altérées, friables à réseau serré de garniérite, d'opale et de giobertite ;
(3)- Serpentines dures, massives, le plus souvent dépourvues de minéralisation visible ou à réseau lâche d'opale et de garniérite (2 à 15m) ;
(2)- Péridotites en voie de serpentinisation, montrant de grand cristaux résiduels d'enstatite associé à de la bastite, visibles sur 10m en galerie ;
(1)- Harzburgite saine.

- **Bemainty** : (X= 634 ; Y= 900) : 30Km au Sud-est d'Ambatondrazaka. Faisceau de péridotite le plus important, la lentille est située dans une boucle de la rivière Sahananto, dans une zone de colline peu élevées et arrondies. La majeure partie de la lentille est masquée par un recouvrement d'argiles latéritiques ; ses dimensions sont de 800*280m et elle couvre 16 Ha. Les roches constitutives sont des dunites, des harzburgite et des pyroxénolites à olivine plus ou moins abondante. La serpentinisation est très développée.

Coupe de Bemainty :

(4)- Argiles latéritiques avec pisolites ferrugineuses ;
(3)- Argiles latéritiques avec squelette de minéraux, blocs ou fantômes de serpentine et péridotite ;
(2)- Serpentines latéritisées avec structure résiduelle, talc, chlorite en poches ou en filonnets et garniérites, en remplissage de diaclase ou en imprégnation diffuse ;
(1)- Serpentine compacte avec un réseau large d'opale et garniérite et péridotite compacte plus ou moins serpentinisée.

LA CUIRASSE FERRUGINEUSE

La consultation de la littérature a mentionné l'existence de cuirasses ferrugineuses dans quelques régions, à savoir :

- Antandrokomby (X= 620 ; Y= 925), près du Lac Alaotra, Province de Tamatave.
- Ambatomanga-Marololo (X= 622 ; Y= 945), près du Lac Alaotra, Province de Tamatave.
- Mangiaka (X= 630 ; Y= 995), dans la région d'Andilamena, Province de Tamatave.
- Ambatovy (X= 597 ; Y= 804), région de Moramanga, Province de Tamatave.
- Analamay (X= 599; Y= 809), région de Moramanga, Province de Tamatave.

4.3 LOCALISATION DES SITES D'INTERETS

Localisation	Coordonnées Laborde		UTM		Chef Lieu de Fivondronana	Province
	X	Y	UTM-X	UTM-Y		
Bemainty	634	900	250847,635	8009914,620	Sud-est Ambatondrazaka	Tamatave
Nickelville	629	920	245358,806	8029796,060	Est Ambatondrazaka	Tamatave
Valozoro	550	550	176131,973	7657596,850	Sud-est Ambositra	Fianarantsoa
Ampitambe					Nord-ouest Mananjary	Fianarantsoa
Ambohitsara						
Vangoa	310	750	560915,719	7860207,070	Nord-est Miandrivazo	
Soavinadriana-Betafo					Betafo	Antananarivo
Ankara-Bebeloka					Ouest Soanierana-Ivongo	Tamatave
Andriamena	520	960	135302,857	8067193,720	Tsaratanana	Majunga
Andriantantely	648	825	266713,726	7935264,730	Nord-ouest Brickaville	Tamatave
Ankera	646	855	263960,520	7965210,520	Nord-ouest Brickaville	Tamatave
Itsindro	450	645	700062,794	7753993,040	Sud sud-ouest Tananarive	Tananarive
Manama	490	430	119659,667	7535738,890	Ouest Manakara	Fianarantsoa
Ambatovy	597	804	216244,087	7912965,270	Moramanga	Tamatave
Analamay	599	809	218116,816	7918018,140	Moramanga	Tamatave
Ankilizato						
Ambarany					Morafenobe	Majunga
Fonjay					Morafenobe	Majunga
Antandrokomby	620	925	236234,989	8034578,871	Lac Alaotra	Tamatave

6

Localisation	Coordonnées Laborde		UTM		Chef Lieu de Fivondronana	Province
	X	Y	UTM-X	UTM-Y		
Ambatomanga	622	945	237752,496	8054633,715	Lac Alaotra	Tamatave
Mangiaka	630	995	244565,575	8104840,809	Andilamena	Tamatave
Loharindava	634	818	252892,609	7927910,990	Brickaville	Tamatave
Marovato	628	822	246791,150	7931758,752	Brickaville	Tamatave
Antokobe	651	804	270246,267	7914345,680	Brickaville	Tamatave
Ankorabe	646	796	265451,918	7906219,856	Brickaville	Tamatave
Ankitsika	605	975	220027,535	8084240,543	Andilamena	Tamatave
Analamarina	610	1020	223970,809	8129383,622	Andilamena	Tamatave
Vohimenakely	634	975	249039,393	8084929,330	Lac Alaotra	Tamatave
Ambodiampa	635	955	250516,180	8064948,342	Lac Alaotra	Tamatave
Vohitraina	579	552	205079,582	7660431,856	Mananjary	Fianarantsoa
Tsararova	534	1042	147386,387	8149637,118	Tsaratanana	Majunga
Anjahambe	683	965	298277,154	8076092,126	Fenerive	Tamatave
Vohipika (Bebasy)	580	630	203877,907	7738466,529		Tamatave
Andilamavo	625	997	239516,703	8106723,885		Tamatave
Antara	680	1023	293917,417	8134011,787	Ouest Soanierana Ivongo	Tamatave

4.4 SITES SOUS COUVERTURE FORESTIÈRE DE L'EST

Une superposition des sites identifiés dans le sous-chapitre 4.3 sur le fonds de carte de la végétation révèle les sites candidats d'intérêt.

[Voir annexe 1: Carte de localisation des sites]

5. RECONNAISSANCE AÉRIENNE DU 23 MARS 2005

5.1 ITINÉRAIRE

- En date du 23 mars 2005, un vol a été réalisé avec un Maule, dans le but de faire une reconnaissance préliminaire et identifier des sites avec des forêts primaires rabougries ressemblant aux forêts azonales d'Ambatovy - Analamay ;
- L'itinéraire de survol est rapporté sur la carte de l'annexe 2.

[Voir annexe 2: Carte de l'itinéraire]

5.2 CONSTAT ET IDENTIFICATION D'UN SITE D'INTERET

- Au cours du vol, 11 sites ont été survolés. Mis à part un seul site, tous les sites survolés n'ont pas relevés les caractéristiques de la forêt azonale recherchée.
- Par contre, le site d'Ankera (n° 8) a été retenu étant donné l'aspect de sa forêt rabougrie avec des ouvertures naturelles ressemblant à des marais saisonniers similaires à ceux d'Ambatovy - Analamay ;
- Il a été décidé de réaliser une reconnaissance avec un hélicoptère pour y effectuer un atterrissage.

PARTIE II : LE SITE D'ANKERA

6. PREMIER VOL DE RECONNAISSANCE

- En date du 07 Août 2005, un premier vol de reconnaissance par hélicoptère afin d'y effectuer une atterrissage pour y effectuer des récoltes botaniques rapides a été réalisé.
- Malheureusement la végétation sur les lieux potentiels d'atterrissage s'est avérée trop haute pour permettre un aterrissage. En plus, les conditions météorologiques (vent, pluie) n'ont pas permis une sortie de l'hélicoptère en vol stationnaire au ras de la végétation.
- Cependant, il a été clairement reconnu que la végétation contient des éléments similaires à celles de Ambatovy - Analamay en incluant des marais saisonniers.

- En plus, les photos prises à basse altitude ont indiqué que la nature du substrat pourra bel et bien être une croûte ferrugineuse.

- Ainsi, l'hypothèse de la similarité entre ce site d'Ankera est celui d'Ambatovy - Analamay a été corroborée et a justifié la conduite d'une seconde visite de reconnaissance sur terrain.

7. DEUXIÈME VOL DE RECONNAISSANCE ET VISITE SUR TERRAIN

7.1 DESCRIPTION DE LA MISSION

- En date du 26 au 29 septembre 2005, un deuxième vol de reconnaissance par hélicoptère avec visite sur terrain a été effectué. Les participants ont été au nombre de trois : POB, Franck (géologue) et Richard (botaniste).

- Cette visite de 4 jours (y compris les voyages d'aller et retour) a permis la récolte d'un premier échantillonnage botanique ainsi que la prise d'échantillon de sol. Elle est résumée dans le tableau ci-après :

Date	Déroulement	Travail réalisé
Lundi 26 septembre	Départ à Tana vers 10h 30	Arrivée à 13h : Installation du Campement et Planning de travail
Mardi 27 septembre	Travaux sur terrain	Reconnaissance et échantillonnage
Mercredi 28 septembre	Travaux sur terrain	Echantillonnage et préparation de la zone d'atterrissage de l'hélicoptère
Jeudi 29 septembre	Matinée	Replis du Campement et Retour à Tana

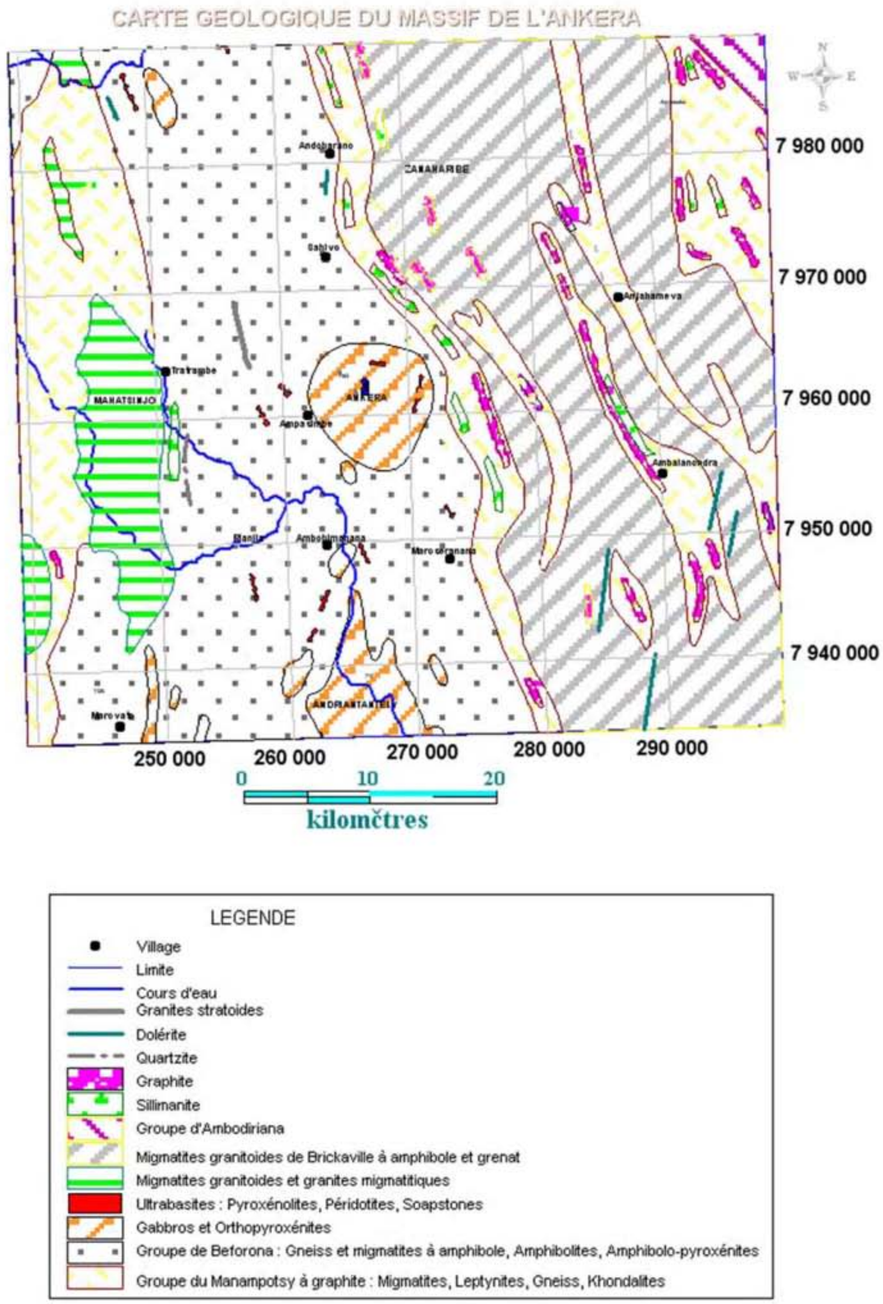
7.2 MORPHOLOGIE ET GÉOLOGIE DE L'ANKERA

- Le relief est accentué avec une altitude au sommet de 1190 m. Ce massif montre le début de l'évolution métamorphique.

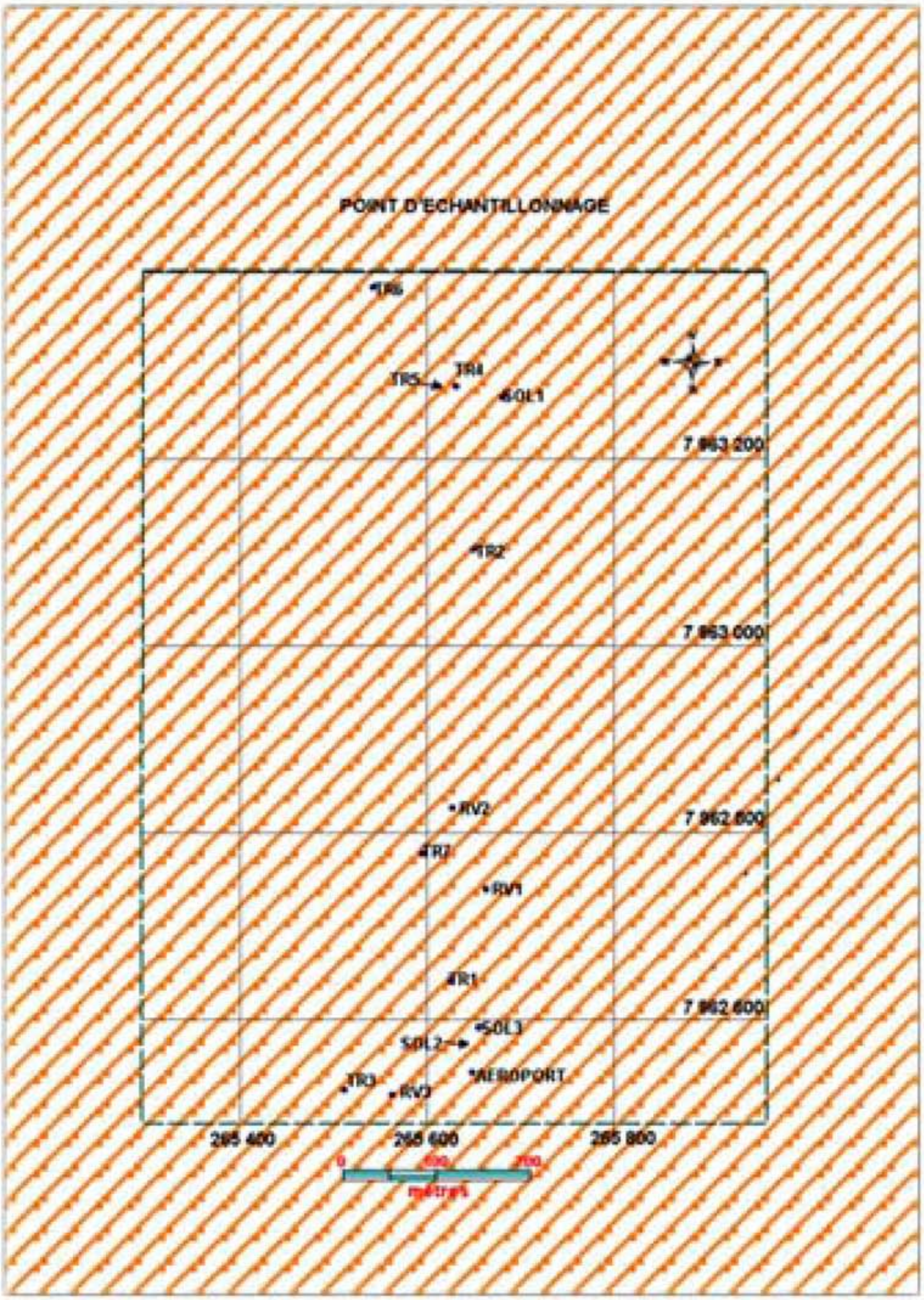
- Il se trouve à 60 Km au sud-ouest de Toamasina et forme une masse quasi circulaire de 10 Km de diamètre avec une ceinture externe d'orthoamphibolites large de 1 à 2 Km

- La partie centrale est constituée de gabbros avec une bordure transformée en amphibolites. La partie orientale renferme des lentilles ou amas très irréguliers d'ultrabasiques pyroxéniques. Le gabbro initial a été transformé en orthoamphibolites feldspathique et le pyroxène a entièrement disparu.

- On a rencontré des cuirasses ferrugineuses dans cette zone. La présence et la nature des végétations n'ont pas permis de trouver un profil lithologique bien précis.


CARTE GEOLOGIQUE DU MASSIF DE L'ANKERA
7 980 000
7 970 000
7 960 000
7 950 000
7 940 000
250 000
260 000
270 000
280 000
290 000
0
10
20
kilomĕtres
MANATSINJO
ANKERA
ANDRANTANTELY
LEGENDE
Village
Limite
Cours d'eau
Granites stratoides
Dolérite
Quartzite
Graphite
Sillimanite
Groupe d'Ambodiriana
Migmatites granitoides de Brickaville à amphibole et grenat
Migmatites granitoides et granites migmatitiques
Ultrabasites : Pyroxénolites, Péridotites, Soapstones
Gabbros et Orthopyroxénites
Groupe de Beforona : Gneiss et migmatites à amphibole, Amphibolites, Amphibolo-pyroxénites
Groupe du Manampotsy à graphite : Migmatites, Leptynites, Gneiss, Khondalites

11


POINT D'ECHANTILLONNAGE
TR6
TR5
TR4
SOL1
7 963 200
TR2
7 963 000
RV2
7 962 800
TR7
RV1
TR1
7 962 600
SOL3
SOL2
AEROPORT
TR3
RV3
265 400
265 600
265 800

12

LISTE DES ECHANTILLONS								
Local Site	Idnt. Sample	Coordonées			Prélèvement	Poids [Kg]	Photos	Observations
		UTM-X	UTM-Y	Z[m]				
Ankera	SOL1	265 681	7 963 266	1 051	A un horizon de 30 cm	0.886	[Voir Annexe-3 Photo-1]	Altération d'une roche Blanc jaunâtre
Ankera	SOL2	265 640	7 962 575	983	A un horizon de 40 cm	3.193	[Voir Annexe-3 Photo-2]	Argile de couleur grise
Ankera	SOL3	265 655	7 962 592	984	Horizon de 50 cm	3.268	[Voir Annexe-3 Photo-3]	Cuirasse altérée et argileux
Ankera	TR1	265 624	7 962 642	982	A la surface	2.741	[Voir Annexe-3 Photo-4]	Cuirasse ferrugineuse
Ankera	TR2	265 649	7 963 103	1 028	En surface	1.756	[Voir Annexe-3 Photo-5]	Cuirasse ferrugineuse
Ankera	TR3	265 512	7 962 525	980	En surface	1.980	[Voir Annexe-3 Photo-6]	Cuirasse ferrugineuse
Ankera	RV1	265 663	7 962 739	1002	En surface	1.097	[Voir Annexe-3 Photo-7]	Cuirasse ferrugineuse
Ankera	RV2	265 627	7 962 827	984	En surface	1.253	[Voir Annexe-3 Photo-8]	Cuirasse ferrugineuse
Ankera	RV3	265 562	7 962 519	975	A la surface	1.641	[Voir Annexe-3 Photo-9]	Cuirasse ferrugineuse
TOTAL	09 Echantillons					17.815 Kg		

LISTE DES POINTS LEVES

IDNT	UTM-X	UTM-Y	Z
SOL1	265 681	7 963 266	1 051
SOL2	265 640	7 962 575	983
SOL3	265 655	7 962 592	984
TR1	265 624	7 962 642	982
TR2	265 649	7 963 103	1 028
TR3	265 512	7 962 525	980
RV1	265 663	7 962 739	1 002
RV2	265 627	7 962 827	984
RV3	265 562	7 962 519	975
TR4	265 631	7 963 278	1 053
TR5	265 612	7 963 278	1 082
TR6	265 542	7 963 384	1 170
TR7	265 594	7 962 779	984
AEROPORT	265 648	7 962 543	982

MATERIELS UTILISES

Les matériels suivant ont été utilisés durant cette visite sur terrain :

- GPS Garmin
- Sac plastique
- Marteau Géologue
- Boussole
- Angady
- Tarière

7.3 CARACTERISTIQUES BOTANIQUES DE LA VEGETATION D'ANKERA

- Selon les constats préliminaires du Missouri Botanical Garden (MBG) dont un botaniste était sur terrain avec l'équipe de DYNATEC, nous pouvons affirmer que malgré un échantillonnage préliminaire, la flore est riche et contient beaucoup d'éléments similaires à celle d'Ambatovy - Analamay ;

- Il s'est également avéré que le site d'Ankera n'a pas été anthropisé et que la végétation est primaire, même dans les zones dénudées naturellement où aucune trace de feu n'a été observée ;

- Il va de soi que des inventaires plus approfondis seront nécessaires pour caractériser cette flore d'Ankera et se prononcer définitivement sur la similarité avec celle d'Ambatovy - Analamay ;

- Ci-joint la liste des plantes récoltées à Ankera comparant la présence (+) et l'absence (-) des espèces en commun avec Ambatovy et Analamay (note : les cases où il n'y a pas de remarque n'ont pas été identifiées au niveau d'espèces et rendant ainsi la comparaison impossible) ;

- Dans la liste postérieure, l'avant-dernière colonne indique la présence d'espèces sur les sites d'Ankera qui avaient été identifiées comme espèces de préoccupation pour le site d'Ambatovy (espèces de préoccupations sont des espèces classées comme endémiques locales à faute de ne pas avoir été identifiées en dehors de l'empreinte minière).

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Compiled by Pierre O. Berner

Listes des plantes récoltées à Ankera (à 70 km NE d'Ambatovy) du 26 au 29 Septembre 2005

Famille	Genre	Espèce	Variété	Auteur	on site SOC	on site species
(Lichen)	*Cladonia*	*sp*				
(Mousse)	*Frulania*	*sp*				
ANACARDIACEAE	*Campnosperma*	*micranteium*		Marchand		-
ANACARDIACEAE	*Protorhus*	*sericea*		Engler		-
ANACARDIACEAE	*Rhus*	*thouarsii*		(Engl.) H. Perrier		-
APOCYNACEAE	*Petchia*	*cryptophlebia*		(Baker) Leeuwenber.		+
ARALIACEAE	*Polyscias*	*cf zanthoxyloides*		(Baker) Harms.		
ARALIACEAE	*Polyscias*	*ornifolia*		(Baker) Harms.		+
ARALIACEAE	*Polyscias*	*sp1*		J.R. Forst. & G. Forst		
ARALIACEAE	*Polyscias*	*sp2*		J.R. Forst. & G. Forst		
ARALIACEAE	*Schefflera*	*cf longipedicellata*		(Lecomte) Bernardi		-
ARALIACEAE	*Schefflera*	*sp*		J.R. Forst. & G. Forst		
ARECACEAE	*Dypsis*	*thiryana*		(Becc.) Beentje & J. Dransf		-
ASPHODELACEAE	*Aloe*	*leandri*		Bosser	+	+
ASTERACEAE	*Apodocephala*	*sp*		Baker		
ASTERACEAE	*Helichrysum*	*gymnocephalum*		(D.C.) Humbert		-
ASTERACEAE	*Helichrysum*	*onivense*		Humbert		-
ASTERACEAE	*Helichrysum*	*retrorsum*		DC		+
ASTERACEAE	*Psiadia*	*leucophylla*		(Baker) Humbert		-
ASTERACEAE	*Vernonia*	*sp1*		Schreb.		
ASTERACEAE	*Vernonia*	*sp2*		Schreb.		
BALSAMINACEAE	*Impatiens*	*sp*		L..		
BIGNONIACEAE	*Clerodendron*	*moramangense*				-
BIGNONIACEAE	*Ophiocolea*	*floribunda*		(Bojer ex Lindl.) H. Perr.		+
CELASTRACEAE	*Polycardia*	*sp*		Juss.		
CLUSIACEAE	*Calophyllum*	*milvum*		P.F. Stevens		+
CLUSIACEAE	*Eliaea*	*reticulata*				-
CLUSIACEAE	*Garcinia*	*sp*		L.		
CLUSIACEAE	*Symphonia*	*sp*		L. F.		
CONVALARIACEAE	*Dracaena*	*reflexa*		Lam.		+
CUNONIACEAE	*Weinmannia*	*bernadi*				-
CUNONIACEAE	*Weinmannia*	*decora*		Tul.		-
CUNONIACEAE	*Weinmannia*	*humbertiana*		Bernardi		-
CUNONIACEAE	*Weinmannia*	*madagascariensis*		DC.		-
CUNONIACEAE	*Weinmannia*	*sp*		L.		
CYPERACEAE	*Cladium*	*flexuosum*		(Boeck) C.B. Clarke		-
DILLENIACEAE	*Hibbertia*	*coriacea*		(Pers.) Baill.		+
EBENACEAE	*Diospyros*	*cf lanceolata*		Poir.		
EBENACEAE	*Diospyros*	*sp*		L.		
ERICACEAE	*Philippia*	*floribunda*		Benth.		-
ERICACEAE	*Philippia*	*sp*		Klotzsch		
ERICACEAE	*Vaccinium*	*emirnense*		Hook.		+
RUBIACEAE	*Alberta*	*minor*		Baill.		+
EUPHORBIACEAE	*Blotia*	*sp*		Leandri		
EUPHORBIACEAE	*Uapaca*	*cf densifolia*		Baker		
IRIDACEAE	*Aristea*	*madagascariensis*		Baker		-
LAURACEAE	*Cryptocaria*	*sp*		Gay		
LOGANIACEAE	*Anthocleista*	*madagascariensis*		Baker		+
LORANTHACEAE	*Bakerella*	*clavata*		(Desr.) Balle		+

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Listes des plantes récoltées à Ankera (à 70 km NE d'Ambatovy) du 26 au 29 Septembre 2005

Famille	Genre	Espèce	Variété	Auteur	on site SOC	on site species
LYCOPODIACEAE	*Lycopodium*	*cernuum*		L.		
MALPIGHIACEAE	*Acridocarpus*	*vivy*		Arènes		+
MELASTOMATACEAE	*Dichaetanthera*	*cf cordifolia*		Baker		
MELASTOMATACEAE	*Dichaetanthera*	*sp*		Endl.		
MELASTOMATACEAE	*Gravesia*	*sp*		Naudin		
MELASTOMATACEAE	*Medinilla*	*sp*		Gaudich		
MELASTOMATACEAE	*Memecylum*	*sp*		Gleditsch		
MYRICACEAE	*Morella*	*spathulata*		(Mirb.) Verdc. & Polhill		-
MYRSINACEAE	*Monoporus*	*cf clusiifolius*		H. Perrier		
MYRTACEAE	*Syzygium*	*cf aurantiacum*		(H. Perrier) Labat & G.E. Schatz		
MYRTACEAE	*Syzygium*	*danguyanum*		(H. Perrier) Labat & G.E. Schatz		-
OCHNACEAE	*Campylospermum*	*sp*		Tiegh		
ORCHIDACEAE	*Bulbophyllum*	*baronii*		Ridl.	+	+
PANDANACEAE	*Pandanus*	*sp1*		Parkinson		
PANDANACEAE	*Pandanus*	*sp2*		Parkinson		
POACEAE	*Nastus*	*aristatus*		H. Camus		+
PODACARPACEAE	*Podocarpus*	*madagascariensis*	humbertii	Baker		+
PODOCARPACEAE	*Podocarpus*	*madagascariensis*	procerus	Baker		+
PROTEACEAE	*Faurea*	*forficuliflora*		Baker		+
PTERIDACEAE	*Dicranopteris*	*sp*		Bernh		
RHIIZOPHORACEAE	*Carallia*	*madagascariensis*		(DC.) Tul.		-
RHIIZOPHORACEAE	*Cassipourea*	*sp*		Aubl.		
RUBIACEAE	*Antirhea*	*borbonica*		J.F. Gmel.		+
RUBIACEAE	*Coptosperma*	*sp*		Hook. F.		
RUBIACEAE	*Gaertnera*	*macrostipula*		Baker		-
RUBIACEAE	*Galeniera*	*sp*		Lam.		
RUBIACEAE	*Schismatoclada*	*aurea*		Homolle		+
RUBIACEAE	*Schismatoclada*	*cf thouarsiana*		(Baill.) Homolle		
RUTACEAE	*Vepris*	*cf macrophylla*		(Baker) I. Verd.		
SALICACEAE	*Casearia*	*nigrescens*		Tul.		+
SANTALACEAE	*Thesium*	*leandrianum*		Cavaco & Keraudren		+
SAPOTACEAE	*Faucherea*	*laciniata*		Lecomte		+
SAPOTACEAE	*Faucherea*	*manongarivensis*		Aubréville		-
SAPOTACEAE	*Faucherea*	*parvifolia*		Lecomte		+
SAPOTACEAE	*Faucherea*	*sp*		Lecomte		
SAPOTACEAE	*Faucherea*	*thouvenotii*		Lecomte		-
SARCOLAENACEAE	*Leptolaena*	*cf raymondii*		G.E. Schatz & Lowry		
SARCOLAENACEAE	*Sarcolaena*	*oblongifolia*		F. Gérard		+
VELOSIACEAE	*Xerophyta*	*sp*		Juss.		
VERBENACEAE	*Vitex*	*bojeri*		Schau		+
VERBENACEAE	*Vitex*	*chrysomallum*		Steud.		+

Liste arrêtée à 90 espèces réparties dans 67 genres et 46 familles de plante

7.4 COMPARAISON GENERALE DES SITES

- D'une façon très préliminaire, un tableau de comparaison entre le site d'Ambatovy et celui d'Ankera a été élaboré :

HORS SITE : VISITE DE RECONNAISSANCE
Du 26 au 29 septembre 2005

PARAMETRES	AMBATOVY / ANALAMAY	VOHIMANA - ANKERA	REMARQUES
Géologie	Basique et intrusion ultramafique	Intrusion ultramafique	Besoin d'autres informations de la part de l'équipe géologue (Franck Ny Onja, mercredi 05 Octobre 2005)
Roche mère	Péridotite, pyroxénite, gabbros mésocratique et syénite	Gabbros, pyroxenites, pyroxenolites entourées d'amphibolites	
Taille de l'intrusion	6 Km X 6 Km pour l'intrusion entière et deux intrusions ultramafiques de 3 Km X 3 Km	Intrusion circulaire d'environ 7 à 9 Km de diamètres	
Altitude	950 à 1100 m au-dessus du niveau de la mer	950 à 1193 m au-dessus du niveau de la mer	Généralement similaire mais voir les différences géomorphologiques (faible volume du massif d'Ankera)
Climat	1400 mm de précipitation de septembre à novembre, faible précipitation e saison sèche et brouillards	Influences alizés / pluies orographiques, importante précipitation horizontale (selon littérature, précipitation estimée entre 3000 à 4000 mm)	Besoins de re-confirmation des données sur la précipitation du site d'Ankera (excepté la variation entre le versant est et le versant sud-ouest
Géomorphologie	Dégradation modérée avec plateau ferrugineux et pisolite sur versant	Pente modérée autour des montagnes avec domination de crêtes d'est à l'ouest.	La géomorphologie des deux sites est différente en terme de type de plateau ferrugineux à Ambatovy. Cependant à Ankera, une série de dépressions marécageuses témoigne que le terrain n'est pas humide partout.
Profil latéritique	Variable entre 30 à 100 m	Non déterminé réellement durant la première reconnaissance à cause de l'épaisseur et la solidité de la croûte ferrugineuse	Nécessité de plus de travail pour évaluer la nature de régolite entre la croûte et la roche mère. Ce point est particulièrement important du fait que le profil pourrait contenir le minerai d'intérêt
Croûte ferrugineuse	Croûte consolidée sur 2 à 3 m d'épaisseur sur le plateau	Croûte consolidée épaisse sur tous les périmètres visités (incluant la crête et le mi-versant)	Les deux sites montrent une croûte ferrugineuse qui semble être similaire dans sa morphologie générale. Besoin d'autres informations de la part de l'équipe géologue (Franck Ny Onja, mercredi 05 Octobre 2005)

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PARAMETRES	AMBATOVY / ANALAMAY	VOHIMANA - ANKERA	REMARQUES
Sol et substrat	Natte de racine dense sur la croûte ferrugineuse et pisolite. Couche supérieure réduite au dessus de la latérite	Natte de racine dense et épaisse sur la croûte ferrugineuse. Epaisse couche supérieure incluant des mousses (typique des sols de forêts de montagne avec cycle de nutriment forte et lenteur relative de la transformation de l'azote comparées au autres sols forestiers)	En général, les sols d'Ambatovy sont nettement moins humides que celui d'Ankera et les arbres subissent plus de stress hydrique en saison sèche
Structure de la végétation forestière	Forêt dense rabougrie et bush sclérophylle azonal	Forêt azonale dense type rabougrie avec tapis de mousse	En général, une bonne similarité structurale semble émerger en terme de densité, diamètre, fréquence de distribution, architecture, hauteur mais des données manquent
Végétation ouverte	Sur et autour des marais saisonniers, et sur les plateaux anthropisés	Cuvettes ferrugineux avec la végétation marécageuse (Pandanus), croûte ferrugineuse consolidée avec seulement touffe (épaisse) et végétation au ras du sol	La végétation non – arbustive du site d'Ankera possède des caractères très primaires et contient probablement des espèces endémiques locales
Composition de l'ensemble de végétation	Incluent des associations d'espèces qui dominent dans la forêt azonale en terme d'abondance et incluent les endémiques locales (cependant, plusieurs espèces sont probablement aussi représentées dans les forêts de transition, des recherches de suivi sont nécessaires pour confirmer la liste des endémiques locales)	Les résultats de recherche d'échantillonnage de reconnaissance du MBG reçus le 15 Octobre. Il semble que la flore d'Ankera est sous régime de haute humidité et de forte précipitation et incluent plus d'éléments de la forêt orientale en contraste avec Ambatovy où la flore de plateau est tout à fait abondante.	En terme d'évolution, la distance de 70 Km entre les deux sites et la différence de position géographique est substantielle et provoque une évolution spatiale tout à fait différente en pression. La biogéographie doit être plus approfondie.
Étangs et Marais	Environ 50 étangs saisonniers, partiellement le résultat de la formation de fosses dans la croûte ferrugineuse	Cuvette de croûte ferrugineuse avec de l'eau stagnante sur le substrat de type hystosol	Seulement quelques uns ont été visités pendant le court exercice de reconnaissance et plus d'approfondissement doit être conduit pour évaluer la similitude de ces habitats secondaires azonaux.
Ruisseaux	Ruisseaux saisonniers et ruisseaux permanents dans les vallées avec des solides en suspension résultant des forages d'exploration et des routes. Les berges de la plupart d'entre eux ont été impactés par des	Ruisseaux permanents sur croûte ferrugineuse sans trace de solide évident même pendant la période de forte pluie. Des bords primaires, sans trace apparente d'impacts humains	Le système de ruissellement à Ankera contient une série d'habitats superbes qui devra être maintenue dans cet état primitif autant que possible.

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PARAMETRES	AMBATOVY / ANALAMAY	VOHIMANA - ANKERA	REMARQUES
	récoltes et des travaux de forage d'exploration de la mine		
Faune	Indri-Indri, Sifaka, petits mammifères, poissons endémiques, abondance d'herpès, oiseaux, arthropodes	Indri-Indri, herpès, et abondance d'autre faune (recherche requise)	Plus de travaux au sol ont dû être conduits pour évaluer la nature de la faune au site d'Ankera. Le déplacement de l'espèce d'Ambatovy à Ankera ne doit pas être vu comme option viable (voir également la remarque sous la rangée de composition en végétation).
Anthropisation	Cueillette, chasse, abattage, feux, forage d'exploration	Secteur primitif comprenant la végétation ouverte sans épisodes apparentes de feu (on a observé seulement un tavy isolé sur la pente Est de la montagne).	Une différence substantielle entre les deux sites qui placera Ankera en un potentiel site de conservation.
Biodiversité	Habitat en forêt azonale unique avec ses endémicités mais apparaissant probablement dans d'autres endroits dans la même région si des recherches approfondies sont réalisées	En incluant d'autres paramètres plus fiables pour présumer une biodiversité élevée (besoin d'autres études)	Pourrait bien être une hotspots de biodiversité à l'intérieur du corridor Zahamena- Mantadia en termes de végétation. Une hypothèse digne d'être examinée.
Statut de Conservation	Projet minier proposant un effort de conservation sur site de 20% de la forêt azonale (en rapport avec certains risques liés aux tailles des surfaces conservées et la proximité de la mine).	Partie prolongeant la limite orientale du corridor Mantadia - Zahamena, secteur actuellement sous le statut de conservation en termes de décret de la vision de Durban. Le secteur doit être mis sous un régime de gestion rigoureux de conservation si sa conservation doit être fixée à long terme.	Actuellement aucun effort de conservation sur le terrain
Potentiel de conservation	Important pour la protection de Torotorofotsy en tant que site Ramsar. Opérationnalité difficile pour la conservation à long terme étant donné la complexité de la divergence des besoins.	Sécuriser la conservation étudiée sur terrain est fortement désirée, réalisation facile si la pression anthropique est réduite	Mettre en application l'emplacement de site de conservation à Ankera pour augmenter le gain net de biodiversité au-delà de la durée du projet aurait constitué un scénario gagnant-gagnant pour le projet et les entités régionales en matière de conservation même.

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7.5 CONCLUSION

- La similarité générale entre ces deux sites a été établie mais pour estimer son degré, des recherches ultérieures sur terrain seront nécessaires, notamment en ce qui concerne la flore et la faune.

- Néanmoins, et en fonction de cette généralité similaire, nous pensons que ce site devrait être retenu par les promoteurs du projet Ambatovy Nickel comme candidat de protection hors site de la foret azonale sur cuirasse ferrugineuse comme une contribution au gain net à la biodiversité comme une mesure d'investissement environnemental allant au-delà des mitigations des impacts direct du projet minier.

Appendix 7: Comparison of Ambatovy / Analamay and Ankerana Azonal Habitats

Parameters	Ambatovy / Analamay (Project Site)	Vohimana – Ankera (Off-Site)	Remarks
overall vegetation composition	includes species guilds that dominate in the azonal forest in terms of abundances and that include local endemics (however, most species are likely to be also represented in the transitional forests, follow-up research needs to be commissioned to reduce the list of local endemics)	it seems that the flora of Ankera responds to a higher rainfall-humidity regime and includes more elements of the eastern forest in contrast to Ambatovy where the plateau flora is quite abundant.	in evolutionary terms, the separation of the two sites by 70 km and their different geographical position in regards to their positions on the easterly gradient is expected to be substantial and bring about quite different evolutionary pressure in time and space. More on the biogeography needs to be understood
ponds and marshes	about 50 seasonal ponds, partially the result of sinkhole formation in ferricrete	ferricrete bowls with stagnated water on hystosol- type substrate.	only a few bowls were visited during the short reconnaissance exercise and more groundwork needs to be conducted to assess the similarity of these azonal sub-habitats
creeks	seasonal creeks on plateau and permanent creeks in valleys with suspended solids as a result of exploration drilling and roads. Most creeks have impacted edges gathering, logging and mining exploration.	permanent forest creeks on ferricrete with no visible suspended solid material even during heavy rain episode; edges are pristine with no apparent human impacts throughout	the creek system at Ankera contains a series of superb habitats that need to be kept in this pristine stage whenever possible
fauna	Indri-Indri, Sifaka, small mammals, endemic fishes, abundance of herptiles, birds, arthropods	Indri-Indri, herptiles, and abundant other fauna (research needed)	more ground work needed to be conducted to assess the nature of the wildlife at the Ankera site; displacing species from Ambatovy to Ankera must not be seen as a viable option (see also remark under Vegetation composition row)
anthropization	gathering, hunting, logging, fires, exploration drilling	pristine area including open vegetation with no apparent fire episodes (only one isolated tavy on the east slope of the mountain was observed)	a substantial difference between the two sites that makes Ankera a very attractive site in terms of potential conservation scenarios
biodiversity	unique azonal forest habitat with local endemics but likely to occur elsewhere in the region provided more research time is being made available	includes most parameters to safety hypothesize high biodiversity (need for further investigation)	could well be a biological hotspot within the Zahamena-Mantadia corridor in terms of vegetation; a hypothesis worthy to be tested
conservation status	proposed mining project with planned on-site conservation effort by setting aside 20% of the azonal forest (linked with certain risks given the sizes of the patches and the proximity of the mine)	part of easterly extension of Mantadia-Zahamena forest corridor; area currently under conservation status in terms of the Durban vision decree; area needs to be put under a stringent managerial conservation regime if its conservation is to be secured in the long term	currently no conservation effort on the ground
conservation potential	important for Torotorofotsy Ramsar site watershed protection; operationality difficult for long-term conservation given the complexity of divergent stakeholder needs	secure conservation studies on the ground highly desired, implementation easy in light of reduced anthropomorphic pressure	implementing the Ankera off-site conservation site for enhancing the overall net biodiversity gain over the lifetime of the project could constitute a win-win scenario for the project and the regional conservation entities alike

To learn more about the BBOP principles, guidelines and optional methodologies, go to:

www.forest-trends.org/biodiversityoffsetprogram/guidelines