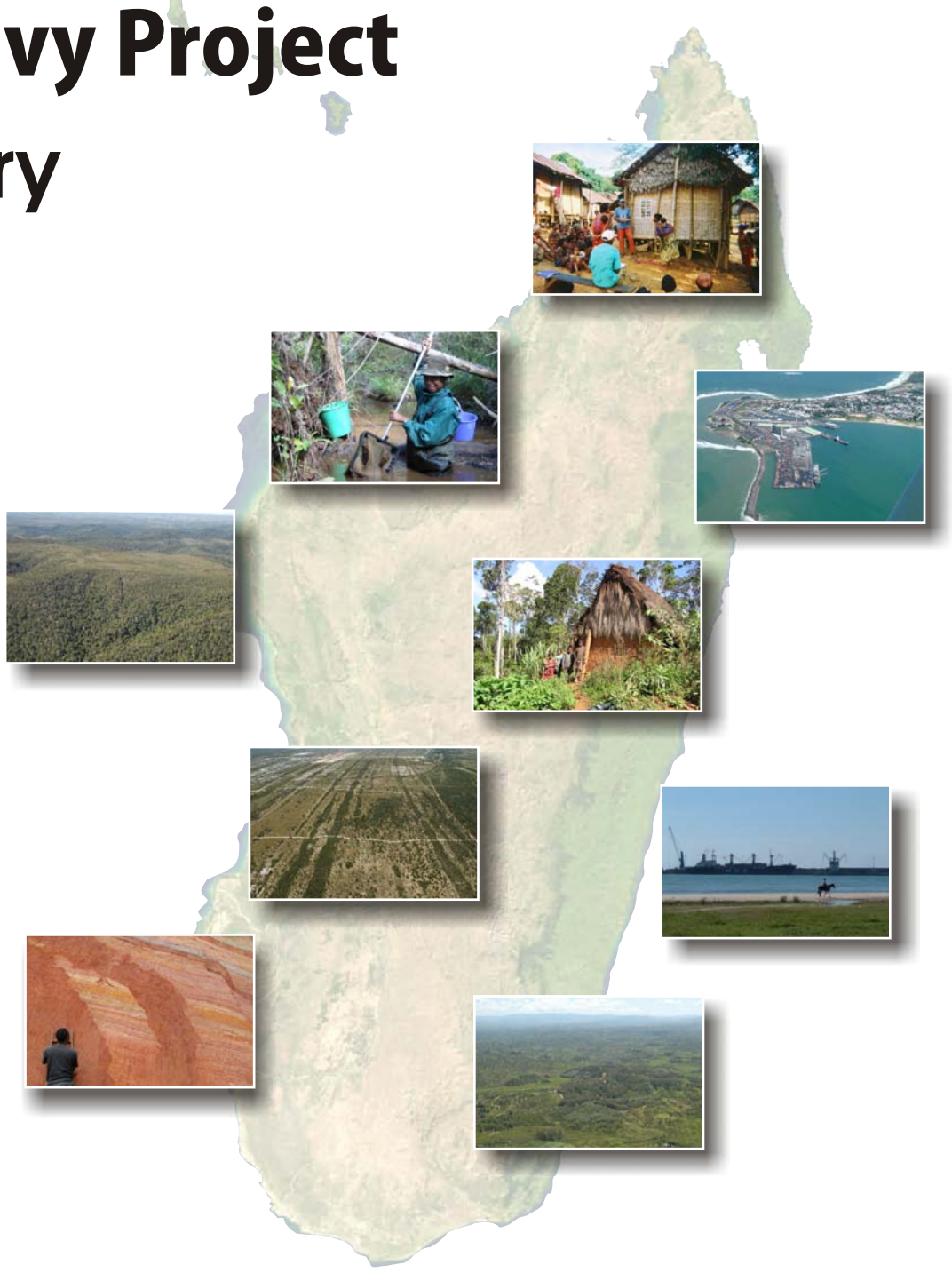
Environmental Assessment Ambatovy Project

Summary



Submitted by Dynatec Corporation of Canada on behalf of the Ambatovy Project

January 2006

Golder Associates

ATTACHMENTS

INTRODUCTION

Location of the Ambatovy Project in Madagascar

In 1960, the Malagasy Geologic Service first mapped the Ambatovy and Analamay nickel / cobalt ore bodies north of Moramanga in central Madagascar. Since then several companies have conducted exploration drilling to evaluate the mineral deposits, including most recently Dynatec Corporation of Canada (Dynatec). Now a joint venture including Dynatec is proposing the development of both ore bodies through the Ambatovy Project (the project). For the purpose of the Environmental Assessment (EA), the project is divided into five sites:

- mine site;
- slurry pipeline;
- process plant;
- tailings facility; and
- port expansion.

The open pit mine will produce nickel and cobalt ore over at least 27 years. A slurry of ore and water will be sent by pipeline from the mine to a process plant near Toamasina on the east coast. A tailings facility will be constructed southwest of Toamasina, to receive tailings solids from the process plant. In Toamasina, the existing port will be expanded to allow for import of raw materials such as limestone, coal and sulphur, and export of a mixed metal sulphide. The exported product will be refined to pure nickel and cobalt at an off-shore refinery. The schedule for the project is subject to Environmental Assessment (EA) review, permitting and detailed engineering design, but proposes construction from 2007 to 2009, with production beginning in 2010.

Over the 30 year lifetime of the project, average direct employment of Malagasy labour is estimated at between 1,400 and 2,000 jobs annually. Money spent in Madagascar is estimated to be over US$100 million annually. In addition, an estimated annual average of US$25 million will be paid to the Malagasy government (duties, tax and royalties). Many additional indirect and induced economic benefits will also be realized and will be described later in this summary.

In developing the Ambatovy Project, including preparing the EA, the proponents have strived at all times to maintain high social and environmental standards. The EA explains proposed mitigations that will be implemented to ensure that beneficial project effects are optimized and negative impacts minimized. The proponents are committed to

teaming with communities, government and other stakeholder groups, to integrate the project regionally as a contribution to sustainable development.

The National and Regional Context

Madagascar, located off southeast Africa in the Indian Ocean, is the fourth largest island in the world. Madagascar has a total land area of 587,040 km^2 and is rich in natural resources and ecosystems, including some of the world's most unique biodiversity. Despite its diverse resource base however, the country's 18 million people represent one of the world's least economically developed nations, with over 70% of the population living below the national poverty line.

Rural poverty and the environment are closely linked. Environmental degradation along with associated soil erosion is reducing agricultural productivity and increasing rural poverty. Madagascar has lost about 50% of its forest cover since 1960, with about 12 million hectares cleared. Forest clearance, practiced in the 1970s and early 1980s to produce more rice to feed the growing urban population, accounted for a large proportion of the lost forest cover. However, since the launch of the Government's National Environmental Action Plan in the late 1980s, deforestation rates have declined.

Special reserve near Andasibe

Madagascar has 53 protected areas, with a total surface area of just under 2 million hectares, or 3% of total land area. This network of protected areas is overseen by the National Association for the Management of Protected Areas (ANGAP). A commitment known as the Durban Vision was made by the President of Madagascar to triple the area under protection (including terrestrial and aquatic/marine protected areas) to six million hectares by 2009.

Recently, the government has aggressively pursued reforms, particularly oriented towards gaining the confidence of private investors. Public sector, tariff and customs reform, concessioning of major public enterprises and infrastructure and a concerted effort to battle corruption, create an improved climate for foreign investors. Regulatory reform has focussed on the mining sector, as the rich natural resource base is considered a potential source of economic growth and development. The determination of the government to reform in the interest of national economic and social development has resulted in support from international financial institutions and bilateral development assistance agencies.

The country is politically divided into six faritany or provinces, 22 regions, 110 prefectures, and over 1,500 communes, which are the smallest formal administrative units. All components of the Ambatovy Project are located in Toamasina Province. Early efforts in the mid 1990s at decentralization legislated responsibilities of commune governments,

including responsibilities for social services and development planning. However, the process of strengthening the capacity of rural communes has been difficult and is ongoing.

Fokontany and fokonolona are kinship-based units, composed of extended families and are traditionally governed by elder representatives of principal families. These units are no longer recognized by the new legislation on decentralization, but still have real value in practical terms. These have been the basic units of social organization.

Regional Planning

Lake Alaotra

A number of important government planning initiatives relevant to the development of the Ambatovy Project also take place at a regional level. Madagascar has been split into 22 regions for the purpose of aiding decentralisation of economic development, with each region producing a regional development plan focused on sustainable development and poverty reduction. The regions are not only planning units, but also decentralized territorial collectives and administrative areas (Article 4, law no. 2004-001). Alaotra–Mangoro and Atsinanana are the main regions in the project area. At a smaller scale, Toamasina Province is split into three regions, with each developing a regional development plan. The project is located within the Mangoro and Toamasina economic zones. Lastly, within a large central part of Toamasina Province, a planning structure has been created for the Ankeniheny–Zahamena Corridor. (This corridor was previously called the Mantadia–Zahamena Corridor, and is so named within most of the EA.) The planning region comprises much remaining tropical forest and the initiative aims to harmonise development with natural resource conservation needs.

The Environmental Assessment Process

The Ambatovy Project requires an EA approval to commence mining, as described in Madagascar's Environmental Charter of 1990 with subsequent modifications. This EA follows the Terms of Reference (ToR) issued in 2004 by the Malagasy National Office for the Environment (ONE). The ONE therefore appointed a Technical Evaluation Committee (CTE) in 2004 to review the EA.

Community consultation

Work on the EA started in January 2004, and benefited from studies during 1996 - 1998 for the Phelps Dodge mine project at Ambatovy. As required by the ToR and international guidelines, ongoing consultation has been, and continues to be, an important part of the EA process. Over 150 disclosure and consultation meetings took place in 2004 and 2005, with a variety of stakeholders: the public, NGOs, special interest groups, and regional and national government. Some meetings were large and involved many stakeholder groups at once, while others were small, such as meetings with village members living near the project. Along with professional expertise, consultation provided a solid basis for

focusing mitigation planning and impact analyses on issues of concern. The CTE also participated in consultation during 2004 when the focus was on project disclosure and identification of issues, and late 2005 when the emphasis changed to discussing proposed mitigation.

CTE workshop 2005

Many issues were raised during consultation and these have been discussed throughout the EA. As an aid to the reader, a conformity table links the main issues raised to the sections in the EA where they are addressed (see Attachment 2). Some key issues include:

- the need to optimize employment and economic benefits for Malagasy people;
- concern over the need to re-settle people, especially from the tailings area;
- concern over possible health and safety effects on people, including from HIV/AIDS linked to migrant workers;
- concern that changes to water quantity and quality downstream of the mine and tailings area could damage the environment and affect people and agriculture;
- concern over the level of impact the mine will have on biodiversity; and
- concern that the slurry pipeline will further fragment primary forest in the Ankeniheny–Zahamena forest corridor.

Public consultation will continue during construction and operations.

The preparation of the EA also involved collaboration within the project's EA team, which comprised Dynatec staff, international consultants and many specialists based in Madagascar. The EA considered baseline conditions, construction, operations and closure phases for the project. As required by the ToR, the EA process included the following steps:

- identify the environmental and socio-economic resources potentially affected by the project;
- predict positive and negative effects and the extent to which positive effects can be enhanced and negative effects mitigated;
- quantify and assess the significance of effects where possible;
- consider the need to compensate for any high residual negative effects; and
- identify methods to monitor resources that may be affected by the project.

The above steps suggest a linear flow of activities. However, in many instances, results of initial impact analyses were provided to the engineering design team, so that negative impacts could be minimized through improved design. The EA provides the basis for the development of an environmental and social management plan for construction, operation and closure.

As reflected in this summary, the EA considers each of the five project sites in turn. This approach allows for a focused assessment that considers each spatially separated site in detail. However, the Ambatovy Project is a single project, composed of all project sites. Combined effects of the project as a whole are assessed after each site is considered in turn. Further details on the structure of the EA report are provided at the end of this summary.

Project Policies

Project-specific policies on environment, health and safety, re-settlement and biodiversity have been developed for the Ambatovy Project. It is the policy of the project to maximize Malagasy employment to the extent feasible given skill requirements. It is also project policy that training programs be put in place to enhance the skill level of local residents, enabling increased employment over time. The human resources policy also promotes project programs to enable local companies to participate in the project, with a focus on Small and Medium Enterprises (SMEs). The Project has also endorsed the Equator Principles developed by financial institutions to assess and manage environmental and social risk in project financing (see Attachment 3).

MINE SITE

Social Context

The mine site is about 14 km northeast of the regional centre of Moramanga, and near the communes of Morarano Gare, Ambohibary (also called the Suburban Moramanga Commune), Ampasipotsy and Andasibe. The sub-villages of Berano, Behontsa, Andranovery and Ampangadiantandraka are closest to the mine site. The total population in the mine social study area approached 80,000 people in 2003, with less than half of these in the town of Moramanga.

Moramanga

The economy has both rural and urban aspects. Rural livelihoods are based largely on subsistence agriculture, predominantly rice and manioc, and to a lesser extent livestock. People depend on the nearby markets of Moramanga to sell agricultural and artisanal products. They also exploit forest resources for additional subsistence and work in the wage economy. The town's economy was based primarily on forestry, including production of lumber but also manufacturing of wood products. This industry is in decline.

Valley with the sub-village of Berano near mine site

Culture

The rural population is very young, with well over half under the age of 16. Overall, the rural economy is characterized by multiple cash income and subsistence sources, of which agriculture is the chief component although accounting for only about one quarter of income. This is despite the fact that according to focus groups, about 95% of the population works in the agricultural sector. At present, land use by people in the general mine area is gradually transforming the vegetation cover of the landscape. It is estimated that the current national rate of deforestation is about 1% per year.

Belief in tradition and in the accumulated wisdom of the ancestors has shaped Malagasy culture. Beliefs and customs remain a key part of Malagasy life today. The table below lists the main types of cultural sites that occur in the region of the Ambatovy Project.

Main Types of Cultural Sites in the Project Area

Site Category	*Sub-Categories*	*Cultural Relevance*
tombs	Fasana	considered ancestral residences, their displacement requires careful attention to proper ritual
	Tranomanara	
	Feraomby	
cemeteries	--	as above
ceremonial sites	Jiro	family prayer altar
	Fisokona	communal prayer altar
nefarious places	Tany Mahery	bad luck area
sacred waterfalls	Riana	symbolize purity; place for offerings
other cultural / archaeological sites	Vatolahy	large raised stone commemorating an important person or event of the past
	Tsangambato	small raised stones symbolizing a tomb
	Tanana Taloha	ancient abandoned villages

During surveys of the mine site, three sacred waterfalls, three ceremonial centres, two symbolic tombs, and several ancient villages were found. Of these cultural resources, however, only one sacred waterfall is located within the actual mine footprint. In addition, about eight kilometres east of the Ambatovy ore body, a hill named Ambavahadivohitra has been identified as being a principal communal prayer area (fisokona) used by the regional population as a whole. Overall, there is a relative scarcity of cultural sites in the mine area. Also, people have not been dependent on the generally stunted azonal forest (see description below), but have focused on the thicker forests farther away from the proposed mine area.

Environmental Context

The project proponents recognize that Madagascar has a unique biological diversity within a sensitive tropical environment. Because of this, a very experienced group of over 50 local specialists joined the EA team and conducted extensive soils, water, flora and fauna baseline surveys in the mine area. This allowed the EA team to be in a good position to assess potential impacts and design mitigation.

The mine area includes the eroded remnants of a plateau located at about 1,100 metres above sea level (masl). Temperatures in the area of the proposed mine have ranged from 8°C to 31°C with an annual average of 17°C. The plateau is flanked to the west by the broad alluvial plain of the Mangoro River and to the east by the Torotorofotsy Wetlands and forested hills.

The plateau surface is fairly uneven with numerous depressions that form ephemeral pools. Small headwater streams originate in the mine area and flow away in all directions as part of six basins. The mean annual rainfall is estimated to be 1,700 mm. Based on the Madagascar classification system for surface waters, most watercourses and water bodies near the mine site are assigned to “Class A” (i.e., water is suitable for multiples uses). In a few samples, baseline concentrations of lead, nickel and arsenic were higher than the World Health Organization drinking water quality guideline values.

Aerial view of mine site at Analamay

The mine site is covered with natural forests. The surrounding area includes intact and degraded forests and scrublands, areas dominated by grasses, eucalyptus plantations, woodlots and rice paddies. The soils in the mine region are generically known as laterites, which are highly weathered iron-rich tropical soils. The ore bodies are characterized by ferricrete soils with a hard, rock-like surface. This has resulted in the forests on the ore bodies being different (azonal) from the surrounding primary forest (zonal).

These azonal forests and shrub lands have been found to have a high percentage of listed species (listed as at risk by conservation agencies) and locally endemic species (species only known from the local area), especially flora. Botanists from Missouri Botanical Gardens (MBG) based in Madagascar, working as part of the EA team, have been studying this area extensively and identifying the species of concern (local endemic species currently only known from the mine footprint). So far there is a total of 127 flora species of concern at the mine site. Of this total, 53 species are currently listed in one of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) appendices, five are on the International Union for the Conservation of Nature (IUCN) list, and there are 68 others currently only known to occur in the Ambatovy/Analamay area. As MBG note, most of these species likely occur at one or more sites outside the Ambatovy/Analamay area, and in many cases they are probably present

within at least one protected area. As a result, further investigations are being conducted to search for species of concern off-site in the period before construction. Until evidence has been gathered that confirms the existence of populations outside the immediate mine area, each species will be retained on the list and they will be subject to focused species-level conservation programs.

Faunal species of concern in the mine area include local and regional endemics, rare species and species restricted for trade under CITES. Five amphibian and reptile species are regionally endemic and cause for conservation concern. Three of these species are not currently officially classified. Two species are new to science and have been found only in the Ambatovy area. As in the case of flora, while discovery of individuals of these species outside the project area is likely, they must be considered locally endemic to the project area until found elsewhere. Six of the species observed in the mine area are listed by IUCN and 21 species are listed by CITES.

The slender-billed flufftail

The most significant bird species was observed outside of the immediate mine area in the Torotorofotsy Wetlands. This species is the endemic slender-billed flufftail, which is only known from one other location in Madagascar and is facing severe habitat loss. Studies for this project have added greatly to the understanding of the biology of this species. Marsh habitat is severely threatened in Madagascar due to conversion of marsh into irrigated rice. Fifteen of the bird species observed in the mine area are listed by IUCN and 16 species are listed by CITES.

An indri

For mammals, nine lemur species were found in the mine area. All lemurs are endemic to Madagascar and seven of the nine lemur species observed are listed by IUCN. All lemur species are listed in Appendix I of CITES. One of the small mammal species, a shrew tenrec, may represent a new species. Two species identified during the surveys are IUCN listed but none is listed by CITES. Six bat species and one genus were detected during the bat survey, with one species listed by IUCN. None of the bat species detected is listed by CITES.

For insects, an important discovery was the observation of colonies of the *Pilotrochus* ant near Ambatovy. This endemic genus has not been observed since 1975 near Moramanga, despite widespread surveys. The discovery in the Ambatovy area suggests that *Pilotrochus* is locally endemic. In addition, one ant species is IUCN listed as vulnerable, but none is listed by CITES. The detection of the rare *Hovala* 2 is the most significant butterfly observation. There are less than 10 known specimens of this undescribed *Hovala*, which appears localised to the Analamazaotra region. The IUCN vulnerable species, *Papilio mangoura*, a swallowtail butterfly, was recorded although this has not yet been confirmed from detailed taxonomic analysis. No butterfly species is listed by CITES.

About half of the aquatic sites surveyed in the mine area were natural and largely undisturbed. However, within the Torotorofotsy Wetlands aquatic habitats generally had significant disturbance and loss of natural ecosystem function. Fifteen fish species were collected from the mine area, of which three were endemic, eight introduced and four native (natural to Madagascar but also found elsewhere). A fourth endemic, a new species of Malagasy rainbowfish (*Rheoclès* "*Ambatovy*"), may also be present. Two fish species were IUCN listed. A total of 70 aquatic macro-invertebrate taxa were recorded in the mine area. In contrast to the fish fauna, both diversity and abundances of the macro-invertebrate fauna were high. The ephemeral ponds were fishless, but contained a unique assemblage and diversity of macro-invertebrates and plankton.

The above summary shows the high level of biodiversity in the mine area, across a wide range of taxa. A large number of species present are also of conservation concern, as judged by IUCN (54 species) and CITES (104 species). Within the mine area the azonal habitat scored the highest for most biodiversity measures, particularly for number of species, habitat rarity and numbers of locally endemic species.

Regional conservation planning

Torotorofotsy Wetlands are the largest and most intact natural marsh in eastern Madagascar and are now a Ramsar site (wetlands of international importance). The proposed Ankeniheny–Zahamena Conservation area is also located east of the mine. The Corridor is in the process of being defined as a Conservation Site by the Government of Madagascar, with input from other interested parties.

Project Description

Mining is planned for the first 20 years of operation and stockpiled low grade ore would subsequently be reclaimed and processed over an additional seven years. The total area to be mined progressively over the 20 year period is about 17 km^2.

Ore body exposure

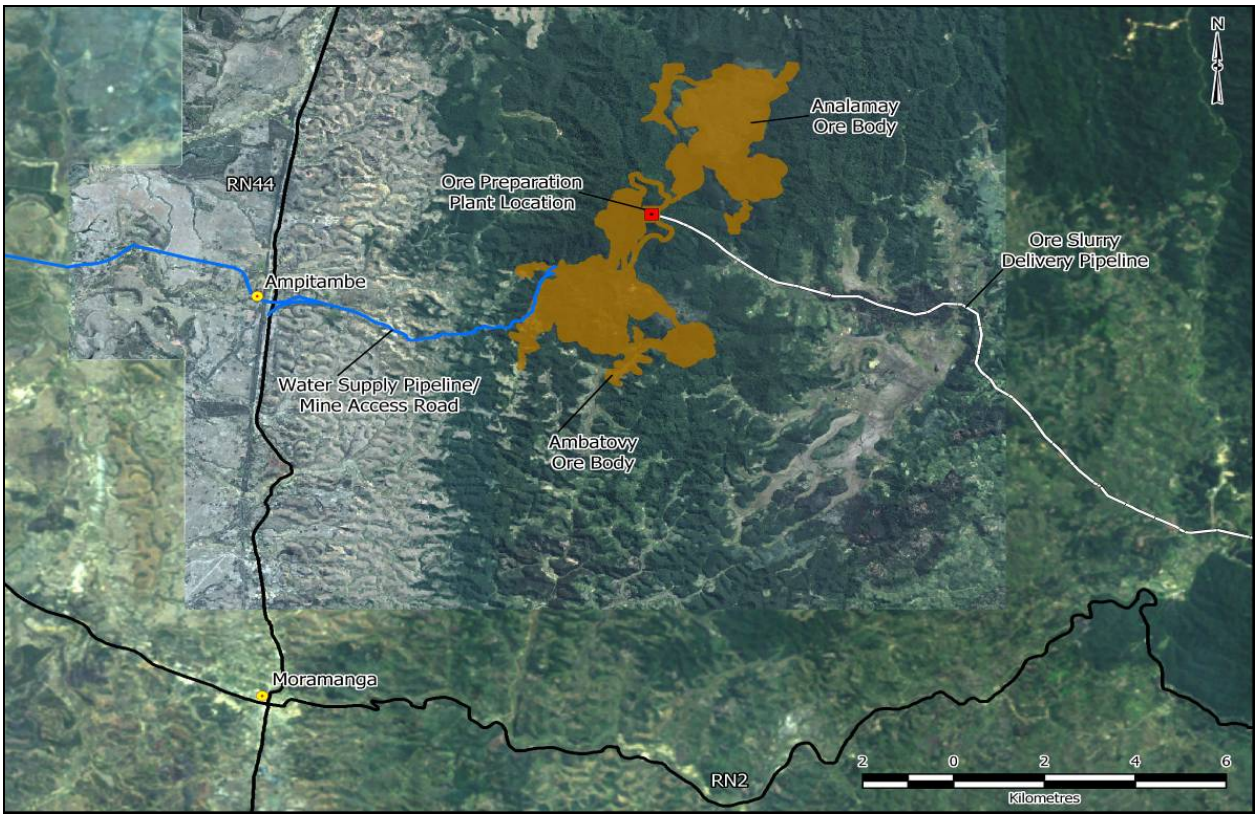
The ore bodies are up to 100 m thick and within several metres of the surface, allowing extraction by the shovel and truck method, which is flexible and economic for ore bodies of this type. The ore would be screened to obtain material of the size needed for mixing with water to make a slurry. The slurry would be sent by pipeline to the coast for processing. In addition to screening and mixing facilities, there would be offices, workshops and accommodation facilities at the mine site.

The access road to the mine site from Ampitambe will be upgraded. Mine site activities would require transport of supplies from Toamasina and Antananarivo. Following mitigation, increased risks to the public and the environment of natural hazards, such as flooding, as a result of the mine, are estimated to be low and within international standards.

Water supply for the operations will be provided by pipeline from the Mangoro River and supplemented with storm water runoff collected from the mine site. On-site diesel generators will supply power. During operations, re-vegetation of disturbed surfaces will be started as ore is removed and areas are released from mining activity.

The development of the mine site will involve removing some land from agricultural use. Compensation for this land will be planned and implemented according to International Finance Corporation (IFC) guidelines, in full consultation with the land users. At the present time, two households in the mine footprint area are planned to be re-settled. A Resettlement Action Plan (RAP) is being developed in parallel with this EA.

Construction can only start after EA review, permitting, additional engineering design and a formal development decision has been made. Construction will continue for about three years. There would be a large construction labour force, hired to the greatest practical extent from the Malagasy population. Details of training initiatives are given below. The total workforce would average 1,420 during construction, of which 540 are predicted to be locals. The operations phase workforce is expected to be about 390 over the mine life, of which 360 are predicted to be Malagasy.



The mine area

Key Impacts and Mitigation

Main issues identified through consultation and through the professional experience of the Malagasy and international EA team included:

- the need to train local people and optimize employment benefits for the Malagasy population;
- in-migration issues from a migrant labour force, including HIV/AIDS;
- impacts on tombs and cultural sites;
- impacts on rare tropical forest habitats and the biodiversity they contain; and
- water quantity and quality impacts on people and the environment, including the nearby Torotorofotsy Ramsar site.

Water

The mine layout and water management plan have been designed to minimize off-site impacts, with special attention to the Torotorofotsy Wetlands. Early in the design phase, it was decided to protect the Torotorofotsy Wetlands by keeping project elements away from the basin draining to the Torotorofotsy. A preliminary assessment determined that based on economic, social and environmental perspective the reliability of meeting the water needs for the ore processing plant and downstream users would best be met through the combined use of the Mangoro River and mine runoff collection. As a result, the Mangoro River water pipeline was included to provide water for ore processing, especially in the dry season. Maximum ore processing water requirements represent less than 0.3% of the mean annual flow in the Mangoro River, and less than 1.5% of the flow for dry conditions. The goal of the mine water management plan is to provide enough water for the slurry plant, while maintaining seasonal flows off-site. There will be some additional wet season flows during operations, because of vegetation clearing, but these will be offset by reduced groundwater flow. At closure, the mine area will be returned to natural runoff conditions through reclamation.

Torotorofotsy Wetlands

The water released from the runoff collection ponds into the downstream basins will be designed to meet World Bank suspended solids concentration criteria of 50 mg/L or less, based on a 1 in 10 year storm event. For storm events greater than the design storm, suspended solids levels entering the receiving streams may exceed the 50 mg/L criteria for short periods. The elevated concentrations, however, will be diluted by high downstream flows. Due to the sensitive nature of downstream receiving environments and requests during consultation, additional sediment modelling is being undertaken to better understand the probable suspended solids concentrations that could be released from the ponds during extreme storm events, such as two cyclones in quick succession. There will be flow monitoring in streams around the mine during operations, plus regular contact with downstream users on the acceptability of flows.

For other water quality parameters during operations, it is predicted that chromium will have the greatest increase over baseline, owing to run-off from the mine and waste areas. However, because of mitigation, the predicted concentrations for chromium and other parameters of concern are below the World Health Organization (WHO) drinking water guidelines. During post-closure, predicted maximum concentrations for all substances will be at or below baseline levels. Water quality and suspended solids concentration will be monitored at the clarification pond outlets and key downstream locations.

Biodiversity

Habitat level

Activities related to construction and operation of the mine will result in vegetation losses, including rare habitat types. This is due to the direct linkage of these rare azonal habitats with soils overlying the ore bodies. There will be a loss of 1,326 ha of azonal and transitional vegetation types, which represents 46% of these habitats in the local study area. Forest types to be re-established through progressive reclamation will be more zonal than azonal. As a result of the predicted high residual impacts to biodiversity and the importance of azonal and transitional areas to supporting rare plants and fauna within the mine area, the proponent is proposing a comprehensive on- and off-site mitigation plan to preserve key habitat elements. Given current trends in habitat loss due to timber cutting for construction, firewood and charcoal production within Madagascar, the proposed mitigation and compensation plan should provide more positive long-term benefits to the region than if the status quo (no project alternative) were to remain. The main mitigation and compensation to address these impacts include:

Azonal forest – Ambatovy

- two on-site azonal conservation areas totalling 305 ha will be established within the bounds of the ore body complex to provide protection for locally endemic plants, fauna and aquatic resources;
- project participation in design and implementation of a cooperative buffer zone forest management plan (FMP) with the Malagasy government and stakeholders, to provide a framework for sustainable forest management within the local region; and
- establishment of an off-site azonal conservation area as part of the compensation for the impact to this habitat type — a potential azonal off-site conservation area on an ultra-basic outcrop was identified at Ankera near Mantadia National Park during an aerial reconnaissance of a number of ultra-basic sites located from geological maps; work is continuing in this area.

The above biodiversity offsets together cover approximately 7,100 ha off-site, compared to the impacts to natural habitats on the mine site during construction and operations, which cover about 1,700 ha. This does not take into account on-site mitigation initiatives, including progressive reclamation. Thus for the mine, the offsets are four times the impacted area.

Species level

At the species level several mitigations will be implemented to reduce or eliminate the possibility of species loss in the mine area. These include:

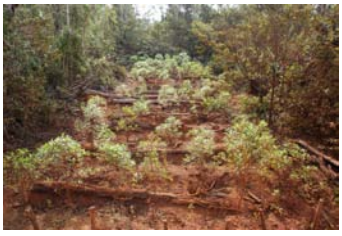
- provision for on-site and off-site azonal conservation areas, which will also provide protection for vulnerable species;
- continue to conduct on-site and off-site surveys to confirm the presence of rare species away from the disturbance area and so reduce or eliminate the list of species of concern, especially for flora;
- establish species-level conservation programs including collection, identification, transplantation and cultivation of any remaining flora species of concern before construction begins;
- preservation of seasonal downstream flows to maintain natural ecosystem functions and aquatic biodiversity; and
- relocation or collection of selected rare fauna before site clearing.

Through these mitigations, the Ambatovy Project is committed to ensure that viable populations of rare species are secure during construction, operations and following closure of the mine. Monitoring programs will be implemented for flora and fauna, especially to confirm the status of on-site azonal conservation areas during operations. Monitoring will also be important to evaluate the effectiveness of progressive reclamation efforts.

Reclamation and Closure

A reclamation and closure plan has been prepared as part of this EA. This document will be updated throughout the project life to reflect changing conditions and input of regulators and stakeholders. Progressive reclamation will be implemented where possible. Main goals of reclamation are:

- the reclamation and closure design will ensure that long-term physical and chemical stability is provided for disturbed surfaces;
- upon cessation of operations, the area will be decommissioned and rehabilitated to restore the site to forested habitat consistent with the surrounding zonal forest; and
- revegetation research and implementation of progressive reclamation will guide the refinement of concepts for final closure.



Reclamation of exploration disturbance

The mine site is in a near-primary forest matrix at the western edge of the Ankeniheny–Zahamena forest conservation planning area. The primary objective of reclamation at the mine site will be to maintain biological integrity of landscapes, ecosystems, communities, habitats, as well as fauna and flora populations. Forest protection on the mining lease will be planned, implemented and enforced through the forest management agreement being developed by the project proponent with the Malagasy Forestry Service.

Socioeconomics

Consultation results indicate that economic opportunities created by the mine are a main concern. This includes people who do not expect to directly benefit, but who are interested to see economic alternatives to agriculture are available to young people. Mitigation for socio-economic effects includes reduction of negative effects and enhancement of positive benefits.

Local labour and businesses

The project is expected to bring large economic benefits to the Moramanga area through creation of employment, demand for businesses, contributions to educational institutions and improvements in infrastructure. The project will partner with Moramanga and commune governments to jointly manage the socioeconomic challenges and opportunities that may arise as a result of the project. Emphasis will be to see that the project is well integrated into the Moramanga area as a sustainable development initiative. It needs to be considered that economic benefits in and of themselves are associated with improved socioeconomic status. To the extent that there is potential for negative effects, direct mitigation and an adaptive management strategy will be put in place to address the evolving effects so as to enhance the realization of benefit.

The project will extend employment and business opportunities on a preferential basis to mine site communes. Training and other assistance will be provided to these communes to help residents take advantage of these opportunities. When evaluating proposals for work on the project, the extent to which suppliers and subcontractors employ and contract mine site commune labour and businesses will be considered. Local labour needs at the mine are expected to average 540 during construction and 360 during operations.

Existing local businesses tend to be small and mainly oriented to serving the needs of local residents and tourists. The proponent has worked successfully with some local businesses over the exploration phase of the project. Similar to employment, local business participation in the project is expected to grow with time with the implementation of measures to assist that participation. The project will implement these measures under the Ambatovy Empowerment Program which is designed to enable local companies to participate in the project, with a focus on Small and Medium Enterprises (SMEs).

Local Economy

Total construction expenditures at the mine site are expected to reach US$150 million. Operational expenditures are expected to be in the order of US$7 million per year over the 27 year operations phase. Closure and post-closure activities will also require local expenditure. Therefore the total inflow of expenditures on local wages, goods and services could be in the order of approximately US$340 million over the life of the project. There are no estimates of the size of the economy in

the Moramanga area, however it is likely that an injection of expenditures in the above amounts will be a large benefit.

Employees during exploration phase

In addition to direct employment and business opportunities, the project will be a stimulus for indirect and induced employment and business opportunities. Businesses contracted to supply the project will require new employees. With increasing direct and indirect local economic activity, individuals and business will spend more on local goods and services. This in turn will induce more employment and perhaps more small businesses as people in the community organize to provide additional goods and services for others with new disposable income. The project is predicted to create 2,200 local indirect and 590 local induced jobs during mine construction and 340 local indirect and 150 local induced jobs during mine operations.

Training

The project will develop a formal training program for employees. This will include skills upgrading, apprenticeship training and the establishment of entry-level positions with a view to advancing people beyond entry level on a regular interval. At present US$10 million is estimated for training purposes over the life of the project. As the project moves forward, employees and suppliers are also expected to gain valuable experience that will position them to increase their level of participation. To the extent that this training program uses local educational institutions the quality of skills training in the Moramanga area is expected to improve.

Commune government budgets

Legislation in Madagascar requires a portion of royalties paid in relation to mining projects be directed to communes within which mineral resources lie. In addition, a portion goes to the provincial and national governments. The large scale of the mine means that annual royalty payments will be very large in relation to existing commune revenue flows. However, the project footprint goes beyond the mine area, extending along the slurry pipeline route to the tailings and process plant facilities. These other areas, although far from the ore bodies, will experience project effects that royalty distribution is intended to help address. The proponents are willing to work with the Government of Madagascar to establish an equitable system for distribution of royalties paid by the project.

Migration

The economic opportunity of a large project such as the Ambatovy Project has the potential to attract large numbers of migrants. Existing trends in rural urban migration, tensions over land in rural communes and the shortage of housing in Moramanga suggest that additional migration as a result of the project could be difficult to manage. The project will develop recruitment policies to discourage migration, and advertise these aggressively. The project will provide accommodation, meals, services and transport to and from their points of hire for all out-of-country workers during construction and operations.

Water

In addition to various mitigation measures intended to manage water quality and quantity effects around the mine, the proponent will monitor water flow and quality and engage in ongoing consultations with nearby farmers. This will provide more information on the basis of which mitigation can be improved. It will also provide the data necessary to adequately address any grievances about water. Given the priority accorded to improving water management for farmers in the communes around the mine site, it is expected that the project will assist communes in this regard, as part of additional social investment.

Forest use

The buffer zone forest management plan, being developed with the Government of Madagascar and the local community, aims to preserve the integrity of the forests around the mine while allowing for their sustainable use. Although the plan will be developed in consultation with stakeholders, it could limit access to specific areas and/or specific forest resources, at short term cost to some people's livelihoods. In the event of grievances of this nature, the project will investigate to adequately address them.

Health and safety

People in the mine area are concerned that out-of-area workers and economic migrants are a threat to health and safety within their communities. There is a link between mining camps filled primarily with men of single status and/or having increased income and public health issues such as incidents of sexual abuse, teenage pregnancy, single parenthood, sexually transmitted diseases including HIV/AIDS, substance abuse and crime. This association guides current best practice in managing the behaviour of workers living in camps near rural communities and in limiting the potential for contact between workers and local people. Although the project will implement these best practices, employees housed at camp, any new migrants, and in-transit workers associated with the project, will inevitably interact in unpredictable ways with people of the mine site area. Attention to the potential for increasing the incidence of HIV/AIDS is particularly critical given the low HIV/AIDS prevalence rates in Madagascar and an aggressive HIV/AIDS prevention program will be implemented.

Consultation with people near the mine

The human and ecological health assessment evaluated the potential for adverse effects to health associated with emissions from the mine. Predicted impacts on human health due to possible changes in water, soil, air and produce quality were considered negligible. Monitoring of operational emissions will take place to confirm that guidelines are met and that downstream impacts are minimized.

Impacts on livelihood resources, including agriculture, livestock and fisheries due to changes in water quality during mine operation are also considered negligible upon application of the water management plan. The health and survival of fish and other aquatic resources, including organisms living in the Torotorofotsy Wetlands, are also unlikely to be affected by the mine.

Social investment


Andasibe

The Ambatovy Project plans to supplement mitigation and benefit enhancement measures directed at specific impacts, with wider social investment. This investment would be a response to expectations of negative impacts that will occur as a result of the project, but that are not amenable to full mitigation. An example would be negative effects of migration. The project will also address unpredictable impacts that could evolve, as these are discovered through social monitoring, including consultation with project affected people and their governments. Examples could include pressures of migratory populations on schools or increases in crime. Madagascar is in a process of decentralization that has seen the establishment of multiple planning agencies. The project will offer participation in planning to those agencies involved in the implementation of programs if needed. Such project contributions to social investment will be a benefit to communes around the mine site, but also across a wider area insofar as regional planning capacity and initiatives are supported.

Culture

Although the sacred waterfall at the mine site cannot be relocated, its sacred aspect can be modified. This is accomplished by virtue of the people's loss of contact with it – if rituals cannot be conducted there, it is no longer considered sacred by them. Such cases are common in Madagascar, occurring for example, in areas of urban expansion. For this to occur, however, proper protocol involving correct rites and rituals must be observed. Discussions and negotiations with resident groups will be conducted in this regard, facilitated by the proponents' Malagasy cultural specialists in order to find acceptable solutions.

Monitoring

It is in the interests of the project to understand socio-economic trends such that where the project is able to intervene effectively, it has the information to do so. The project has a long term interest in healthy communities. In addition, putting in place a monitoring framework that attempts to understand cause and effect is important to both the proponents and affected people. This will contribute both to maintaining a constructive relationship between affected people and the project and to adjusting project mitigation measures in response to evolving impacts. A socioeconomic monitoring plan will be implemented, with three main components:

- operations monitoring of project inputs (benefits enhancement), to track success;
- monitoring effectiveness of mitigation of negative effects; and
- monitoring more widely, to better provide a context for adaptive management and additional social investment.

SLURRY PIPELINE

Social Context

Stop during aerial survey of pipeline route

Twelve communes are crossed by the slurry pipeline route, which include: Andasibe, Ambatovola, Andekaleka, Lohariandava, Fanasana, Fetraomby, Vohitranivona, Ambalarondra, Ambinaninony, Ampasimadinika, Fanadrana and Toamasina II. Three major land use zones were defined along the route: the western section, which is within the Ankeniheny–Zahamena forest corridor (corridor zone); the central section, which passes around primary forest fragments through an area defined primarily by tavy (tavy zone), and the eastern section, comprising mainly agricultural lands (agricultural zone). Consultation and socioeconomic baseline data collection took place in over 70 villages along the approximately 195 km route. Communities were mainly accessed by foot in three surveys, one for each zone. In general, people appear to be economically worse off than those in the mine area. While land shortages do not apply, crops are often lost as a result of an inability to manage water through variations in rainfall. Due to remoteness and lack of transportation, people are often unable to access markets to sell surplus products. There are limited options for diversification of livelihood – employment for cash income is generally not available and over much of the slurry pipeline route there are few forest resources.

Aerial view of slurry pipeline route in Tavy zone

Culture

Field work resulted in an initial list of cultural sites near the pipeline route. In all, 27 tombs, 19 symbolic tombs, two ceremonial sites, three abandoned villages and one church were located within a 1 km wide corridor.

Environmental Context

The slurry pipeline runs from the hills north of Moramanga, along the north side of the Torotorofotsy Wetlands, through a series of watersheds with steep valleys and granite outcrops and continues over rolling hills until reaching the flat coastal dune area near the east coast. The route assessed crosses about 100 watercourses, ranging from small streams to large rivers. About 80% of the rainfall in the western portion of the route occurs from November to March. Rainfall near Toamasina occurs year-round and is double the amount received at the mine site.

Pipeline stream crossing location

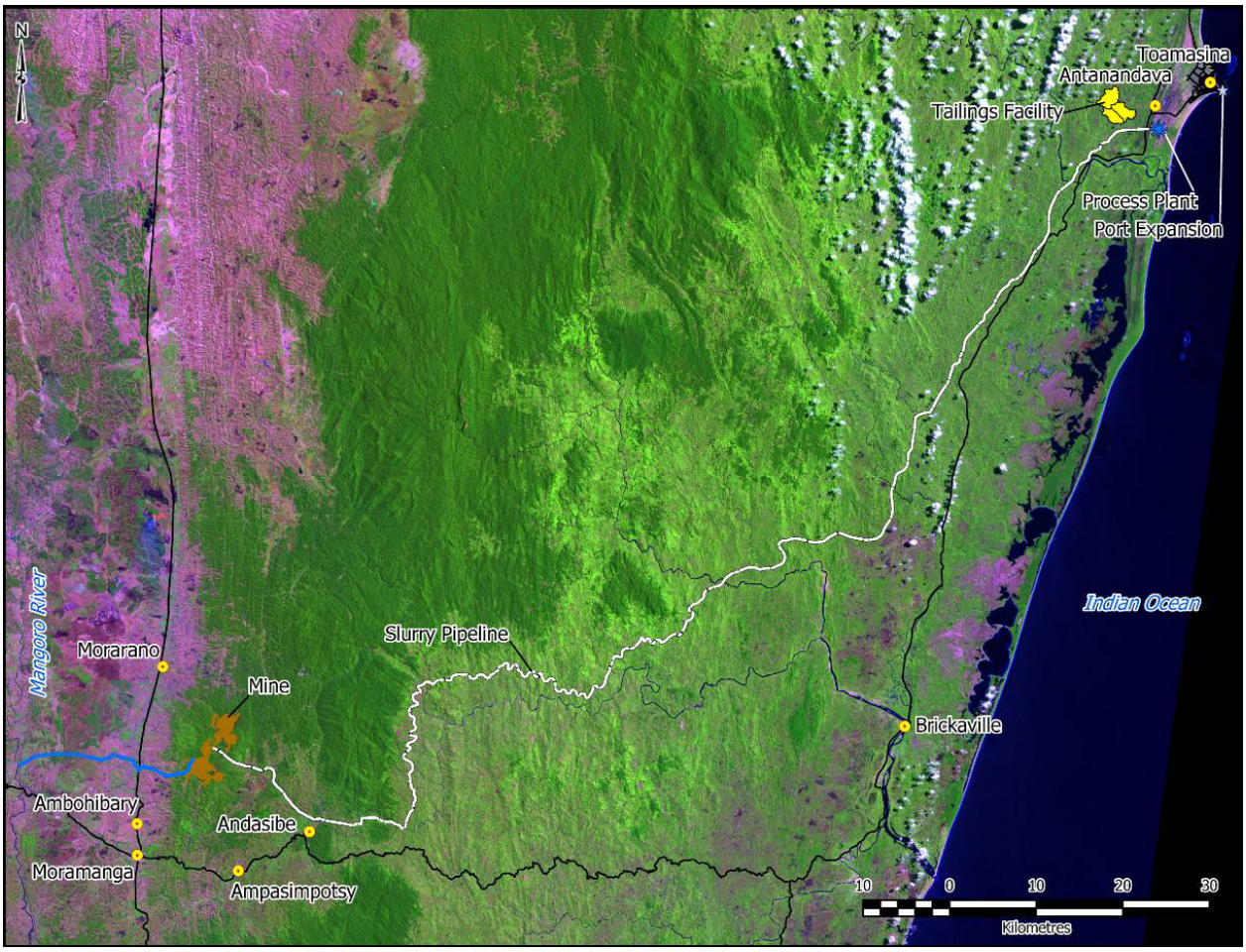
Laterite soils along the pipeline route have developed on old terrain with almost no vestige of the original rock structure. The routing of the pipeline has been chosen to cross mainly disturbed areas, especially through the Ankeniheny–Zahamena forest corridor. The dominant vegetation type along the route is tavy (85%) which is largely disturbed, composed of cleared forest and scattered shrubby vegetation or trees. The second most common vegetation is degraded primary forest (4%) comprised of either heavily logged forest or very small forest patches that have been invaded with exotic species. Primary forest is the third most dominant vegetation type (also near 4%) and occurs near the mine site and within the Ankeniheny–Zahamena Corridor. This is zonal tropical forest that may have been sparsely logged, but still contains species that are characteristic of a pristine forest.

Faunal survey team in Torotorofotsy Wetlands

The number of fauna species surveyed was generally highest in the primary forest with fewer species in the more disturbed areas closer to the coast. Seventy-six species of reptiles and amphibians were surveyed in primary forest. With the exception of one amphibian species, all reptiles and amphibians were endemic to Madagascar, with three species listed by the IUCN. Disturbed habitats, such as primary forest fragments, secondary forest and tavy, had five or fewer reptile and amphibian species. Most bird species were also detected in forested habitat (62 of 86 species), including all eight IUCN-listed species. A total of 26 fish species were recorded at pipeline stream crossing survey sites. Eight species were endemic, 11 were native (indigenous but not endemic) and seven were exotic. No fish species are listed by CITES. Thus main areas to focus on with respect to potential impacts from the pipeline on biodiversity are primary forest and stream crossings.

Regional conservation planning

Two proposed or existing protected areas and a Ramsar site are located near the pipeline route: the Torotorofotsy Ramsar site, the Ankeniheny–Zahamena Corridor and Mantadia National Park. The right-of-way avoids the national park, but crosses the Ramsar site and the forest corridor. The routing of the pipeline has been aligned with a proposed infrastructure right-of-way, which will be excluded from the future protected area of the corridor. The Torotorofotsy Ramsar site contains the largest and most intact natural marsh in eastern Madagascar. However, the marsh is not pristine, with about 40% disturbed by either slash-and-burn (tavy) agriculture, eucalyptus plantations or rice paddies. The Ankeniheny–Zahamena forest corridor is planned to accommodate both biodiversity protection (75%) and multiple-use areas (25%). Mantadia National Park is representative of the humid tropical forests of eastern Madagascar, characterized by high levels of biodiversity and endemicity.



Slurry pipeline route

Project Description

Mined ore will be mixed with water from the Mangoro River and supplemented with collected storm runoff water, to prepare a slurry of 40% ore and 60% water. The slurry is then pumped through a 55 cm diameter buried pipeline to the process plant on the coast. A number of pipeline route alternatives have been compared during project planning, with respect to engineering, economic, social and environmental costs and benefits. The assessed route runs adjacent to an old forest railway line from the mine site to near Andasibe. It then turns east to Fanovana avoiding the Mantadia National Park, before heading north to near Fitanisirana. Here it turns east to the north of Lanonana, up to Androsalabo and generally parallels the RN2 to the Toamasina plant site. The assessed pipeline route was chosen, in consultation with government representatives and NGOs, to avoid crossing national parks and primary forest in the Ankeniheny–Zahamena forest corridor. In the Torotorofotsy Ramsar site it is routed along an old railway line at the north edge of the wetland.

Aerial survey of pipeline route

The pipeline will be buried along its approximately 195 km length, with the exception of some steep sided river channels, which would have aerial crossings. Pipeline burial depths beneath streams will be at a depth that will prevent pipeline scouring within the stream. The disturbed surface near crossings and elsewhere will be reclaimed to minimize erosion. A control system will be built into the pipeline to monitor the movement of the slurry and to halt the flow of slurry if required.

Hydrostatic testing of the pipeline will be conducted before it is commissioned to ensure there are no leaks. That testing will require water withdrawal from rivers and/or streams. Withdrawal locations will be selected with the aim of minimizing changes in affected water bodies. Water will typically be disposed of to designated vegetated areas. Any water disposed directly to water bodies will be controlled to minimize flow impacts and ensure there are no water quality related issues.

Long-term safe and reliable operation of the slurry pipeline began in the design phase and will continue through operations. Application of proven design practices and development of project-specific safety systems ensures this reliability can be achieved. Commercially operating slurry pipelines have provided reliable service in high earthquake zones (Chile and Peru), extremely wet environments (Brazil), and in remote regions (China and Australia). The proposed slurry pipeline route does not present unique conditions for which successful pipeline designs have not been achieved. In all aspects, the pipeline is within commercially proven limits. The residual risks during all project periods are in the low category and within international standards to minimize risk to downstream public and environmental resources.

Pipeline construction would utilize local labour where possible. However this would not be high, because of a rapid construction schedule and

little time for training. Once the pipeline becomes operational, only a few maintenance and monitoring jobs will be required.

Results of this EA, combined with the start of detailed engineering design in late 2005, have prompted consideration of a modified routing of the pipeline in the eastern part of the assessed alignment. This re-route of some 60 km would follow a more southerly course from Fanovana to the coast and appears to have some constructability and environmental advantages. Specifically, it avoids running close to the east side of Mantadia National Park. This change, once fully developed and confirmed to be an improvement to the current routing, would be submitted as an EA amendment, supplementing the assessment provided here.

Key Impacts and Mitigation

Main issues identified through consultation and through the professional experience of the Malagasy and international EA team included:

- compensation for any needed re-settlement, damage to crops and livestock, or hindrance to movement;
- concern over safety should the pipeline break during operations;
- the possibility of new roads associated with the pipeline were viewed positively, however there was concern that outsiders could come in and exploit the pipeline area;
- fragmentation effects on the Ankeniheny–Zahamena Forest Corridor, which would negatively affect biodiversity; and
- effects on water quality, fish and other aquatic resources at stream crossings, including in the Torotorofotsy Wetlands.

Socioeconomics

As for other project sites, consultation showed that economic opportunities created by the pipeline are of great interest to people. Whereas it is the project's policy to maximize local employment and procurement and to provide training, the pipeline provides fewer jobs than other sites and almost all during the construction phase.

Economic opportunities

The pipeline construction process has job skill and health and safety requirements that will make it difficult to employ many people. As well, given only a short presence of construction crews along any given stretch of pipeline and a tight schedule, there will be fewer training opportunities than at other project sites. Total labour requirements during construction for the pipeline would be around 800 people of which, about 345 would be local. Employment of local people would mainly be in support of construction and reclamation activities. The workforce requirement for the operations phase is very small and occasional. The remoteness and rural nature of the local economies

along the route suggest that any business benefits will also be lower than at other sites.

Infrastructure

There is some potential for short-term disruption of travel and transport routes, both by land and water. However, consultative forward planning of disruptive construction activity and provision where necessary of alternative means of travel and transport, will be used to mitigate these. In order to construct the pipeline, access roads will need to be built both to and along the route. There are a number of alternatives for access routing to service the pipeline, but due consideration is being taken for the needs of local populations for a permanent road. It was clear during consultations that there is a strong desire for roads on the part of people in the less accessible communes between Moramanga and Toamasina. In addition, baseline studies indicated very poor health and education status of remote populations and an inability to market agricultural surplus. Access roads, with government or private transport services, would significantly assist in addressing fundamental socio-economic constraints.

RN2 bridge over Mangoro River

Culture

A cultural specialist will be part of the team working with the land survey crew prior to construction of the pipeline. The objective will be to fine tune the route so as to avoid damage to cultural sites identified during baseline studies and any additional ones that might be found. Should this not be possible, then a relocation process for the resource would need to be agreed to with affected people, using accepted local cultural practice.

Biodiversity

The main potential impacts to biodiversity concern the required routing through the Ankeniheny–Zahamena forest corridor, plus potential impacts to endemic fish and other species at river crossings.

Flora and fauna

Avoidance of primary forest during design, provides the best mitigation to limit native plant community losses with associated reduction of impacts to fauna. Over 90% of the route occurs in areas that have already been disturbed by people. A total of 116 ha of forest land (12% of the route) will be affected by construction of the pipeline. Of this portion, primary forest amounts to 28 ha while disturbed or managed forests amount to 88 ha.

Ankeniheny–Zahamena Corridor

Two general methods of reclamation will be used along the route. For a majority of the route where areas have been previously disturbed, the primary reclamation objective is erosion control. However, within sections where transitional and zonal forest exist near the mine site, and in currently disturbed sections in the Ankeniheny–Zahamena Corridor, habitat rehabilitation will incorporate the use of native species with the long-term objective of re-establishing primary forest on the right-of-way. The restoration program will cover 60 ha and be within the framework of a well designed research project. Re-establishing tropical forest in

Madagascar is a developing field and revegetation trials will be established to increase this knowledge base and develop pragmatic restoration solutions. The lessons learned from these trials will also be made available to other restoration efforts planned by other organizations within the Ankeniheny–Zahamena Corridor.

Impacts to faunal populations as a result of habitat fragmentation are predicted to be low because most of the route was sited along pre-existing disturbance and the pipeline will be buried. Construction will create temporary barriers to movement (e.g., roads, construction activity) for fauna in environmentally sensitive forest areas near the mine. Connectivity will be restored once the pipeline is buried and the route reclaimed to forest on the right-of-way in these sensitive areas. In some areas, roads will be left in place as part of regional planning, so barriers to movement will remain. However, the majority of these roads will be in areas of existing disturbance and higher population density. No maintenance road will be constructed alongside the sections of pipeline to be reclaimed to primary forest near the mine and in the Ankeniheny–Zahamena Corridor.

Aquatic resources

Minimization of impacts to aquatic and riverside resources will come from mitigation applied at stream crossings. Construction of the slurry pipeline will involve about 100 watercourse crossings of a variety of sizes. Initial assessments of the crossings have been conducted to assist in pipeline routing. Just prior to construction, an environmental team will conduct a further field survey of the crossing locations and identify any with high sensitivities with respect to aquatic and riverside resources. Where feasible, the pipeline route will be adjusted through design or minor reroute to avoid or minimize impacts on the sensitive areas. The majority of watercourse crossings will be buried and will involve excavating across the channel, laying the pipe and backfilling the trench. Where possible, water will be diverted to one side of the stream to enable a relatively dry work space on the opposite side. Construction of crossings will typically be conducted during low flow conditions to minimize water depths and the amount of suspended solids generated and transported to downstream reaches. The effects on suspended solids levels are expected to be high during construction, but to last only a short time, on the order of hours for small streams and up to a few days for very large streams. No effects on sediment levels are expected in the streams during operation or post-closure since revegetation and erosion controls will have been applied and stream banks will be stabilized.

Aquatic organisms survey

Endemic fish species were mainly associated with the presence of natural forest stream habitat (40% of sample sites). Assuming open cut installation of the pipeline, effects will be primarily short-term disturbance of riparian and instream habitat and limited to the construction period.

In addition to the slurry pipeline route, access roads will be required for people and equipment. These roads will create additional access to watercourses crossed by the pipeline. Harvesting of flora and fauna by project staff will be restricted to control direct impacts on terrestrial and aquatic resources.

Monitoring

A survey team including Malagasy environmental and cultural specialists will work with the engineering team before construction to fine tune the route to further minimize impacts. Inspections during construction will monitor the effectiveness of erosion and sediment control along the route. Inspections of the route will be conducted during operations to monitor the effectiveness of erosion control measures, slope stability, stream bank stability and revegetated and reclaimed areas. Monitoring to control rates of water withdrawal and disposal of hydrostatic test water will ensure that impacts are minimized. A vegetation monitoring program will be implemented during operations to ensure that specific vegetation restoration efforts are successful in the reclaimed areas and that vegetation cover is maintained to control erosion.

PROCESS PLANT

Social Context

The process plant will be located within Toamasina II commune. With the exception of people living along the RN2 highway, where renting is more common, most people have at least traditional rights to the land they use. A census was conducted on 35 households in and near the plant site. Wage employment takes a larger role in livelihood strategies than it does at the mine site, since there are more opportunities for part time or occasional work for people who live close to a large urban area. Wage employment, artisanal production and business together account for the primary economic activity for over 60% of the population near the plant. The plant area is sparsely settled by new arrivals who are trying to gain livelihoods through participation in wage employment and business. However, there remains a dependence on agriculture.

Culture

During the assessment of the plant area, six tombs, four ceremonial sites and four archaeological sites were found. All are within the plant property boundary and are considered to be in the project footprint.

Environmental Context

The process plant is located about 2 km from the coast. The area is flat with beach ridges extending north-south. Seasonal wetlands are located in low-lying areas between many of the ridges. The elevation varies between 6 and 10 masl. Vegetation within the region was once part of an extensive coastal band of eastern lowland rainforest. Now, the primary forests are gone at the plant site and in most parts of the coast. They have been replaced with degraded secondary forest patches, shrublands and grasslands, as a result of clearing and invasion by exotic species.

The dominant vegetation at the plant site is a coastal shrubland/ grassland. The second most common vegetation is degraded residual coastal woodland. Exotic tree species have altered species composition and forest structure; however, there are still remnant species that once existed here in greater numbers. The third most common vegetation is a beach ridge complex. Vegetation within this type varies with position. It is characterized by coarse grass on the ridges and dense wetlands vegetation on organic soils within the low areas.

Three endangered or vulnerable IUCN-listed species were found in the area. In total, 185 flora species were inventoried. Due to the disturbed nature of the site, many species are invasive and common within the region. No locally endemic species were identified.

All terrestrial habitats are already disturbed and support low numbers of fauna species. Four amphibian and six reptile species were recorded. Thirty-four bird species were observed, of which two were IUCN-listed and one CITES-listed.

Aerial view of the plant site

The plant site contains only a few seasonal wetlands. Outside the property boundary, permanent watercourses which are associated with plant infrastructure (adjoining pipelines and access roads) include the Pangalanes Canal (a series of freshwater and brackish lakes, lagoons and rivers that were joined for commercial traffic) which is only a few hundred metres from the sea, the Ivondro River south of the plant site and an unnamed tributary to the Ivondro River.

In the Ivondro River and Pangalanes Canal, several fish species and invertebrate species are commonly harvested by local fisherman. In the Ivondro River, exotic species such as tilapia were the most commonly harvested fish. Some smaller fish along with crustaceans were also captured in reed traps.

Project Description

An analysis of alternatives was conducted to compare potential plant site locations at the mine site, Brickaville and Toamasina. A number of factors favoured Toamasina as the preferred location. The site was already disturbed and zoned industrial; good logistics were nearby, including the port; and it was close to a large source of potential labour. An offshore refinery was chosen for final metal processing.

The process plant is to be situated on an 80 ha site on the southern outskirts of Toamasina, about 10 km from the port. The process plant has an annual capacity of 60,000 tonnes of nickel and 5,600 tonnes of cobalt over a period of 27 years. The plant includes a leach plant and associated utility plants. The utility plants include: power, steam and water plants, a hydrogen plant, a hydrogen sulphide plant, a sulphuric acid plant, and a limestone and lime plant.

Ore will arrive at the processing plant via the slurry pipeline. The ore slurry will be treated in autoclaves to extract the nickel and cobalt. Processing includes first the addition of acid at high temperature to dissolve the nickel and cobalt. The solid tailings are then separated from the solution, which contains the nickel and cobalt. This solution will be neutralized with limestone and then treated with hydrogen sulphide to precipitate a concentrate of nickel and cobalt. This mixed metal sulphide is approximately 54% nickel and 5% cobalt. It will be exported for refining to pure metal products.

Water for the process plant will come from the water used as the transport medium in the ore slurry pipeline, with makeup as required from the Ivondro River, delivered to the plant by a buried water pipeline. The process plant would use about 60 megawatts of electricity and a large quantity of steam, both to be produced in a coal burning plant. Additional steam is produced in two sulphur burning sulphuric acid plants.

The process will require the import of large quantities of sulphur, limestone and coal. The plant will produce sulphuric acid from the imported sulphur, which will be consumed at the plant site. The plant will also produce hydrogen, hydrogen sulphide and lime for use in processing the ore to the mixed metal sulphide.

Construction of the process plant is expected to take about three years. There will be a large construction labour force of about 2,800, with the intent of hiring over 1,100 from the Malagasy population. There will also be a large operations phase workforce of about 1,150, of which 1,100 will be from the Malagasy population, following extensive training programs.

Model of process plant south of Toamasina

The plant is designed for an operating life of over 27 years. With closure of the Ambatovy mine, the plant could continue to process ore from other mines that may be developed either within or outside of Madagascar.

Risks to the plant from high winds and cyclones will be mitigated by a combination of detailed engineering design and appropriate emergency response protocols. Best management practices will be utilized for the construction and operation of the plant to ensure the health and safety of the workers and people near-by. Similarly, high environmental standards will be established for operations. All water and air emissions will be managed to meet regulated criteria.

Key Impacts and Mitigation

Main issues identified through consultation and through the professional experience of the Malagasy and international EA team included:

- concern about air emissions that would affect peoples' health and about greenhouse gas emissions;
- concern that the design of the plant has accounted for extreme natural events, including cyclones;
- optimization of local hiring and use of local businesses to serve the needs of the plant;

- concern over the development of a “worker-based” city near the plant, with public health and safety impacts; and
- concern that the use of an offshore location for final metal refining would reduce economic opportunities within Madagascar.

Environment

Air quality

Activities during operations of the plant will result in the release of sulphur dioxide (SO_2), nitrogen oxides (NO_X), particulate matter and hydrogen sulphide (H_2S) to the atmosphere. Air quality modelling was conducted to identify the needed emission controls to achieve ambient ground level concentration criteria in the vicinity of the process plant. The proponent has committed to installing equipment that will meet or better the World Bank criteria based on 24-hour and annual average emissions.

With respect to odour, it has been estimated that the average H_2S concentration may exceed the World Health Organization recommended 30-minute odour threshold at some communities south of Toamasina, close to the plant site. Unlike the 24-hour H_2S criteria, the shorter period criterion is based solely on odour perception. A worst-case prediction is that odour may be detectable about 4% of the time.

Emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and total greenhouse gases (GHG), expressed as equivalent carbon dioxide (ECO_2) were estimated for the operations phase of the process plant and associated power plant. Greenhouse gas emissions from the whole facility are predicted to be 1,920 kt ECO_2/yr. Malagasy GHG emissions in 1994 were estimated to be 456,323 kt ECO_2/yr by the National Ministry of the Environment. The emissions from the process plant would therefore represent a 0.4% increase in national GHG emissions.

Noise

Noise level modelling was conducted to predict continuous noise levels at various communities as a result of the process plant operations. To ensure a “worst case” was assessed, the model is based on the assumption that all equipment will be in use at full design capacity. The modelling demonstrated that World Bank noise criteria will be met at all communities.

Biodiversity

Of the habitats that will be impacted as a result of the plant, all are highly disturbed. Avoidance of native vegetation through site selection provides the most effective mitigation to limit native plant community and associated fauna losses.

Disturbed vegetation at plant site

Socioeconomics

Human health

The human and ecological health assessment evaluated the potential for adverse effects to human health associated with emissions from the plant. The incremental health risks of human exposure to drinking water, eating fish and produce, as well as air inhalation, skin contact with soil and accidental eating of soil during operations and post-closure were considered low to negligible. Potential impacts on aquatic life and livestock resources were also considered negligible.

Socioeconomics

The scale of the plant project is expected to bring large economic benefits to the Toamasina area through creation of employment, demand for businesses, contributions to educational institutions and improvements in infrastructure. Such an economic stimulus will result in improved socioeconomic status overall. The potential for economic and social change in the local area requires an adaptive management strategy to optimize benefits and minimize negative effects rather than specific mitigation measures. The socioeconomic analysis provided here includes the three coastal project components (port expansion, tailings area and plant site), since they will affect the same local area, which includes the city of Toamasina.

Economic opportunities

The project will offer pre-employment training, basic skills training, jobs and other benefits to local people. To mitigate uncontrolled migration to the project site, the recruiting area for job training, employment and procurement opportunities will be Toamasina. Business opportunities in the immediate vicinity of the plant site and tailings are likely to be fewer than for Toamasina generally, given there very few small businesses in what is a largely rural setting, however this has potential to grow with time. Given the size of the project, the high volumes of materials required for operations and the fact that many of these materials will pass through the port, there will be a large number of business opportunities created by the project. Businesses with capacity to supply, even if located elsewhere in Madagascar, can be expected to expand or relocate to Toamasina in order to be close to what will become a major customer. In addition, assistance to businesses under the Ambatovy Empowerment Program will expand their capacity to supply project goods and services over time.

River taxi on Pangalanes canal

Direct Malagasy labour force requirements at all three Toamasina area project sites, will be about 1,100 out of the total work force of 2,800 over the 36-month construction phase. About 1,100 individuals from the local Toamasina area would be employed during operations. As local people gain skills and experience through the construction stage and through training, they would be in a better position to access more skilled jobs.

It is estimated that US$100 million annually will be spent in the Toamasina area, during the three years of construction. The estimated annual spending during operations would be US$67 million. In addition to the local expenditures, the indirect and induced employment benefits and economic activity will be significant. It is predicted that an additional 1,100 direct jobs, 6,700 indirect jobs and 1,470 induced jobs will be created during construction. The equivalent numbers for operations would be 1,100, 3,810 and 710. As well, it is expected that the improvements to infrastructure will stimulate the local economy through employment creation. Because anticipated project expenditures are expected to be comparatively large relative to the size of the local economy, the benefit is considered of high consequence.

Conducting seismic survey at plant site

It is the project's policy to provide training to employees. This will improve skills needed for better job performance and promotion, and broaden the skill base of employees and prepare them for new opportunities in the future. It is also the project's intention to address the need for a broader-based education and training strategy through support for educational institutions in Toamasina. The formal training program developed for the project will be accessible on a preferential basis for employees local to Toamasina and the tailings and plant site areas. As at the mine site, the project will also address the need for a broader-based education and training strategy to provide assistance to those who wish to develop skills that could position them for employment and/or supply of goods and services at levels beyond those they would otherwise be qualified for.

Induced urbanization may begin with the construction stage. Migrants may be attracted initially to construction camps and the perceived potential for employment with the project. Controls will be put in place through:

- the establishment of recruitment offices located only within Toamasina (no recruitment at the plant and tailings sites);
- fencing will be placed around the camp and plant site; and
- workers will be transported to and from the site.

Through the project development, the city of Toamasina may see a rapid growth rate outside its current boundaries. The more rapid urbanization is a process that would have likely occurred even without the project because Toamasina is in the process of expanding residential areas southward. Developments in conjunction with the port have also been proposed for nearby land. The project will work with planning authorities to develop a comprehensive strategy for monitoring and dealing with uncontrolled labour migration.

Access to natural resources


Settlements near the plant site

People whose lands are required for the project will be resettled as per the Resettlement Action Plan. Depending on livelihood resources that are affected by the project, additional people may or may not be resettled. There are alternatives that may be preferable, including replacing that portion of livelihood resources affected with alternative resources. This could include compensation and/or employment. At present, two households will be fully resettled at the plant site, with additional compensation being developed for 25 households.

Social services and infrastructure

It is not expected that migration can be limited to such an extent that additional pressures on not only services, but also goods and land, can be fully mitigated. In the interest of original residents and of any migrants, flexibility in the response to migration is necessary. The proponent alone cannot address in-migration and urbanization issues in the Toamasina area. It is the project's intention to supplement mitigation and benefit enhancement measures directed at specific project impacts with participation in additional community development efforts. The approach will be to partner with government, NGO and community groups to support interventions to address the effects associated with induced urbanization.

The project itself will make few demands on services and infrastructure, in so far as out-of-country workers will be housed at camps where all their service requirements will be met. As well, the project will have independent systems for power, water, communications etc. Improvements to transportation infrastructure associated with the project, including roads, the port and the railway, will strengthen the capacity of Toamasina to serve as a full-service transportation node relative to other Madagascar alternatives.

Wellbeing

Attention to the potential for increasing the incidence of HIV/AIDS is particularly critical, especially at the plant site given that the incidence in the Toamasina area is suspected of being higher than in Madagascar generally. Movement of workers and migrants into the area as a result of the project could contribute to increasing the incidence of HIV/AIDS. To mitigate this potential impact, vigorous codes of behaviour and aggressive HIV/AIDS prevention and treatment programs for the workforce will be implemented at the plant site, in line with practices at the mine site.

As described for the mine site, the project represents a significant force of socioeconomic change. The potential of the project to generate such change is greater than at the mine site, given the size of the plant facility and the expected employment it is to generate locally. The project intends to participate in this transformation as a positive force,

contributing to economic and social development through employment, business opportunities and training, as well as through support of planned urban growth.

Closure

The current plan calls for closure after 27 years. It is likely that this will occur later as a result of the addition of reserves at the mine site over time and the plant site being able to continue to operate using ore from other Madagascar or offshore sources. One of the goals of the project leading up to closure will be the sustainability of the local community, with the aim to leave it in a viable position to continue to prosper and build on the socioeconomic progress made through the life of the project and plant operation.

Culture

The cultural sites within the plant site will be relocated. For this to occur in a culturally acceptable manner, proper protocol involving correct rites and rituals will be observed. Discussions and negotiations with resident groups will be necessary in this regard, facilitated by the proponents' Malagasy cultural specialists. Any archaeological sites deemed of value by regulators and local experts, which cannot be re-located, will be visited by a Malagasy archaeologist and excavated prior to disturbance to record information from each location.

Reclamation and Closure

At the time of project completion, the plant will be assessed for potential future use in other industrial projects. It is expected that the site will be partially decommissioned and sold to another industrial user so that the benefits of the constructed facilities can continue to support the local economy. Buildings and infrastructure at the site with no useful function will be dismantled and removed from the site at the time of project closure. Waste materials will be removed from the site and disposed of properly.

Monitoring

The process plant would be the largest industry in the Toamasina area. Ambient air monitoring beyond the fence line and process monitoring will take place to ensure emission criteria are met. Consultation will take place with local communities to address any issues or concerns residents may have, particularly with respect to any odour issues.

Social monitoring programs, ongoing consultations and the grievance and dispute resolution mechanisms are also critical to capturing the actual effects of urbanization so that these can be addressed with additional mitigation where warranted. These mechanisms are important, since while the types of effects can be predicted to some extent, the magnitude of the effects and the individuals specifically affected cannot be.

TAILINGS FACILITY

Social Context

The tailings facility will be located on the boundary between the communes of Toamasina II and Fanandrana. The number of households surveyed in or near the tailings facility site was 406, of which 165 are identified for resettlement. The tailings site population is a long established rural population. They experience constraints to agricultural production due to extreme rainfall and reduced access to both services and markets. The area is remote without easy access to the opportunities presented by Toamasina. Artisanal production (largely weaving and the making of small stools) is important, but given the generally low returns to this type of economic activity, this importance suggests marginal livelihoods. Agriculture, including crops in addition to rice, is an important economic activity. Other agriculture includes cultivation of fruit trees, but also maize, manioc, sweet potatoes and other subsistence crops, as well as limited cultivation of cash crops, particularly ginger.

Valleys in the tailings area

Water management is not generally perceived to be a problem, as there seems little demand for irrigation systems. This is likely because the high year-round rainfall ensures continual river flow and thus the capacity to route water for agricultural use. There is a problem with excess flow during periods of exceptionally high rainfall. Potable water comes mainly from springs, which are characteristic of the higher altitude hills and are considered to be cleaner than rivers.

Forest cover has largely been removed, although some stands of secondary vegetation appear to be maintained and isolated woodlots have been established. There is some harvesting of available vegetation for household needs and for artisanal products. Fishing contributes to wellbeing, however, biological resources do not make the degree of contribution to livelihoods that forests make in the mine site area.

Culture

During the assessment of the tailings area, seven tombs, 12 ceremonial sites, 10 archaeological sites and one symbolic tomb site were found. Seven ceremonial sites, three tomb sites and two archaeological sites were also found near the tailings area boundary.

Environmental Context

A series of three valleys west of Toamasina make up the planned tailings facility. The valleys are moderately steep often with vegetated hillsides and valley walls which descend into flat, wide valley floors. The highest elevation is 90 masl at the western end and the lowest elevation is 4 masl in the eastern portion of the tailings study area. The valley floors, in particular the northern valley, have been developed into rice paddies.

The streams and rivers at the site contain the headwaters of three sub-basins of the Ambolona watershed. Drainage flows in an easterly direction in the valleys along a natural gradient of less than six degrees (10%). The mean annual precipitation is about 3,300 mm. March is the wettest month (473 mm) and October is the driest month (115 mm). Estimates of maximum 24-hour rainfall amounts range from 273 mm once in 10 years, to 465 mm once in 100 years.

Based on the Madagascar classification system, baseline surface water quality in the tailings facility area is typically classified as moderate (Class B), with some watercourses classified as poor (Class C). There were no surface waters that are considered to be excessively contaminated (Class HC). Manganese was the only water quality substance with some observed baseline concentrations above the WHO drinking water guideline value.

Aerial view of tailings facility area

Tailings area soils are naturally acidic, low in nutrients and well drained on upper slopes. Soils in the depressions are often water-logged with some peat accumulation. Although nutrient poor, these depression soils are suitable for rice production.

The vegetation is composed of secondary habitats influenced by an array of human-induced disturbances, mainly agricultural. Due to the disturbed nature of the area, many plant species are invasive and common within the region. One tree species present (pallisandre) is identified as vulnerable by IUCN, but is a widespread species in Madagascar exploited for its valuable wood. No locally endemic plants were found.

Biodiversity in the tailings area is mainly linked with the remaining natural wetlands. Wetlands in the tailings area had the highest number of amphibian and reptile species and the second highest richness of bird species, compared to other habitats. Seven amphibian and 11 reptile species were recorded within the tailings area, none of which were listed by IUCN. One amphibian and five reptile species are listed by CITES. Fifty-two bird species were documented, of which two are IUCN-listed and five CITES-listed.

All aquatic sampling sites in the tailings area exhibited significant disturbance and loss of natural ecosystem function. Much of the valley bottom area and associated stream habitat has been developed into rice paddies. However, 17 fish species, comprising five endemic, four native, and eight introduced species were collected from the tailings area, which is actually similar to the mine site. One species of Madagascar rainbowfish (*B. madagascariensis*) was the most abundant endemic, which is listed as “Near Threatened” by IUCN. The tailings area contains a low number of endemic species relative to the 27 described endemic species reported for this region of Madagascar.

Within the tailings area, biodiversity within aquatic systems is the main concern with respect to potential project impacts.

Existing marine conditions

The outfall for the effluent pipe from the tailings facility is located approximately 8 km south of Toamasina harbour, on a straight section of coastline without any visible rock outcrops. The sandy bottom is gently sloping at depths exceeding 10 m. The location is in a high energy near-shore zone with high natural levels of turbidity, strong currents, and rough seas. The average recorded wave height was 1.4 m, but wave heights of up to approximately 11 m can be expected for a 1:100 year cyclone.

The southward flowing east Madagascar current generates an offshore reverse current adjacent to Isle Sainte-Marie. Farther south, the east Madagascar current generates inshore, northward-flowing reversal currents. Toamasina lies within the convergence of these two systems. In summer, the currents cause low-grade up-welling south of Isle Sainte-Marie, further contributing to the turbidity in the area.

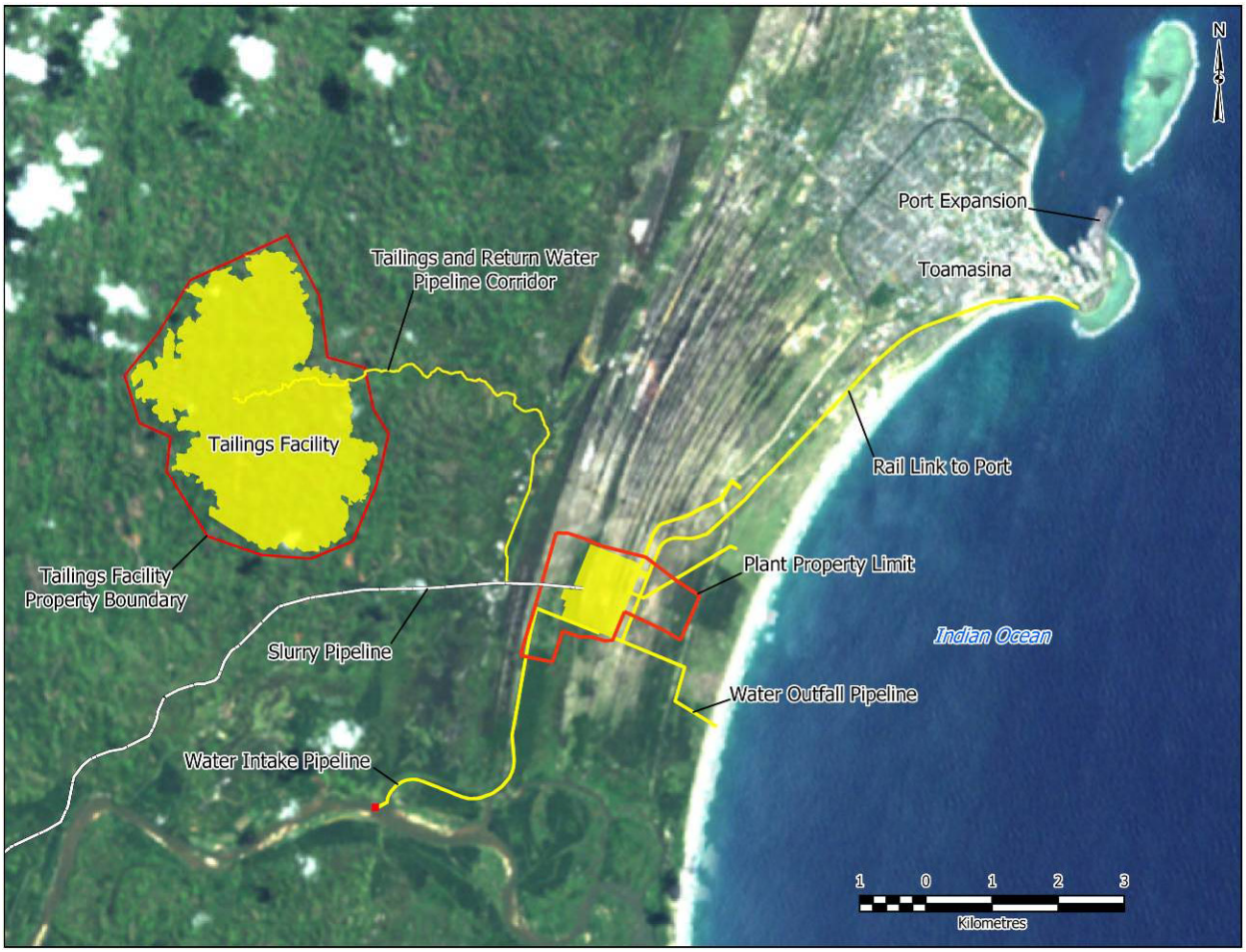
The combination of high summer rainfall, terrestrial sediments, cyclones, and strong winter winds cause nearly year-round turbidity in the region. The area is thus not conducive to coral reef development and the damage caused by cyclones and rough seas adds to this stress. Existing literature highlighting environmental indicators in the Province of Toamasina lists major littoral reef complexes, none of which is near the project site. Diving surveys for this EA confirmed that assessment. The closest reef of consequence is at Isle Sainte Marie over 60 nautical miles to the north.

Fishermen near Toamasina

Dive surveys conducted for this EA showed that the reefs around Toamasina were fairly homogenous. They were relatively flat in profile, probably due to rigorous conditions generated by frequent cyclonic seas and they formed shallow fringing reefs, with the exception of Recif du Sud, which shelved off at a depth of 5 m. Most reef profiles were only broken by shallow gullies, forming spur and groove formations. In a few instances, the reefs rose on the seaward side in a steep wall before flattening out. Reefs observed were poor in terms of their biodiversity. At Recif du Sud, the hard coral cover was poor, but it had a moderately high cover of the soft coral genus, *Sinularia*, on the shallow reef flat; this is typical of such wave-cut platforms. This habitat was not found elsewhere during the survey and Recif du Sud had higher biodiversity with some species not encountered on the other reefs investigated.

Several turtles were observed; all were believed to be Green turtles. Marine turtles are regarded as a key indicator species in Madagascar. Turtles are listed as Endangered by IUCN due to extreme hunting pressure.

Dives also showed that while many of the major fish groups are represented in the outfall area, some are more noticeable either by their absence or poor representation. These include the snappers, emperors, kingfishes, seabream, rockcods and rubberlips. The absence of many of these fish may be due to high regional fishing pressure, although the outfall location itself is not used much as a fishing ground.



Location of project sites near Toamasina

Project Description

Three alternative tailings facility locations were selected for detailed consideration:

- a valley site north of Brickaville;
- a valley site south-west of Toamasina; and
- a Toamasina ring dyke alternative on flat land near the coast.

The Toamasina area was selected as the preferred site for the plant, thus the Brickaville location was not considered further for the tailings. The high cost of the ring dyke precluded its further consideration. Four alternative options were then compared within the Toamasina valley site. Minimizing the tailings footprint and locating the site to minimize effects on people living in the area were the main goals in developing the preferred tailings option. There is a relatively large population in the eastern end of the Toamasina valleys, and this would have a high socioeconomic impact, as well as an adverse effect on project cost and

schedule. The option chosen does not use the lower elevation areas of the valleys, avoiding the areas of highest population density.

The tailings facility will be constructed and operated in three phases to permit progressive reclamation and progressive resettlement of affected people. The processing of the ore results in about 1.3 tonnes of residue (tailings) per tonne of ore – about 220 million tonnes in total over the 27 year life of the project. The tailings would be neutralized to a pH of 8 at the process plant and then pumped as a slurry into the tailings pond. Due to the neutralization process most of the metals will be precipitated as solids and immobilized in the tailings facility. The tailings area will offer an opportunity for the solids to settle and consolidate.

Water, which will include rainwater, will be pumped from the tailings facility back to the process plant where some will be reused; the balance will be disposed of to the ocean via an outfall pipeline. In order to minimize the discharge of water directly to the downstream environment, the tailings facility is designed to be capable of temporarily storing rainwater from a 1 in 50 year storm, above the maximum normal operating level.

Dams containing the tailings would be built according to rigorous safety standards that take into account extreme rainfall events and seismic activity. Following mitigation, the residual risks during all project periods are predicted to be low and within international standards. The main risk concerns heavy rains causing maximum flows over pond spillways. However, the extent of predicted flooding is relatively similar with or without the tailings facility in place.

Key Impacts and Mitigation

Main issues identified through consultation and through the professional experience of the Malagasy and international EA team included:

- concerns over re-settlement and the resettlement process, including land tenure, conflict resolution and adequacy of funding;
- concern that the movement of tombs be compensated and conducted in a culturally appropriate manner;
- concern that water quality and quantity will be affected around the tailings area, with impacts to crops, livestock and people;
- concern over what will be pumped into the ocean from the tailings area; and
- danger to people if water comes over the top of the dam in a cyclone or if the dam breaks.

Freshwater

During operation, flows downstream of the tailings embankment will be reduced considerably due to the reduction in drainage area as a result of runoff diversion in the upper basin. The expected changes along the main stems of the streams are high (greater than 30%) in basins affected by the development. The high impact extends through to the large tributary that joins the Ambolona River system. Changes in downstream flows for post-closure conditions are low.

A stream below tailings area

Six water quality assessment scenarios were modelled, corresponding to key project phases that represent baseline, operations (years 14, 20 and 27), post-closure (15 years after closure) and far-future conditions (80 years after closure). The results of initial assessments showed that groundwater seepage would result in elevated levels of mainly manganese in downstream surface water, above the World Health Organization drinking water guidelines. Based on these observations, a groundwater interception system is proposed to collect seepage immediately downstream of the tailings facility to minimize the downstream impact to the surface water. The intercepted seepage will be managed with the tailings facility effluent.

The final modelling results predict that during operations all surface water parameters of concern will be below WHO drinking water criteria. Copper, manganese and zinc do exceed the South African Ecosystems guidelines in some downstream basins, but only marginally for copper and zinc. Baseline conditions for copper and zinc also exceeded these guidelines. Therefore, manganese is identified as the critical substance to manage in water below the tailings facility. For the post-closure scenarios, parameters were predicted to be below drinking water guidelines and there were marginal exceedences in some of the basins of the South African Ecosystem guidelines for copper and manganese.

The Ocean

The marine outfall will be assembled on land, floated out to sea, flooded and sunk onto the sea bottom. The construction activities will result in increased turbidity around the pipeline which will have an effect on the local marine resources. The effects will be short-term and on a local scale. The effluent to be discharged into the marine environment contains a variety of minerals, many of which are constituents of seawater. However, the continuous discharge of large volumes of effluent water will lead to the elevation of certain minerals to levels above those which occur naturally in the Toamasina region.

The impact of tailings water discharge on marine water quality was modelled based on predicted tailings water quality estimates derived from laboratory testing of processed ore samples. The dilution and settling modelling of the effluent, indicated that TSS, manganese and sulphate were the constituents which would be above natural levels or

above the Malagasy water quality standards. These parameters require further dilution on disposal into the marine environment in order to reduce possible negative impacts.

Reef near Toamasina

According to the modelling, effluent components will be diluted to within water quality limits by the time they reach the water surface. However, the discharge of effluent may result in a change in species composition and abundance in the immediate sea bed area (500 – 1000 m) around the effluent disposal site. This will prevail throughout the operational phase of the mine until natural recovery of the benthic biota occurs once the mine is decommissioned. However, the impact occurs within an area of low conservation importance, which already experiences high levels of turbidity. Therefore, the overall environmental consequence has been predicted to be low.

Although increases in turbidity are generally non-toxic, they can have both direct and indirect impacts on the marine environment. Specific consideration was given to the corals found at Nosy Faho, south of the proposed outfall. The modelling indicates that the outfall plume could move in the direction of Nosy Faho, but due to dilution, the TSS would be similar to present conditions and the impact would be low around this reef.

Predicted manganese concentrations derived from conservative modelling indicate that guideline levels will be achieved through rapid dilution in the outfall area. Manganese is not predicted to pose a risk to ecological health.

A local change in sea bed biota near the pipe outfall may result in a moderate impact on the local fishery right by the outfall. The fisheries sometimes operating within the area are the small scale commercial operators and artisanal fishers who occasionally venture out to sea from the Ivondro estuary. The line fishery operates on deeper reefs, none of which are found around the proposed outfall location.

Socioeconomics

Human health

The human and ecological health assessment evaluated the potential for adverse effects to health associated with seepage from the tailings facility. Human exposure to drinking water and eating fish and aquatic life exposure to water and sediment were evaluated as well as potential effects on changes in livelihood resources due to impacts on surface water quality. With the proposed mitigation in place, potential effects were rated as low to negligible for people, aquatic life, livestock and produce.

Socioeconomics

For the population between the tailings facility and the plant site, the impact analysis is similar as has been summarized for the plant area, with some differences of emphasis as noted below. Differences are

largely related to the more rural setting of people closer to the tailings area, with less linkage to Toamasina.

Resettlement

People whose lands are required for the project will be resettled as per the Resettlement Action Plan (RAP). This applies to people who live and/or have agricultural lands within the tailings site boundaries. At present, the RAP identifies 165 households to be resettled from the tailings site. Planning for resettlement has been facilitated by the establishment of a Resettlement Committee that currently includes 16 persons representing the regional and local governments, traditional authorities from the affected population, the NGOs working in the area and the proponents.

Economic opportunities

Business opportunities will be few adjacent to the tailings facility, as this area is more rural than is the case nearer the plant site. The intention to deepen training and education, to target people who are less educated and require more education is especially relevant to those in the tailings area.

Access to natural resources

Depending on livelihood resources that are affected by project infrastructure land disturbances and requirements for rights-of-way (for roads, pipelines and power lines) people may or may not be resettled. There are alternatives that may be preferable, including replacing that portion of livelihood resources affected by alternative resources, which could include compensation and/or employment. The intent is to ensure that people are not harmed by the project. The water flow reductions below the tailings area will be monitored to see if people are affected by it; it is possible there will not be an impact in this very high rainfall area. Water management practices and fisheries management may be improved with assistance from the project to avoid impacts and enhance benefits.

Infrastructure

Project contributions to the development of local infrastructure, including road improvements, will be especially useful near the tailings area.

Wellbeing

As described above, the project represents a significant force of social change, particularly in the more rural areas near the tailings site. This area will be part of more general monitoring to be undertaken, as described below.

Culture

Of the ten archaeological sites found in the tailings footprint, five were judged to represent significant historical resources. For these five sites, which cannot be relocated, further work consisting of preliminary archaeological excavations to determine the exact nature of

A Malagasy family southwest of Toamasina

the sites is required. Depending on the nature of the data recovered, additional excavations may be warranted. The tombs, symbolic tomb and ceremonial sites situated inside the proposed tailings impact zone will be relocated. For this to occur, proper protocol involving correct rites and rituals must be observed. Discussions and negotiations with resident groups will be necessary. The resettlement of people that will be required also implies a requirement to relocate tombs or other cultural sites associated with households that have to be resettled, irrespective of the position of the tombs in relation to construction impact zones.

Biodiversity

Avoidance of native vegetation through siting the tailings facility in a disturbed area, provides the most effective mitigation to limit flora and fauna impacts.

Main impacts will occur to biodiversity associated with remaining aquatic habitats. Effects on fish will occur as a consequence of the loss of watercourses in the tailings area and impacts to downstream habitats resulting from reduced flows. The upstream areas in the tailings footprint are likely less important than the larger water bodies downstream. However, salvage of selected endemic fish will take place prior to construction, if suitable release sites or use can be identified.

Reclamation and Closure

Reclamation and closure of the tailings facility will be based on the following goals:

- the reclamation and closure design will ensure that long-term physical and chemical stability is provided;
- progressive reclamation will be implemented where possible; and
- upon cessation of operations, the area will be decommissioned and rehabilitated to allow for future land use as guided by local authorities and stakeholders.

The tailings reclamation and closure plan will be updated throughout the project life to reflect changing conditions and the input of local authorities and stakeholders.

The tailings will be allowed to air dry for a period of time and progressively revegetated to provide a stable erosion-resistant surface which may be safely crossed by people and livestock. A research-based reclamation trials program will be utilized to help ensure that adequate and desired vegetation cover can be achieved. A residual sedimentation pond will be left in place to collect sediment until the vegetation becomes well established and may remain as a wetlands area. Suitable drainage measures will be designed and implemented for maintaining stability

during storms and cyclones. A closure spillway will redirect flows from the tailings basin into the original valley downstream. The groundwater pump back system located at the base of the tailings basin will operate for about 15 years post-closure, or until groundwater monitoring demonstrates that seepage quality will not reduce the surface water quality downstream.

Monitoring

Operational monitoring of stream flows and suspended solids concentrations within the affected basins will be conducted to support an improved understanding of water flows in the study area. Stream flow records will be evaluated along with climate data to further assess water availability for various environmental and social needs downstream of the tailings facility.

Water quality monitoring will be routinely conducted on the tailings effluent within the collection pond, the groundwater seepage from the interception system, the down gradient groundwater wells and the downstream surface water systems. Monitoring will be conducted during operations and will continue through the short-term and long-term closure scenarios, until results indicate that seepage from the tailings facility will have no detrimental effect at downstream sites. Monitoring downstream of the tailings of selected aquatic resources will occur, linked with ongoing stakeholder consultation and any needed assistance for local fishery management. A vegetation monitoring program will be implemented to ensure that reclamation efforts are successful and erosion control measures are working effectively.

Fishermen's boats near Toamasina

Additional marine baseline water quality information will be obtained along with further assessment of environmental health, to provide a stronger baseline against which to compare operational monitoring. More detailed information on the fish and fisheries will also be obtained (particularly the southern gillnet fishery) prior to construction. Along with effluent water quality monitoring, periodic monitoring of the marine biota will occur during operations to track species distribution, composition and abundance. The involvement of local fishermen in marine monitoring will be most important, including evaluating any trends and considering possible additional mitigation. Water samples will be collected during operations at the outfall and at reference sites for the determination of TSS levels. In order to monitor regional water quality, the sample strategy being used to assess baseline conditions will continue into the operational phase. Currently, the focus is on sampling the waters in and around the reefs (reference sites). During operations, water samples will also be taken within the outfall area. In addition, suitable marine indicator organisms which are sensitive to outfall constituents will be identified for use in a biological monitoring programme. Species which are frequently monitored in these programmes include algae, mussels and territorial reef fish. Selected sites on Nosy Faho and Le Grand Recif would represent good long-term monitoring sites.

Social monitoring programs, ongoing consultations and the grievance and dispute resolution mechanisms are also critical during construction and operations in the Toamasina area. The primary objectives of socioeconomic monitoring are to:

- record the uptake of employment, business and training opportunities over time and analyze the trends in relation to expectations and targets;
- monitor the implementation and effectiveness of socioeconomic impact mitigations; and
- evaluate the trends in local economic and social development and well-being, as well as the relationship between these and project operations.

PORT EXPANSION

Social Context

Toamasina is a large city, with an educated population, institutional presence and some depth to business activity. The port at Toamasina is Madagascar's main port, handling approximately 80% of the country's imports and exports. In 2003, the port handled 1.5 million tonnes of traffic. From 1997 to 2003, container traffic increased steadily, at an average rate of 10% per year. Much of the country's non-perishable products are transported from secondary harbours to Toamasina where shipments are loaded onto international cargo carriers. Education and job experience in Toamasina is somewhat better than found in more rural areas, and the urban population is over 200,000. As a result, it is expected that there will be many people who would qualify for employment.

Flooded road, Toamasina

The expansion of the port, construction of the plant and tailings facilities and improvements to other infrastructure in association with the project, all have the potential to transform the city's economy. Whereas the tailings and plant facilities will have effects on the immediate area around their locations, the largest economic effect will be seen in the city of Toamasina, including those parts of Toamasina II which are more urban in character. This enables Toamasina to be in a position to take good advantage of project benefits over time.

Environmental Context

The port has been active for about 75 years, while nearby shore areas have been mainly dedicated to, or influenced by the port. Toamasina is built on a 5 to 6 km-wide coastal sandy plain. The plain is bordered by coastal reefs and inlets, which lie parallel to the coast at depths of 20 to

40 m. Due to these coral reefs and local sea movements, two coastal extensions developed. Hastie Reef to the southeast of the port, assisted with the formation of a land extension on which the port and old town were constructed. Grand Recif helped form Tanio Point, upon which Toamasina has expanded since 1981. Tanio Point and the north coast have been impacted by erosion for almost a century, however this is more of an issue now with the town's expansion northward.

Port of Toamasina

Moles A and B at the port are constructed on sandy zones within the protection of Grand Recif, while Mole C is constructed on the edge of the reef. Diving surveys have shown the seabed near the docks to be covered by muddy sediments and solid wastes from port activities. Recent studies of sediment quality in the harbour have confirmed contamination from heavy metals and organic compounds associated with anti-fouling paints, fuels, and zinc used for anticorrosion on metal structures. The marine environment in the harbour is seriously degraded, as are many major ports, with few free-swimming organisms present.

Outside the harbour, Toamasina Bay is up to 10 m deep, with a bed of sand and clay sediments. The bay has limited species richness, likely because of strong water movements coupled with large erosion and sedimentation processes. Both Hastie and Grand Recif have been transformed by the port, including being used to stock dredged material.

Project Description

Materials required by the project that are not available locally, especially raw materials required during operations, will be purchased on international markets and shipped to Madagascar. Studies showed that due to the quantities involved, an expansion of the existing port will be required. Several expansion alternatives within the port were compared, as the three moles at the port each have their advantages and limitations. Extension of Mole B was eventually chosen for the following reasons:

- the berth and its approach are deep enough to accept 30,000 to 40,000 dwt vessels without dredging;
- berthing is sheltered; and
- both sides of the mole may be used for berthing, thus increasing the availability of the berth.

The extension will be about 250 m long and constructed on open pilings. This construction type represents the lowest cost option and provides a typical fit-for-purpose solution, which does not offer the option of handling significant quantities of any other type of cargo. This option also has the least potential for creating environmental problems with minimal interference with existing water movement patterns within the

harbour. The table below summarizes predicted cargo movements for the project.

Port of Toamasina - Predicted Ambatovy Cargo Movement Through Mole B

Material	*Import / Export*	*Description*	*Annual Quantity (tonnes nominal)*
sulphur	import	dry bulk	700,000
coal	import	dry bulk	300,000
limestone[(a)]	import	dry bulk	1,600,000
nickel sulphide	export	bagged	117,000
total			**2,717,000**

[(a)] Limestone requirement is 1.5 – 1.6 Mt/a depending on limestone grade.

Railway just south of Toamasina

Two main alternatives, rail and truck, were considered for transport of imported materials between the port and the plant and for export of metal sulphides. For its reliability and lower social and environmental impact, the railway alternative was selected, although some trucking will still occur. The railway method requires the project to invest in extra railway equipment, in addition to loading facilities at the port and unloading facilities at the plant.

The design of the port structures takes into account extreme storm events. The berth would be vacated during cyclone activity. An initial investigation of the wave penetration through the gap between Grand Recif and the port breakwater indicated that wave penetration would not be a problem for the extension.

Key Impacts and Mitigation

Main issues identified through consultation and through the professional experience of the Malagasy and international EA team included:

- a request for project proponents to cooperate with public works companies and to provide training, so as to maximize opportunities to create jobs for local people;
- concern that design will take account of potential impacts from cyclones;
- concern over health and safety effects from increased road traffic in the port area; and
- concern of possible increased coastal erosion if the port extension affects coastal currents.

Socioeconomics

Port of Toamasina

The effects of the port expansion need to be considered as part of an analysis of all project activities in the Toamasina area. The project is expected to bring enormous economic benefits to the Toamasina area, through creation of employment, demand for businesses, contributions to educational institutions and improvements in infrastructure. Such an economic stimulus will result in improved socioeconomic status overall. The project will partner with the city of Toamasina and commune governments to jointly manage the challenges of urbanisation. Emphasis will be to see that the project is well integrated into the Toamasina area as a sustainable development initiative. It needs to be considered that economic benefits in and of themselves are associated with improved socioeconomic status. To the extent that there is potential for negative effect, direct mitigation and an adaptive management strategy will be put in place to address evolving effects are expected to enhance the realization of benefit.

In a context of already ongoing rural urban migration, the Ambatovy Project is certain to provide additional stimulus. Given constraints on housing and physical infrastructure in Toamasina, and distance between the city and the plant site, it is expected that many migrants will choose to relocate closer to the site than in the city itself. However as businesses gear up to supply the project, this will attract migrants to the city centre. Also, since many project employees will live in Toamasina, the induced economic effect of increases in disposable income will provide opportunities for migrants. As noted for the plant site, an influx of workers also brings a potential array of negative effects. The project will work with the city of Toamasina and communes affected, to manage to the extent possible the expected increases in population.

Environment

During construction, drilling of the pilings will disturb sediments and cause re-suspension of contaminants. During final design, drilling options to best limit this contamination will be chosen. However, at the present time Mole A is regularly dredged, which releases sediment. Although noise impacts will be short term, investigation will continue on the utilization of techniques such as a bubble curtain around the pile driver, to reduce the spread of acoustic noise in the marine environment.

The possibility of the introduction of exotic marine organisms by ships will occur throughout the life of the port and as such it is an impact that occurs during both the construction and operational phases. This threat is not unique or new, and is a problem currently faced by the Port of Toamasina and ports around the world. The main mechanisms by which organisms could be introduced will be through ballast water of ships, which originate from their previous area of operation. Mitigation in the form of a rigorous ballast water plan and extensive cleaning of the dredgers will be important to reduce the probability of occurrence.


Ship berthed at Toamasina port

The port expansion will result in an increase in vessel traffic and as such there is an increased chance of ship collision. The following mitigations will reduce the likelihood of collisions:

- the proponent will participate with port authorities in a revision of the future traffic movement control systems for the region; and
- revisions will ensure that the larger fishing ship movements will be integrated into the traffic control of the bay.

A coordinated approach to vessel traffic control by trained personnel will help to lower risks of vessel collision.

The development and use of preventative Health and Safety Plans plus Emergency Spill Response Plans will mitigate for potential impacts from fuel and other materials handling during operations.

Monitoring

Monitoring with respect to the port area, will mainly be routine measures required to assess the success of health and safety measures.

CUMULATIVE EFFECTS

The cumulative environmental effects analysis of the Ambatovy Project with other projects will be limited to an evaluation of those other projects and activities within the region that are planned or are reasonably foreseeable. A precursor to that evaluation will be a consideration of all project effects (i.e., considering all project components together), since outside of the cumulative case, project components have generally been assessed independently.

Combined Project Site Effects

The majority of combined project impacts for physical, biological and social issues are similar to the results obtained when each site was assessed separately. In many instances, the geographical separation of project components means that no combined effects are predicted. Some exceptions are noted below.

Although several kinds of natural risk consequences may combine to produce cumulative consequences, all of these combinations are considered extremely unlikely. All identified risks are being managed through mitigation measures to achieve international standards as described in the natural risks section of each component EA.

Torotorofotsy Ramsar site

For effects on area of conservation significance, the mine will impact 300 ha of the Torotorofotsy Ramsar site and the slurry pipeline will impact an additional 70 ha. Combined, the mine and pipeline will result in clearing 370 ha of vegetation from this 9,300 ha area (4%). These impacts will be mitigated as described in the flora section for the mine and slurry pipeline. This combined impact is moderate in magnitude and regional in geographic extent because it extends beyond one Local Study Area. Because impacts were rated as local in extent in the individual mine and pipeline assessments, they were considered low in magnitude in both individual assessments.

As required by the ToR, an economic evaluation of residual project impacts on biodiversity has been conducted for the mine and other project elements. This methodology is developing, especially when considering impacts from a single project as opposed to eco-regional analyses. However, economic evaluation helps consider a range of impacts that are otherwise very difficult to appraise and compare. Economic impacts are assessed through consideration of ecological services provided by high biodiversity habitats, especially forests. In addition, project benefits from biodiversity offsets are described in terms of carbon sequestration. Where possible, project impacts to ecological services have been estimated in dollar terms. Main ecological services determined to be of relevance in the analysis were:

Ankeniheny–Zahamena forest corridor

- atmospheric gas regulation by natural vegetation;
- regulation and maintenance of water flows by undisturbed watersheds;
- erosion control and sediment retention by undisturbed watersheds;
- detoxification of contaminants by forests and wetlands;
- food production in natural and agro-ecosystems; and
- supply of raw materials.

The whole project macroeconomic analysis provides the best overview of project economic benefits. The economic benefits will be derived from three major areas of activity:

- direct project investment;
- increased consumption by workers employed both directly and indirectly as a result of the project; and
- government spending of increased revenues generated from the project.

Over the 30 year project life cycle, US$3.2 billion (over US$100 million annually) will be spent in Madagascar. It is expected that the Ambatovy Project will:

- increase local capital investment in Madagascar by over US$1.3 billion (over 30 years) or US$45 million annually and create 1,400–2,000 direct jobs for local workers, through the project lifetime;
- generate over US$80 million lifetime or approximately US$2.8 million annual income and 4,600 indirect jobs, in other sectors, through local project expenditures;
- induce the creation of approximately 2,800 jobs in other sectors to satisfy the demands of increased consumer spending; and
- contribute approximately US$25 million annually to government revenues, of which about 50% might be used to create additional indirect job opportunities.

Cumulative Effects With Other Foreseeable Projects

The following are the main ongoing and planned projects and activities which could overlap with effects from the Ambatovy Project:

- deforestation due to logging and tavy agriculture;
- conservation protection for the Ankeniheny–Zahamena forest corridor;
- reforestation brought about by the regional Carbon Project;
- future management of the Torotorofotsy Ramsar site;
- growth in ecotourism;
- Andasibe sawmill activities;
- four graphite mines (Andasibe, Toamasina, Brickaville and Vatomandry);
- paved and unpaved roads upgrading;
- upgrading a segment of the Madarail system operating within the study area;
- growth in urban centres and villages;
- dry port development south of Toamasina; and
- Logistique Pétrolière Terminal project south of Toamasina.

Analyses were undertaken of the potential for Ambatovy Project impacts to combine with these foreseeable future activities to produce cumulative impacts. Cumulative impacts of higher magnitude than that already assessed for the project alone, were usually not identified. Some exceptions are noted below.

Toamasina looking south

Air emissions from the growing city of Toamasina include vehicle exhaust and other fuel combustion sources that may combine with air emissions from the process plant and port expansion during certain meteorological conditions. The air emissions from Toamasina were not quantified, therefore a cumulative assessment could not be made. An ambient air quality monitoring program around the plant will be implemented to track background levels and plant performance.

In terms of natural risks, a natural event resulting in flood-runoff of contaminants from the project plant site and the Logistique Pétrolière terminal and other industrial developments south of Toamasina could result in an elevated cumulative impact in local small watersheds and especially in the marine environment. The probability of such an event is very low and no additional mitigation is proposed.

During operations of both the Logistique Pétrolière terminal project and the Ambatovy Project, there is the potential for increased cumulative risk of ship collisions. However, Ambatovy Project mitigations, including working with port authorities on a revision of the regional traffic movement control system, are predicted to offset potential cumulative negative effects.

Forest clearing

Forestry data indicate that past, current, and future clearing likely represents the largest incremental impact to loss of plant communities in the cumulative effects study area during the life of the Ambatovy mine. For certain vegetation types, the magnitude and geographic extent of impacts from deforestation are predicted to be higher relative to all other future projects and activities in the study area, including from the Ambatovy Project. These clearing activities will impact primary zonal forest the greatest because it supports fertile soils for slash and burn agriculture, the desired species used in home construction and is a source of firewood and charcoal. The potential for logging activities to directly impact azonal vegetation types in the mid-altitude eastern forest region is predicted to be negligible. However, indirect impacts could occur through fire and other disturbance, as has occurred in the past. Azonal forest outcrops in the region are uncommon and the only intact site known to occur in the cumulative effects region will likely be designated as a conservation area as part of the biodiversity offsets planned for the project. Even when other regional activities are considered, planned mitigation and off-site compensation provided by the Ambatovy Project will still result in a net positive effect to azonal flora. Site clearing activities will also affect primary zonal forest within the mine site and western portion of the slurry pipeline. Following project mitigation and off-site conservation, analysis indicates there would be a low negative to positive cumulative environmental consequence to this vegetation type.

Initiatives such as the Carbon Project and public awareness programs on the ecological benefits of conducting land use practices away from conservation and reclamation areas should provide positive benefits to

flora and fauna, including fish, their habitats and to biodiversity in general. Combined with the proponent's involvement in a buffer zone Forest Management Plan, plus on and off site azonal conservation areas, biodiversity should increase in previously altered habitats in the regional study area.

The greatest cumulative effect for traffic is expected to occur along the new direct access road between the port and process plant. Several other future projects have a relatively high probability to require this road for substantial traffic volumes, including the Logistique Pétrolière Terminal and the dry port development. Cumulatively, these developments will result in a substantial traffic increase both on the portion within Toamasina (which is presently congested) and south of Toamasina (which is presently a little-used dirt road). This cumulative impact will mainly be mitigated by improvement of the road.

CONCLUSION

The success of the Ambatovy Project requires that the needs of Malagasy people are addressed and that their concerns are fully assessed in the EA. Through project disclosure and consultation the proponent has been made aware of the socio-economic challenges facing Malagasy people and the many linkages between people and the environment in Madagascar. Having an EA team comprised of Malagasy and international specialists, plus undertaking extensive consultations, has allowed key issues to be identified upon which to focus the EA.

Key socioeconomic issues include the need to optimize benefits to Malagasy individuals, businesses, communities and the national government. These issues are addressed through proposed local hiring and training programs, support for local businesses and payment of taxes and royalties. Potential negative socioeconomic effects are addressed through resettlement planning and programs concerning health, wellbeing and cultural sites. The project also offers to provide planning assistance and capacity building as a contribution toward enhancing the net benefits.

Key environmental issues that are being addressed include potential impacts to water quantity and quality below the mine and tailings areas, plus potential impacts to biodiversity at the mine site, and subsequent effects on people in the project area. Water management is a project priority, with a commitment to monitoring and ongoing consultation with local people, to gauge the effectiveness of mitigations and quickly address any deficiencies. The high importance accorded to biodiversity, especially in the mine area, has been reflected in extensive baseline studies, interactions with the design team and impact analyses. A main mitigation is a commitment to on-site and off-site conservation areas. Along with future monitoring, these mitigation and compensation

initiatives aim to provide net benefits to the region compared to the existing conditions.

The proponents are committed to translating the results of this EA into an effective Environmental and Social management Plan (ESMP) for the construction, operations and closure phases of the Ambatovy Project. A participatory approach will be followed, so that stakeholder input, and where appropriate teaming, will help ensure that negative impacts are minimized and positive benefits enhanced. The mitigations developed in the EA, and laid out in the ESMP, are believed to be practical and achievable. After the implementation of mitigations and compensation, it is predicted that the Ambatovy Project will cause a net positive outcome for Madagascar, in terms of both socioeconomics and the environment.

STRUCTURE OF THE ENVIRONMENTAL ASSESSMENT

The EA for the Ambatovy Project is intended to meet the information requirements outlined in the ToR in an easily understood and comprehensive package of information. Information is presented in 11 volumes that address specific subject areas. The volumes are as follows:

- Volume A: Introduction
- Volume B: Environmental Assessment - Mine
- Volume C: Environmental Assessment - Slurry Pipeline
- Volume D: Environmental Assessment - Process Plant
- Volume E: Environmental Assessment - Tailings Facility
- Volume F: Environmental Assessment - Port Expansion
- Volume G: Environmental Assessment - Cumulative Effects
- Volume H: General Appendices
- Volume I: Physical Appendices
- Volume J: Biological Appendices
- Volume K: Social Appendices

Volume A introduces the project and the EA process and contains study area and methodological information pertaining to all disciplines and all project components.

For the convenience of readers who wish to read only specific parts of the EA, each of the assessment Volumes B through F provides the project description and environmental assessment for each specific project area. Therefore, a reader who is interested in one particular project site may read the corresponding assessment volume.

Volume G contains a cumulative effects assessment that addresses the combined effects of all project components and cumulative effects of the whole project plus other foreseeable developments in Madagascar. The economic assessment of all project components combined is provided in this volume.

Where appropriate, the EA refers to separate documents in Volumes H through K called Appendices, which contain additional technical and baseline information on all project sites. These volumes also contain environmental assessment appendices for some disciplines with information of relevance to the environmental assessment for multiple components of the project. Environmental and Social Management Plans are included in Volume H. The glossary, acronyms and references for all volumes are listed in Appendices H-12 and H-13.

Attachment 1

Conformity Table of EA with the Terms of Reference

ONE Terms of Reference	Section of EA
Introduction	
Refer to ToR in EA	Volume A, Section 7; Volume H, Appendix 1
Part I: The Nature Of The Impact Assessment And The General Criteria To Be Taken Into Consideration	
EA to employ scientific methods	Volume A, Section 7
Population's concerns to be taken into account	Volume A, Section 6; Volume H, Section 5
EA to be focused, with baseline inventory in Appendices	Appendices in Volumes H, I, J and K
I-1 The Characteristics Of The Impact Assessment	
Analyses of project alternatives to be clearly set out	Volume B, Section B-1; Volume C, Section C-1; Volume D, Section D-1 ; Volume E, Section E-1 ; Volume F, Section F1
I-2 Government Requirements	
2.1 The Environmental Charter : shall be followed	Volume A, Section 5; Volume H, Section 4
2.2 The MECIE Decree: shall be followed	Volume A, Section 5; Volume H, Section 4
2.3 Applicable legislation: shall be followed	Volume A, Section 5; Volume H, Section 4
I-3 The Scientific Method And Standards	
3.1 The scientific study: scientific methods to be used	Volume A, Section 7
Endemicity and threat status to be used for biology	Volume J
Market valuation needed if large removal of trees or crops occurs	Volume J, Section 5.1
3.2 Modelling: to be used as appropriate	Volume A, Section 7
3.3 National and international personnel: provide list of experts	Volume A, Section 8
3.4 Standards	
Proponent to comply with national standards or international ones	Volume A, Section 7; Volume H, Section 4
I-4 Taking The Public's Concerns Into Account	
Consultation by proponent to prepare EA and by ONE to review EA	Volume A, Section 6; Volume H, Section 5
Consultation to use appropriate visual aids	Volume H, Section 5
Part II: Content of the Environmental Impact Statement	
II-1 Putting The Project In Context	
1.1 Proponent details	Volume A, Section 1
1.2 Context of the project	Volume A, Section 3

Conformity Table of EA with the Terms of Reference (Continued)

ONE Terms of Reference	Section of EA
II-2 Characteristics Of The Receiving Environment	
2.1 Assessment study areas	Volume A, Section 7
2.2 Baseline information	
2.2.1 General: baseline needs to separate out effects of project exploration from other aspects of baseline disturbance	Volume A, Section 7
2.2.2 The physical environment	
Climate	Volume I, Section 4.1; Volume I, Section 8.1
Meteorology	Volume I, Section 4.1; Volume I, Section 8.1
Physiography	Volume I, Section 1.1
Topography	Volume I, Section 1.1
Geology	Volume I, Section 2.1
Geochemistry	Volume I, Section 2.1
Soils	Volume I, Section 3.1
Hydrology	Volume I, Section 8.1
Hydrogeology	Volume I, Section 7.1
Sedimentology	Volume I, Sections 9.1,10.1
Marine currents and water quality	Volume I, Section 10.1
2.2.3 The biological environment	
Flora (including endemicity and valuation)	Volume J, Section 1.1
Fauna (including endemicity and valuation)	Volume J, Section 2.1
Aquatic fauna	Volume J, Section 3.1
Habitats and protected areas	Volume J, Section 6.1
Fauna – flora relationships	Volume J, Section 2.1
2.2.4 The Social Environment	
Anthropology	Volume K, Sections 1.1 and 2.1
Political and administrative context	Volume K, Section 1.1
Population and demography	Volume K, Section 1.1
Traditional ways and survival strategies	Volume K, Section 1.1
Current and planned land use	Volume K, Section 3.1
Current and predicted use of resources	Volume K, Section 1.1; Volume J, Section 5.1
Human health and quality of life	Volume K, Section 4.1

Conformity Table of EA with the Terms of Reference (Continued)

ONE Terms of Reference	Section of EA
Socio-economics (local and regional)	Volume K, Section 1.1
Landscape; includes visual aesthetics	Volume I, Section 11.1
Noise	Volume I, Section 5.1
Concerns and opinions of affected populations	Volume H, Section 5
II-3 Project Description	
Separate description for mine	Volume B, Section 2
Separate description for slurry pipeline	Volume C, Section 2
Separate description for the process plant	Volume D, Section 2
Separate description for the tailings facility	Volume E, Section 2
Separate description for the port	Volume F, Section 2
Separate description for the limestone quarry	Not now in project; see Volume A, Section 3
3.1 Planning	Volume A, Section 3; Volume B, Section 2; Volume C, Section 2; Volume D, Section 2
3.2 Construction	Volume A, Section 3; Volume B, Section 2; Volume C, Section 2; Volume D, Section 2
3.3 Mining	Volume A, Section 3; Volume B, Section 2; Volume C, Section 2; Volume D, Section 2
3.3.1 Similar cases : one or several other projects to be described	Volume A, Section 4
3.3.2 Cross sectoral studies	
Land purchase plan	Sections 2, 5.1 in Volumes B – F
Human development and re-settlement plan	Sections 5.1 in Volumes B – F, Volume G, Section 4.1
Economic analysis and value added aspects for Madagascar	Sections 5.1 in Volumes B – F, Volume G, Section 4.1
3.3.3 Dynatec – community partnerships during exploration	Volume A, Section 2
3.4 Closure and post-closure	
Mine	Volume B, Section 6
Port	Volume F, Section 6
General restoration of reclaimed areas	Volume H, Section 6
Tailings Facility	Volume E, Section 6
Closure and reclamation of buildings	Volume H, Section 6
Plant	Volume D, Section 6
Slurry Pipeline	Volume C, Section 6

Conformity Table of EA with the Terms of Reference (Continued)

ONE Terms of Reference	Section of EA
II-4 Analysis Of Alternatives	
Use technical, economic and environmental criteria; including technical and financial constraints, sensitive environmental features and social benefits and impacts.	Volume B, Section 1; Volume C, Section 1; Volume D, Section 1 ; Volume E, Section 1 ; Volume F, Section 1
Predicted return pattern for any public investment	Volume A, Section 4
Final chosen sites are mapped and land status described	Volume K, Appendix 3.1
Water supply and power production decision process, with reference to Moramanga's and Toamasina's power needs	Volume A, Section 4
II-5 Impact Analysis	
5.1 Determining the impacts	
Positive, negative, direct, indirect, cumulative and synergistic impacts	Volume A, Section 7; Volumes B, C, D, E, F, G
Criteria for assessment of impacts, including uncertainty	Volume A, Section 7; Volumes B, C, D, E, F, G
Sensitivity, linkages, uniqueness and value of environmental components	Volume A, Section 7; Volumes B, C, D, E, F, G
Consider regulatory requirements	Volume A, Section 7; Volumes B, C, D, E, F, G
For social aspects: population level; institutional / community level; communities in transition; individual and family level; and community infrastructure	Volumes B, C, D, E, F, G, Socio-economics sections
5.1.2 Impact analysis	
Construction, operations and closure periods	Volumes B, C, D, E, F, G
5.1.3 Issue identification	
Social issues , such as employment and training, benefit enhancement, land purchase and re-settlement, relocation of tombs, migration, inflation, HIV/AIDS, cultural changes, integration with existing development plans, community development, local benefits, expansion of nearby towns, economic return (local, regional and national)	Volume A, Sections 6 and 7; Volume H, Section 5
Physical issues such as quality and quantity of water and atmospheric emissions	Volume A, Sections 6 and 7; Volume H, Section 5
Biological issues such as biodiversity, ecological value and re-vegetation of disturbed areas	Volume A, Sections 6 and 7; Volume H, Section 5
5.1.4 Mitigation, compensation and residual impacts	
Impact analyses after implementation of mitigation, with determination of residual effects	Volumes, B, C, D, E, F, and G
Monitoring and / or compensation for certain residual effects	Volume H, Section 6
5.2 Impact analysis and mitigation summaries	
Collation of results of impact analyses, including mitigation and residual effects, for construction, operations and closure	Volumes, B, C, D, E, F, and G

Conformity Table of EA with the Terms of Reference (Continued)

ONE Terms of Reference	Section of EA
Sequential reclamation and re-vegetation of mine during operations	Volume B, Section 6
Mitigation of mine water run-off and plant site tailings discharges	Volume B, Sections 3.2, 3.8 and 3.9; Volume E, Sections 3.2, 3.8, 3.9 and 3.10
Opportunities to extract other mineral by-products at the plant	Volume D, Section 2
Re-use and re-furbishing of equipment after project use is finished	Volume H, Appendix 7
Raising usefulness of restored areas (i.e. for fauna habitat)	Volume B, Sections 4.1 and 6
Socio-economic spin-off effects	Sections 5.1, Volumes B - F
Actions to be taken if mining operations cease either permanently or temporarily	Sections 6, Volumes B - F
Compensation for unavoidable residual impacts: i.e. biological (offsite mitigation) or social	Volume B, Section 4.1; Volume G, Section 3.4; Sections 5.1, Volumes B – F
Measures to maximize attainment of positive impacts	Volume B, Section 5.1
5.3 All project impacts and cumulative effects	
Combine all project elements together and then also with other projects	Volume G
5.4 Risk and hazard analysis	
For all main project components	Volume I, Section 6.1; Volume H, Section 6; Natural Risk Sections in Volumes B - G
5.5 Safety measures and emergency planning	Volume H, Section 6
Safety measures for all sites	Volume H, Section 6
Emergency response plans for all sites	Volume H, Section 6
II-6 Environmental Management Plan	
Monitoring plans and schedule to meet regulatory compliance; also to confirm effectiveness of mitigation where high uncertainty existed in impact analysis; physical, biological and social	Volume H, Section 6
Mitigation implementation schedule and adaptive management feedback	Volume H, Section 6
6.1 Planning phase: closure plan if project does not proceed	Volume H, Section 6
6.2 Construction phase: monitoring	Volume H, Section 6
6.3 Mining phase: monitoring	Volume H, Section 6
6.4 Closure phase: monitoring	Volume H, Section 6
II-7 Project Synthesis	
The project, impacts, mitigation and compensation summary; including reference to sustainable development and Dynatec's environmental and social policy	Summary; Volume A, Sections 1 to 4; Volume H, Section 2

Conformity Table of EA with the Terms of Reference (Continued)

ONE Terms of Reference	Section of EA
Part III: EA Presentation	
III-1 Methodology	
Use maps and diagrams to good effect	All Volumes
Include limitations of methods used	All Volumes
Provide locations of sample sites	Baseline Sections in Volumes I, J and K
Provide references	Volume H, Section 10
Provide name, profession and position of EA team members	Volume A, Section 8
Baseline data to go in appendices	Baseline Sections in Volumes I, J and K
III-2 Confidentiality	
Any confidential information to go in a separate document	None
III-3 Report Development And Production	
All reports and attachments to be submitted in French	All Volumes and Sections
Reports and summary to comply with MECIE decree requirements	Summary; All Volumes and Sections
Sixty hard copies of final EA to be provided, with summary in French and Malagasy	Yes
At least 10 copies of all annexes and attachments to be provided	Yes
Full report to be provided on CD-ROM (Word 7.0)	Yes
ANNEX (Details of baseline and EA requirements provided above)	
Physical environment	Volume I (Physical appendices); physical discipline sections in Volumes B to G
Biological environment	Volume J (Biological appendices); biological sections in Volumes B to G
Social environment	Volume K (Social appendices); social sections in Volumes B to G

Attachment 2

Conformity Table of EA with Main Issues Raised During Consultation

Main Issues	Section of EA
Mine Site	
Water quality around the mine may be affected, with effects also to the environment, people, agriculture and livestock	Volume B, Sections 3.8, 3.9, 5.4
Water flows may be affected around the mine, with effects also to the environment, people, agriculture and livestock	Volume B, Sections 3.8, 5.1, 5.3
Extraction of cobalt could affect health through radioactivity	Volume B, Section 5.4
Cutting of trees with affect run-off and even climate	Volume B, Sections 3.4, 3.8
Impacts to locally endemic species	Volume B, Sections 4.1, 4.2, 4.3, 4.4
Effects on high biodiversity habitats	Volume B, Sections 4.1, 4.4
Effects on protected areas, including the Torotorofotsy Ramsar site	Volume B, Section 4.5
Local employment should be maximized	Volume B, Section 5.1
Vulnerable population groups will be impacted	Volume B, Section 5.1
Access to forest resources will decline	Volume B, Section 5.1
Will terms of land acquisition be fair?	Volume B, Sections 1, 5.1
Commune boundary dispute exists in mine area	Volume B, Section 5.1
The project main cause increased inflation	Volume B, Section 5.1
Assistance is needed for implementation of community development initiatives	Volume B, Section 5.1
Benefits should be equitable distributed	Volume B, Section 5.1
In migration could occur, with many negative impacts	Volume B, Section 5.1
HIV/AIDS could increase because of migrant workers	Volume B, Section 5.1
Crime could increase with migrant workers	Volume B, Section 5.1
Any tomb relocation requires compensation	Volume B, Section 5.2
Non Malagasy workers must be respectful	Volume B, Section 5.1
Consultation must be on-going	Volume A, Section 6
Slurry Pipeline	
Water quality may be affected by the pipeline	Volume C, Section 3.7
Water quantity may be affected by the pipeline	Volume C, Section 3.6
Noise, especially during construction will be a problem for people	Volume C, Section 3.4
Soil erosion could affect vegetation, fish and people	Volume C, Sections 3.2, 4.1, 4.3, 6
Reclamation needs to be done well for vegetation, including to primary forest in parts of the Ankeniheny–Zahamena corridor	Volume C, Sections 4.1, 6

Conformity Table of EA with Main Issues Raised During Consultation (Continued)

Main Issues	Section of EA
The Torotorofotsy needs protection from watershed effects	Volume C, Sections 1, 3.6, 3.7, 4.5, 7
Key forests and protected areas should be protected	Volume C, Sections 1, 4.5
Undesirable plants should be kept out of the Torotorofotsy wetlands	Volume C, Section 4.1
Concerns over compensation or any needed resettlement	Volume C, section 5.1
Young people should be employed	Volumes, B and C, section 5.1
Breakage of the pipeline is a concern	Volume B, Section 3.6
Movement of cattle and people may be affected	Volume C, Section 5.1
Any tomb relocation requires compensation	Volume C, Section 5.2
Diseases such as malaria could get worse	Volume C, Section 5.1
Need for good, timely communications	Volume A, Section 6
Non Malagasy workers must be respectful	Volume C, Section 5.1
Local wood-cutting may be affected during pipeline construction	Volume C, Section 5.1
Tavy plots may be lost	Volume C, Section 5.1
The road along the pipeline has generally good aspects, but some bad	Volume C, Section 5.1
Views of affected people as well as NGOs need taken into account	Volume A, Section 6
Land owners and land users must all be treated fairly	Volume C, Section 5.1
Costs and benefits from social, environmental and economic perspectives need taking into account	Volume C, Section 1
Tailings Facility	
Concern over water quality effects downstream and in the ocean	Volume E, Sections 3.9, 3.10, 5.4
Reefs may be harmed	Volume E, Section 3.9; Volume F, Section 3.3
Biodiversity will be lost to the tailings facility	Volume E, Sections 4.1, 4.2, 4.3, 4.5
Human and ecological health will be affected near the tailings facility	Volume E, Section 5.4
There was a main concern over resettlement needs and giving up land	Volume E, Section 5.1
Maximising employment opportunities	Volume E, Section 5.1
Impacts to agricultural land	Volume E, Sections 5.1, 5.3
Hope that the land could be returned to original owners after 27 years	Volume E, Section 5.1
Need for a dispute resolution mechanism regards resettlement	Volume E, Section 5.1
HIV/AIDS could increase because of migrant workers	Volume E, Section 5.1
Any tomb relocation requires compensation	Volume E, Section 5.2

Conformity Table of EA with Main Issues Raised During Consultation (Continued)

Main Issues	Section of EA
Family members could not stay in single worker accommodations	Volumes B and D, Section 5.1
Land prices may rise because of the project	Volumes B and D, Section 5.1
Toamasina – Processing Plant and Port	
Cyclones could damage the plant and port expansion and impact people and the environment	Volume D, Sections 1, 2, 3.5; Volume F, Sections 1, 2, 3.5
International agreements must be considered	Volume A, Section 5
The port may cause erosion on the north beach at Toamasina	Volume F, Sections 1, 2, 3.3
Noxious plant emissions and greenhouse gases are a concern	Volume D, Section 3.3
Water quality effects are a concern	Volume D, Section 3.8; Volume F, Section 3.3
Business opportunities need to be maximized	Volume E, Section 5.1
Emergency measures need to be put in place in case of accidents	Volume H, Section 6
Hiring should be done locally and training provided	Volumes B – F, Section 5.1
Migration could cause a worker based city out near the plant	Volume E, Section 5.1
Lots of migration could contribute to cultural change	Volumes B – F, Section 5.1
Royalty distribution needs to consider the coastal area as well as the ore body area	Volumes B – F, Section 5.1

Attachment 3

Conformity Table of EA with the Equator Principles

Main Components of the Equator Principles	Section of EA
Complete EA for Category A or B projects	All sections
Assess baseline environmental and social conditions	Volumes I, J and K
Address requirements under host country (Malagasy) laws and regulations, applicable international treaties and agreements	Volume A, Section 5
Address sustainable development and use of renewable resources	Sections 1 and 2, Volumes B to F; Socio-economic sections, Volumes B to G
Protection of human health	Human and ecological health sections, Volumes B to G; Volume K, Appendices 4.1 and 4.2
Protection of cultural properties	Cultural property sections, Volumes B to G; Volume K, Appendix 2.1
Protection of biodiversity, endangered species and sensitive ecosystems	Flora, fauna, aquatic resources and biodiversity sections of Volumes B to G and corresponding appendices in Volume J.
Use of dangerous substances	Sections 7, Volumes B to F; Volume H, Appendix 6
Major Hazards	Natural Risks sections in Volumes B to G; Volume I, Appendix 6.1
Occupational Health and Safety	Volume H, Appendix 6
Fire prevention and life safety	Volume H, Appendix 6
Socioeconomic impacts	Socioeconomic sections, Volumes B to G
Land acquisition and land use	Sections 2, Volumes B to F; land use sections Volumes B to G; Volume K, Appendix 3.1
Involuntary resettlement	Socioeconomic sections Volumes B to G; resettlement action plan to accompany this EA
Impacts on indigenous peoples and communities	Socioeconomic sections Volumes B to G
Cumulative impacts of existing projects, the proposed project and anticipated future projects	Volume G
Participation of affected parties in the design, review and implementation of the project	Volume A, Section 6
Consideration of feasible environmentally and socially preferable alternatives	Sections 1, Volumes B to F
Efficient production, delivery and use of energy	Sections 1 and 2, Volumes B to F
Pollution prevention, waste minimization, solid and chemical waste management	Volume H, Appendix 6
Pollution controls (liquid effluents and air emissions)	Sections 1, Volumes B to F; Air Quality sections, Volumes B to F; Hydrology and water quality sections, Volumes B to F
Make reference to minimum standards under world bank and IFC Pollution Prevention and Abatement Guidelines	Volume A, Section 5; as appropriate throughout EA sections, Volumes B to F

Conformity Table of EA with the Equator Principles (Continued)

Main Components of the Equator Principles	Section of EA
Take into account IFC safeguard policies	Volume A, Section 5; as appropriate throughout EA sections, Volumes B to F
Prepare and Environmental Management Plan, which draws on conclusions of the EA	Volume H, Appendix 6; Sections 7, Volumes B to F.
Consult, in a structured and culturally appropriate way, with project affected groups, including indigenous peoples and local NGOs.	Volume A, Section 6
The EA, or summary thereof, has been made available for a reasonable minimum period in local language and in a culturally appropriate manner	EA in French, with French and Malagasy summary; final EA review being led by Malagasy government after submission
EA will take account of consultations and be subject to expert review	Results of post submission review to be processed and provided to proponent by Malagasy government. Malagasy government contracting independent expert review.
Proponent has covenanted to comply with EMP in construction and operation of the project	Yes, so written in EA
Proponent has covenanted to provide regular reports, prepared by in-house staff or third party experts, on compliance with the EMP	Yes, so written in EA
Proponent has covenanted to, where applicable, decommission facilities in accordance with an agreed Decommissioning Plan	Reclamation and closure sections, Volumes B to F; Volume H, Appendix 7
As necessary, lenders have appointed an independent environmental expert to provide additional monitoring and reporting services	To be determined once lenders confirmed
Where a borrower is not in compliance with social or environmental covenants, such that any debt financing would be in default, the bank (s) would engage in its efforts to seek solutions to bring it back into compliance with its covenance	Agreed by the project
These above principles apply to projects with a total capital cost of $US50 million or more	Such as the Ambatovy Project

Volume A Preface

The Environmental Assessment (EA) for the Ambatovy Project (the project) is intended to meet the information requirements outlined in the Terms of Reference (ToR) in an easily understood and comprehensive package of information. Information is presented in 11 volumes that address specific subject areas. The volumes are as follows, and the structure of each volume is depicted in Figure 1:

- Volume A: Introduction
- Volume B: Environmental Assessment - Mine
- Volume C: Environmental Assessment - Slurry Pipeline
- Volume D: Environmental Assessment - Process Plant
- Volume E: Environmental Assessment - Tailings Facility
- Volume F: Environmental Assessment - Port Expansion
- Volume G: Environmental Assessment - Cumulative Effects
- Volume H: General Appendices
- Volume I: Physical Appendices
- Volume J: Biological Appendices
- Volume K: Social Appendices

Volume A introduces the EA and contains study area and methodological information pertaining to all disciplines and all project components.

For the convenience of readers who wish to read only specific parts of the EA, each of the assessment volumes B through F include descriptions of the project component being addressed. Therefore, a reader who is interested in one particular component may read the corresponding assessment volume.

Volume G contains a cumulative effects assessment that addresses the combined effects of the project components and cumulative effects of the whole project plus other foreseeable developments in Madagascar.

Where appropriate, the EA refers to separate documents in volumes H through K called Appendices, which contain additional technical and baseline information. These volumes also contain environmental assessment appendices for some disciplines with information of relevance to the environmental assessment for multiple components of the project. The glossary, acronyms and references for all volumes are listed in Volume H Appendices 12 and 13.

Figure 1 Environmental Impact Study Structure for the Ambatovy Project

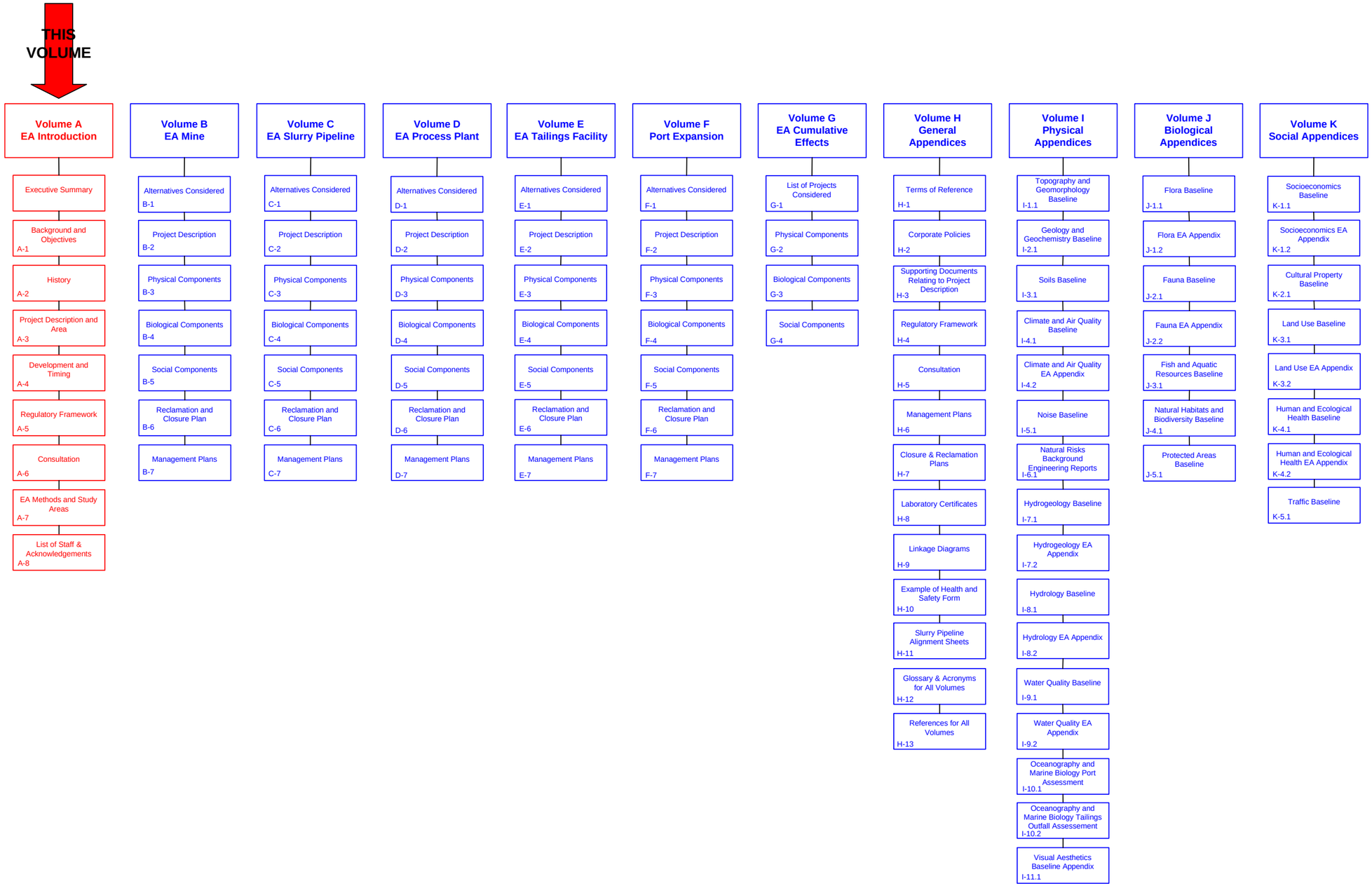


TABLE OF CONTENTS

SECTION **PAGE**

LIST OF TABLES

LIST OF FIGURES

1 BACKGROUND AND OBJECTIVES

The joint venture of Dynatec Corporation of Canada (Dynatec), and Sumitomo Corporation of Japan (Sumitomo) is proposing the development of the Ambatovy Project (the project). The project involves the development of a nickel laterite mine and process plant in Madagascar. The project will have the capacity to produce approximately 60,000 tonnes of nickel and 5,600 tonnes of cobalt annually over a 27-year period. The ore deposits are located close to Moramanga, about 130 km east of Antananarivo, in east central Madagascar, with process facilities located on the east coast near the port city of Toamasina.

The exploration rights to the deposits are currently owned by Ambatovy Minerals Société Anunyme (SA), which in turn is owned by the joint venture. The exploration rights may be converted to mining rights upon application to the Ministry of Mines and approval of an Environmental Assessment (EA) submitted to the Ministry of the Environment (Office National de l'Environnement, ONE).

The joint venture proposes to have the facility in production in late 2009 and operations will last through 2036.

The project EA has been prepared pursuant to the national legislation of Madagascar, including Decree No. 99-954 of December 1999. The EA follows the Terms of Reference, issued by the ONE in July 2004 (Volume H, Appendix 1)

The joint venture is committed to develop the project in an environmentally responsible manner, as a good citizen of the communities in Madagascar where it proposes to work. From the beginning of the project, Dynatec has been very much aware of the uniqueness of the Madagascar environment and the sensitivity to its preservation. The environmental objectives are:

- to conduct business operations with the highest level of legal and ethical commitment;
- to comply with all applicable laws; adhere to high standards of safety and care for the protection of employees, the public, and the environment, and promote these policies through education, supervision, and regular reviews;
- that the project follows the general principles of the International Standards Organization's environmental management standards (ISO 14000), and complies with World Bank policies and guidelines, the Equator Principles, Malagasy law, and other applicable internationally accepted guidelines;

- that the costs of initial and on-going compliance with international and national environmental policies and standards (being consistent with Malagasy law) is factored into the project's economic feasibility assessment; and
- for maximum expertise, drawn from Malagasy and foreign sources, to be available to evaluate environmental impact predictions and to support those predictions before the public.

2 HISTORY

2.1 EXPLORATION AND PROJECT DEVELOPMENT

The Ambatovy and Analamay deposits consist of thick nickel/cobalt lateritic mineral occurrences, first noted in 1960 during regional geologic mapping by the Malagasy Geologic Service. In the early 1970s, Groupement d'Etude de Nickel de Moramanga (GENiM), a consortium comprising Société Le Nickel, Ugine Kuhlmann, Anglo American, and Bureau des Recherches Géologiques et Miniéres (BRGM), conducted a major evaluation of the deposits. GENiM drilled 368 wide-spaced holes at the deposits. This drilling program led to an estimate of mineralized material of 190 million tonnes grading 1.10% nickel and 0.10% cobalt, at a 0.80% nickel cutoff.

Phelps Dodge secured the mineral rights in May 1995, and subsequently conducted extensive work on their Ambatovy/Analamay Project. The work included 22,000 m of drilling, batch and continuous testwork, an environmental impact assessment, and a feasibility study based on geological data collected and available up to July 1997. The feasibility study was done in 1998, and it defined a "base case" in which only part of the lateritic mineralization (the "Ambatovy West" deposit) was considered for mining and processing. The environmental study was not filed with regulators, but has been used for its very good data, in the current Environmental Assessment (EA).

The base case contemplated the processing of 2.67 million tonnes of ore per year, and metals production of 26,400 tonnes of nickel and 2,400 tonnes of cobalt per year. The study also stated that the Ambatovy West deposit contained proven and probable reserves of 37 million tonnes, averaging 1.10% nickel and 0.10% cobalt, which was sufficient to maintain production at the stated level for a 15-year period.

The resource was identified as being amenable to open pit mining, and the project contemplated in the 1998 study was based on using the pressure acid leach process. The geologic resource, including all occurrences currently identified, was stated to exceed 113 million tonnes grading 1.13% nickel at a cut-off grade of 0.8%.

Further exploration work and refinement of the May 1998 study led Phelps Dodge Madagascar to consider a "recommended case" which was based on a longer mine life, higher throughput and increased ore head grade, by mining 3.33 million tonnes of ore from two ore zones identified as Ambatovy and Analamay. This recommended case resulted in a mine life of 25 years and

increased production to 36,500 tonnes of nickel and 3,000 tonnes of cobalt per year.

Between 1997 and 1999, various alternative sites for the ore leaching and processing facilities were examined. In early 1999, an environmental assessment, based on World Bank guidelines, was completed for the project comprising a mine, process plant, auxiliary facilities including tailings and other support elements including extraction of limestone from a deposit located north of Ambatovy and Analamay.

In August 2003, Dynatec signed a joint venture agreement with subsidiaries of Phelps Dodge Corporation, to enable Dynatec to evaluate the development of the Ambatovy Project. Under the joint venture agreement, Dynatec would be the operator at Ambatovy, and would have the right to earn a 53% interest in the project by funding a portion of project costs, including expenditures for a Feasibility Study, and by providing a commercial license for use of Dynatec's metallurgical technologies for the project.

A detailed feasibility study was done between August 2003 and February 2005, based on the development of the mine, ore preparation, slurry pipeline, pressure acid leach plant and metal refinery, tailings facility, port facility and infrastructure.

The study indicated a capital cost for the project, in mid-2004 dollars, of US $2.253 billion, and net of credits for by-product cobalt and ammonium sulphate, and operating cost of US $0.67 per pound of nickel.

Key developments since the deposits were discovered are summarized below.

- 1960: Malagasy Service Géologique first notes the presence of nickeliferous laterites.
- 1962: BRGM (France) completes 2,500 m of auger drilling and pitting.
- 1972: GENiM consortium completes major evaluation over three years, including 11,700 m of core drilling covering Ambatovy and Analamay on a 195 m grid.
- 1978: North Korean interests take 4,000 tonne bulk sample for pyrometallurgical tests.
- 1980: Malagasy Service Géologique completes minor drilling on Ambatovy.
- 1995: Phelps Dodge granted exploration permits and pitting started.

- 1996: Metallurgical testing, drilling, and Environmental Assessment (EA) initiated, scoping study completed.
- 1997: Feasibility study initiated, 22,000 m drilling program completed, continuous pilot plant work completed.
- 1998: Initial mine block model and mine plan, EA and feasibility study completed; project put on hold due to initiation of development of legislation on large-scale mining sponsored by World Bank.
- 1999: New Mines Code promulgated, forest co-management agreement signed.
- 2001: Exploration licenses renewed to 2010, terms of Ambatovy surface lease established.
- 2002: Large Mining Investment Act (LGIM) promulgated.
- 2003: LGIM regulations passed, Dynatec and Phelps Dodge sign Joint Venture Agreement, Dynatec initiates further drilling, metallurgical testing, and feasibility study.
- 2004: Revised EA initiated.
- 2005: Dynatec acquires 100% ownership of the project, and enters into a new joint venture.

2.2 COMMUNITY PARTNERSHIPS

Exploration activities causing impacts to natural forest habitats in the Ambatovy-Analamay region, for which the Ambatovy Project must take full responsibility in terms of future rehabilitation, started in 1995 with the Phelps Dodge Exploration Campaign. Subsequently, reclamation activities were initiated in 1997. Community partnerships involved the hiring of restoration staff from nearby villages who were involved in erosion control, site preparation, revegetation and subsequent management and stewardship activities. The true partnership was established after local communities took ownership of the initiatives and, to a certain degree, collaborated with cattle grazing restrictions, fire management and reduced use of restored roads.

A eucalyptus mulching operation conducted by local communities was put in place based on an initiative between Phelps Dodge and the Landscape Development Initiative (LDI) project (USAID financed; a Chemonics initiative) in Moramanga. The work ended in 2003 but was restarted without LDI and continues to produce eucalyptus mulch up to the present.

After and in conjunction with Dynatec's upgraded geological drilling campaign in 2003 and 2004, Dynatec conducted site rehabilitation of roads and platforms, with staff from local villages. This work is ongoing.

Two village-level nursery projects were made operational recently, providing a fair proportion of the saplings used in the Dynatec revegetation campaign. The remainder of the saplings are grown by a project-level nursery which employs a small staff of local people.

Two agreements were also ratified, one with the government on the project's participation in re-establishing the connectivity of the Ankeniheny-Zahamena corridor, the other with local partners on the development and conservation of the Torotorofotsy Ramsar site.

Since 1996, and throughout the restoration of exploration disturbances, the project has maintained community health support with the presence of an MD conducting village-level consultations out of a local community dispensary.

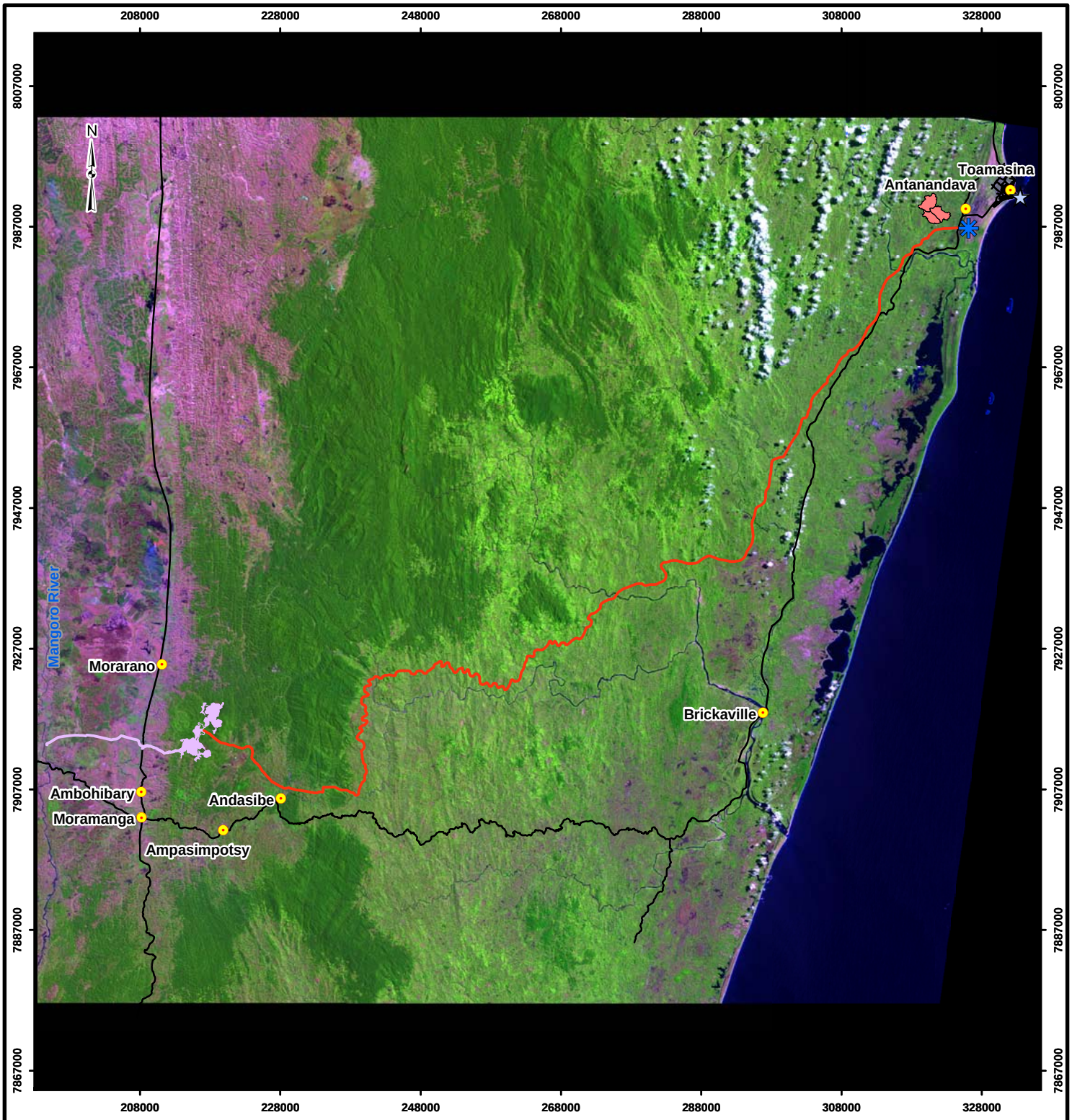
3 PROJECT DESCRIPTION AND AREA

The project is located in Madagascar, the world's fourth largest island, which is located in the Indian Ocean about 400 km off the eastern coast of southern Africa.

The mine site is located in the central highlands near Moramanga. By road, the mine is about 150 km from the capital city, Antananarivo, and about 275 km from the country's main port and second largest city, Toamasina (Figure 3-1). The elevation at the mine site is about 1,000 m, about 600 m lower than Antananarivo. The main highway and rail line in Madagascar run from Antananarivo to Toamasina, passing through Moramanga and then following a downward slope to the coast.

The processing plant will be built near Toamasina, which will facilitate the import of bulk materials, such as sulphur, coal and limestone. The ore will be transported from the mine site to the process plant in a slurry pipeline. The components of the Ambatovy Project (the project) cover a variety of areas and include the following.

- The development of two separate ore bodies, Ambatovy and Analamay, near Moramanga, through open-cut progressive mining and reclamation. The mines will produce the ore for an ore processing plant at the mine site, and this plant will prepare the ore slurry feedstock.
- A slurry pipeline about 195 km long to transport the ore slurry from the mine site to the process plant near Toamasina.
- The process plant will use pressure acid leaching, and while the February 2005 Feasibility Study contemplates a metal refinery to produce cobalt and nickel, the current joint venture will develop the refinery at an offshore location. A feasibility study update will be done, with no refinery at the Toamasina site of the pressure acid leach plant, and a nickel-cobalt refinery outside of Madagascar. The Madagascar facility will include a power and steam plant, water treatment, acid plants, a hydrogen sulphide plant, a hydrogen plant, an air separation plant and a limestone and lime processing plant.
- The tailings pond will be located in valleys south and west of Toamasina, this area will be used and reclaimed progressively and will contain all of the tailings solids generated.
- The expansion of the existing port in Toamasina will accommodate raw material and product movement in and out of Madagascar. Railcars will be used to move the bulk products from the port to the process plant.



LEGEND

- POPULATION CENTRE
- PLANT SITE
- PORT SITE
- ROAD
- PIPELINE ROUTE
- MINE SITE AND ACCESS CORRIDOR
- TAILINGS FACILITY

20 0 20

SCALE 1:775,000 KILOMETRES

REFERENCE

Datum: WGS 84 Projection: UTM Zone 39S
Landsat 7 Mosaic Image; Captured April/Sept. 2001

PROJECT

AMBATOVY PROJECT

TITLE

PROJECT REGION

Golder Associates
Calgary, Alberta

PROJECT No. 03-1322-172			SCALE AS SHOWN	REV. 0
DESIGN	LB	03 Sep. 2005	FIGURE: 3-1	
GIS	TN	14 Nov. 2005		
CHECK	GJ	06 Feb. 2006		
REVIEW	DM	06 Feb. 2006		

I:/2003/03-1322/03-1322-172/mxd/General/Fig3-1_Project_Region.mxd

4 DEVELOPMENT AND TIMING

The initial data review of Phelps Dodge information was completed in October 2003. This review concluded that the project was viable and outlined the activities required, which included a feasibility study (SNC Lavalin 2004) and an Environmental Assessment (EA). The scope of work for the feasibility study included:

- resource estimation;
- testwork;
- study engineering;
- environmental assessment;
- mine plan; and
- marketing.

With each of the above activities, numerous support programs were undertaken, often proceeding in parallel with the main activities.

As part of the feasibility study, the proponent established a team to establish the relationships/groundwork for the project to proceed into implementation. The activities include:

- accounting support;
- environmental impact assessment review;
- community relations;
- Madagascar office;
- management support; and
- corporate support.

In March 2004, BNP Paribas was retained as a financial advisor to the project.

Upon completion of the feasibility study in February 2005, ongoing activities included completion of the EA and a further update of the feasibility study. In addition, project development work and interim engineering are proceeding, in order to avoid time loss on an aggressive schedule which targets production beginning in late 2009.

The project schedule from completion of the feasibility study through to plant commissioning is outlined in the following table.

Table 4-1 Project Milestones

Activity	Start Date	Completion Date
feasibility study update	February 2005	April 2006
detailed engineering	March 2006	September 2008
procurement – fabrication and delivery	February 2006	June 2009
construction	March 2007	November 2009
pre-commissioning	July 2009	November 2009

4.1 UTILITIES & INFRASTRUCTURE

A careful study was conducted to evaluate the utility needs of this project from the perspective of water and water treatment for domestic purposes and power.

4.1.1 Water

There will be a requirement for potable water at the mine site and at the Toamasina pressure acid leach facilities, in addition to sewage wastewater treatment at these locations. These needs will be met using packaged plants which assure the production of drinking water to world health organization standards and wastewater treatment that meet discharge criteria.

Due to the remoteness of operations from population centres, it is not anticipated that potable water distribution or the availability of sewage water treatment facilities, from Ambatovy operations will be practical or economic. However, where deemed appropriate for social investment, the project will consider providing assistance in developing community water wells and other potable water improvement projects.

4.1.2 Power

Electric power is required at all project operating sites. Within the project feasibility study, all power will be supplied by the project with no planned access to national or regional grids.

With responsible engineering as a project policy, all power generation points will have a modest excess capacity. The most significant of these will be at the

process plant near Toamasina, where one 30MW generator set will normally be on standby. The feasibility study does not include project capital for linking the Ambatovy power plant to the Toamasina grid.

4.1.3 Infrastructure and Public Investment

There are no direct infrastructure investments on the part of the government required toward the project. Planned Toamasina city infrastructure improvements will however facilitate movement of materials to meet the needs of existing and future commercial developments between the harbour and the industrial area near the plant site. The returns on any project infrastructure improvements or future maintenance of infrastructures (following project closure) such as access roads, will be realized through improved material movement and opportunities for growth and development.

4.2 PROJECTS WITH PROPONENT'S INVOLVEMENT

The Ambatovy Project is a large nickel laterite mining and processing venture, with all operational activities to be conducted at a world scale. However, it has been approached with the philosophy that there will be no need for the use of new technology. All the operations will have been successfully conducted at other operations, at a comparable scale, elsewhere. This does not require that the operations have been integrated in the same way, nor does it imply that all the operations have been necessarily conducted by the proponents.

There are four nickel laterite projects that utilize the pressure acid leach technology, as proposed for Ambatovy. Dynatec is the process licensor for major portions of the two large operating projects listed below. In this capacity, Dynatec has done much of the testwork and basic engineering to support plant construction and operation. Start-up and technical services support has also been provided by Dynatec.

Site	Operator	Production (t/y Ni)
Moa Bay, Cuba/ Ft. Saskatchewan, Canada	Sherritt/ General Nickel	~30,000
Murrin Murrin, Australia	Minara Resources	~35,000

The Murrin Murrin Project in Western Australia, operated by Minara Resources (formerly Anaconda nickel), is similar in many respects to Ambatovy. Although

it has lower capacity (design capacity 45,000 t/y Ni+Co) and a somewhat different ore as feed, the unit operations in the process plants are quite similar.

The other two pressure acid leach nickel laterite operations are much smaller, each at approximately 10,000 t/y Ni capacity. Both are in Western Australia and one, Bulong, has ceased operations. The other, Cawse, continues in operation, but produces only an intermediate product which is processed to pure metals elsewhere. The proponents are aware of these operations, but have had no direct input to them.

The Ambatovy Project proponents have extensive links, technical, engineering, operations, or financing, to numerous other base and precious metals operations. Examples of these follow.

4.2.1 Dynatec Corporation

For the commercial plants listed below, Dynatec has provided testwork, process licenses, engineering, start-up and other services.

Nickel, Cobalt, and Copper

Ammonia Pressure Leaching

- Sherritt, Canada (1993, 1954)
- Western Mining Corporation Ltd., Australia (1969)

Hydrogen Reduction

- Outokumpu Oy. Finland (1995, 1957)
- Impala Platinum Ltd., South Africa (1983, 1969)
- Marinduque Mining and Industrial Corporation, Philippines (1974)
- Western Mining Corporation Ltd., Australia (1969)

Acid Pressure Leaching

- Anaconda Nickel, Australia (1998)
- Stillwater Mining Company, USA (1995)
- Bindura Nickel Corporation, Zimbabwe (1995)

- Northam Platinum Ltd., South Africa (1992)
- Western Platinum Ltd., South Africa (1990, 1983)
- Barplats (Pty) Ltd., South Africa (1989)
- Rustenburg Refiners (Pty) Ltd., South Africa (1982)
- Impala Platinum Ltd., South Africa (1969)
- Moa Nickel S. A., Cuba (1959)
- Sherritt, Canada (1953)

Zinc

- Hudson Bay Mining and Smelting Co. Ltd., Canada (1993)
- Ruhr-Zink GmbH, Germany (1991)
- Kidd Creek Division of Falconbridge Limited, Canada (1983)
- Cominco Ltd., Canada (1981)
- Akita Zinc, Japan (1973)

Gold

- Lihir Gold Ltd., Papua New Guinea (1997)
- Placer Dome Inc., Canada (1991)
- Porgera Joint Venture, Papua New Guinea (1991)
- Sao Bento Mineracao S.A., Brazil (1986)
- Homestake Mining Co., USA (1985)

Uranium

Acid Leach

- Key Lake Mining Corporation, Canada (1983)

5 REGULATORY FRAMEWORK

5.1 ENVIRONMENTAL LEGISLATION

The national legislation of Madagascar is the legal framework that protects both individual and societal environmental and social rights in the course of infrastructure development and other economic activities. Key relevant legislation is listed in Appendix 4 of Volume H and summarized in this section.

The development of the Ambatovy Project (the project) cannot be carried out without a prior environmental assessment (EA) as described in Madagascar's Environmental Charter of 1990 (Amended Act 90-033). An environmental authorization is granted by the Minister of the Environment. Decree No. 99-954 of December 1999 relating to the compatibility of investments with the environment specifies that a mining operation such as this project be subjected to:

- an environmental impact study;
- obtaining an environmental authorization following a favourable assessment of the impact study; and
- the delivery of an environmental management plan (EMP) of the project that includes the environmental effects of the project and a program of implementation and follow-up measures considered by the EA to stop, reduce and/or compensate effects to the environment.

In Madagascar, the process of the EA is managed by the National Office for the Environment (ONE). ONE approves the EA Terms of Reference (ToR) and manages both the technical review and the public consultation processes that are required to approve the EA. A technical evaluation committee (CTE) is appointed to review the technical issues of the EA (Order No. 4743/97MINENV). Decree No. 95-377 provides general guidelines for EA preparation, while Act No. 95-016 provides mining-specific guidelines for EA preparation.

As noted in the consultation section (Volume A, Section 6), the draft ToR for the project was subject to public consultation in early 2004, was edited after that consultation, and the final ToR was issued by ONE in July 2004. The ToR is provided in Volume H, Appendix 1. At the same time ONE confirmed the composition and role of the CTE for the project. Through the inclusion of a diverse membership, the composition of the CTE has allowed for different members to especially facilitate review and discussions in major environmental and social themes.

The CTE has the responsibility to determine what means will be used to consult with the public. Interministerial order No. 6830/2001 of June 28, 2001 describes

the public consultation process. The ongoing involvement of the CTE with the proponents in public consultation and technical meetings prior to EA submission, including with technical advisors, was envisaged as the ToR were being approved. Such ongoing involvement has taken place as noted in Volume A, Section 6. Public hearings after EA submission could be requested for a project such as this, requiring resettlement of more than 500 persons (Art. 3). A fuller review of regulatory requirements for consultation is given in Volume A, Section 6.

Decree No. 99-954 of December 1999 specifies that ONE is in charge of proposing the standards and environmental guidelines for each type of activity (Art. 8) with the collaboration of the concerned departments. In the absence of national standards, Decree No. 99-954 states that those responsible for EA studies will default to international environmental guidelines of organizations affiliated with the United Nations (Art. 9). EA provisions are recently being incorporated into Decree 167/2004. These provisions, in addition to the ToR, have been considered where appropriate throughout the various sections of the EA.

General EA provisions and minimum criteria include the need to provide a basic EA summary, avoiding technical terms, in French and Malagasy, which covers main points of the EA (see Section A, Executive Summary). Act No. 90-033 mentioned above, further provides regulatory limits with regards to effluent discharges from industrial projects, which have been taken into account in water quality assessments in this EA.

Environmental Assessment requirements for mine development are further specified by Interministerial Order No. 12032/2000 on regulations of the mining sector. The order describes the process for submission, review, approval and regulation of the EA. The EA is prepared in order to develop the EMP where mitigation and rehabilitation measures are described, to reduce impacts on the environment and improve the well-being of local people. The EMP should include a budget, a financing plan, and a management mechanism to insure that funds will be available for mitigation and restoration measures (Art. 40, 41, and 42). Environmental Management Plan details are provided in Volumes B to F, plus Volume H, Appendix 6.

Project design for construction, operations and closure has necessitated an understanding of legislation enacted to promote various aspects of planning, including for land use, renewable resource use, protected areas development and conservation. Act No. 96-025, permits rural communities to effectively participate in natural resource management, including for forests and aquatic and terrestrial fauna and flora. The proponents' commitment to co-operative management of a forest buffer zone around the mine area is discussed in Volume B, Sections 4.1 and 5.3. Forest management is further included in Act No. 97-017 and Decree No. 97-1200, which include reference to the state goal of

voluntary re-forestation. Re-vegetation, including re-forestation, of the mine is discussed in Volume B, Section 6.

The definition and delimitation of sensitive areas is covered under Interministerial Order No. 4355/97. Sensitivity can be related to various physical, biological and cultural factors. Such considerations have been used throughout this EA. In terms of marine topics, Act No. 99-028, consolidated the Maritime Code and includes aims to reduce and manage pollution at sea. Relevant legislation also includes Madagascar's commitments to various international treaties, including Act No. 95-013, which ratified the adoption of the International Convention on Biological Diversity. Special attention has been paid to mitigation with respect to biodiversity, as detailed in biodiversity sections in Volumes B to G.

Much additional Malagasy legislation is relevant to mine development and permitting, both before, but especially after, an EA is approved. Act No. 99-022 of August 1999, referred to as the Mining Code, specifies that mining exploration requires a permit type "R". This permit allows the right to explore and prospect an ore deposit for a period of 10 years, renewable for an additional period of 5 years (Art. 37). The completion of the EA is one main requirement before the permit can be transformed into an exploitation permit for production. A revision to the mining code has recently been enacted, Law 2005-021 of October, 2005.

Act No. 2001-031, the Large Mining Investment Act (LGIM), establishes special rules for large investments in the Madagascar mining sector and applies to holders of mining permits that satisfy criteria specified in Art. 157 of the Mining Code. Proponents can benefit from certain investment incentives, once a project is certified under the LGIM. Certification of a project under LGIM requires completion of environmental studies, issuance of mining or exploration permits, and certification by the Malagasy government of the investment plan, which must exceed 1 trillion Malagasy Francs. The LGIM also guarantees that permit conditions, including environmental permits, will not be changed once granted. A revision to the LGIM has recently been enacted, Law 2005-022 of October, 2005.

In addition to these acts and decrees, the construction, operation, and closure of the project will result in many types of works and activities. Prior to proceeding, different authorizations, permits, licenses and agreements will have to be obtained. A new decree gives power to the ONE only to deliver the environmental permit. Decree No 2000-170 defines the environmental authorizations that the project must obtain before beginning construction. For large projects of this nature, authorizations or agreements are managed by many jurisdictions at national, regional and local levels. The Ministries of Environment, Water and Forests, Energy and Mines, Transport and Public Works, Economy and Finance, and the Prime Minister's Office are those most heavily implicated in project permitting.

Table 5-1 Project Permits and Licences

Authority	Permit/License
Commission sur les Grands Investissements Miniers (CGIM)	- Certificate of Eligibility under the LGIM
Ministry of Energy and Mines	- Exploration - Timber Concession (exploration) - Surface Water Appropriation - Export (testing and analysis) - Construction and mine safety - Export (nickel and cobalt) - Hazardous and solid waste disposal - Exploitation - Storage of explosives - Construction (open pit/process plant) - Timber Concession (mining) - Surface Water Diversion - Groundwater Appropriation - Discharge of Dredged or fill material into streams - Air emissions
Ministry of the Environment	- Environmental Impact Assessment - Notice of Impact - Environmental Management System - Effluent discharge - Groundwater discharge
Ministry of Territory development and local authorities	- Occupation Domaniale (determines project site building plans and legal status) - Construction (buildings) - Construction (employee hygiene/sanitary facilities)
Ministry of Transport	- Construction (airport/airstrip) - Transport of petroleum products and hazardous chemicals - Construction (port)
Civil Engineering Ministry	- Alignment and building construction - Construction (roads, railways, bridges)
Ministry of Telecommunications	- Radio - Construction of transmission, radio, aerial cables
Ministry of Water and Forests	- Removal of sensitive flora - Relocation of sensitive fauna
Ministry of Agriculture	- Construction (dams, channels and dykes)
Ministry of Culture	- Relocation of sacred sites and monuments
Ministry of Army	- Possession of weapons for security personnel

Once the environmental authorization is granted following EA approval, the following authorizations, permits, licenses and agreements will have to be obtained (Table 5-1).

Also, where the project component is located near protected areas, such as along the slurry pipeline right-of-way (see Volume C), the National Association for the Management of Protected Areas (ANGAP), the governmental body that controls and regulates national protected zones, has to be consulted to verify the needs for any special permits and authorizations. Logging is also a complex issue: additional special permits may be required with local and regional governments.

5.2 WORLD BANK GROUP POLICIES AND GUIDELINES

The World Bank Group (World Bank) consists of the International Bank for Reconstruction and Development (IBRD), the International Development Agency (IDA), the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency (MIGA). The World Bank has developed many environmental and social policies, guidelines and other directives, to minimize negative environmental and social impacts of the development projects it supports. The safeguard measures were initially developed by the World Bank for public sector projects which they were financing. Once in place, policies and guidelines were adopted with minimal changes by the IFC, to assist with private sector projects.

The IFC and World Bank have also developed a set of Environmental, Health and Safety Guidelines, mostly contained in the Pollution Prevention and Abatement Handbook (PPAH). IFC Safeguard Policies are currently undergoing a revision to a Policy on Social and Environmental Sustainability and a series of Performance Standards. The direction of this review is summarized in Appendix 4 of Volume H. Many of these are of relevance to the project and have been considered in various aspects of project design and impact assessment.

In 2003, a group of 10 commercial lending institutions initiated a standardized process for addressing environmental and social issues linked to projects for which they were to provide financing. In the intervening two years several additional banks have also formally adopted these standards, which are called the Equator Principles. In general the Equator Principles endorse the environmental and social policies and guidelines of the World Bank and the IFC. Thus with the adoption of the Equator Principles, commercial lending institutions are also formally accepting IFC safeguard policies. The Ambatovy Project proponents have publicly endorsed the Equator Principles, which confirms their commitment that the EA is conducted to World Bank standards.

6.1 INTRODUCTION

6.1.1 Consultation Objectives

The objectives of public consultation and information disclosure for the Ambatovy Project (the project) Environmental Assessment (EA) have been to:

- identify project stakeholders, and present timely information on the project to them;
- provide ongoing opportunities for stakeholders to ask questions and express interests and concerns relative to the project;
- record stakeholder questions, interests and concerns so they can be relayed to the project proponents (including project engineers and the EA team) for timely integration into work being done to develop the project;
- engage government and civil society at all levels as active participants in developing the EA;
- supplement baseline data collection for the EA through qualitative information provided from consultations that enhances understanding of the opportunities and constraints of potentially affected stakeholders;
- solicit stakeholder participation in developing mitigation and benefit enhancement measures, including analyzing project alternatives; and
- engage with potential partners, such as donor agencies, nongovernmental organizations (NGOs), academia and local government, to link existing expertise and programming in the implementation of environmental and social mitigations that may be developed.

6.1.2 This Public Consultation Section

In accordance with the Terms of Reference (ToR) and international standards, this section is provided as a summary record of consultations that have taken place to date. Consultations included those:

- of the proponent with senior Government of Madagascar representatives, in relation to introducing the project, in 2003-2004;
- of the proponent with local government and populations at the mine site, largely in relation to the exploration program in 2003-2004;

- of the proponent and its EA consultants, with stakeholders in the project areas in specific relation to scoping EA issues for the project, in 2004 and 2005;
- of the proponent and its EA consultants, with stakeholders in project areas in specific relation to discussing the efficacy of proposed mitigations for the project, in 2005; and
- of the proponent and its consultants, throughout the EA process, to provide iterative input into project decision-making as it has progressed.

In addition to potential negative impacts and benefits associated with the construction and operation of the mine, slurry pipeline, processing facility, tailings facility and port expansion, the project will include provision for resettlement and compensation of households whose livelihoods are directly affected, specifically at the site of the processing and tailings facilities, but also to a more limited extent at the mine site. Public consultation specific to resettlement and compensation is addressed as part of the Resettlement Plan and is only briefly covered here.

Information provided in the following sections include:

- a description of the regulatory requirements for environmental assessment and public consultation and information disclosure for the project;
- a review of consultation activities that have been completed before initiating EA work;
- an inventory of key stakeholders;
- a description of the public consultation and information disclosure activities that have been undertaken to date in relation to drafting the EA;
- a summary of the public consultation results for each project component (mine, process plant, slurry pipeline, tailings facility and port expansion);
- a description of consultations on suggested mitigation of project effects; and
- a description of consultations for future and ongoing consultation activities during project construction and operations.

6.2 REGULATORY REQUIREMENTS

The public consultation and information disclosure activities undertaken to date are in compliance with relevant national legislation as well as with international policies and best practice guidelines as described in International Finance Corporation (IFC) documentation. Additional information on regulatory requirements for the EA is provided in Volume A, Section 5.

6.2.1 Government of Madagascar

The national environmental legislation of Madagascar is the legal framework that protects both individual and societal environmental and social rights in the course of infrastructure development and other economic activities. The laws and precedents relevant to public consultation and information disclosure regarding a project such as this include:

- *Decret No 99-954 relatif a la mise en compatibilité des investissements avec l'environnement:* This Decree accords to the National Office for the Environment (ONE) the responsibility to produce the EA terms of reference, taking into account the views of government, any interested parties and the project proponent.
- A project-specific Technical Evaluation Committee (CTE) is appointed to review the EA. In addition to the technical review by the CTE, the review process includes public consultation as the EA is being conducted. ONE and the CTE have the responsibility to determine what means will be used to consult the public, including after final EA submission.
- *Loi No 2001-031 établissant Régime Spécial pour les Grands Investissements dans le Secteur Minier Malagasy:* This provides for agreement between a project proponent and ONE on the conduct of an EA. Expectations are that projects the size of the Ambatovy Project require extensive public consultation.
- *Le Project Ilmenite Etude d'Impact Social et Environmental (QMM):* QMM's consultations for their project were largely consistent with international best practice, and represent the single precedent of an approved EA in Madagascar for a project similar in scope to that of the project. QMM engaged in extensive consultation with implicated government agencies, civil society and potentially affected populations at all levels from the national to the local level in order to finalize EA terms of reference and subsequently to develop mitigation for potential social and environmental impacts.

In addition to national laws, there are various processes and planning initiatives which may affect the development of a large project, including assessment of potential impacts and of selection of environmental and social mitigation and benefit enhancement strategies. While these do not prescribe consultative processes for EAs within the jurisdictions they apply to, consultation is required to ensure that project activities accommodate and complement to the extent possible these already agreed participatory planning frameworks. These include not only regional and commune development plans, but also donor-funded environmental programs and sector planning by national government agencies.

Finally, ONE issued the ToR for the EA, that require various forms of public exchange occur to inform the development of the EA; that the EA take into account the opinions of those parties that are directly and indirectly affected or interested in the project, cite the means used to do so, and provide a list of all organizations that were contacted. Consultation follows the policies of the Malagasy Environmental Charter, adopted in 1990, which recognizes environmental protection as a top priority, the duty of each to protect it, and the right of each person to be informed of and participate in decisions, thereby exerting some influence on the environment.

While the TOR itself do not define a process for consulting, there is a recommendation that not only written but also visual methods of presenting the project are used, such as 3-D models, videos, poster boards and diagrams. The project accordingly developed several different materials for purposes of consultations (See Volume H, Appendix 5).

6.2.2 International Best Practice

International best practice for public consultation and information disclosure are outlined in IFC documents as follows:

- IFC Operational Policies (OPs), particularly *OP 4.01 Environmental Assessment*; and
- IFC's Guidance Note F: Guidance for Preparation of a Public Consultation and Disclosure Plan.

The IFC's Operational Policy OP 4.01 requires public consultation and information disclosure for all large mining projects, such as this project. IFC particularly promotes early and ongoing public consultation and disclosure by the project proponent, during scoping of EA issues for purposes of EA Terms of Reference, during preparation of the EA and once a draft EA has been prepared.

The IFC guidelines are particularly oriented towards ensuring that local populations potentially directly affected by a project are adequately consulted. Care is to be taken to ensure the following:

- Populations targeted for consultations are recognized to have different interests and concerns relative to the project, and may need to be segmented for consultation purposes. Different consultation methods may be required for different stakeholder groups.
- Information materials are prepared in format, language and content that is appropriate to the capacity of populations to absorb, so they can provide input from an informed position. This may require for example limiting written documentation in favour of pictorial representation of information on a project and its potential impacts and benefits.
- Means for information distribution and notice of upcoming consultations events are timely and appropriate to the target populations. This may require for example posting information notices well in advance of consultation events in commonly used public areas rather than use of media such as newspapers.
- Logistical arrangements for consultation events acknowledge the constraints to participation by certain segments of the population. This may require for example scheduling consultations so they do not conflict with times of intense agricultural activity.
- Proactive measures are taken to ensure that any vulnerable, or socially marginalized, groups such as women, the very poor or minority ethnic groups are able to participate in consultations.

6.2.3 Consultation Methodology

At the outset of the EA process the proponent expressed their commitment to implementing a structured program for public consultation and to working closely with communities in the spirit of mutual respect and integrity.

Consultation activities have been organized and conducted by various staff of the project and its EA consultants, Golder Associates, Soateg and Social Capital Group, depending on the purpose of the specific consultation activity. Dynatec senior management has been in constant communication with national and regional governments as project development and the EA have moved forward.

The proponent and the EA consultants have also met regularly with ONE and the CTE to work collaboratively on the development of the EA and its results, as these have become available. Formal meetings, including the preparation of materials, have taken place at appropriate intervals and have been supplemented with more informal but regular meetings between the proponent, the EA consultants and representatives of ONE and the CTE.

At the more local level, the project has established two offices, one each in Moramanga and Toamasina, staffed with *agents communitaires* with mandates which include engaging the public on a regular basis. These *agents communitaires* are available to answer questions and to attend and/or call meetings at the request of stakeholders, and have been backed up with technical support by the proponent and the EA consultants as necessary.

The proponent and EA team have also participated extensively in the design and implementation of the consultation program specific to the EA. Consultation materials have been developed, and various specific consultations held in technical EA disciplines. An issues database has been developed for purposes of systematically documenting and tracking issues arising from consultation. To date, over 600 issues have been entered into the database although it is to be noted that many of these issues are duplicates as different stakeholders have raised the same issues (see Volume H, Appendix 5 for an extract of the issues database).

Public concerns and interests have been integrated throughout the EA. Soateg has led village and commune level scoping consultations and focus group meetings across the project area to collect social baseline data, and has at the same time documented peoples' concerns and interests for input into the issues database. Social Capital Group has been responsible for consultations for resettlement, as part of the resettlement planning. Over 150 meetings have been held since January of 2004 linked to the EA for the project (see Volume H, Appendix 5 for a list of meetings), although there have also been innumerable daily contacts with stakeholders as the EA has moved forward. Also, consultations that occurred within socioeconomic baseline data collection meetings have been reported on separately in detail (see Volume K, Appendix 1.1) and so are not also tracked in detail in the meetings list.

The general method for the project's approach to local-level EA consultations can be described as a 'whole of community' approach. Efforts have been made to ensure that all segments of the community are included or represented. The key to such an approach is to engage early and engage often and to use many communication tools: key informant interviews, focus groups, participatory workshops, public meetings, comment boxes and open houses. Assistance from

informal community leaders in facilitating consultations and communication has been critical, as has been working with local politicians and representatives of NGOs, traditional leaders and others who influence community opinions and activities. Most important, consultations have been conducted in the spirit, not merely the letter, of the law. To successfully adapt to and resolve public concerns the project recognizes that it is important to keep the process ongoing and flexible, according to the needs and interest level of stakeholders.

6.3 STAKEHOLDERS

In addition to the obligation to consult as widely as possible with project stakeholders and in the interests of including their input as appropriate into project design and into the EA, the proponent is concerned to ensure that, to the extent practical:

- consultation completed that is relevant to assessing environmental and social impacts is included in the EA;
- the project is integrated into national, regional and local development planning; and
- partnerships with agencies of government and civil society can be developed in the interests of effective environmental and social mitigation and to optimize the positive effects of the project.

To these ends, efforts were made to identify stakeholders as inclusively and broadly as feasible. A preliminary list of stakeholders was developed for launching a formal consultation program in early 2004 to scope the issues that should be addressed in the EA. Efforts were made to identify interested groups at national, regional and local levels. In addition to government at all levels and communities potentially affected by the project, emphasis was placed on NGOs and advocacy groups that have interests in the areas of Moramanga and Toamasina, where the large majority of project effects will be experienced, as well as on donor agencies, whose existing or planned project investments may be affected or affect the project. As consultations proceeded, and as more information became publicly available about the project, this preliminary list of stakeholders was expanded. Stakeholder groups, their expected interest in the project, and their potential roles in project development, are summarized below.

6.3.1 National Level Government

Madagascar's EA process is managed by ONE, which issues any eventual environmental permit. ONE is supported, specifically in relation to the project, by the Ministries of Environment, Water and Forests; Energy and Mines; Transport and Public Works; and Industry, as those most heavily implicated in project permitting, as well as by other ministries and agencies of government with interests in specific potential project impacts that fall within their areas of responsibilities. These would include for example the National Association for the Management of Protected Areas (ANGAP), the Vice Prime Minister's Office, Ministry of Energy and Mines, Madagascar Rail, and others as the project is advised by ONE and the CTE. National level government is also a stakeholder by virtue of its responsibility for the economic and social wellbeing of the people of Madagascar.

6.3.2 Regional and Local Government

Madagascar is split into 22 regions. Mangoro-Alaotra and Atsinanana are the main regions in the project area. The government of the Province of Toamasina, within which all components of the project are located, and governments at the prefet, sous-prefet and commune levels are also stakeholders. In addition, the Committee for Regional Development for the Mangoro region is a stakeholder. These levels of government have responsibility for economic and social development within their areas of jurisdiction. Other regional level stakeholders are the *Plateforme de Gestion du Corridor Ankeniheny-Zahamena*, provincial representatives of national level ministries such as CIREF/DIREEF Moramanga and Toamasina, the municipal government of the City of Toamasina, and the port authority in Toamasina. Project mitigation and benefit enhancement will be integrated with existing development planning, specifically for the town of Toamasina, the Mangoro Region and at the commune level, but also with respect to government participation in infrastructure development related to the project.

6.3.3 Civil Society

Civil society organizations are stakeholders insofar as they are able to inform on EA issues and as they represent potential partners in the development and implementation of both environmental and social management and monitoring plans.

International and national environmental and social development NGOs, some with offices not only in Antananarivo but also in Moramanga and Toamasina, are

particularly well resourced and well heard in Madagascar. Such international and national NGOs include:

- Conservation International (environment)
- World Wildlife Fund (environment)
- Wildlife Conservation Society (environment)
- Voarisoa (environment)
- Tanymeva (environment and social development)
- Pact (governance and environment)
- *Service d'Appui à la Gestion de l'Environnement (SAGE)* (environment)
- Mitsinjo (environment)
- *Projet National pour la Lutte contre le SIDA (HIV/AIDS)*
- CARE (mining and HIV/AIDS)
- Church of Jesus Christ Department for Development (SAF FJKM) (social development)
- Eco-Regional Initiative Project (ERI)
- Tany Tsara
- *Group d'Etude Sur les Primates de Madagascar* (GERP) (Primate Research Insitute)
- Adventist Development and Relief Agency (ADRA) (social development)
- Landscape International
- *Centre National de Recherche sure l'Environnement* (CNRE) (environment)
- *Groupe de Spécialistes des Plantes Malagaches* (GSPM) (environment)
- Provincial delegation for Education (DPFTP) (education)

In addition to NGOs, staff of research and academic institutions such as the University of Antananarivo and of Toamasina, an advisor from the polytechnical school in Moramanga, and the chief doctor the Moramanga Hospital have identified themselves as stakeholders and have attended consultation sessions.

6.3.4 Donors

Given the profile of Madagascar's environmental heritage, many of the large bilateral and multilateral donors are deeply involved in the environment sector, the interface of the environmental and social sectors through, for example, community management of environmental resources, or in the social development sector, and have been for many years. They are both active and knowledgeable, and are implementing projects that will interface with the Ambatovy Project. Entities contacted include the U.S. Agency for International Development (USAID), specifically in relation to environmental programming in the area of the mine site; and the World Bank, specifically in relation to the national environmental program.

6.3.5 Affected Populations

The project and all its associated facilities are within the boundaries of Toamasina Province. At the mine site, the project has the potential to affect the populations of Morarano, Ambohibary, Ampasimpotsy and Andasibe Communes, as well as the town of Moramanga. This represents a directly affected population of about 85,000.

The pipeline, particularly its construction, will affect populations from the following Communes along the route assessed in this EA: Ambatovola, Andekaleka, Lohariandava, Fanasana, Razanaka, Fetraomby, Vohitranivona, Ambalarondra, Ambinaninony and Ampasimadinika.

The tailings facility will be located on the boundary between Antanadava, in the Commune Sub-Urbanine de Toamasina II and Antananambo in Fanandrana Commune. These rural populations, and the population of the city of Toamasina (over 200,000 people in total), will see significant economic and social project effects as a result of these project components specifically. The expansion of the port will also affect Toamasina. For a map showing locations of affected populations, see Volume K, Appendix 1.1.

6.4 PUBLIC CONSULTATION AND DISCLOSURE

6.4.1 Before Launching the Environmental Assessment

In 2003, the proponent took over responsibility for reinitiating the development of what was originally a Phelps Dodge project, including a drilling program at the mine site to confirm resource availability. The proponent thus met with a broad range of national, provincial, district and local government representatives, at both the political and administrative levels, to introduce the project and solicit input into its future development. This consultation has been an iterative one. As site investigation and project design studies advanced, new information became available and was provided to the Government of Madagascar, in the spirit of collaboration in project development.

Meetings at the political level indicated strong interest in seeing the project proceed, on the grounds of the economic, employment and business benefits it would bring to government and local populations. Madagascar gives some priority to the mining sector as a force of economic growth, source of government revenue, contributor to infrastructure development and opportunity for skill and capacity building (both direct employment in the formal wage economy and supply of goods and services). Madagascar is however very concerned to see that its unique environmental heritage and the well-being of its population are protected in the course of project development, construction and operations.

At the official level, the project has primary interface with the Ministries of Energy and Mines; Environment, Water and Forests; Industry; and Transport and Public Works.

6.4.2 National, Provincial and Regional Government

6.4.2.1 Methodology

As described above, engagement with national and regional level governments has been ongoing, in the course of the activities the proponent has undertaken since 2003 to develop the project in all its elements – engineering studies, land acquisition, interface of the project with infrastructure development (port and railway), initiatives being undertaken by the Government of Madagascar, etc.

The proponent has also formally engaged governments at national and regional levels through large meetings which bring together senior corporate management with Madagascar government ministers and officials. These meetings are

intended to provide updates on project activities, collaborative approaches, and challenges the project development is facing.

6.4.2.2 Results

Although very senior government representatives are often called away on an urgent basis, attendance at consultation meetings has been good, and participation very active. Strong interest and support for the project are evident. A summary of issues raised follows:

- Employment and training: There was strong interest to see that employment benefits would be maximized, through not only a commitment to hire in Madagascar to the extent possible but also through training of Malagasy employees to upgrade skills. Training should permit the percentage of the workforce that is Malagasy to increase over time. Concern about employment benefits also extended to questions about health and safety of workers, terms of employment for expatriate employees, how trainees will be selected and other human resource issues.
- Closure: Recognizing that the mine itself now has a projected life of 27 years, although the processing facility could be operational for longer, there was interest to see what is being planned for closure. Post-operations land use, training of Malagasy employees, and the potential for economic dislocation were of specific interest.
- Value added: Madagascar was interested to understand what potential there might be for increasing the value added within Madagascar.
- Reclamation and revegetation: Land reclamation and revegetation particularly of the mine site will have implications for environmental integrity and subsequent land use. There was interest to know how land will be reclaimed, with what species it can be revegetated for example, and what this may imply for future economic use of the land.
- Land acquisition and expropriation: The process of land acquisition is still underway, thus there were questions regarding any expected requirements for expropriation relative to private sale or agreements with the state. This relates to any expected role for government as well as to project proponents' expectations and intentions regarding resettlement.
- Project alternatives: As the proponent considered various alternative sites and routing for project-associated facilities, participants have been interested to understand what the criteria for site selection are, and to provide viewpoints on the advantages and disadvantages from the government point of view. There was also interest to see that alternatives were eliminated as soon as possible, so that work –

including government participation – can proceed on the basis of firm decisions.

- Interface with existing development plans (regional and urban and transport): The project will interface with existing planning and implementation of government-led infrastructure projects, for example those related to port improvements, the building of a dry port, and/or road and rail improvement. There was therefore a concern to ensure that the project's expectations and needs are fully understood by relevant government agencies and departments on the one hand, such that they can assist. On the other hand, there is a requirement to ensure that project plans are consistent with these planned or existing infrastructure projects.
- HIV/AIDS: With a comparatively low HIV/AIDS incidence in Madagascar, high incidence in countries from which expatriate workers might be drawn, and the association between mining workers and HIV/AIDS, there was concern to see that this issue is aggressively addressed early in project development.

6.4.3 Civil Society

6.4.3.1 Methodology

The proponent and its EA consultants have met with representatives of NGOs and donor agencies since January 2004. Interest in the project is largely related to environmental and social impacts at the regional and local levels, as well as to the interface between project mitigations and ongoing initiatives, particularly in the Torotorofotsy and Mantadia-Zahamena forest corridor.

As information became available on the project, many formal meetings were held, in which over 85 NGO representatives and other stakeholders attended.

6.4.3.2 Results

Results from these consultations in the first half of 2004 are summarized as follows:

- Community Development: There was concern to see community development integrated with Commune Development Plans and that community development initiatives and benefits are widely distributed, extending beyond the immediate area of the mine site. NGOs asked for assurance of transparency of project benefits, with funds tracked so that stakeholders can see where funds have been spent.

- Biodiversity: The protection of the Torotorofotsy and the Mantadia-Zahamena Corridor would need to be assured, with the aim of not only mitigating impacts through ecological restoration but also of creating environmental value for Madagascar. NGOs asked that pipeline routes be chosen with the lowest risk to the environment.
- Ecological Value: There was a request that the EA include an analysis of the ecological value of the mine site area, reflecting a concern that the no action alternative receives appropriate consideration in the EA.
- Mine Site Ecology: There was concern that the mine site, because of its unusual soil properties and thus specialized vegetation cover might represent a unique ecology that would need to be protected. In addition, this raised questions as to the potential for revegetation using different species native to the area, as post-mine soil conditions will be different and perhaps not support a similar ecology to what exists presently.
- Training: There was interest to ensure that the project, in developing and implementing its training plan, work with local educational institutions.
- HIV/AIDS: There was concern to know what the project will do to prevent the spread of HIV, which is associated with migration as the result of projects such as mines. It is expected that the project's workforce management plan address the prevention of HIV/AIDS.
- Value Added: There was interest in seeing how, beyond mining and processing, the project could bring additional economic benefits to Madagascar, both by sourcing more project inputs in the country and by finding means to sell not just nickel and cobalt, but using other project outputs, such as mine tailings.
- Alternatives: There was concern to know what alternatives have been considered and what criteria were being used to evaluate these towards final decision-making.

6.4.4 Affected Populations

The consultations strategy is one that proactively informs and consults with stakeholders on the development of the mine, with all of its associated facilities, and the EA process itself. Results of local-level consultations are presented below, for each project site.

6.4.4.1 Mine Site

Local-level consultations were held in four communes surrounding the mine site, as well as in the town of Moramanga. The ore bodies are located primarily in the Commune of Ambohibary but may also extend into other communes, thus the excavation and associated facilities have potential impacts on land use in all four

communes. Ambohibary, Ampasimpotsy and Andasibe all have populations that use for their livelihoods the area around the Torotorofotsy Wetlands, and there is thus some potential for impact in this regard. The population of particularly Andasibe is also implicated in the developing tourist industry and in environmental conservation of existing and potential tourist sites. As all four communes straddle the main road and rail access routes to the site, there is potential also for a range of impacts, such as increased traffic, migration and employment. As the main regional centre, Moramanga is also likely to see impacts related to migration and expanded employment and business opportunities in relation to mine activities. The mine site and adjacent Torotorofotsy Wetlands were also discussed at various meetings with civil society and government stakeholders.

Issued raised during the consultations, including those written into notebooks and dropped into suggestion boxes, are summarized below.

Physical

- Water quality: There was concern that chemical elements from mine activities will reach water resources. These include water for human and animal consumption – potentially affecting health of both, for irrigation and for fishing. The relationship between cutting forests and sedimentation of rivers is also of concern, particularly as this may affect rice fields (Morarano) and the Torotorofotsy (Ampasimpotsy and Andasibe).
- Water quantity: There was concern that the water requirements of the mine (including withdrawal from the Mangoro River) will result in less water being available, which would be a serious impact given the importance of irrigation for rice fields, the dependence on fish for livelihoods in the area of Torotorofotsy and the tourism potential of the Torotorofotsy. (Ambatovy workforce, Ampasimpotsy, Andasibe).
- Cobalt: There was concern that the extraction of cobalt will result in health threats because of the perceived radioactive properties of this mineral. (Morarano, Moramanga).

Biophysical

- Depletion of forest resources: There was concern that the tree cutting required to develop the mine will not only result in other environmental effects, on water, but also on rainfall. (Morarano, Ampasimpotsy, Andasibe).
- Biodiversity and habitat: There was concern about the potential effects of the mine generally on biological integrity, as the site lies within the Mantadia-Zahamena corridor slated for protection. More specifically

however, the Torotorofotsy is of concern, as this is the location of endemic species, is a Ramsar site, is gaining economic importance as a tourism site and provides livelihoods for people. (Ampasimpotsy, Andasibe).

- Locally endemic species: The ore body lies under, and has helped create, rare azonal forest habitats, which support locally endemic flora and fauna. There was concern that mining could significantly affect these species which may not occur elsewhere in Madagascar. (Andasibe).

Social

- Local employment: There was strong feeling that the mine should maximize the employment of local people, and target employment to youth. There was concern to see that any such employment is equitably distributed and that working conditions are just and safe. (Morarano, Moramanga, Ampasimpotsy, Andasibe, Ambohibary).
- Vulnerable groups: There was concern that the many people will not benefit from employment by the mine, but nevertheless may be negatively affected by the project, through for example inflationary effects on the cost of living, loss of livelihood resources or health impacts. (Ambatovy workforce).
- Continued access to forest resources: There are some people whose livelihoods depend on access to the land within the boundaries of the mine site, specifically for rice cultivation but also for various forms of forest resource harvesting. Given this economic dependence there was concern raised that the presence of the mine will both result in removal of forest resources and reduce access to the remaining forest. (Morarano).
- Requirements for property: The project will require property to develop the mine and its associated infrastructure, including the pipeline. People expressed concern about the terms of expropriation and/or resettlement, particularly since livelihoods depend on this land and few have clear title to the lands they use. For some people, losing land in exchange for jobs is not considered a real option. (Morarano, Ampasimpotsy, Andasibe, Ambohibary).
- Boundaries: There was concern in Ampasimpotsy and Andasibe that their claims that the ore bodies were at least partially within the commune boundaries be acknowledged.
- Inflation: There was concern that increased economic activity implied by the mine development, the import of skilled workers and the arrival of migrants, will have an effect on the cost of living. (Morarano).

- Community development initiatives: The communes do not have all the health, education and physical infrastructure (irrigation for rice fields, electricity) services they feel they need for economic and social development. They do however have recently formulated community development plans although they lack the financial resources needed to implement these. There is concern that they be compensated for negative impacts of the project through assistance with the implementation of existing plans and wish to work collaboratively with Dynatec in this regard. (Morarano, Ampasimpotsy, Andasibe, Ambohibary).
- Equity in distribution of benefits: This is related to commune boundaries on the one hand and expectation of impacts on the other. There was concern that particularly employment but also community development initiatives are equitably distributed among communes that have land interests that will be affected by the project, and that may experience other impacts. (Andasibe).
- Migration: There were concerns raised that the construction and operation of the mine will engender the migration of people to the area in search of expected economic opportunity, with all the potential for negative impact that such migration can have on the local economy and resource availability, health status of the population and public security. (Moramanga).
- HIV/AIDS: There is significant awareness of HIV/AIDS in the area due to ongoing campaigns of government, and consequent concern expressed that out-of-area workers and migrants will induce an increase in incidence. There is a desire for earliest intervention on the part of Dynatec in HIV/AIDS programming. (Morarano, Moramanga, Andasibe, Ambohibary).
- Physical security: There was concern that with the introduction of out-of-area workers and the arrival of migrants there will be an increase in crime. (Moramanga).
- Resettlement of tombs: It is expected that even where requirements for property do not require resettlement of individuals, tombs may be affected. There was concern that the movement of tombs be compensated and conducted in culturally appropriate ways. (Morarano, Ambatovy workforce, Moramanga, Ampasimpotsy, Andasibe, Ambohibary).
- Behaviour of expatriate staff: There were observations related to the hope that non Malagasy employees of the project would, in their interactions with local people, acknowledge traditions and culture, and demonstrate respect. (Moramanga, Ambohibary).
- Communication: There was demand across the area for more, continuously updated, information on the project. There was also in Morarano a desire to better understand what it was reasonable to expect

from the proponent in terms of mitigation and benefit enhancement without prejudicing the potential for the project to proceed. The Ambatovy workforce wanted to understand the EA process better, wondering that if there were negative impacts identified would the project not proceed, or would the proponent be able to resolve negative impacts satisfactorily. The Ambatovy workforce was also concerned that their participation in consultations should be treated discretely. In Moramanga, the need for another EA was questioned, and there was interest in seeing the EA terms of reference. In Ambohibary there was concern to better understand the role of national government representatives relative to the proponent and the project.

6.4.4.2 Pipeline

The project includes an approximately 195 km pipeline from the mine site to the coast, with an assessed route traversing settlements in the communes of Ambatovola, Andasibe, Andekaleka, Lohariandava, Fanasana, Razanaka, Fetraomby, Vohitranivona, Ambalarondra, Ambinaninony, and Ampasimadinika. The route through the Mantadia-Zahamena Corridor was selected, in consultation with government representatives and environmental NGOs, to minimize potential effect on primary forests. The construction of the pipeline will cause disturbance to some of the people who are presently living on or otherwise using the route. Consultations were held in over 70 settlements along the pipeline route, and route alternatives, as part of broader socioeconomic baseline studies. However, since these main issues have been extracted from the baseline reports, they are not attributable to individual communities. Many of the same main issues were raised in many villages.

Physical

- Air quality: There were questions about carbon balance and any possibilities of a carbon sequestration project. In other words a request for re-forestation along the pipeline route in the Mantadia-Zahamena Corridor, to help off-set forest loss at the mine site. (NGO present at community meeting).
- Water quantity: There was concern that water supply would be affected by the construction of the slurry pipeline.
- Water quantity: There was concern that water extraction used to make the slurry would result in less water availability for local people and less water in the Torotorofotsy.
- Soil erosion: There was concern that pipeline construction, particularly at river crossings, would result in soil erosion that would negatively affect lands, water resources and fish populations that people depend upon.

Biophysical

- Depletion of Forest Resources: There was concern that proposed tree planting and forest restoration projects after the pipeline is buried, be adequately studied and that reclamation meets stated conservation goals. Given the biological importance of residual primary forests and the key role of the Mantadia-Zahamena forest corridor in particular, there was concern that primary forest not be affected. (NGO present at community meeting).
- Wetlands and Watershed: There was concern that the watershed of the Torotorofotsy be evaluated with a view to protecting the marsh system and developing a management plan.
- Biodiversity and habitat: There was concern about loss of biodiversity, as routing will pass through the Torotorofotsy and construction could result in the destruction of primary forest. The private reserve of Vohimana is of concern as is the Mantadia-Zahamena forest corridor, both areas of focused conservation efforts. There was concern that construction would disturb remnants of littoral coastal forest, if the route via Brickaville was chosen.
- Ecological Concerns: Given that ecological conditions of certain portions of the Torotorofotsy Wetlands system along the dis-used railway are already poor, there was concern that pipeline construction and any associated road development would provide opportunity for an invasion of undesirable plants.

Social

- Livelihoods: Residents were concerned about measures to be put in place for any required resettlement of houses and/or community infrastructure and to be properly compensated for any damages and losses of crops and livestock. Not only land owners, but also sharecroppers on others' land need to be adequately compensated. It was also noted that compensation should be negotiated and paid before any removal of houses or effects on crop and livestock. People are not sure of their rights, increasing such concerns.
- Employment: There is concern that the proponent make every effort to employ young people and that recruitment strategies target specific geographical areas.
- Physical Security: For pipeline sections that remain above ground, the issues of vandalism and damage to the pipeline was of concern along with the suggestion that the pipeline be guarded by security personnel. It is expected that any repairs to the pipeline or compensation for resulting damage, due to, for example, mud flows after a break would be the responsibility of the project.

- Movement of People and Cattle: People were concerned that the pipeline be buried because any parts of the route that are along the main rail line are currently used as a path for children to travel to and from school and as a path for men and women to carry water and other goods such as bananas. There was also concern that there be no disruption of their movements or of movement of their cattle during the construction phase all along the route.
- Displacement of Tombs: There was concern that a process be defined as to the displacement and/or replacement of tombs and that replacement tombs are made available before destroying the existing tomb.
- Health and Safety: There was concern that construction activities could result in the introduction of new diseases or exacerbate existing ones such as malaria. There was also concern about the potential for the pipeline to break or explode and the risk people might experience if living near the pipeline.
- Communication: People noted that they will need adequate notice of pipeline installation and would like to have more information on any required displacement of houses, access roads and rights-of-way (RoWs).
- Economic Infrastructure: There was concern that the creation of a road along the pipeline route could open up traffic to outsiders and the subsequent exploitation of land and forest. There is also, however, general interest in having a new road, as this will create access to markets for agricultural products and to social services for many remote populations. There was also concern that ecotourism activities will be affected by the pipeline.
- Forest Use: There was concern that different stakeholders hold different values with regard to the use and management of forest resources, and that the needs of local people, who may not share the values expressed by environmental NGOs, also be considered in decisions regarding the building of the pipeline.
- Land Tenure: There was concern that land tenure, which is often held without formal titles, will become an obstacle to fair treatment of people whose lands may be affected by construction of the pipeline.
- Logging/Woodcutting: There was concern that the local wood cutting and logging industry will not be permitted near the pipeline route—particularly during the construction period—thus affecting the incomes of many households.
- EA Processes: There was concern that costs and benefits be identified from social, environmental and economic perspectives and in the long term.

- Tavy: There was concern, expressed by many, that tavy plots will be permanently lost, without compensation or relocation.
- Pipeline Routing: People have asked that routing alternatives be explored to protect primary forest. There is concern to know how the selection of the final route is made and if there are parts of the route that will require additional structure for the pipe, so that the RoW can be reforested.
- Behavior of Expatriate Staff: There was concern among the local people that because expatriate staff are unaware of local beliefs and customs, their behavior will bring harm to villagers.

6.4.4.3 Tailings Facility

The construction of the tailings facility and nearby plant on lands belonging to both the Toamasina II and Fanandrana communes will require the resettlement of households in fokontany of Antanadava and Antanambo over a phased 10-year period. Surrounding communities will have potential to be affected by the resettlement of their neighbours and will experience a range of other effects such as increased traffic, migration and employment. Issues are summarized from all local consultations in the Toamasina area as follows for the tailings facility:

Physical

- Water Quality: There was concern the tailings may contain heavy metals and that the water in the tailings ponds will be affected and then seep into the groundwater. There is also concern that in extreme weather events, tailings pond water will overflow and reach the sea without being treated.

Biophysical

- Marine Habitat: There was concern about harm to the reefs off Toamasina from tailings.
- Biodiversity and Natural Habitats: There was concern that biological resources will be permanently lost to the tailings pond.
- Ecological and Human Health: There was concern that the tailings will affect drinking water, rice plantations, flora and fauna.

Social

- Resettlement: There has been significant concern about resettlement generally. People in the resettlement area do not believe that resettlement funds will cover the costs of moving. There are also concerns that resettlement forces people to move from ancestral lands

which hold deep significance and meaning to local populations. There is concern that those without clear land titles will not be adequately resettled. Questions have been raised as to how sharecroppers and agricultural workers will be compensated in addition to actual land owners. In particular, people have wanted to know if agricultural workers and sharecroppers or rent payers will be compensated based on how long they have worked the land, as many have for years, or by what criteria.

- Employment: There was concern to see the project generate long-term employment. People would like to know the types of jobs that the project will create and the training and qualifications required.
- Livelihood Strategies: Concerns were raised about loss of livelihoods due to loss of agricultural land or impacts on agriculture from tailings. Others are concerned to find economic opportunities such as using the tailings for other mineral extraction, for fertilizer or for construction material.
- Land Tenure: There was some suggestion that land be rehabilitated and returned to the original owners after 27 years, when the tailings facility is closed.
- Social Conflict: There is great anxiety around dividing the population because of the perception, for example, that only land owners with large parcels of land have been informed about the project. Questions have arisen as to what happens if land owners refuse to co-operate and/or refuse to be relocated elsewhere. People are concerned to know what dispute resolution mechanisms will be put into place.
- Public Health and Safety: There has been concern about the spread of HIV/AIDS and of the safety and health and welfare of young people, generally, as people are concerned about the behavior of the construction workforce and the proponent's ability to enforce a strict code of conduct.
- Water Quality: There was concern that water quality will be affected around the tailings facility and this in turn may affect livestock breeding, crops and drinking water.
- Worker Accommodation: There was concern that if accommodation facilities for workers are for "singles" only, family members may not be able to visit or stay overnight.
- Economic Impacts: There was concern that land prices will rise.
- Social Change: There was grave concern expressed about giving up land that ensures subsistence for current and future generations. The population has few economic resources and land is their most valuable inter-generational asset.

- Resettlement of tombs: There was concern that the movement of tombs be compensated and conducted in culturally appropriate ways.

6.4.4.4 Plant and Port

Toamasina will experience many economic and employment impacts, related to the construction of the processing facility and the port expansion. The project will provide a significant boost to the economies of Toamasina I and II, out of which fall migration, public health and security, social change and other potential effects. Issues raised during the consultations are summarized below:

Physical

- Ecological and Human Health: There was concern as to what effect cyclones may have on the plant and port sites and whether or not project design has taken into account such potential catastrophic events in order to prevent damages to ecological and human health.
- Erosion: There are concerns about the potential for erosion on the coast, particularly North Beach, if the port extension affects coastal currents.
- International Agreements: There is concern to see that the International Atmospheric and Marine Conventions to which Madagascar is a signatory are strictly held to.
- Air Quality: There were concerns raised about carbon emissions, noxious gases and greenhouse gases and how these will be addressed in the EA.
- Water Quality: There were concerns as to whether water quality will be affected and methods of treatment. There is concern that a good groundwater monitoring system be put in place.

Social

- Business Opportunities: There was concern to see cooperation between the proponent and public works companies and to maximize opportunities to create jobs. There is great interest in indirect economic effects such as employment created from supplying the plant with needed goods and services as well as services to migrants.
- Human Health and Safety: There was concern to have emergency measures in place due to the risk of industrial accidents at the plant and port. There was concern about safety should a conveyor belt be built to transport product between the port and plant.
- Employment: There was concern to have fair recruiting practices and that the proponent recruit locally. There is concern to provide job training so that jobs do not exclusively go to experienced workers.

There was also some concern in that the propoent will negatively affect the labour market for other employers, hiring away their experienced workers.

- Migration: There was concern about migration to the area of the plant site, and the development of a "worker based" city, with consequent public health and safety effects.
- Cultural Change: There was concern that particularly during the construction stage, which would see a large contingent of expatriate workers, most of whom would be single, that there would be large potential for the introduction of cultural change. The values and traditions of local people would be affected.
- Distribution of Royalties: There was acknowledgement that royalty distribution was a function of the local ore body, rather than the processing plant. Concerns have been raised as to how the Toamasina area will benefit and whether resources will be made available to implement development plans.

6.5 CONSULTATIONS ON MITIGATION STRATEGIES

Consultation to discuss project mitigation strategies took place during September 2005.

6.5.1 Technical Evaluation Committee (CTE) Workshops

6.5.1.1 Introduction

The goal for the September 14th to 16th CTE-sponsored workshops held in Toamasina, was to consult on the results of impact analyses. As agreed with the CTE, three main themes were addressed: water, biodiversity and socioeconomics. Four main specific objectives were suggested by the EA team for the meeting:

- to examine if the mitigations proposed cover all issues identified from both public consultation and from the professional experience of the EA team;
- to consider whether the proposed mitigations could actually be implemented, in terms of practicability and logistics within Madagascar;
- assuming the mitigations could be implemented, would they be effective in addressing the issue to which they are directed; and
- to verify that proposed monitoring during construction and operations is adequate to meet required objectives.

The workshops provided an opportunity for the CTE and other attendees to provide feedback and recommendations that could be included in the EA as it underwent final preparation. The workshops also allowed all participants to be better briefed on key aspects of the EA, to aid review after submission. To help these meetings, a briefing binder was supplied in advance of the meeting, as requested by the CTE. Those briefing documents were mainly draft sections of the final EA, in the areas of water, biodiversity and socioeconomics.

The meetings were split into three main sections: a half-day introduction; two half-days for the three working groups; a final two half-days of plenary for reporting back. The first morning was an introductory plenary session. This was chaired by the CTE / ONE. It included an introduction by ONE on the objectives for the meeting, plus a critique of the briefing package provided. This critique recognized that the briefing package comprised parts of the EA, in draft form, and that additional items of interest would be provided in the complete EA. The proponent then provided a project update, after which the following overall guidance was provided, on how the three working groups (water, biodiversity, socioeconomics) should function. Each of the three working groups would progress through the following stages:

- Introductions by participants and statements of their interests in the Ambatovy Project.
- A presentation from the EA team, emphasizing main issues identified and proposed mitigations.
- Election of a chairman to run the working group, a minute taker and a *rapporteur* to supply a report at the final plenary. In all cases, as suggested, the chairman and *rapporteur* for each group were from participants other than the EA team.
- Agreement as to how the working group would decide priorities (issues, sites, etc.) to work on.
- Agreement as to what the products would be from the working group. These could include:
  - consensus on key issues;
  - consensus as to an evaluation as to the effectiveness of proposed mitigations and monitoring;
  - a list of questions to pose to the other two working groups;
  - miscellaneous recommendations; and
  - a list of any areas where consensus could not be reached.

Over sixty attendees took part in addition to the EA and promoter team. These included the CTE members, ONE representatives, technical representatives from government and NGOs, plus administrators and political representatives from a large range of local and regional administrative structures. There was a high level of participation by all working group attendees. Written reports were tabled in the final plenary from all three groups and presentations and discussions held on those reports.

6.5.1.2 Results

What follows is a summary of the workshop reports, which are provided in Volume H, Appendix 5. Also, each group listed questions for the other two groups, which were discussed, including at plenary. Minutes from the plenary sessions were taken and additional issues and responses added to the EA issues data base. The results of the working groups, plus the additional comments in plenary, have been taken into account in the final preparation of the EA.

Working Group 1 – Water

The results of the water working group focused on the mine site and the tailings facility, where most key water issues were believed to lie. Results emphasized topics which would require more in-depth treatment in the EA.

Mine Site

- The project description should clearly show how surface water flow to the Torotorofotsy will be regulated to mimic natural seasonal flows at baseline. The same level of detail is needed for other basins as well, plus full details of how water quality limits will be met, especially total suspended solids (TSS). The same level of explanation should cover closure planning.
- Consider obtaining details about downstream users of Mangoro water and whether monitoring should occur during operations to check on lack of differences to baseline flows that could be attributed to the project.

Tailings Facility

- The project alternatives section should clarify design decisions made with respect to water quantity and quality effects, including use or not of liners and underground drains.
- Good coverage is needed of predicted marine effects, including TSS and other water quality parameters, taking into account local currents.

- Good explanation is needed of mitigation to minimize risk to people, including human health effects from contaminants of concern like manganese.
- Clarification of compensatory process and measures should there be a conflict in water use, owing to a reduction in flow down stream from the tailings facility.

Working Group 2 – Biodiversity

The results of the biodiversity working group session were summarized by the group in a matrix. The matrix listed 48 issues brought up through discussions, which were first ranked as to importance (high, medium or low). For those 19 issues deemed of high importance, proposed mitigation was listed and ranked in terms of how well it addressed the issue and whether it was believed feasible to implement or not.

No proposed mitigations were found to be inappropriate for the issue they addressed and none was found to be infeasible to implement. However, several mitigations were marked for careful consideration, as they were only considered moderately appropriate and / or moderately feasible to implement; these are mentioned below:

- Minimizing off-site effects on the vegetation in the Torotorfotsy Wetlands is dependent on success of the mine site water management plan. This plan should address the possibility of two cyclones occurring in swift succession. Likewise extra checks will be needed on the pipeline through the Torotorfotsy, to ensure no leaks. Biological monitoring is also needed in the Torotorfotsy, to improve the understanding of the wetlands. These studies should be integrated with the Ramsar management initiative.
- Additional flora taxonomic work should proceed, to identify any species for which targeted conservation action is required before construction. This should take place both on-site and in potential off-site azonal vegetation conservation areas.
- The on-site azonal conservation areas will need monitoring during construction and operations to ensure they are effective, being so close to the mine.
- Reclamation success will rely on successful propagation and use of endemic species. This aspect requires ongoing research. Reclamation success will also be dependent on successful buffer zone management, that must be a priority.

Working Group 3 – Social

The social working group split their time by two sub-themes: socioeconomics and culture, then re-settlement. Emphasis was placed on identifying key issues and / or key mitigations that should be adopted.

- Education and training planning is very important, so that main project benefits can be realised by Malagasy people. This planning must be based on a clear understanding of current capabilities and current demographics.
- A second main issue concerns potential negative effects that could occur from immigration of various types of people to project areas. Direct and indirect impacts across a range of socioeconomic, cultural and health areas must be well analyzed within the EA, with suggested types of mitigation.
- International best practice must be followed regarding resettlement planning. There was concern over the effectiveness of consultation with potentially affected people. A need was also perceived to better clarify the relative responsibilities of different stakeholders, including the proponent, national government, local government and civil society.

6.5.2 Biodiversity

Over 25 attendees took part in a meeting in Antananarivo on September 22, 2005, to consult on the efficacy of proposed mitigation with respect to biodiversity, especially at the mine site. Attendees were from NGOs and government departments. Minutes are provided in Volume H, Appendix 5. There was general support for the level of baseline studies that had been undertaken to date and endorsement that additional flora taxonomic work in conjunction with Missouri Botanical Gardens (MBG) should continue both pre- and post-construction. There was also general support for the range of on-site mitigations planned to minimize biodiversity impacts at both the habitat and species level. There was also support for the four types of proposed off-site compensatory mitigation that was being proposed:

- buffer zone forest management;
- support for the Ramsar management in Torotorofotsy;
- forest restoration along the pipeline route in the Mantadia – Zahamena corridor; and
- establishment of an off-site azonal forest conservation area.

However, it was suggested that all these off-site mitigations are directly linked to the success of mitigation of direct project impacts on biodiversity. For example, buffer zone management is required to help assure the viability of the on-site azonal protection areas and assist with on-site reclamation. Likewise the off-site azonal conservation area is required as a back-up to ensure successful conservation of rare azonal habitat and associated species. The group challenged the project proponent to also support biodiversity off-sets, not related to project impacts, to a value of at least three times the amount of biodiversity being lost as residual impacts from the project. It was noted that QMM had perhaps set a bar with such a level of net biodiversity enhancement for their project.

6.5.3 Torotorofotsy

The same attendees referred to above, plus additional representatives from social NGOs, took part in a meeting in Antananarivo on September 23, 2005, to consult on the efficacy of proposed mitigation with respect to the Torotorfotsy Wetlands. Minutes are provided in Volume H, Appendix 5. This meeting was a follow-up from a similar one in March 2005, where project details were disclosed and issues discussed. The consultation emphasized two main areas in need of additional attention:

- The first main area was the issue of predicted sediment loadings in water to flow into the Torotorofotsy during construction and operations. There should be a good analysis of alternatives in the EA, showing the advantages of a 1-in-10 year storm design for the water reservoirs. There is a need to complete additional work on predicted TSS loads in extreme storm events greater than 1-in-10 years, plus additional baseline recording of current TSS during cyclones. After that work is done, there should be a re-analysis of alternatives for reservoir sizing, to see if the 1-in-10 year design is still most advantageous when all engineering, risk, cost, social and environmental factors are compared. If, as is likely, this could not be finished in time to go in the EA, it should be undertaken and reviewed before construction.
- The Ambatovy Project and its surrounding forest buffer zone management area overlaps with several regional planning initiatives, such as the Ramsar site, regional land use planning (Gelose) and regional water management and irrigation initiatives. The project proponents need to be well linked and integrated with such initiatives, especially as regards regional water management for both ecological and social requirements. The project proponents should be linking at the community level in this regard, as well as at the management level.

6.6 FUTURE AND ONGOING CONSULTATIONS

What has been described in the previous sections are consultations undertaken to date to disclose project details, including of alternatives, to scope issues, and recently to discuss the results of impact analyses and the efficacy of proposed mitigations. The EA stage of the consultation process effectively ends with public review meetings led by the CTE, following submission of the EA. Those meetings will be organized by government in co-operation with the project.

However, the project proponents will work in close collaboration with governments, affected people and NGOs, as well as other interested parties to identify concerns, minimize impacts and enhance benefits over the life of the project. Indeed many main areas of proposed mitigation require close collaboration with existing regional management structures, for example for buffer zone management around the mine and for many of the social mitigations such as those for training and health. Proponent community liaison staff will continue to work beyond the EA, into project construction and operations. In general, future consultation is required as follows:

- the proponents will involve stakeholders in the implementation of impact mitigation and benefit enhancement measures across a broad range of mitigation initiatives;
- with regards to resettlement specifically, there will be regular meetings between the resettlement team and affected people, both as communities and as affected individual households, to plan and implement resettlement; and
- the project proponents will put in place a formal grievance mechanism, to ensure recourse if stakeholders have issues they feel have not been adequately addressed.

7 ENVIRONMENTAL ASSESSMENT METHODS AND STUDY AREAS

The Environmental Assessment (EA) has been prepared in accordance with the Terms of Reference (ToR) for the Ambatovy Project (the project) (Volume H, Appendix 1). The ToR requires the EA to:

- identify the environmental and socioeconomic resources potentially affected by the project;
- predict positive and negative effects and the extent to which positive effects can be enhanced and negative effects can be mitigated;
- quantify and assess the significance of effects where possible; and
- identify means to monitor the resources that may be affected by the project.

This section of the EA:

- provides an overview of the EA methods;
- describes the use of linkage diagrams;
- presents the spatial and temporal boundaries for the EA;
- discusses the impact assessment methods to be used;
- discusses how effects will be described; and
- presents the assessment cases.

7.1 OVERVIEW OF ENVIRONMENTAL ASSESSMENT METHODS

The impact assessment complies with Madagascar regulations and guidelines, and best international practices and includes both environmental and social assessments (Volume A, Section 5). The EA will use the following tools and procedures to analyze and address potential effects:

- quantitative and qualitative information on the existing environmental and socioeconomic conditions;
- predictive tools (models) and methods to quantitatively and qualitatively describe future environmental and socioeconomic conditions;

- quantitative and qualitative evaluation of the significance of potential effects, including reference to management objectives, baseline conditions and the views of the proponent and stakeholders; and
- characterization of potential residual effects and their consequences for the environment.

Key to the mitigation strategy is the environmental and social design of the project. The Dynatec engineering design team worked with the environmental and social scientists during project planning to develop solutions to potential environmental and social impacts. Mitigation techniques were thus developed early in the design process to address potential effects to physical, biological and social components. Many examples are included in analysis of alternative sections, such as pipeline route alternative analyses (Volume C, Section 1). Other examples occurred in many discipline areas, such as the feeding back of initial plant air emissions results to the design team, with the result being improved emissions technology and lower emissions.

7.1.1 Key Questions

One of the main purposes of an EA is to provide answers to questions that people have about how a project could affect something that matters to them. To focus the assessment and ensure that the EA clearly addresses the issues of concern, questions have been formulated that capture the concerns relative to a particular issue. In this report, those concerns are expressed as "key questions", and they form the basis of the investigations of potential project impacts. The process for developing a list of key questions involves the development of a list of all possible issues related to a project by means of consultation (Volume A, Section 6) and the experience of the assessment team. These issues are then refined into those that are relevant to the project. All issues are addressed, and the appropriate mitigations developed.

An example of a key question is:

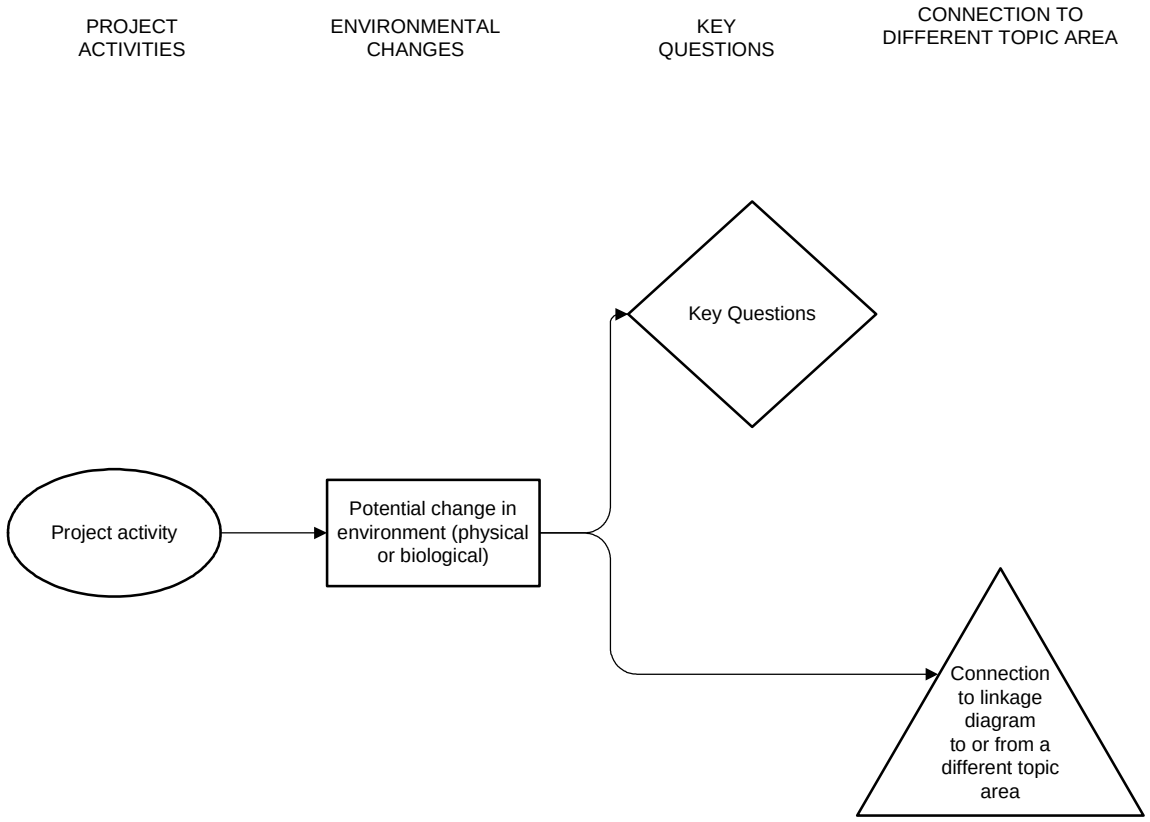
Air quality key question What Effect Will Dust Emissions From the Mine Have on Ambient Air Quality?

Key questions for the EA are provided for each project component in Volumes B to F.

7.1.2 Linkage Diagrams

To show how the answers to the key questions are derived, technical specialists illustrated their analytic process by developing a "linkage diagram". Each linkage diagram depicts the relationships between the project, the information collected during the baseline program and the issues raised during consultation. The linkage diagram also shows connections to other key questions or topics. Figure 7.1-1 illustrates the typical format of a linkage diagram. The linkage diagram assists specialists in their work and enables readers to understand what has (and has not) been included in the impact analysis.

Figure 7.1-1 Example of a Linkage Diagram



Preparation of linkage diagrams requires the following key elements:

- identify project components that may affect an environmental resource (illustrated by an oval);
- predict the environmental changes that may result from the project (illustrated by a rectangle);

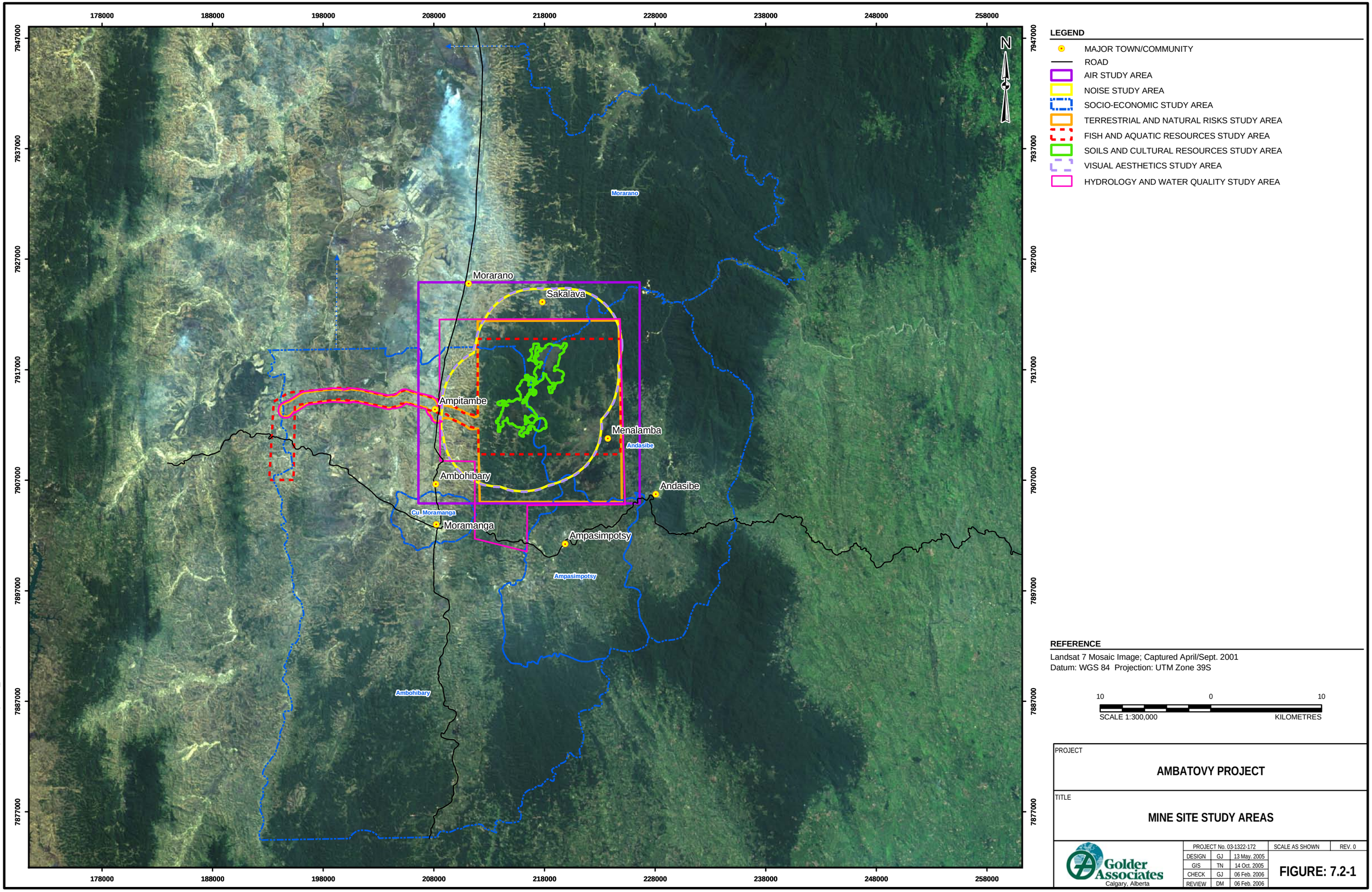
- clearly identify the issue that is being investigated. This is the purpose of the key question, which is identified by a diamond icon in the linkage diagram; and
- identify other components of the environment, and thus the EA analysis, that are inter-related. A triangle indicates information that either is provided from the analysis of a different key question, or is used in the analysis of another key question.

By defining the possible impact pathways between project activities and environmental changes, a determination is made as to the relevant impacts to be assessed. In cases where changes due to the project do not affect specific environmental characteristics being assessed, this is clearly stated and further analysis is not done.

7.2 STUDY AREAS

Defining the geographic extent of study areas is a key element of EA. For the assessment of local impacts, the area should be large enough to efficiently analyze and mitigate the obvious potential effects from the project on the receiving environment, but not too large as to dilute or confound the potential project-related effects with other human-induced and natural influences. Typically, the assessment of impacts within the local area of the project, or Local Study Area (LSA), is based on the spatial extent of the footprint and an associated buffer that includes potential immediate indirect effects on the receiving environment. Alternately, the assessment of potential broader or regional cumulative effects from the project in association with other anthropogenic activities and natural factors requires a larger geographic area, and may be based on ecological and/or land use and planning criteria. Study areas may also be specific to environmental components (e.g., air, soils, geology, ground water, surface water, aquatic organisms, flora, fauna) and individual components of the project such as the mine site, slurry pipeline, tailings, process plant facilities and port facilities.

Study areas were selected for each discipline based upon the anticipated areas of influence of the project. They are provided in Figures 7.2-1 (mine site), 7.2-2 (pipeline) and 7.2-3 (plant site, tailings facility and port).



LEGEND

- MAJOR TOWN/COMMUNITY
- ROAD
- AIR STUDY AREA
- NOISE STUDY AREA
- SOCIO-ECONOMIC STUDY AREA
- TERRESTRIAL AND NATURAL RISKS STUDY AREA
- FISH AND AQUATIC RESOURCES STUDY AREA
- SOILS AND CULTURAL RESOURCES STUDY AREA
- VISUAL AESTHETICS STUDY AREA
- HYDROLOGY AND WATER QUALITY STUDY AREA

REFERENCE

Landsat 7 Mosaic Image; Captured April/Sept. 2001
Datum: WGS 84 Projection: UTM Zone 39S

10 0 10
SCALE 1:300,000 KILOMETRES

PROJECT

AMBATOVY PROJECT

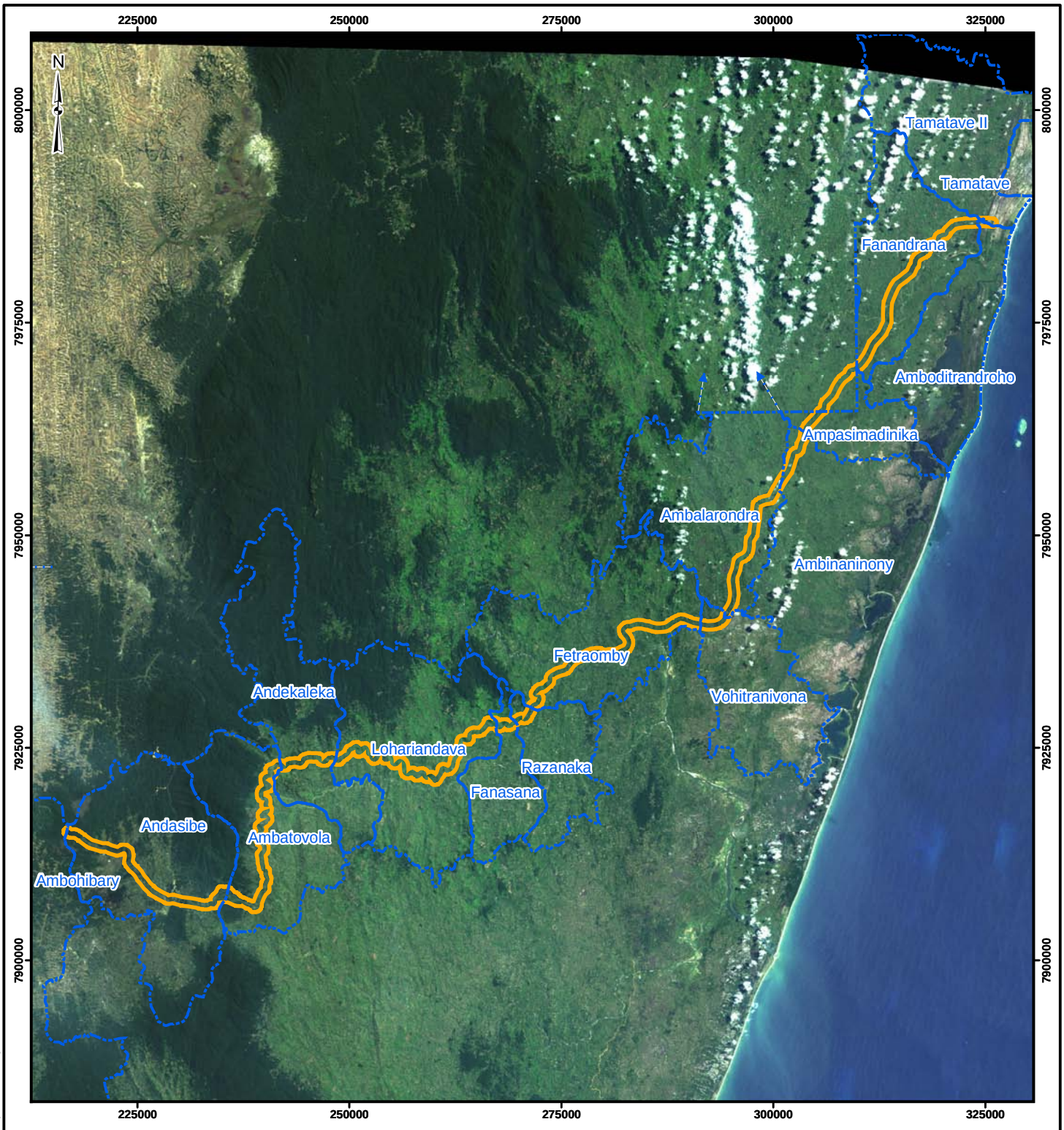
TITLE

MINE SITE STUDY AREAS

Golder Associates
Calgary, Alberta

PROJECT No. 03-1322-172			SCALE AS SHOWN	REV. 0
DESIGN	GJ	13 May. 2005	**FIGURE: 7.2-1**	
GIS	TN	14 Oct. 2005		
CHECK	GJ	06 Feb. 2006		
REVIEW	DM	06 Feb. 2006		

i:/2003/03-1322/03-1322-172/mxd/StudyAreas/Fig7.2-1_MineStudyArea.mxd



15 0 15

SCALE 1:650,000 KILOMETRES

LEGEND

- SOCIO-ECONOMIC STUDY AREA
- GENERAL STUDY AREA

REFERENCE

Landsat 7 Mosaic Image; Captured April/Sept. 2001
Datum: WGS 84 Projection: UTM Zone 39S

PROJECT

AMBATOVY PROJECT

TITLE

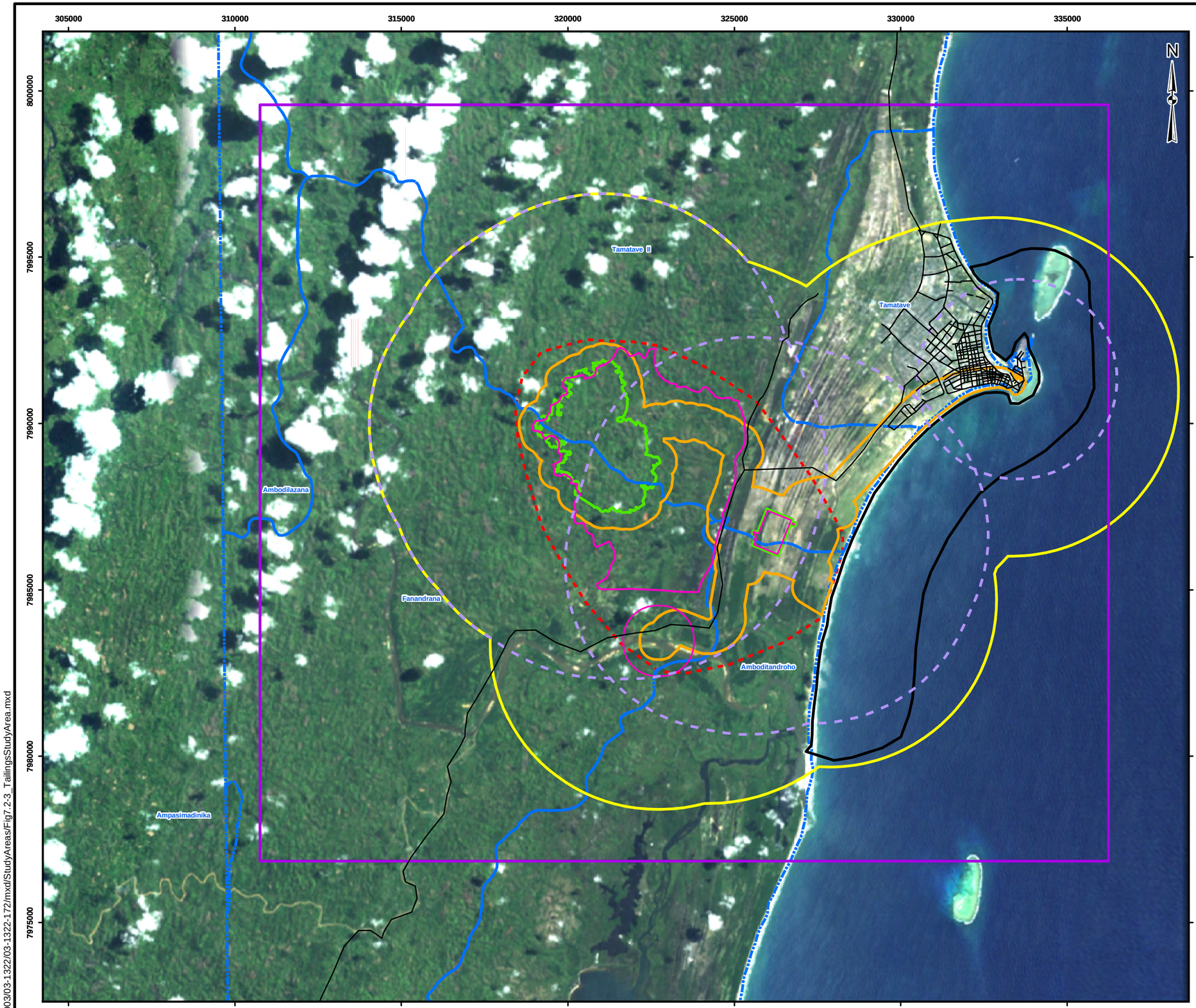
SLURRY PIPELINE STUDY AREAS

Golder Associates
Calgary, Alberta

PROJECT No. 03-1322-172		SCALE AS SHOWN	REV. 0
DESIGN	GJ	13 May. 2005	
GIS	TN	14 Oct. 2005	
CHECK	GJ	06 Feb. 2006	
REVIEW	DM	06 Feb. 2006	

FIGURE: 7.2-2

i:/2003/03-1322/03-1322-172/mxd/StudyAreas/Fig7.2-2_PipelineStudyArea.mxd



LEGEND

- ROAD
- AIR STUDY AREA
- NOISE STUDY AREA
- SOCIO-ECONOMIC STUDY AREA
- TERRESTRIAL AND NATURAL RISKS STUDY AREA
- FISH AND AQUATIC RESOURCES STUDY AREA
- SOILS AND CULTURAL RESOURCES STUDY AREAS
- MARINE BIOLOGY STUDY AREA
- VISUAL AESTHETICS STUDY AREAS
- HYDROLOGY AND WATER QUALITY STUDY AREAS

REFERENCE

Landsat 7 Mosaic Image; Captured April/Sept. 2001
Datum: WGS 84 Projection: UTM Zone 39S

3 0 3
SCALE 1:115,000 KILOMETRES

PROJECT

AMBATOVY PROJECT

TITLE

TOAMASINA AREA STUDY AREAS

Golder Associates
Calgary, Alberta

PROJECT No. 03-1322-172			SCALE AS SHOWN	REV. 0
DESIGN	GJ	13 May. 2005		
GIS	TN	14 Oct. 2005		
CHECK	GJ	06 Feb. 2006		
REVIEW	DM	06 Feb. 2006		

FIGURE: 7.2-3

i:/2003/03-1322/03-1322-172/mxd/StudyAreas/Fig7.2-3_TailingsStudyArea.mxd

7.2.1 Air

The air quality study area for each project component was selected based on the following criteria:

- it must encompass the entire project component and all the emission sources associated with that component (e.g., mine footprint and ore processing facility);
- it must encompass any sensitive receptors near the site which may be influenced by air emissions such as individual homes and communities; and
- it must encompass a certain percentage of predicted air concentrations resulting from project component emissions. This ensures that all areas potentially affected are included.

For coastal components that are near each other, the study area was adjusted to include all components (process plant, port and tailings facility at Toamasina).

7.2.2 Noise

The noise study area for each project site was selected based on the extent of project activities, the expected sound level emissions and locations of sensitive receptors. In general, they cover an area that extends at least 5 km from the limits of project activity. A single study area was delineated to cover plant site, tailings facility and port.

7.2.3 Visual Aesthetics

The visual aesthetics study areas are based upon the viewshed of each project component. In other words, the area from where the current landscape or the future landscape plus project facilities (e.g., plant stacks) can be seen. Because of the effect of distance on diminishing impacts of visual changes, the visual aesthetics study area is also limited to the region within 5 km of each project component.

7.2.4 Groundwater

The groundwater study areas were defined based on the extent of the potentially affected aquifers, determined through field studies and modelling. These more complex areas are not illustrated in the figures of this section, but are described in Volume I, Appendix 7.1.

7.2.5 Hydrology, Water Quality and Aquatic Resources

Mine

The aquatic study area (Figure 7.2-1) for the mine is based on surface water features potentially directly affected by the mine and ancillary activities. This includes the rivers, streams, ephemeral ponds, springs and wetlands within the drainages directly affected (i.e., footprint of the mine and ancillary activities) or indirectly affected (i.e., change in downstream flow and water quality). The boundaries generally identify the limit of definable impact. The study area also includes the water bodies within the water pipeline corridor (within and immediately downstream of the pipeline right-of-way) from the Mangoro River and the general area of the water intake structure on the Mangoro River.

As the ore bodies lie generally on a high plateau and a drainage divide, the headwaters of several basins originate within the ore body area. An internationally recognized Ramsar wetlands system, the Torotorofotsy Wetlands, is located immediately downstream of the mine site, and is included in the study area (Figure 7.2-1).

Slurry Pipeline

The aquatic study area for the slurry pipeline includes the waterbodies:

- within the pipeline corridor and crossed by the pipeline; or
- potentially influenced downstream by operation and maintenance of the system.

Most studies focus on the general study area illustrated in Figure 7.2-2, but additional regional areas are described in appropriate discipline sections.

Tailings and Plant

The aquatics study area for the tailings facility and process plant includes (Figure 7.2-3):

- the drainages and water bodies affected by the footprint of the tailings pond, pipelines or process plant;
- the downstream portions of the drainages which could potentially be affected by changes in water quality or volume; and
- drainages and water bodies which may be affected by air emissions from the processing plant and/or associated power plant.

The plant site does not overlap any watercourses; however, ancillary facilities may affect some local tidally influenced ditches, canals and wetlands.

The tailings facility overlaps several drainages. Water bodies located near the tailings area include several small rivers and streams, ponds and wetlands.

7.2.6 Soils

The soils LSAs for each project component are defined as the disturbance footprints. These LSAs cover the areas where soils are being affected by the project.

7.2.7 Terrestrial Biology

Mine

The LSA is designed to capture the direct effects of the physical footprint of the mine on terrestrial resources, and the immediate indirect effects of mining activities (fugitive dust, changes in surface water flow or disturbance of wildlife) on flora, fauna, biodiversity and natural habitats. Thus, the study area is large enough to predict the potential effects of the mine on the vegetation and the home ranges of animals living within or adjacent to the mine area.

The LSA includes the rivers, streams, ephemeral ponds, springs and wetlands within the drainages directly affected or indirectly affected by the mine to capture effects on taxa, including herpetofauna and birds, associated with wetter areas. This includes the Torotorofotsy Wetlands, and the water bodies within the water pipeline corridor (within and immediately downstream of the pipeline right-of-way) from the Mangoro River and the general area of the water intake structure on the Mangoro River. Any direct or indirect effects on flora, fauna and biodiversity would also be captured within this study area. The aquatics study area was modified in light of the above criteria to derive the terrestrial biology study area (Figure 7.2-1).

Slurry Pipeline

The LSA for the slurry pipeline includes the footprint and a 1,000 m buffer on each side of the right-of-way (Figure 7.2-2). Any potential impacts from construction and operation of the pipeline on flora, fauna, biodiversity and natural habitats would be identified within this corridor. Special attention was given to crossings of water bodies where potential downstream impacts may be a concern. Any direct or indirect effects on flora, fauna and biodiversity within

upland or riparian/wetlands (i.e., adjacent to watercourses) would be captured within this study area.

Process Plant and Tailings Facility

Because the process plant and tailings facility are near each other, these two components of the project were contained within one LSA. The LSA for these two facilities includes the drainages and water bodies potentially affected by the footprint of the tailings pond, pipelines and process plant, plus the access between the plant site and the port, all with a 500 m buffer. Other elements that were considered in determining the spatial extent of the LSA for these facilities include downstream portions of the drainages, which could potentially be affected by changes in water quality or volume, or by air emissions from the process plant and/or associated power plant. Any direct or indirect effects on flora, fauna and biodiversity within upland or riparian/wetlands (i.e., adjacent to watercourses) would be captured within this study area.

7.2.8 Marine Biology and Oceanography

The marine biology and oceanography local study area comprises the near-shore area from the port at Toamasina, to the proposed tailings effluent outfall south of Toamasina.

7.2.9 Social

The cultural property (archaeology and cultural sites) study area is the footprint of the project and its associated facilities plus a buffer. Socioeconomic study areas will include consideration of potential effects at the national, regional and local levels. The LSAs for socioeconomics are described below.

Mine

The mine site is located in Moramanga District, about 10 km north of the town of Moramanga. The socioeconomic study area for the mine area is thus the town of Moramanga and the rural communes that surround the ore bodies.

Slurry Pipeline

The socioeconomic LSA for the slurry pipeline is the pipeline route plus a 1,000 m buffer on either side to allow for modifications during route planning (Figure 7.2-2). A regional study area includes all communes crossed by the right-of-way (Figure 7.2-2).

Plant, Tailings and Port Facilities

The socioeconomic study area includes the footprints of the facilities including potentially affected communities such as Toamasina. Study areas for resettlement have been determined based on the project footprint. However the complete socioeconomic study area is broader, to also assess the impacts of the tailings area on surrounding populations who will not need to be resettled.

7.3 TEMPORAL SCOPE

The temporal scope of the EA is defined primarily by the anticipated project duration, which is as follows:

- Construction – 3 years;
- Operation – 27 years; and
- Closure – 30 years and beyond.

The main project phases include construction, operations, and closure (Volume A, Sections 3 and 4). Some effects are limited to the period of time that the project activity is occurring, such as the socioeconomic effect of the peak construction workforce. Other effects, however, will extend beyond the period of time of project activity. For example, certain project facilities, such as the tailings landscape, will become permanent features of the environment.

Some EA disciplines, particularly terrestrial, examine the project under three temporal conditions: pre-development, full development (i.e., maximum extent of disturbance) and closure. Although there will be sequential removal and reclamation of terrestrial components, this sequential development and reclamation process will not be included in the assessment. Therefore, the assessment will be conservative in its approach as the maximum possible extent of disturbance will be considered. As requested in the ToR, the extent of existing disturbance from ongoing exploration in the mine area has been captured and reported separately in the EA. For the terrestrial assessments, closure was defined as ten years following reclamation.

7.4 IMPACT ANALYSIS

Impact analyses will be performed for the key questions for each EA component (discipline). The impact analysis consists of five main steps:

- identification of project activities that could contribute to environmental change;
- evaluation of the potential effects;
- description of mitigations for potential effects;
- analysis and characterization of residual effects; and
- identification of monitoring to evaluate and track performance.

For the purpose of this EA, mitigation applies to the construction, operation and closure design principles to minimize or eliminate potential adverse impacts and, where possible, enhance environmental quality.

Quantitative methods of assessment are used where possible. The predictive modelling is used as a tool in the air, hydrogeology, hydrology and water quality assessments. Geographic information systems (GIS) will be used to assess impacts on terrestrial resources and land use.

7.4.1 Impact Description Criteria

The impacts that remain following mitigation or residual impacts, for the environmental components will be classified using criteria to determine the overall effect, termed the environmental or social consequence. Each impact will first be described using the following criteria: direction, magnitude, geographic extent, duration, reversibility and frequency (including seasonal effects):

Direction: this may be positive, neutral or negative with respect to the key question (e.g., a habitat gain for a key species would be classed as positive, whereas a habitat loss would be considered negative).

Magnitude: is the degree of change in a measurement or analysis, and is classified as negligible, low, moderate or high. The categorization of the impact magnitude is based on a set of criteria, ecological concepts and/or professional judgment pertinent to each of the discipline areas and key questions analyzed.

Much ecological literature points to changes in measurement endpoints of over 20% as compared to baseline as having a high magnitude impact on biological systems. Suter et al. (1995) have identified that the 20% rule for the severity of effects from contamination is applicable by analogy to areal scales of ecological effects. Lande's (1997) demographic model predicted that species with low demographic potential cannot persist if suitable habitat is reduced by more than 20%. These impacts are variable; species are predicted to exhibit a diverse array

of responses to habitat fragmentation depending upon the specific combination of life history traits and dispersal capabilities (With and King 1997). Species with limited reproductive potential go extinct sooner than predicted by Lande's model. Therefore, based on the bulk of available literature, the 20% criterion is the base case used in the Ambatovy EA, unless additional data suggest a higher or lower value.

Geographic extent: refers to the area affected by the impact and is classified as local, regional or beyond regional. A method of defining impacts within a study area, in terms of the percentage of a certain resource affected, is influenced by the size of the study areas. As such, quantitative values of impacts must be tempered with an overall qualitative approach that considers the project impacts on the overall viability and diversity of ecological units.

Duration: refers to the length of time over which an environmental impact occurs. Short-term is defined as less than the construction phase (< 3 yr); medium-term as longer than short-term and up to the operational duration of the project (3 to 30 yrs); long-term is greater than medium term (> 30 yrs).

Reversibility: is an indicator of the potential for recovery following the impact.

Frequency: describes how often the effect occurs within a given time period and is classified as low, medium or high in occurrence. Seasonal considerations are discussed when they are important in the evaluation of the impact.

Impact description criteria have been made for all project components based on professional judgment of the EA team and the considerations of the issues that were identified as particularly significant to stakeholders. The precise use of the above system will be varied as appropriate for certain disciplines.

The overall residual impact for each effect, or environmental or social consequence, will be classified to one of: negligible, low, moderate or high by evaluation of the rankings for magnitude, geographic extent and duration (Table 7.1). For example, an impact with a moderate magnitude, local extent, and short duration would be classified as having a low overall impact classification. This system is used to ensure that the final classification is consistent among EA disciplines.

Table 7-1 Screening System for Environmental Consequences

Magnitude (Severity)	Geographic Extent	Duration	Environmental Consequence
negligible	all	all	negligible
low	local	short-term	negligible
low	local	medium-term	low
low	local	long-term	low
low	regional	short-term	low
low	regional	medium-term	moderate
low	regional	long-term	moderate
low	beyond regional	short-term	low
low	beyond regional	medium-term	moderate
low	beyond regional	long-term	moderate
moderate	local	short-term	low
moderate	local	medium-term	low
moderate	local	long-term	moderate
moderate	regional	short-term	moderate
moderate	regional	medium-term	moderate
moderate	regional	long-term	high
moderate	beyond regional	short-term	moderate
moderate	beyond regional	medium-term	high
moderate	beyond regional	long-term	high
high	local	short-term	moderate
high	local	medium-term	high
high	local	long-term	high
high	regional	short-term	moderate
high	regional	medium-term	high
high	regional	long-term	high
high	beyond regional	short-term	high
high	beyond regional	medium-term	high
high	beyond regional	long-term	high

Prediction Confidence

Although not explicitly included in the impact criteria, uncertainty regarding the effects described is inherent, due to the predictive nature of the analytic process. The certainty of an impact analysis depends on several factors including:

- the understanding of natural/ecological processes at work now and in the future; and
- the understanding of present and future properties of the potentially affected resources.

The level of confidence for an impact analysis is discussed when there are questions about the factors reviewed above. Where the level of prediction confidence is low, a subjective assessment is made based on the available information, the applicability of information on surrogates, and on professional opinion.

7.4.2 Assessment Cases

Three EA cases, or scenarios, will be considered for the EA:

- baseline;
- project; and
- cumulative effects.

Each of these scenarios are discussed in this section.

Baseline

Baseline for the EA is defined to include all existing disturbances. Baseline therefore includes existing disturbances from agriculture and grazing, houses, roads and trails, plus disturbance from mine exploration activities. However, as required in the ToR, exploration disturbance caused by Dynatec and its previous partner Phelps Dodge (PDM) will be separated out from other older exploration disturbances.

From a resettlement perspective, the baseline case predates the acquisition of land within the project sites by Dynatec. Thus, resettlement is included as part of the project and will be assessed in the EA.

Project

The project description (Volume A, Section 3) reflects the following:

- input from public consultation as well as regulatory and technical workshops (Volume A, Section 6);
- conservative estimates of the layout, project duration, and emissions; and
- environmental and social considerations to reduce potential impacts.

The project is designed to mitigate the potential negative effects and enhance the potential positive effects wherever possible.

Further refinements to the project design will occur as ongoing public input is received, during the detailed engineering design work, during the contract tendering process, and during construction and commissioning.

Cumulative Effects

The cumulative environmental effects of the project and other existing projects or disturbances will be limited to an evaluation of those effects within the region that are planned or are reasonably foreseeable (Volume G). A precursor to that evaluation will be a consideration of all project effects (i.e., considering all project components together), since out side of the cumulative case, project components have generally been assessed independently.

7.4.3 Monitoring

A clear framework of principles and criteria are required to decide on the requirements for monitoring after project approval. Elements of the framework that will be used are laid out in more detail in the Environmental Management Plan (EMP) Appendix (Volume H, Appendix 6). Two main principles are:

- monitoring provides answers to specific questions regarding compliance and operations; and
- monitoring identifies opportunities for improvement.

The need for monitoring programs is developed in specific discipline areas for each project component and the monitoring plans to be implemented are presented in the EMP sections.

8 LIST OF STAFF AND ACKNOWLEDGEMENTS

8.1 ACKNOWLEDGEMENTS

This EA could not have been produced without the cooperation of the stakeholders who participated in extensive consultations during 2004 and 2005. Many members of the public took the time to consider the Ambatovy Project and provide their issues and concerns; their involvement is much appreciated. In addition, many Non-Governmental Organizations and other special interest groups took part in meetings and workshops, including ones where the adequacy of proposed mitigation was specifically discussed. Their contributions to help see a better project is produced are gratefully acknowledged. The help of many local, regional and national government departments is also appreciated, including those working on the Technical Evaluation Committee, who have helped with consultation in 2004 and 2005. We would especially like to thank staff at the National Office for the Environment for their leadership of the EA process, including the many meetings they have held with project proponents and the EA team over the last two years.

The production of this environmental assessment also involved collaboration between the proponent's EA team leaders at Dynatec Corporation of Canada (Dynatec), plus international EA specialists, and consultants based in Madagascar. Dynatec hired Golder Associates Ltd. (Golder) to be the lead consultant for the EA and to coordinate the involvement of Malagasy specialists. Dynatec also coordinated the involvement of the engineering design team and other consultants to provide input to, and prepare sections of the Environmental Assessment. This specifically involved Knight Piesold for hydrogeology and natural risks; Groundwater Consulting Services for hydrogeology; and Coastal and Environmental Services for harbour expansion, oceanography and marine biology. Dynatec also coordinated the involvement of Social Capital Group, which is leading the preparation of the resettlement action plan, with EA social team members. As requested in the terms of reference (Volume H, Appendix 1), a list of the main professional and technical specialists who took part in the EA is provided below (Table 8-1).

8.2 LIST OF STAFF

Table 8-1 Main EA Professional and Technical Team Members

Team Member	Title / Area of Specialization	Project Role
Proponent EA Team (Canada And Madagascar)		
Gerry Bolton	Vice President, Dynatec	Ambatovy Project Manager
Stan Penttinen	Environmental Specialist, Dynatec	Ambatovy EA leader
Yves Fourmanoit	Director General, Dynatec, Madagascar	Within Madagascar liaison
Bill Vardill	Senior Manager, Dynatec	Past Project Manager (2004)
EA Consultants (Canada – USA – South Africa – France – Peru)		
Derek Melton	Associate, Senior Biologist, M.Sc., Ph.D., Golder	EA Project Manager, Biology lead
Michael Raine	Associate, Ecologist, M.Sc, Golder	Project Manager (Jan – Oct 2004)
Greg Jones	Assistant Project Manager, Ecologist, MEM, Golder	Co-ordinator, Land-use, Protected areas, Visual aesthetics
Murray Fitch	Hydrologist, M.A.Sc., P.Eng., Golder	Hydrology lead
Deborah Chan-Yan	Hydrologist, M.Sc., Golder	Hydrology
Robert Mugo	Water Quality, Ph.D., Golder	Water Quality lead
Alison Humphries	Water Quality, M.Sc., Golder	Water Quality
Rens Verburg	Geochemist, Ph.D., Golder	Geochemistry
John Virgl	Ecologist, M.Sc., Ph.D., Golder	Biodiversity lead
Carol Stefan	Wildlife Biologist, M.Sc, Golder	Wildlife co-lead
Darrin Nielsen	Vegetation Specialist, M.Sc., Golder	Flora co-lead
Porter P. Lowry II	Curator, Ph.D., Head Africa and Madagascar, MBG	Flora taxonomy lead
Luc Bouchet-Bert	Archaeologist, MAA, Golder	Archaeology
Dale Doram	Reclamation Specialist, M.Sc., P.Ag., Golder	Reclamation and soils lead
Ethan Richardson	Soil Scientist, M.Sc., Golder	Soils
Mel Zwierink	Soil Scientist / Forester, B.Sc., Golder	Soils and reclamation
Darrell Chollak	Environmental Scientist, CEAA, Golder	Environmental Management Plans
Susan Ross	Associate, Development Specialist, M.Sc., Golder	Social lead
Alka Clarke-Patel	Development Specialist, M.Sc., Golder	Social
Claude Rezumat	Development Consultant, M.Sc.	Social
Mike Rankin	Senior Toxicologist, M.Sc., Golder	Human health lead
Rosana Carvalho Moraes	Toxicologist, Ph.D., Golder	Human health
Brian Griffin	B.Sc., Prof. Eng., Risk Specialist, Golder	Natural Risk lead
Curtiss McLeod	Principal, M.Sc., Golder	Fish and Aquatic Resources
Johann Rall	Fish Specialist, M.Sc., Ecosun Consultants	Fish and aquatic resources lead

Table 8-1 Main EA Professional and Technical Team Members (continued)

Team Member	Title / Area of Specialization	Project Role
Angus Paterson	Marine Biologist, Ph.D., Coastal Environmental Services Ltd.	Oceanography lead
Brian Colloty	Marine Biologist, Ph.D., Coastal Environmental Services Ltd.	Oceanography
Aidan Wood	Ichthyology and Fisheries. Ph.D., Gleneagles Environmental Consulting	Oceanography
Michael Schlever	Marine Biologist, Ph.D. Oceanographic Research Institute in Durban	Oceanography
Anton Holzhausen	M.Sc. Engineering. Prestedge Retief Dresner Wijnberg	Oceanographic dispersion modeling
Teresa Drew	Air Quality and Noise Specialist, M.Sc., Golder	Air Quality and Noise lead
Greg Unrau	Air Quality Scientist, M.Sc., Golder	Air Quality
Candace Bell	Air Quality Meteorologist, M.Sc., Golder	Air Quality
Aurelie Verge-Marion	Asst. Project Manager, B.Sc., Golder	Coordinator, 2004
Michel Julien	Geotechnical Engineer, Ph.D, Golder	Physical lead, 2004
Gary Small	Hydrogeologist, M.Sc., Groundwater Consulting Services	Hydrogeology
Martiens Prinsloo	Hydrogeologist, B.Sc., Groundwater Consulting Services	Hydrogeological Modeling
Alkie Marais	Hydrogeologist, M.Sc., Groundwater Consulting Services	Hydrogeological Modeling
Alan Dabbs	Social Specialist, Social Capital Group	Population Resettlement lead
Jaime Rubio Del Valle	Social Specialist, Social Capital Group	Population Resettlement
Matthew Parfitt	Geotechnical Engineer, P.Eng., Knight Piesold	Geotechnical, Hydrogeology, Reclamation lead
Richard Cook	Environmental Scientist. B.Sc., Knight Piesold	Risks, Co-ordination
Deena Duff	Civil Engineer and Hydrologist. B.Sc., P.Eng., Knight Piesold	Hydrology
Sheldon Richard	Graphic Modeler, Diploma, Knight Piesold	Graphic Modeling
Jamie Cathart	Hydrologist, P.Eng., Ph.D., Knight Piesold	Hydrotechnical modeling
Douglas Dorren	Geotechnical Engineer, M.Sc., P.Eng., Knight Piesold	Geotechnical
EA Consultants - Madagascar		
Pierre Berner	Spécialiste de la Végétation, Ph.D.	Chef d'équipe
Agnès Joignerez	Eau et hydrologie, Aquaterre, M.Sc.	Eau et Hydrologie chef d'equipe
David Meyers	Zoologiste, Ph.D.	Chef d'équipe
Odon Narijoelina Rakotonomenjanahary	Spécialiste Oiseaux, ingénieur forestier	Chef d'équipe
Lily-Arison Rene de Roland	Spécialiste Oiseaux ,Docteur en sciences naturelles	Membre

Table 8-1 Main EA Professional and Technical Team Members (continued)

Team Member	Title / Area of Specialization	Project Role
Bruno Raveloson	Spécialiste Oiseaux	Membre
Jeannot Rafanomezantsoa	Spécialiste Reptiles et Amphibiens, DEA en écologie animale	Membre
Christopher Raxworthy	Spécialiste Reptiles et Amphibiens, Ph.D.	Chef d'équipe
Rosalie Razafindrasoa	Spécialiste Reptiles et Amphibiens, DEA en écologie animale	Membre
Valerie Rakotomalala	Spécialiste Papillons, AEA attestation d'étude approfondie en sciences biologiques	Membre
David Lees	Spécialiste Papillons, Ph.D.	Chef d'équipe
José Myriel Ralison	Spécialiste Primates, DEA en biologie animale	Membre
Daniel Rakotondravony	Spécialiste petits mammifères, Doctorat III cycle,maître de conférence	Membre
Hary Nantenaina Randriamanantsoa	Spécialiste petits mammifères, DEA en sciences biologiques	Membre
Steve Goodman	Spécialiste petits mammifères ,Ph.D.	Chef d'équipe
Tressa Gilbbard	Travaux de terrain	Coordonateur
Richard Jenkins	Spécialiste Chauves-souris, Ph.D.	Chef d'équipe
Amyot Kofoky	Spécialiste Chauves-souris, DEA en sciences biologiques	Membre
Cecile Bidaut	Spécialiste Chauves-souris, DEA en sciences biologiques	Membre
Felicien Randrianandrianina	Spécialiste Chauve-souris, AEA en sciences biologique	Membre
Daudet Andriafidison	Spécialiste Chauves-souris, DEA en sciences biologiques	Membre
Nicolas Ranaivoson	Spécialiste Chauves-souris, DEA en sciences biologiques	Membre
Hanta Julie Razafimanahaka	Spécialiste Chauves-souris, ingénieur agronome	Membre
Fanja Ratrimomanarivo	Spécialiste Chauves-souris, DEA en sciences biologiques	Membre
Rado Andrianaivoarivelo	Spécialiste Chauves-souris, DEA en sciences biologiques	Membre
Brian Fischer	Spécialiste Fourmis, Curateur	Chef d'équipe
Tantely Randriambololona	Spécialiste Fourmis, Maîtrise en écologie animale	Membre
Jean Jacques Rafanomezantsoa	Spécialiste Fourmis, Maîtrise en biologie animale	Membre
Helian Ratsirarson	Spécialiste Fourmis, Maîtrise	Membre
Raminosoa Rasoamampionona	Spécialiste Poisson, Doctorat d'Etat	Chef d'équipe

Table 8-1 Main EA Professional and Technical Team Members (continued)

Team Member	Title / Area of Specialization	Project Role
Tsilavina Ravelomanana	Spécialiste Poisson, AEA en sciences biologiques	Membre
Randrianantenaina Lalanandrianina Nivosoa	Spécialiste Poisson ,AEA en sciences biologiques	Membre
Razafindranaivo Fenohanta Estelle	Spécialiste Poisson, AEA en sciences biologiques	Membre
Ravoahangimalala Ramilijaona	Spécialiste Poisson ,Doctorat d'Etat	Membre
Madame Prof Noro	Spécialiste Poisson (Université), Ph.D. Sciences naturelles	Chef d'équipe (U. Tana)
Jean Chrisotome Randriamboavonjy	Spécialiste Sols et Forestier, Ph.D.	Soils
Jean-Aimé Rakotoarisoa	Archéologie (Musée Université), Docteur en géographie humaine Docteur en archéologie	Chef d'équipe
Jean Michel Dufils	Directeur, Pact, Ph.D. Geography sciences	Social
Emilienne Raparson	État et Sciences Économiques, Ph.D.	Chef d'équipe
Mahefa Randrianalijaon	Spécialiste des aspects sociaux, M.Sc.	Membre
Chris Birkinshaw	Conseiller technique, Ph.D.	MBG - Madagascar
Lalao Andriamahefarivo	Botaniste, DEA en biologie, écologie	MBG - Madagascar
Patrice Antilahimena	Botaniste, BEPC	MBG - Madagascar
Jérémie Razafintsalama	Botaniste, DEA en biologie, écologie	MBG - Madagascar
Roger Lala Andrianarisoa	Botaniste, DEA en biologie, écologie	MBG - Madagascar
Richard Razakamalala	Botaniste, BEPC	MBG - Madagascar
Benja Rasolondraibe	Botaniste, DEA en écologie végétale	MBG - Madagascar
Jacky Andriatiana	Botaniste, Maîtrise	Parc Botanique et Zoologique de Tsimbazaza
Raymond Rabevohitra	Botaniste, Ingénieur civil	FOFIFA
Mamy Ramanantsoa	Botaniste, BACC	FOFIFA
Thierry Rakotomamonjy	Botaniste, licence en sciences	Membre
Guy Rafamatanantsoa	Botaniste, licence en sciences naturelles	Membre
Félix Andriatsiferana	Botaniste, Maîtrise	Membre
Roger Edmond	Ecologiste spécialiste de la végétation,, Ph.D.	Antananarivo University
Pierre Jules (Coca) Rakotomalaza	Botaniste,Maîtrise	Membre
Sylvia Razafindralambo	Administrateur	Administration