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Final Report

ENVIRONMENTAL REVIEW OF P.T. FREEPORT INDONESIA COPPER AND PRECIOUS METALS MINE IRIAN JAYA, INDONESIA

Presented to the

OVERSEAS PRIVATE INVESTMENT CORPORATION

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INTRODUCTION

EnviroSearch International was contracted by the Overseas Private Investment Corporation (OPIC) to conduct a review of environmental documentation of the P.T. Freeport Indonesia (PTFI) copper and precious metals mine in Irian Jaya, Indonesia. Additionally, the scope of work entailed a site visit, conducted in July 1994, and interviews with PTFI, governmental and non-governmental personnel. The work was conducted as part of OPIC's project environmental monitoring requirements.

The most substantive document reviewed for this report was the Studi Evaluasi Linkungan or SEL. The Government of Indonesia (GOI) requires a SEL to be completed prior to the expansion of an existing project and is effectively an environmental impact statement with additional requirements for socio-economic impact evaluation. The SEL was produced by PTFI in-house personnel with contributions from numerous outside sources including consultants as well as academic institutions in Indonesia. The final SEL was presented by PTFI to the GOI in a formal hearing in September, 1993, and was approved on February 22, 1994 by the Department of Mines & Energy, Republic of Indonesia.

Problems were identified, based on a review of PTFI documentation, interviews and the site visit, for the following issues: tailings (physical impacts, potential toxicity), acid rock drainage including overburden management, solid and hazardous waste, environmental monitoring activities and reclamation efforts. Other issues not reviewed in this stage of the assessment were glacier stability, and the occupational safety and health program.

The SEL process requires socio-economic analyses of the proposed project expansion, but a review of this individual aspect was not included in this Scope of Work.

General Comment on the SEL and This Document

The following evaluation is based on a review of SEL documents, additional documentation provided by PTFI which describes PTFI's environmental programs, a site visit conducted in July 1994, and interviews with PTFI, governmental and non-governmental officials. According to PTFI, substantial additional environmental data and information have been generated by PTFI which is not included in the SEL and has not, to date, been available for review. The authors recognize that many of the issues discussed below may be further understood and resolved when this information becomes available.

Background on Ore Production

Since the original Contract of Work (COW) was signed in 1967 between PTFI and the GOI, the mine has substantially increased production as well as the size and scope of its infrastructure. Main activities include mining and overburden management in the Irian Highlands, ore processing at the Mile 74 Concentrator, concentrate transportation via pipelines to the Irian lowlands, and concentrate drying and shipping at the Portsite (Amamapare) facility on the coast (see enclosed map).

In 1987, ore production was increased to over 16,000 tons per day (TPD), nearly three times the 1967 rate; in 1989, approval was given to expand to 32,000 TPD which was not achieved until 1990. Project expansion in 1992 achieved a rate of 66,000 TPD and a Feasibility Study projected expansion to 160,000 TPD, according to the SEL.

Current ore production rate is estimated to be 110,000 TPD with an estimated 4 billion tons of potential reserves. The current tailings discharge volume is approximately 106,700 TPD; which represents 97 percent of the total mill throughput.

While the SEL was developed in anticipation of an eventual project scale-up to 160,000 TPD, many of the conclusions in the SEL are based not on this production rate, but rather on 60,000 TPD, according to PTFI, thus complicating analysis of true environmental impacts of full project scale-up. Additionally, the SEL was compiled from numerous environmental studies conducted by PTFI over the years, including historical data that may not be an appropriate basis from which to predict environmental impacts of a much larger scale operation.

According to PTFI, the approved SEL actually allows a production rate of 176,000 TPD (representing a 10% increase over the SEL-approved production). Should production go beyond this rate, the GOI will require a new SEL to be developed. (According to a government official in the Ministry of Mines & Energy, any production beyond 160,000 TPD will require a new SEL).

According to PTFI, the SEL underwent many changes, revisions and negotiations with the GOI due to changes in agency personnel, perceived needs by the government, an evolving environmental regulatory system as well as a variety of other reasons. Moreover, the GOI indicated that it required changes during the SEL process due to a much higher project scale-up rate than PTFI had originally presented to the agencies.

1. TAILINGS

Mine tailings discharged to the river systems within the PTFI COW consist of finely ground rock from which certain minerals such as copper, gold and silver have been mostly removed by a flotation process located at the Mile 74 Concentrator Plant in the Irian Highlands.

Issues regarding the tailings are summarized by two potential problems: physical impacts and potential toxicity. Neither of these issues are satisfactorily resolved in the SEL.

1.1 Physical Impacts

The fine tailings particles representing various grain sizes are initially discharged from the Concentrator at Mile 74 to the Aghawagon River, which subsequently flows to the East Otomona, Otomona, Ajkwa and Lower Minajerwi River system. Prior to mid-1990, the Ajkwa River carried the tailings to the Arafura Sea, but a severe storm caused significant log jams which blocked the Ajkwa's flow. The sole road to the mine site below the town of Timika was flooded, threatening PTFI's lowlands infrastructure and necessitating the construction of levees. The levee system was built only on the west bank, thus redirecting the tailings in an eastward direction toward the Minajerwi River and away from PTFI's infrastructure and Timika, currently the fastest growing population center in Irian Jaya.

Currently, slow depositional sheeting of tailings, representing 97% of total mill throughput, moves in a southeasterly fashion, resulting in a massive die-off of vegetation. To accommodate this eastward sheeting, the Ministry of Environment, Ministry of Mines & Energy and the Ministry of Forestry extended the COW boundary to the east, thus legally allowing the deposition of tailings in this area, according to PTFI. In areas where the tailings no longer undergo active sheeting, apparent plant growth can be seen from the air. No ground reconnaissance was conducted of these areas due to scheduling restraints, but the vegetation appeared not to recover (as yet, if at all) to the full height of the surrounding, unaffected jungle canopy.

The sheeting is exacerbated, according to PTFI, by an emphasis on the increase in Concentrator throughput, resulting in less grinding of ore and larger grain sizes in tailings than previous, smaller scale operations produced. The larger grain sizes have a tendency to settle earlier as the river loses its energy in the lowlands, the result of which is larger areas of braided deposition than previously observed. While the SEL frequently refers to sedimentation studies that have been conducted, no data are presented for independent review.

Left unchecked, the tailings are anticipated to continue sheeting in an uncontrolled fashion, eventually reaching the Arafura Sea via an undetermined and apparently unpredictable course and at an undetermined discharge point.

The physical sheeting, aside from potential tailings toxicity issues, is a major problem not only for PTFI but for the GOI as well. According to an unconfirmed report from the Jakarta-based non-governmental organization WAHLI, the town of Koperapoka (population unknown) was moved in its entirety, at PTFI expense, due to anticipated directional sheeting of the tailings. Additionally, indigenous people rely heavily on planting, harvesting and consumption of the sago crop, and the sheeting of tailings adversely affected this agricultural resource for the town, according to WAHLI.

The SEL emphasizes that the mine and subsequent discharge of tailings is merely *"accelerating a naturally occurring process"*. This is an inappropriate attempt to downplay the impact of the tailings deposition. Using PTFI's figures of 730 billion tons eroded from the river drainage system over geologic time (assuming PTFI is referring to the 14 million years since New Guinea was uplifted from the ocean floor), this calculates to an average mass transport rate of 52,000 tons/year. The mine produces approximately 18,000,000 tons of tailings/year, so the argument that the mine is accelerating a naturally occurring process is not supported by this weak comparison. Moreover, natural sedimentation over geologic time, regardless of rate, results in an ecosystem in equilibrium, allowing fauna and flora to appropriately adapt to changing events. The fantastically accelerated depositional rate of the tailings, on the order of 300 times the natural rate, restricts such adaptive strategies by indigenous organisms.

Infrequent, intensive, relatively short term periods of high natural solids transport in parts per million (ppm) of total suspended solids, as would occur in a "natural", non-anthropogenically altered system which included high periods of precipitation and runoff is not analogous to intensive, continuous, increasing discharge of tailings in percent levels of solids.

1.2 Bioavailability/Toxicity Considerations

PTFI's official position as represented in the February 1994 SEL is that the tailings are "not toxic": Volume II - Appendix, Detailed Discussions of Surface Water Quality/Chemical & Physical Analysis states:

"Spatial and temporal analyses were conducted for total and dissolved metals for various locations in the study area. Although some total metal concentrations were higher in the Aghawagon/Otomona/Ajkwa River system receiving mill tailings discharge, it is the dissolved metal fraction that is potentially bioavailable and most important from an ecotoxicological and human health perspective. Research has shown that the toxic form of metals is the dissolved, ionic form of the metal, not total metals which are not bioavailable. Metal speciation in water is affected by many site-specific factors. Within the Ajkwa/Minajerwi River system, the following site-specific factors greatly reduce the dissolved metal fraction, hence bioavailability and potential toxicity of metals to aquatic life:

1) mined ores are not treated chemically, therefore the metals are locked in minerals contained in the rock matrix of the tailings;

2) the naturally high pH levels in the rivers limit metal solubility; and

3) high suspended solids, inorganic and organic ligands, hardness and alkalinity all combine to reduce bioavailability of metals to aquatic life. For these reasons, the primary discussion on metals in this SEL report will focus on dissolved metal concentrations."

1.3 Discussion

It is possible that PTFI's environmental studies have generated data that, subject to peer review, would corroborate its position, however, information provided in the SEL was insufficient to permit this independent review. In fact, each point presented in the SEL arguing against bioavailability of tailings has an equally plausible scientific antithesis suggesting that heavy metal bioavailability from adsorbed/absorbed sources may be an issue at this site. A comprehensive review of the raw data, study design, sample collection and analytical methods, QA/QC procedures, etc. is necessary to further understand PTFI's claims.

<u>PTFI Position 1</u>: *"mined ores are not treated chemically, therefore the metals are locked in minerals contained in the rock matrix of the tailings."*

Comment: It is true that the flotation process used at the mile 74 Concentrator utilizes chemicals that cause a physical, and not chemical separation process between the minerals and native rock to occur; however, this does not mean that the metals are inextricably bound up **in perpetuity**. In fact, the flotation process has nothing to do with limiting or not limiting bioavailability, and just because the ore is *"not treated chemically"* does not mean that the metals are *"contained"* in the ground fines of the mill tailings. Numerous factors, explained in this section, can act singly or in tandem in the environment to which the tailings are discharged to cause heavy metal bioavailability; the SEL incorrectly and simplistically dismisses these considerations.

The virgin ore body may be subject to chemical weathering which releases metal ions into the watershed. However, grinding the ore increases the surface area available for chemical reactions, potentially increasing the rate of metal release. Additionally, the high humic conditions of Irian riverine systems may **increase** rather than, as argued in the SEL, decrease bioavailability of metals.

PTFI Position 2: *"the naturally high pH levels in the rivers limit metal solubility."*

Comment: The SEL inappropriately, and inconsistently overemphasizes the importance of high pH in the river systems as being an overall limiting factor in the potential bioavailability of heavy metals. There are two possible difficulties with this position: a) metal solubilities may not be very low at the actual pH found at various points in the river, and b) solids containing metals can be transported downstream to regions of lower pH, where the metals can be released by dissolution.

It is true that the solubility of divalent metals decreases with increasing pH, due to precipitation of hydroxides. However, as pH increases past a certain point, metal solubility increases again, due to the formation of soluble hydroxy complexes. For example, the minimum equilibrium solubility of copper (potentially toxic to aquatic organisms) in pure water falls in the vicinity of pH 9.5. However, this minimum can shift, depending on the concentrations of other solutes (V.L. Snoeyink & D. Jenkins, Water Chemistry, Wiley, 1980)

Thus, the solubility of metals may be significant at the pH actually found at various points in the impacted system. The pH of the wastewater discharge from the Mile 74 Concentrator is above 10 (Section 3.2.3.4), so increased solubility due to complexation is likely. These complexes may or may not be bioavailable. In lower reaches, such as the Ajkwa river and estuaries, the pH ranges from 7.32 to 8.04. Under these conditions, increased metal solubility due to dissolution of solids is likely. (Several references in the SEL refer to "slightly acidic" conditions in lowland rivers without elaborating or specifically identifying the sites or pH levels, thus presenting another inconsistency in the documentation). It seems clear from analytical data as well as representations in the SEL that pH varies widely in the environment impacted by the tailings, but the potential impacts are categorically summarized and dismissed.

The GOI Class D Water Quality Criteria (water that can be used for agriculture) of SEL Table 4-9 gives 0.02 mg/L as the limit for copper. The World Health Organization (1970) and USEPA indicates 0.05 mg/L as the recommended limit for drinking water, and 1.5 mg/L as the maximum permissible level. (The USEPA action level, intended to allow for corrosion of copper distribution pipes, is 1.3 mg/L.) Dissolved copper levels in PTFI data exceeds the GOI Class D standard in several samples reported in Table 4-10. Additionally, in Table 3-4, Amamapare (Portsite) Settling Pond Wastewater (presumably discharged to the estuaries) exhibits a high range of 1.9 mg/L copper, well outside the range of acceptability.

PTFI Position 3: *"high suspended solids, inorganic and organic ligands, hardness and alkalinity all combine to reduce bioavailability of metals to aquatic life. For these reasons, the primary discussion on metals in this SEL report will focus on dissolved metal concentrations."*

Comment: The SEL argues that high natural suspended solids sorb metals, but the document assumes that sorbed metals are no longer of interest. Metal ions can adsorb to suspended solids of either natural or anthropogenic origin. Smaller particles have more sorption sites per unit weight than larger particles. Since half (by weight) of the particles in the tailings are smaller than 75 microns, adsorption is likely to be very important. Additionally, metal ions can adsorb to surfaces even if they have been complexed by an organic ligand.

However, adsorbed metals are not necessarily unavailable metals. Since adsorption is reversible, the metals can desorb with a change of conditions. River water used for drinking or washing by humans, or ingested by wildlife will almost certainly include particulates. Modern drinking water treatment plants remove particles larger than about 10 microns by filtration and settling, and some smaller particles may be removed by coagulation if necessary to meet turbidity requirements. But the smallest particles, those accounting for the largest fraction of adsorbed metals, are precisely the particles least efficiently removed. In the stomach of humans, with a pH of approximately 2, the metals are likely to desorb and become bioavailable. Furthermore, much of the water potentially used by area people will not be treated beforehand. (It is recognized that PTFI makes an attempt at restricting the use of the tailings-contaminated water systems, nevertheless, it should not be assumed that their efforts are entirely successful). Clearly, wildlife will consume and be in contact with only untreated water.

Further, PTFI argues that *"naturally occurring organic ligands bind metals"*. Metals can be bound by natural organic ligands, but this may increase the bioavailability of the metals rather than decrease them. It is well known, for example, that citric acid, a natural component of many foods, increases the uptake of some dietary metals and decreases others. Similarly, humic materials in water can increase productivity in natural waters by enhancing the solubility of nutrient metals and potentially toxic metals (Pettersson, C., 1993, Water Research (G.B.), 27, 863).

Seemingly complicating PTFI's own position on this issue, the Summary of Freeport Indonesia's Environmental Programs (1992) notes that *"following sedimentation or filtration, the Ajkwa River water has been shown to be within Indonesian and USEPA drinking water standards."* Yet, PTFI reports (ibid) state: *"Studies designed to determine the effect of the tailings discharge on water quality and aquatic faunal communities in the receiving waters have been conducted and long-term environmental monitoring programs have been instituted to continue to gather data. No significant adverse environmental effects to the water quality and aquatic faunal communities have been noted to date and no significant effects are anticipated."* However, the people as well as fauna do not have access to adequate filtration equipment to meet the drinking water standards PTFI refers to.

Additional consideration should be given to the shear volume of copper being discharged to the environment by PTFI. SEL Section 3.2.3.2, Processing Procedure, states that copper discharge in the tailings contains about 0.15 percent, or about 1,500 mg/L (no ranges of other heavy metals in the tailings are found anywhere in the SEL). This significantly high discharge level of copper compares against a USEPA categorical discharge maximum daily standard of 0.3 mg/L Cu (Effluent Guidelines & Standards for Ore Mining and Dressing, Revised July 1, 1991 - Subpart J). Additionally, the USEPA categorical discharge standard for Total Suspended Solids (TSS) is 30 mg/L. This contrasts markedly with a TSS discharge of 300,000 to 350,000 (SEL, Table 3-4) in the tailings. The World Bank Environment, Health & Safety Guidelines (May 12, 1994) limitation for copper discharge is also 0.3 mg/L and 60 mg/L for TSS. Such mass loading of contaminants into the Irian environment competes with an as-yet undetermined ability, or inability, for the natural system to overcome such an impact. The SEL does not adequately address this crucial issue.

Finally, the SEL presents no comprehensive chemical analyses regarding heavy metal content of the either the Ertsberg or Grasberg ore bodies.

1.4 Additional Bioavailability/Toxicity Issues

The SEL often refers to "ecotoxicological bioassays" and "biological surveys" to corroborate PTFI's position on toxicology of the tailings. However, extremely limited discussion regarding methodology, rationale for conclusions, etc. is contained in the SEL and virtually no raw data or sampling/analytical methods with regards to bioassay studies are presented. According to verbal representations made by PTFI, such studies have concentrated on fish tissue samples which local people may be consuming as well as laboratory invertebrate studies. This is likely useful work, however, they were not included in the SEL, precluding them from independent review. In Section 1.3.2.2 Biological/Ecological Components, the SEL indicates that bioaccumulation of metals in fishes was an addressed parameter, but virtually no details of these studies were presented in the documents.

Even so, studies limited to fish currently consumed by humans in the area will not by themselves be sufficient to categorically dismiss potential toxicity of the tailings. It is possible that heavy metal uptake in the ecosystem is currently taking place, and has not yet been scientifically observable in past and/or current PTFI studies.

Some trace metals are directly toxic to aquatic organisms and are also significantly accumulated by many marine and estuarine species. This gives rise to concerns both with respect to the possible detrimental effects of metals on coastal and riverine resources in the Project area, as well as the potential impacts of metals on human health. Appropriate, well designed, monitoring programs are therefore required to establish both spatial and temporal trends in metal abundance and bioavailability in rivers, estuaries and other coastal waters as well as in other terrestrial systems.

Such monitoring could rely upon the quantification of metals in the waters themselves, in the underlying sediments, or in organisms. The analysis of water for metals suffers from several disadvantages. Metal concentrations are very low in natural waters and are difficult to quantify while avoiding extraneous contamination in samples and analytical techniques. Temporal variability is also a problem [as in the case of diurnal fluxing of PTFI site river systems], rendering mean and total range levels of pollutants difficult to determine and questionable as representative. There is also no definite relationship between metals in "soluble" and "particulate" fractions of natural waters and their availabilities to organisms. While there has been considerable worldwide research done on metal levels in sediments, it is difficult to account for effects of particle size and organic carbon content on metal levels. In addition, no simple method exists to determine the bioavailabilities of metals in sediments, and with such a wide range of ecotones in the PTFI COW, it is particularly problematic to assume, as in the SEL, *"limited bioavailability"* of tailings in a reductionist manner.

As a result of these problems, the use of organisms, which by definition reflect bioavailable levels of metals, is now the most widely employed method to monitor the effects on biota of trace elements in coastal waters. Organisms used to quantify pollutant abundance or bioavailability by virtue of their tissue concentrations of contaminants have been referred to as bio-indicators, sentinel organisms, and bio-monitors. The use of a particular aquatic organism as a bio-monitor of metals in coastal (or riverine) waters is defensible only when the resulting picture of environmental contamination truly reflects ambient metal bioavailabilities. (Furness & Rainbow (Heavy Metals in the Marine Environment, CRC Press, 1990).

"It is unfortunate that many studies to date have lost sight of these basic essential prerequisites [listed in text]. *It is not sufficient to simply collect and analyze previously unstudied species, or to analyze any and all organisms available at a study site. Only* **certain** [emphasis ours] *organisms, conforming to well established prerequisites, should be employed in biomonitoring studies."* Ibid.

It is well known, for example, that certain aquatic organisms "regulate" levels of metals in, or out, of their system (R.G. Wetzel, 1983. Limnology, 2nd Ed. CBS College Publishing). In other words, nutrient as well as toxic heavy metals may be "partitioned" by unique, adaptive physiological mechanisms employed by certain organisms. The result would be that if those organisms were inappropriately selected for a biomonitoring study, one could develop an incorrect conclusion as to bioavailability of metals contaminants. It is therefore crucial to fully evaluate PTFI's past, present and future biomonitoring programs to understand their claims of "non-toxic" tailings. The SEL summarily dismisses the toxicity of tailings without providing the extensive documentation necessary for an independent evaluation.

PTFI has apparently conducted numerous biodiversity studies within the COW to further its bioavailability argument (it should be noted that they were conducted when production was much lower than today, let alone the greatly expanded operations proposed by the SEL). These studies have concentrated on "richness" and "abundance" surveys. While these studies may be useful in certain circumstances and for comparative evaluation of certain parameters, they by no means replace the rigorous bioassay testing that should be conducted.

Even so, the biodiversity studies in the SEL suffered from problems in scientific methodology such as different capturing techniques for organisms in "control" areas versus "impacted areas". For example, Tables 1-7 and 1-8 in the SEL Appendix Water Quality & Aquatic Biota Sampling Methods indicate that different capture methods were used for fish collection, "*depending on location and physical constraints*". Sample S-245 in the Ajkwa River was sampled by "*shock-seine*" while Sample S-260 in the same river was sampled by "*trawl-shock*". Similarly, Minajerwi River sampling was: Sample S-261: "*trawl-shock*"; Sample S-400 "*shock-seine*"; Sample S-420 "*trawl; shock*". Such sampling differences may introduce important bias to scientific results.

Additionally, the incorrect use of scientific terminology and techniques further complicates an independent review of the SEL. In the Summary of Freeport Indonesia's Environmental Programs (1992), the following statement is made: "*Various trophic levels were checked* [for metals], *including species which spend most of their life in association with bottom sediments (such as catfishes), as well as top carnivores (large piscivorous fish).*" Selection of various fishes from within the described riverine environment is not an example of "*various trophic levels*", rather, an example of a selection **within** a trophic level. A trophic level is defined as follows: ***"In self-sustaining biological communities, functionally similar organisms can be grouped into a series of operational levels. Each level which usually consists of many species competing with each other for available resources, forms a trophic level"*** (R.G. Wetzel, 1983. Limnology, 2nd Ed. CBS College Publishing). Therefore, a *"large piscivorous fish"* is not a *"top carnivore"*, rather a **primary carnivore** (Star, Cecie, 1984. Biology: The Unity & Diversity of Life, Wadsworth, Inc.), whereas a fish-eating eagle, a **secondary carnivore**, would represent a true change in a trophic level.

The above discussion is important in understanding and differentiating the potential impacts of environmental contaminants to biological communities, including humans. It is crucial to understand if metals and/or organic contaminants are indeed accumulating in and moving through distinct trophic levels into others such as from phytoplankton (capable of bioaccumulating, for example, large amounts of heavy metals) to plant-eating animals (herbivorous fish) to osprey or seals (secondary carnivores). Such a scenario suggests that contaminants are bioconcentrating, bioaccumulating and/or bioamplifying.

Finally, it should be noted that concentrator process flotation (six) chemicals are discharged in small quantities (relative to the tailings) along with the tailings to the Aghawagon River, however, the SEL did not deal with this issue in a substantive manner. One of these chemicals, MIBC (4-methyl-2-pentanol), carries a warning in the Material Safety Data Sheet (MSDS) to *"keep out of surface waters"* due to the representation that *"high concentrations* [without definition] *are known to be toxic"*. Using data presented in the SEL (*0.05 KG MIBC/Tonne of Ore*), 17,600 lbs/day of MIBC alone would be discharged to the Aghawagon River with an ore production rate of 160K TPD.

Although much of the MIBC will evaporate due to its high volatility, some will remain in the water. If it is released into the environment, it is likely to leach through the soil to groundwater due to its high mobility. It is not expected to bioconcentrate in aquatic organisms. Laboratory tests show it to be readily biodegradable, but no data on natural biodegradation was found. The MSDS indicates that exposures to general populations occurs mainly through oral ingestion of contaminated water and through the inhalation of contaminated ambient air. Minor exposure may occur through dermal contact with contaminated water. Occupational exposure limits are 25 ppm for an 8 hr, time-weighted average; 15 minute, short term exposures should be no higher than 40 ppm (Micromedex, Inc. Vol. 16 4/30/93).

According to PTFI officials, very low levels (ppt or ug/liter) of flotation chemicals have been reported at the Otomona Bridge (approximately 30 miles downstream from the Mill). A more rigorous study and discussion for the possible environmental and human health impacts of the discharge of flotation chemicals to the river system, including above the bridge, should be undertaken, including an accurate calculation of the total amount of reagents to be discharged with the SEL-approved, anticipated production rate of 160,000 TPD. (Extrapolating from data presented in the SEL, 28,512 lbs/day or 14.256 tons/day of chemical reagents would be discharged with the tailings to the river system based on an ore production rate of 160K TPD).

1.5 Current Management Strategy For Tailings

PTFI recognizes the need, with substantial pressure from Ministries of the GOI, to develop alternative plans for the tailings and has contracted an extensive study for the following alternatives or combination of alternatives: river diversion, low lowlands impoundments, mid-lowlands impoundments and mid-highlands impoundments. Earlier studies by Fluor Daniel on an ocean outfall pipeline were discarded as an infeasible tailings management alternative due to cost and technical considerations. Similarly, a "high" tailings dam, located at the mine site, was considered "out of the question", according to PTFI, due to seismic activity in the region.

Alternative tailings management scenarios were dismissed without rigorous analysis in the SEL, identifying and finalizing the currently used "Floodplain Management" method. In SEL Section 3.2.3.5, Tailings & Tailings Management, the alternatives are briefly discussed; 1) Tailings Pipeline; 2) Highlands Impoundment; 3) Lowlands Impoundments; 4) River Diversion; 5) Floodplain Management.

It is interesting to note in the matrix of Tailings Management Alternatives (pg 3-44) that the *"Tailings Pipeline"* alternative was summarized as follows: *"Potential for Catastrophic Failure: **High**; Environmental Impact: **High**; Technical Complexity: **Highest**; Operating Cost: **Highest**; Capital Expenditures: **Highest**"*. This contrasts with the *"Floodplain Management"* method as follows:- *"Potential for Catastrophic Failure: **Lowest**; Environmental Impact: **Medium**; Technical Complexity: **Lowest**; Operating Cost: **Lowest**; Capital Expenditures: **Lowest**"*. The SEL does not define or provide the basis for understanding the categories of impact (ie: low, medium, high, highest, etc.).

In its presentation of alternatives to "floodplain management", PTFI characterizes engineered alternatives as having the highest potential for catestrophic failure when the project otherwise takes credit for legendary feats. Such feats include the construction, operation and maintenance of pipelines (130 millimeters in diameter) that carry diesel to the mine site (a distance of 118 kilometers) as well as several concentrate slurry lines moving product next to a heavily traveled, tortuous high mountain road system through to the Irian lowlands ending at the coast. PTFI fails to consider the arguably "catastrophic" environmental impacts of current and continuing depositional sheeting of tailings. Additionally, when other matrix analyses are factored in such as *"Environmental Impact, Technical Complexity, Operating Cost and Capital Expenditures"* in light of the current engineering studies being performed to control the sheeting, the comparison of alternatives as presented in the SEL is further weakened.

The pipeline study, unavailable for review, has been produced as a stand-alone document, and was not included in the SEL, but it is unclear if it and the other alternatives underwent genuine consideration.

Currently being studied by PTFI with interest is Mile 50, a natural geographic depression which PTFI consultants believe could hold up to two thirds of all project tailings or approximately 400 million tons.

Potential problems with this alternative include a high water table, especially in the lowlands, with impacts to local groundwater resources, both from a toxicity issue (heavy metals as well as chemical reagents and possibly chemical leachate carried in the Aghawagon River from higher dump sites) as well as disruption and/or alteration of groundwater flow paths; additional levees and diking systems that may be susceptible to seismic events; and continued displacement of villages and important agricultural practices.

It is important to note that PTFI is not considering, according to company officials, the question of tailings toxicity in its present evaluation of alternative management considerations, rather PTFI is approaching the problem merely as an physical engineering problem. Similarly, if the pipeline approach were to be eventually selected, rejected earlier due to cost constraints, additional environmental issues would need to be investigated.

1.6 Government of Indonesia's Position On The Tailings

The PTFI site has been the subject of intense involvement with several GOI agencies. The Ministry of Mines & Energy has from the startup of the operation been involved in a variety of capacities such as permitting, safety inspections, and more recently, the development of the SEL. The GOI, in issuing approval for the SEL at a maximum ceiling of 160,000 TPD production, imposed a list of conditions PTFI must comply with (Freeport believes **ten** conditions; Ministry of Mines indicates the list is **eight**) . These criteria were unavailable for review at the time of this report. Additionally, the Ministry of Forestry, the Ministry of Agriculture and, more recently, the Ministry of Environment have become involved with the tailings issue, and have reached a "concensus" that significant, unaddressed problems exist.

The GOI has recently indicated that should the tailings eventually move out of the COW in an easterly direction, potentially threatening the Lorentz Nature Reserve, a proposed World Heritage Park, it would take legal action against PTFI. Additionally, the GOI, both in the Ministry of Mines & Energy, the current lead agency with the PTFI project, as well as the Ministry of Environment, are concerned about potential toxicity of the tailings. Both Ministries indicated that they have requested on numerous occasions of PTFI certain data, studies and reports that have not been forwarded by PTFI. These requests have included a presentation by PTFI on the status of tailings management alternatives, including the pipeline option, previously dismissed by PTFI as prohibitively expensive.

The Ministry of Mines & Energy is not satisfied with the status of the reclamation areas; the same ministry also expressed its dissatisfaction with the River Study and the Ocean Study conducted by PTFI in 1990, indicating they insufficiently addressed important issues. The SEL frequently refers to the River Study and the Ocean Study, often relying on data in these studies to help make PTFI's case that the tailings are not toxic, among other representations. These studies were not available for review at the time of this report.

Finally, the Ministry of Environment as well as the Ministry of Mines & Energy expressed a general concern regarding the social impact the tailings has had on indigenous people, without elaborating in detail, other than to mention that the tailings have displaced people.

2. ACID ROCK DRAINAGE

Acid rock drainage (ARD - also known as AMD or acid mine drainage) is the acidification of natural waters which results when oxidation of certain minerals is accelerated by mining activities. It has been identified as the largest single environmental problem facing the Canadian mining industry in 1993 (CIM Bulletin, 1993) and is the subject of considerable concern in the United States and elsewhere worldwide. ARD is the result of sulfide oxidation in the presence of oxygen and water to form sulfuric acid. The reactions vary depending on the mineralization of the ore body and availability of oxygen in previously anaerobic environments.

ARD becomes a problem due to its ability to mobilize potentially toxic metals almost always found to varying degrees in any ore body or associated mining wastes. For this reason, it is crucial to understand the potential for ARD early on in the planning, development, operation, and closure of the mine and to prevent its occurrence and/or mitigate its impacts.

While acid producing reactions occur naturally in ore bodies prior to anthropogenic disruption, their rate and volume are greatly enhanced by mining activities including the removal and placement of overburden, management of tailings, and any activity introducing oxygen into disturbed materials. The chemical changes that cause problematic acid drainage are almost exclusively enhanced by the physical and structural changes in the ore body and by products of mining activities. Additionally, improperly constructed, operated and monitored heap leaching operations are also a potential source of ARD. PTFI is currently investigating the possibilities of conducting heap leaching operations at the upper Mine site.

The initiating chemistry of ARD involves oxidation of pyrite in the presence of water, forming ferrous iron, sulfate, and acidity in the form of H^+ ions. Ferrous iron is oxygenated to ferric iron, followed by hydrolysis of water, precipitating ferric hydroxide which serves as a reservoir of iron (Fe III), and adding acidity to the system. Finally, the pyrite is reduced by ferric iron, further increasing the acidity. All reactions except the oxygenation of ferrous iron impart acidity to the system. The rate limiting step, oxidation of ferrous iron, is accelerated by the bacteria Thiobacillus and Ferrobacillus ferrooxidans. The rapid proliferation of this process is known generically as "going acid".

The PTFI site presents several geographic areas of potential ARD: 1) overburden storage at mine site; 2) the old Ertsberg pit, now filled with water and used as a source of hydroelectric power; 3) the tailings; 4) the Grasberg mine itself; and 5) potential future heap leaching operations, currently undergoing evaluation. Additionally, if the upper mine area "goes acid" and is uncontrolled, it has the potential to dramatically impact the mobility/remobilization of heavy metals in downstream tailings deposition areas via dissolution.

PTFI's official position on ARD potential is discussed in the SEL (4.3.6): *"In summary, all of the testing results from the overburden studies showed that some of the overburden had the potential, based on laboratory conditions, to produce ARD and some samples did not have this potential. A comprehensive management plan for overburden, coupled with the fact that the area is underlain with massive amounts of limestone rock, will enable PTFI to properly manage overburden so that there will be no significant runoff problems that will affect the surrounding environment. Additionally, most water runoff from the mine area and overburden piles is collected for use in the mill process where it is treated with lime to eliminate any acidity."*

In particular, with respect to the tailings, it is stated in the Appendix to the SEL (Determination of Potential For Acid Rock Drainage) that: *"...the tailings do not appear to have potential for significant acid formation"*. From the available data, it appears unlikely that the tailings in the lowlands have the potential for ARD, however, additional evaluation of these data are necessary. The metals in the tailings are also susceptible to re-mobilization should the upper mine and overburden areas generate acidic conditions sufficient to come in contact with the tailings.

Given the negative Net Acid Producing Potential (NAPP) values, PTFI argues that the ARD potential is low, however, as lime is added for the milling operation, the statement is somewhat misleading. Will the amount of lime added during milling operations, especially scale-up, remain the same or will it vary with amount of reactive sulfides? Insufficient information is presented in the SEL to answer this crucial question.

One of the most significant deficiencies in the ARD reports was a lack of mineralogical analyses. There was no indication of percent pyrite or other reactive sulfides in either the raw ore, waste rock material or tailings. Any evaluation of ARD should have these data available for independent review. Most of the information that was presented was in terms of total sulfur, which includes sulfate and other species. There were several references to sulfide minerals throughout the reports, but no data was supplied. The methodology that was used to determine ARD potential of the Grasberg overburden (using ANC - acid neutralizing capacity, and NAPP) showed that the overburden is potentially acid forming, but only 7 of 143 samples, discussed in the Appendix - Determination for Potential for Acid Rock Drainage, were analyzed for sulfate. Additionally, the site inspection revealed what appeared to be obvious signs of ARD already occurring on the southeast flank of the Grasberg mine.

Important questions need to be answered regarding sampling methods to generate the 143 samples. How were the drill core samples systematically chosen to represent the range of overburden material? Does each sample represent an equal amount of material or were several samples taken from essentially the same location? It is necessary to have an identification and analysis of the sulfide minerals present in the overburden, such as percent pyrite, calcopyrite, pyrrhotite, etc. Additionally, the exact locations of the samples and at what depth they were taken would be important to review.

PTFI's own data suggest a potential for ARD. The SEL Appendix Determination of Potential For Acid Rock Drainage indicates that *"...for the NAG* [Net Acid Generation] *tests, 26 of the 41 samples tested (63%) had either no or low potential to be acid forming"*. The report fails to address the fact that the remaining 37% of the samples have the potential to form ARD.

While availability of oxygen is a limiting parameter for ARD potential, and PTFI (Dames & Moore report/SEL Appendix) makes a case that because of the formation of *"low permeability skins"*, air convective currents may be limited, there is not enough information to indicate how permeable these "skins" are or if they indeed limit air intrusion from every possible source in the waste dump site. There is an additional source of oxygen in the rainwater that penetrates or will penetrate the mine and overburden sites. Normally, this is not significant due to the low solubility of oxygen in water, but in light of the extraordinary amount of rainfall in this area and the permeability of the waste rock, there might be enough oxygen from this source for oxidation to occur, even at a low rate.

The second point PTFI makes is the fact that there is a large limestone deposit underneath the storage area that would tend to neutralize any acid that was generated in the waste dump. How extensive is the limestone deposit, how thick is it, and what area does it cover? The SEL mentions the high permeability of the formation. If air (oxygen) can penetrate into the limestone then an "armoring" or "plating" effect might occur with the acid that is generated which would effectively coat the limestone rocks and prevent further neutralization by creating preferential flow paths. Experiments at the US Bureau of Mines and at other institutions have shown this to be the case and thus a great deal of effort must be employed to ensure the limestone is anoxic (without oxygen).

In Section 4.4.2, Ground Water, important representations are made which impact this dicussion:

"This area is characterized by high rainfall, high relief, limestone strata which are known to be cavernous in part, and valleys of glacial origin underlain by substantial thickness of glacial sediments. Because of the terrain, the complex subsurface flow situation and, in particular, the localized flow paths in the limestone, the ground-water levels vary considerably, even over short distances. The groundwater situation beneath the Carstenszweide also appears to be complex. The surface of the meadow is swampy and saturated in part. Elsewhere, the water table exists 2 to 3 meters below the surface. However, drilling indicates a succession of aquifers and aquitards, and it appears that the near surface aquifer is perched. Further evidence of perched water is provided by the presence of a sinkhole or collapse structure on the meadow on which a vortex has been observed, indicating localized downward flow through a discontinuity in an underlying aquitard. The Grasberg mine and immediate surroundings, ***including all potential overburden storage areas*** [emphasis ours], *are located near the headwaters of the Aghawagon River. The Grasberg orebody is surrounded by limestone rocks which contain solution cavities. The lack of outflow from the Carstensz and Wanagon valleys is almost certainly due to surface water entering these cavities flowing through a series of interconnected subsurface channels emerging as springs at lower elevations in the Aghawagon catchment. Surface and groundwater from the overburden placement areas around the mine should all drain towards and be captured by the Aghawagon catchment area, which eventually connects with the Otomona and Ajkwa river systems."*

This language is seemingly in contrast with PTFI's own position on ARD, re-stated here: *"A comprehensive management plan for overburden, coupled with the fact that the area is underlain with massive amounts of limestone rock, will enable PTFI to properly manage overburden so that there will be no significant runoff problems that will affect the surrounding environment. Additionally, most water runoff from the mine area and overburden piles is collected for use in the mill process where it is treated with lime to eliminate any acidity."* This statement would lead one to believe the geology of the mine and overburden area is ideally suited for complete runoff control, containment and neutralization. Yet the discussion of the geologic conditions in the *Groundwater* section seem to indicate the system is poorly understood, subject to rapidly changing conditions and is in fact hydrogeologically connected to the Aghawagon system. This connection, via a complex system of underground aquifers is such that a ready conduit for ARD products is already in place, a problem that may be extremely difficult to control. SEL language seems to support the complexity and seriousness of this issue: Section 4.4.2.1: Mine and Processing Area: *"Surface and groundwater from the overburden placement areas around the mine should all drain towards and be captured by the Aghawagon catchment area, which eventually connects with the Otomona and Ajkwa river systems."*

PTFI appears confident enough in their evaluation of ARD that they are proceeding with extensive studies of heap leaching. Other information provided by PTFI suggests higher sulfate levels in the rivers than what was earlier analyzed, thus possibly indicating ARD problems. Other explanations may explain these data such as higher sulfate analysis in upper ore bodies, but the SEL is unclear regarding this issue. Apparently PTFI remains concerned about the potential for ARD and it has retained Australian ARD experts to continue studying the matter.

An earlier Dames & Moore report on the Carstenz meadow suggested a potential problem with overburden storage in this area due to a then-unexplainable phenomenon of sink hole development in the valley floor (mentioned above in SEL language). PTFI indicated it also continues to study this issue, but as overburden is currently being placed in the meadow, it should become a high priority.

3. SOLID AND HAZARDOUS WASTE

All solid and hazardous waste from the development and operation of the mine remains within the infrastructure of the site. In other words, no waste of any kind has been moved from the general area of its generation other than to a designated "dump" area, none of which have been properly engineered to accept this waste in an environmentally appropriate manner. Numerous unlined solid waste dumps exist, beginning from the very top of the mine site area (just below the Grasberg pit) with temporary, earthen holding areas for solid and hazardous waste near the heap leaching experimental stations, assay labs and maintenance shops. Visual observation confirmed chemicals (likely used oils) floating on standing water in this area with apparent leaching through the "toe" of the earthen berm below. Additionally, dumpsters with large quantities of leaden cupels, used in gold assaying and a USEPA RCRA-regulated hazardous waste, were waiting deposition at these dumps. Lead cupels are 20-30% lead oxide and are easily solubilized.

The Concentrator site has a rather large dump area which receives on a daily basis all solid and hazardous wastes generated in the area. The dump site is not an engineered solid or hazardous waste landfill and is subjected to much higher levels of precipitation than the upper mine site. The tailings also begin their journey here, cutting down the steep slope of this area, some of which apparently is continually pushed out to reclaim land for the expansion of the operations. The dimensions are difficult to estimate because it is deposited across the glaciated and river-cut valley of the headwaters of the Aghawagon River and at the far edge of the Concentrator infrastructure, but it is at least 500 feet across at the "face", possibly 100 feet deep and extends towards the Concentrator infrastructure. PTFI could not verify how far the "landfill" may lay under this area.

PTFI indicated that at least one landslide had removed the concentrate and diesel lines from the roadside pathway in the Highlands area. These lines contain the 32% - 38% copper concentrate as well as the diesel line pumping fuel from the lowlands. It was unclear whether the spills were remediated. PTFI believes it has the capabilities to quickly stop such flows, via emergency shutdown procedures, from the pipelines when such an event occurs. However, it was unclear whether PTFI has a formal emergency response plan to respond to such events.

No inventory of wastes generated during the entire project has ever been developed nor is there a master list of potentially hazardous chemicals used throughout the COW. Given the nature of the types of "mini-industries" comprising the infrastructure of the site, hazardous wastes likely to have been dumped in these areas are used oils, unintended chemical and fuel spills, greases and solvents, off-specification and/or old flotation reagents, PCBs, paints, explosives, laboratory and assay wastes, drilling muds, herbicides and pesticides and vehicle/equipment lead-acid batteries. It is recognized that this list is speculative, however, these constituents have almost certainly been used at this site, and as no wastes have been removed from these areas, it must be assumed that they are still present.

According to PTFI, polychlorinated biphenyl (PCB) transformers have been removed from service and "entombed" at the Mine site; PCB-containing capacitors are still in service, and as a practical matter, an acceptable practice so long as they are not leaking fluids. A highly regulated hazardous substance in most countries in the world, PCBs are extremely environmentally persistent, bioaccumulative, bioamplified, and become bioconcentrated in animal populations, including humans. According to USEPA's Office of Health and Environmental Assessment, they are a "Group B2" chemical, considered to be a "probable human carcinogen".

A solid waste deposition area exists at the town of Tembagapura, according to the SEL and according to PTFI, there is concern that portions of it may have washed down the Aghawagon River. A Ministry of Mines & Energy official indicated that he had smelled solvents in a dump area near the helicopter pad and had seen chemical leachate oozing from the dump.

Additionally, small dumps exist throughout the infrastructure including one at Ridge Camp, the site of most vehicle and heavy equipment maintenance as well as the major rebuild/repair and fabrication facility. This site, unobserved during the visit, may be particularly problematical due to the nature and quantity of the wastes typically generated at large maintenance facilities such as paints, oils, greases, and (likely) chlorinated solvents. Chlorinated solvents were commonly used in industry worldwide until the late 1970s when alternatives were developed. Even so, chlorinated solvents can be found in use in many parts of the world today and are very common groundwater contaminants.

All of these dump sites are susceptible to high precipitation and permeability (according to geologic representations made in the SEL) and should be considered highly capable of leaching hazardous constituents into the surrounding ecosystem including the river and possibly groundwater resources. Each of these may have, depending on a variety of factors, the capability of posing severe, local contamination problems that may persist well into the future, absent remedial attention. The SEL suggests that groundwater resources are relied on by numerous developments within the COW, especially in the lowlands (Timika, Mile 39 construction camp, Timika Airport, Kwamki Lama, Agata and

Mapurujaya). However, it is difficult to determine precisely which current and planned developments rely on groundwater supplies. Additionally, the SEL recognized that limited groundwater monitoring has been implemented throughout the COW and that which has been done shows no signs of contamination, however, no information and/or raw data were presented beyond the simple description. PTFI has no plans for remediation of any of the dumps or landfills.

These observations contrast sharply with representations made in the SEL. Section 3.4.3 states: *"Waste Management and Recycling: PTFI has an aggressive waste management and recycling program. Items recycled include: aluminum, steel, waste oil, drums, wood, wood pallets, and copper wire. Disposal of waste occurs in two landfills....one at Mile 74 (highlands) and Mile 38 (lowlands). The lowlands landfill is also the site where scrap metal materials are stockpiled."* While some components of this may exist at any one time, the site inspection, coupled with interviews of PTFI personnel, did not corroborate these statements. The huge Mile 74 site, literally a "dump" and not an engineered "landfill", had in large quantities virtually every item on the list of "recyclables" including a spool of large gauge copper wire. Additionally, numerous sites throughout the COW act as very active, daily operated solid and hazardous waste dumps, and is not restricted to *"two landfills"*.

Numerous underground and above ground storage tanks (USTs and AGSTs, respectively) containing fuels and other chemicals exist throughout the site, all of which have the potential to become problematic should they leak.

A complete inventory should be conducted of all potentially toxic chemicals used and disposed of during the life of the project. Additionally, a thorough understanding of the hydrogeology surrounding the potentially affected areas is crucial. The SEL states, pages 1-21 to 1-22: *"Regional hydrogeology was studied through a literature survey. Regional groundwater quality and groundwater use were assessed on the basis of data from water wells in the Study Area. A summary of available information was compiled about shallow and deep groundwater in the Study area and its present and anticipated future use."* Unfortunately, no specific hydrogeological information was included in the SEL, such as comprehensive groundwater monitoring system installation /maintenance/sampling techniques, analytical parameters, peizometric and potentiometric contouring, and other important components of a rigorous groundwater monitoring program. The information that the SEL suggests exists should be independently reviewed.

Current waste management plans vary according to the geographic area within the infrastructure. PTFI plans to continue to dump, for the foreseeable future, all solid and hazardous waste at the mine site in the area which has received all waste in the past. The large site at Mile 74 (Concentrator) continues to receive waste on a daily basis. Plans to remove newly generated solid and hazardous waste from this area to a lower, properly designed (solid waste design only) landfill are being considered. The authors recognize PTFI's recent efforts at contracting portions of the solid waste problem to outside companies, but the overall situation requires an immediate and comprehensive effort.

The landfill at Tembagapura is considered "closed" by PTFI; however, this does not mean it has been closed via an engineered approach ie: capped with an impermeable liner, installed monitoring wells in addition to a leachate detection and collection system, etc. Rather, no solid and hazardous waste apparently continues to be deposited in it, according to PTFI, however, there is virtually nothing prohibiting long-term leaching of chemicals from this site.

Plans to upgrade the landfill at Timika are underway, yet the landfill will still accept hazardous waste along with solid waste. As an inventory of hazardous waste generation at PTFI has never been conducted, the quantities and qualities of waste to eventually be deposited remains unknown. The facility will not be constructed to state-of-the-art specifications for hazardous waste management.

Timika is a rapidly developing town and relies on groundwater resources as do other towns and developed areas in the lowlands. Priority consideration should be given to early protection of these resources.

Amamapare (Portsite)/Concentrate Dryer

Perhaps the most troubling lowlands landfill problem is the site at Amamapare (Portsite). Portsite encompasses the Concentrate Drying Plant and shipping operation. The drying plant uses a disc-filter system to aid in drying the concentrate prior to shipment to Japan. The dryers utilize rotating disc filters which are changed out on a daily basis. Current estimates of waste filter generation is approximately 60 per day, according to PTFI. These filters, impregnated with approximately 32% - 38% copper (and an undetermined quantity of silver, also a potentially toxic metal, as well as possible other heavy metals), are dumped at Portsite in an area hydrogeologically connected to the surrounding mangrove estuarine forest. PTFI states that all filters for the history of the project have been disposed in this manner, yet no environmental monitoring plan has been developed to determine if copper or other heavy metal constituents is leaching from the reclaimed landfill area into the estuary. This potential problem should be considered a high priority.

Additionally, the wastewater treatment plant for the Concentrator may be insufficient, based on its size for a lower production rate than that proposed in the SEL, to properly handle wastewater discharges to the estuary. PTFI indicated that "low" copper levels are found in the estuary and may be related to the wastewater discharge as well as from other sources discussed in this section. Any studies that have been generated to address this problem, including raw data, should be independently evaluated.

Observations during the site visit included noticeably greenish small pools of standing water, both within and without the concentrate storage buildings. Additionally, blueish-green crystallization was noticed on building foundations, concrete walkways and dirt roadways. This is likely copper-contaminated media, the result of numerous sources of runoff from the concentrate dryer operations. This may have an overall effect of additional copper loading to the soils and groundwater of the facility, including potential leachate into the surrounding estuaries.

Finally, the concentrate drying plant at Portsite would be required, were it located in the United States, to adhere to the New Source Performance Standards (NSPS), Subpart LL-Standards of Performance for Metallic Mineral Processing Plants. This regulation has particulate standards of 0.5 grams per dscf and 7% opacity. Additionally, no source of fugitive emissions can have more than 10% opacity. (Opacity of the Portsite stack was read at approximately 45% at the time of the site inspection). The air emissions from the concentrate dryer may contain hazardous constituents, especially at the 1000 to 1600 degrees Fahrenheit operational temperature reported in the SEL, whereby heavy metal and sulfur oxides may be formed. According to the "Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point/Area Sources, 4th Edition, USEPA, Sept. 1985 (otherwise known as **AP-42**), para. 7.3.1, Primary Copper Smelting/Process Description: *"Once the ores containing less than 1% Cu are concentrated to about 15-25% Cu and 25-35% Sulfur, the concentrates are roasted. In roasting, the concentrate with a siliceous flux are heated to an air temperature of about 650-900 degrees C (1200-1500 degrees F). This eliminates 20-50% of the sulfur as sulfur dioxide and impurities such as antimony, arsenic, and lead are driven off"*. Note that this description is for an ore of "less than 1%" whereas PTFI ore is just under 2%, thus, the emissions of the dryer in Portsite may be even more in question.

Additionally, the burning of large quantities of used oils (approximately 2,000 gal/day) will result in increased emissions of heavy metals (chrome, nickel, cadmium, lead and sulfur dioxide). Some copper concentrates contain arsenic, cadmium, lead, antimony and other heavy metals, however, a review of air emissions monitoring data, should it be available, will indicate if this is a problem in Amamapare. Specifications on the air pollution control train (APC) were not available for review.

4. MONITORING

PTFI has collected various types of environmental data and information from the site and continues to do so on an on-going basis. While much of this is used and/or quoted in the SEL, a great deal of information exists, according to PTFI, that is not quoted or used in the production of the SEL. Much of this information, such as the Pipeline Tailings Alternative Study has not been available for independent review.

The SEL states in Section 1.4.1 Existing Data/Sources Used In This Study: *"Considerable information and data already existed on many of the components discussed in this report. The use of those data, coupled with the new primary data/samples/collections made specifically for this study, gives a high degree of* *reliability regarding the statistical accuracy of the data. In other words, the primary data collected specifically for this SEL study are within the range expected based on statistical analyses of the existing available information from repetitive sampling and data collection over several years."*

Several comments should be made regarding the above statement. By the SEL's own language, it emphasizes that important conclusions regarding potential environmental impact are represented in the document based on historical data, but this is not necessarily an appropriate extrapolation of conditions to be expected based on a dramatically increased production rate over what was originally investigated. The SEL indicates which studies were included as part of the total review (pg 1-37); it should be noted that the latest environmental study was in 1991 (Environmental Evaluation Study on Copper Mine Activities, Freeport Indonesia, 1991). During 1991, ore production averaged only 35,2000 TPD, far from the projected 160,000-plus TPD that PTFI currently proposes. The review of the SEL by the authors did not provide sufficient assurance that PTFI clearly understands the environmental impacts of the lower historical production rates let alone the dramatically increased rates proposed by the SEL.

Secondly, the statement implies that by combining historical as well as present data, *"a high degree of reliability regarding the statistical accuracy of the data"* is automatically imparted to the SEL. This is simply not true. Statistical accuracy and reliability are a function of rigorous, scientifically-applied principles of mathematical formulae and does not rely merely on the combination of past and current studies, the accuracy of which may both be highly suspect, or conversely, coincidentally robust from a statistical viewpoint.

PTFI has a formal environmental structure within the company, and encompasses several components. All environmental work is overseen by Crescent Engineering, based in Louisiana, a group formerly comprising the in-house environmental section of PTFI until it became a recently "out-sourced" company. Additionally, the site has a full-time environmental manager who overseas four full-time professionals who work in the lab. Another full-time environmental manager lives and works in Jakarta whose main duties have involved the development of the SEL; he currently interacts full-time with Indonesian regulatory officials from a variety of agencies. PTFI is in the process of increasing its environmental professional staff but the remote location of the mine and infrastructure complicates the hiring process.

PTFI has recently undertaken an in-house environmental audit which was not available for review. It is also currently planning for an environmental audit to be performed this fall by BAPEDAL and a consultant. The consultant selection process is underway.

Environmental data collection, transportation, analysis and interpretation has evolved since project inception; until recently, most analytical work has been performed at the Bell Chase laboratories (currently owned by Crescent Engineering). PTFI indicates that numerous problems have occurred and continue to occur regarding sample shipments and holding times, particularly for samples shipped through Cairns, Australia, where samples may remain in the country for 2 to 3 months, prior to government approval for shipment. Depending on the requested analysis and the matrix being analyzed, chemical samples have a certain period of time they may be held in storage prior to their actual analysis and before their original chemical "makeup" may become altered by such storage. This varies from one chemical constituent to another. For example, heavy metals may be held in storage longer (up to 9 months for many metals) than organic samples (as little as two weeks or less) as a general rule. It is crucial, however, that samples reach a laboratory and undergo analysis within a specified time in order for them to be considered "valid" analytical data. If sample handling protocol is violated, the data are often held suspect. PTFI indicates that all field notes, sampling and analytical protocol, holding and shipping times, etc. are available for review. This was not included as part of the SEL and was not available at the time of this report.

A new environmental laboratory has been constructed by PTFI at Timika, near the airport. The purpose of this lab was to ensure a greater quality of data from PTFI and to reduce shipping and holding time error. It is currently undergoing an initial "shakedown" involving calibration of instruments, training of personnel, obtaining new instrumentation as well as the generation of written Quality Assurance/Quality Control procedures. The lab is headed by an Indonesian Ph.D. chemist trained in the U.S. It is currently equipped to handle various types of metals analyses but has yet to obtain the instrumentation to perform organic chemical analyses. Freeport corporate (Crescent Engineering) indicates that it plans to initiate analytical capabilities in a stepped fashion, beginning with metals analyses. No specific plans are underway to perform comprehensive organic analyses and/or to purchase the necessary analytical instrumentation such as a Gas Chromatograph (GC) or a Gas Chromatograph/Mass Spectrophotometer (GC/MS). The Ministry of Mines & Energy expressed their dismay that PTFI had no specific plans to perform organic analysis at the Timika lab.

The capabilities to perform relevant organic analysis at PTFI will be crucial to on-going, meaningful monitoring efforts. This will be especially true for bioassay and ecotoxicological studies as well as on-going water quality monitoring. As noted above, holding times for organic chemistry samples often have a very short allowable period, thus it will be important for PTFI to take this into consideration in current and future analytical planning efforts.

As mentioned above, the Bell Chase lab has performed the majority of the chemical analyses from samples obtained at the site. Crescent has indicated that its lab will act only as a "backup" and/or Quality Assurance laboratory and will not be engaged in primary chemical analysis from the end of this year forward. Even in this proposed restricted role, it should be recognized that this is a potential conflict of interest. The use of a truly independent laboratory for quality assurance reasons, possibly located in Indonesia or Australia, to minimize sample transportation and holding times, should be strongly considered.

The heart of the on-going monitoring plans for the PTFI site is contained in the Environmental Management Plan (Rencana Kelola Lingkungan or RKL) and the Environmental Monitoring Plan (Rencana Pemantuan Lingkungan or RPL), none of which are formally a part of the SEL, nor were they available for review for this report. PTFI indicates that these are currently under development and will be available at a future date. The GOI requires these as part of its approval of the SEL process.

Additionally, PTFI is implementing its Long Term Environmental Monitoring Plan or LTEMP; while this is not technically a part of the SEL nor an Indonesian regulatory requirement, it is an important part of what PTFI is attempting to do in order to fully understand the environmental impact of the project. It is unclear whether the LTEMP is a protocol or a stand-alone report available for independent review.

A general observation should be made regarding presentation of data in the SEL. The SEL reports data on numerous occasions in terms of "average" or "representative" analyses. While average or mean data can be useful, it can also be misleading. For purposes of environmental impact analyses, it is frequently the outliers (extreme data points) as well as the ranges that are more useful. This is a basic deficiency in the report.

Additionally, tables and/or discussion of chemical analyses are frequently inconsistent insofar as the range of parameters being presented. For example, in Table 3-4, Representative Analyses of Mill Tailings and Amamapare Settling Pond Wastewater (pg 3-33 of the SEL), silver is omitted from the presentation and yet it is presented in other tables or discussion in the report (Section 6.1.1.2 Geomorphology, Surface Water, Groundwater & Water Quality). It is unclear if it was analyzed at all (for this particular regime of sampling activities), or if it was omitted for some other reason. This is important for obvious reasons; silver is not only found in the ore body (it is a process-recovered metal albeit likely not with 100% efficiency), but is also a potentially toxic metal. No explanation for this important omission was given nor is it explained in other instances in the report when such data reporting errors are made.

While computer modeling is an important tool and may be used for a variety of environmental investigations, it should not be used as a sole source of predictive analysis. PTFI has used the computer model MINTEQ, without explaining how it was used, what assumptions were considered, etc. It is not a flowrate model, but has been used by PTFI for that purpose. As it cannot be used to predict change in production rates, it may be an inappropriate model.

Finally, it should be noted that sampling of the tailings-impacted Aghawagon river does not occur during the first 25 miles. PTFI indicates that monitoring in this stretch is limited by steep terrain, however, the site inspection revealed that a road adjacent to the river exists just below Tembagapura, which certainly allows access to the river at this point. Additionally, it is possible to sample water chemistry at the tailings discharge point at the Concentrator site. Apparently, this has been done on a periodic basis, however, the data are presented marginally in the SEL.

5. RECLAMATION

PTFI continues its reclamation program which includes planting and monitoring, and to some extent, the mine site and tailings areas. Some re-planting was observed at the upper Mine site, which included plants removed from an area designed to be heavily impacted. These were planted in a small area near a crusher conveyor; PTFI indicated that additional efforts are planned for re-planting this area.

Reclamation efforts are also underway in the lowlands, where tailings sheeting has caused considerable problems, especially since the floods of 1990. PTFI has planted an extensive area of tailings and continues to monitor the biological diversity and heartiness of the plants. PTFI apparently is not monitoring potential heavy metal uptake in the plants or if it is doing so, it has not made the data available. This may be an important issue as sago and other crops found in this area are harvested by local people and heavily relied on as part of their staple diet.

The GOI is relying heavily on PTFI to fulfill its commitment for complete site reclamation and has made it clear that proper reclamation is the "bottom line". PTFI indicates that they have a full-time staff dedicated to reclamation activities and that results are carefully monitored.

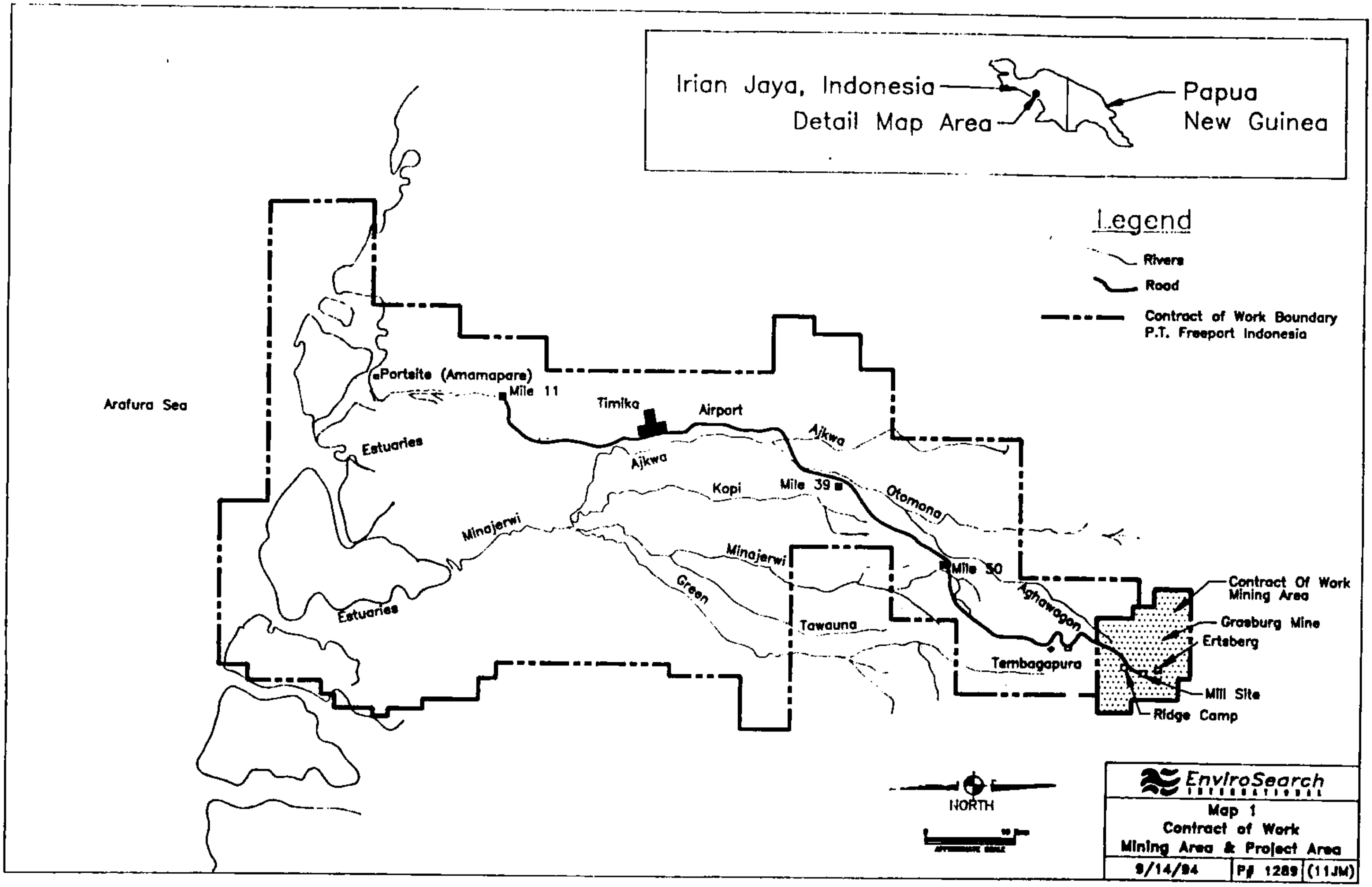
As mentioned earlier, the former path of the Ajkwa River, not currently being impacted due to the eastward sheeting to the Minajerwi River, could be seen from the air to have grown over; the schedule would not permit ground observation of these areas, however, this should be closely monitored. Specifically, it may be important to monitor, given the diets of local people as well as the possible impacts to fauna and flora, potential heavy metal uptake in these plants as they appear to be taking hold in tailings-impacted areas.

6. HEALTH, SAFETY & INDUSTRIAL HYGIENE

The health, safety and industrial hygiene program at the PTFI site is currently increasing in importance to the project, including enhancement of technical capabilities and training on the part of new employees. From the beginning of the project, the GOI has been actively involved with mine safety issues, frequently making inspections of the above and underground portions of the mine; that portion of the program has also matured within PTFI.

The relatively recent addition of a full-time, experienced, qualified health, safety and industrial hygiene professional who oversees two full-time technicians will substantially help the program. Written protocols are currently being developed which will include all aspects of the program but will initially concentrate on dust in the underground mines as well as potential radon exposures.

PTFI indicated that the safety/accident record for the site last year met U.S. standards for the industry, however, the report was unavailable for review.


Irian Jaya, Indonesia
Detail Map Area
Papua
New Guinea
Legend
Rivers
Road
Contract of Work Boundary
P.T. Freeport Indonesia
Arafura Sea
Portsite (Amamapare)
Mile 11
Timika
Airport
Ajkwa
Ajkwa
Estuaries
Estuaries
Kopi
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Otomona
Minajerwi
Minajerwi
Green
Tawauna
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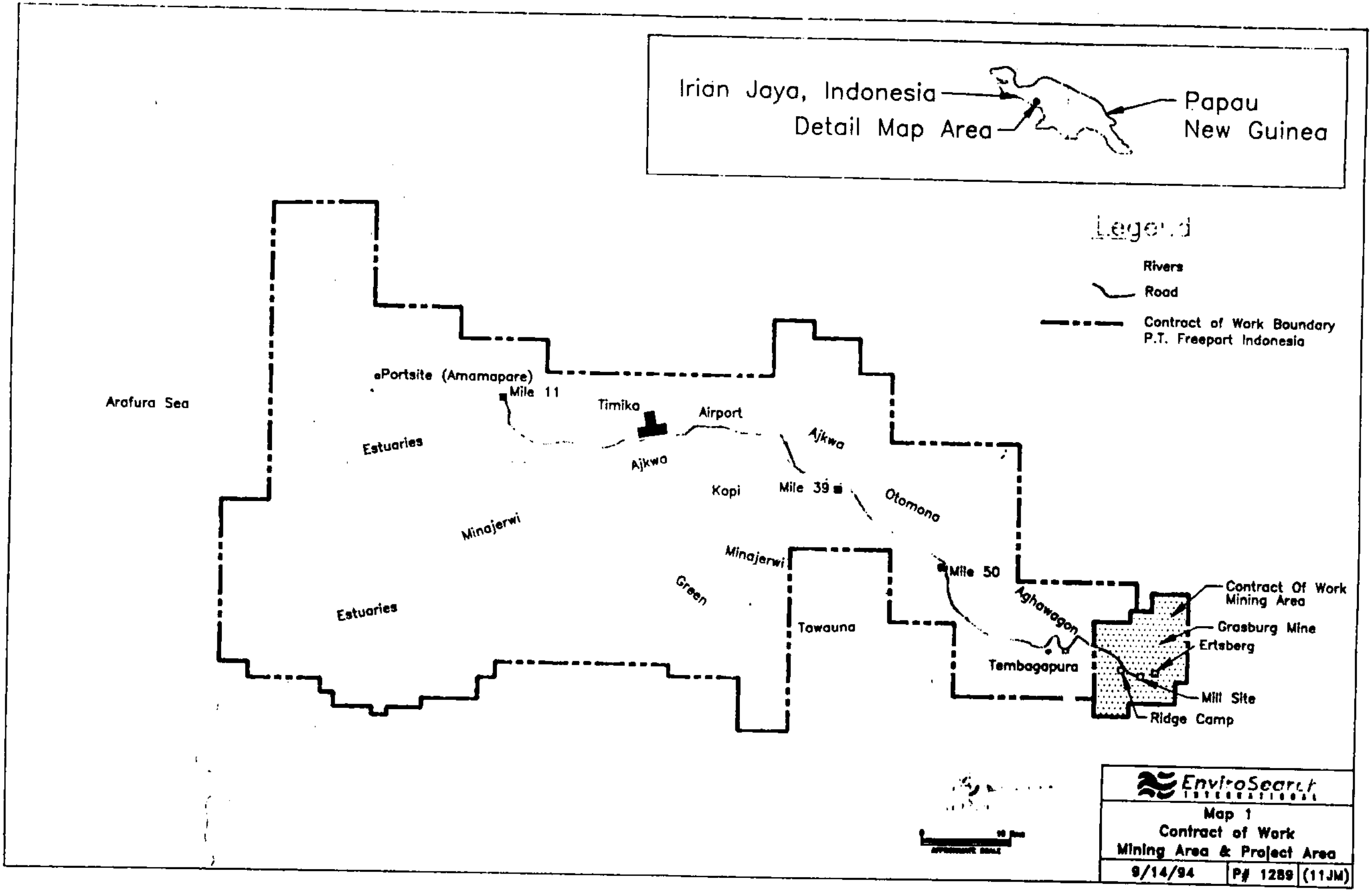
Aghawagon
Tembagapura
Contract Of Work Mining Area
Grasburg Mine
Ertsberg
Mill Site
Ridge Camp
NORTH
EnviroSearch
Map 1
Contract of Work
Mining Area & Project Area
9/14/94
P# 1289
(11JM)



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__Representation:__

"The impact of process waste released to the river (the deposit of sediment in the river bed and the resulting meandering of the river outside its current channel) is of a physical nature which is difficult to separate from processes that occur naturally." (emphasis added)

source: Freeport ANDAL Executive Summary submitted by Freeport November 2, 1989 in support of Insurance application

__Finding:__

"Because of tailings disposal the affected rivers carry a significantly increased sediment load on the average compared to natural conditions and this alters the fluvial geomorphology of the drainage."

source: Freeport SEL February 1994, Volume II, (Appendix. Section 5.4.3.4. (emphasis added)

__Representation:__ "The present expansion of the mill to 52,000 metric tons per day will not have a significant effect upon the river system."

source: Freeport: Environmental River Study, 1990, p. iii.

__Finding:__

"The deposition of tailings and natural sediment [in the overflow area between the Ajkwa and Minajeri Rivers] is altering the topography of the overflow area....the topographic change is essentially permanent and of very high intensity. It has a cumulative effect of has become significant within a relatively short time. The impact is irreversible and has compound effects on many other environmental components, including soils, vegetation, fauna and actual or potential land use." (emphasis added)

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September 5, the day after Labor Day, for your final response.

Appendix A

(1) Scale of the project: The application materials described the project as having a maximum production of 52,000 tons per day through the year 2003. According to information submitted to us by Freeport, the mine is currently producing more than 100,000 tons per day. At no time prior to our monitoring did Freeport inform us that production levels had expanded significantly beyond the 52,000 ton-per-day level.

(2) Operating controls: The application materials indicated that the river system could absorb the tailings without significant adverse impacts provided that the volume and ~~tailings were ground to a specified~~ grain size distribution of the tailings met certain [illegible] before discharge. Information obtained from Freeport in the course of our monitoring indicates that this volume and grain size distribution has not been sustained.

(3) Environmental Impact: Freeport represented to us that the impact of the tailings on the river system would be "difficult to separate from processes that occur naturally." Freeport's own data, obtained through our monitoring, site visit and other independent sources of information, strongly contradicts this representation. In fact, the project has devastated the river system, through excessive discharge and deposition of tailings.