MINERAL RESOURCE ASSESSMENT (MRA) OF SAMAR ISLAND[1]

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by

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EXECUTIVE SUMMARY

The main objective of the Mineral Resource Assessment (MRA) is to determine the viability of pursuing mineral utilization activities in Samar Island and explore how these activities may contribute to the efforts of conserving biodiversity. Specifically, the MRA involves the following components: (a) characterization of the mineral deposits in Samar Island; (b) evaluation of the identified mineral deposits in terms of their mineral utilization potentials; (c) establishment of the values and costs of mineral utilization activities; and, (d) evaluation of the inter-relationship of mineral utilization activities with other potential land uses within the Samar Island Forest Reserve (SIFR).

Qualitative Assessment: The general distribution of mineral resources found in Samar Island is tabulated in ***Table 1.***

Table 1
General Distribution of Mineral Resources in Samar Island

Mineral Resource	Location	Percentage, (%)	Positive Prospect, MT	Grade, %
Bauxite	Mineral Reservations	81.47	149,422,000	41.38 % Al_2O_3
Nickel Laterite	Eastern Samar	8.18	14,995,310	0.78 % Ni
Copper	E. & W. Samar	4.87	8,924,973	1.20 % Cu
Pyrite	Western Samar	4.40	8,062,000	35.46 % S
Chromite	Eastern Samar	0.02	372,000	41.15 % Cr_2O_3
Manganese	Western Samar	0.01	18,570	32.59 % Mn
Others (coal, marble)				

Quantitative Assessment: At the outset, only the amount of mineral reserve and the metal/mineral contents are the only criteria used to evaluate positive prospects, which can be developed for commercial mineral utilization. Mineral utilization involves activities such as development, mineral extraction, processing, rehabilitation and marketing of metals/ or minerals.

The positive mineral prospects considered for initial evaluation in this MRA are as follows:

1. *Bauxite (source of Alumina which is a raw material for Aluminum metal)*

   Deposits: Concord, Hinabangan and Guiuan Areas

   Reserve: 137,859,997 MT with 42.99% Al_2O_3

2. *Copper and Pyrite (source of concentrates for the production of Copper metal and Sulfur)*

   Deposit: Bagacay, Hinabangan

   Reserve: 1,424,973 MT with 2.4 % Cu & 8,062,000 MT with 35.46 % S

3. *Nickel Laterite (source of Nickel oxide and Ni metal)*

Deposit: Hibacon, Borongan

Reserve: 13,278,310 with 0.58 % Ni

Economic evaluation of mineral deposits will be based on this basic equation:

$$V = (A \times B) - (p + q + r + ...)$$

where: V = Value of the deposit; A = workable reserves of mineral/metal; B = cost of metal/mineral; and p, q, r = mining, processing, environmental mitigation costs, etc...

The Net Present Value (NPV) approach was used as the evaluation method. This method forecasts the stream of future net revenues that a positive mineral resource would generate if utilized optimally, and then discounts this revenue stream using an appropriate cost of capital.

The summary of the evaluation of the above-mentioned positive mineral resources is shown in ***Table 2***. Also incorporated are the estimated life of the reserve and the area (in hectares) which can possibly be affected by any activity of mineral utilization. The open-cast method is generally the method to be applied to extract the bulk of materials from the positive reserves. The processes to recover the valuable mineral or metal from the respective mineral deposits are unique for each of the deposits. This will in turn entail different treatments for the resulting tails or waste materials generated from each respective process.

Basic assumptions applied in the evaluation scheme: (1) a three year period is allotted for exploration and development before actual production; (2) A 50% factor is used to determine the recoverable ore for deposits that had undergone semi-detailed exploration and 90% factor for deposits which had undergone detailed exploration; (3) A constant process recovery is assumed; (4) A constant price of metal or mineral per MT is also assumed to be constant throughout the life of the mine; (5) An excise tax of 2% is applied to the gross revenue as a result of sale; (6) Depreciation and depletion were computed using the straight – line basis throughout the life of the mine; (7) Environmental cost is derived from a percentage, i.e. 15%, of both the mining and processing costs; (8) Income tax was assumed to be 35% of the net income before income tax; (9) the exchange rate for 1 US$ was pegged at PhP 50; (10) 12 % discount rate was used in the computation of the NPV.

The Marshall and Swift Cost Index[13] (Open-cast method and Processing) was employed for updating costs incurred in the mineral utilization of above selected positive prospects. Accuracy of estimation is at ± 30 %.

Conclusions and Remarks: The evaluation for bauxite deposit showed more promise compared to the other deposits in support of the conservation of biodiversity because of the following reasons:

(a) A reasonable amount can be allotted for environmental measures to mitigate possible damages incurred in the course of conducting mineral utilization activities.
(b) Some of these mitigating measures can involve a comprehensive rehabilitation program, which includes waste treatment and reforestation activities to restore or even improve the original land and vegetation patterns before performing mineral utilization operations.
(c) Both sustainable mining and processing can be practiced from the very start of operation because of the initial installation of environmental structures and facilities to address immediately negative environmental impacts arising during the course of mineral utilization.

Therefore, the mineral utilization of Samar's bauxite deposits can be considered as a potential land-use alternative within the SIFR.

Table 2
Summary of Mineral Resource Assessment of Samar Island
(Quantitative Evaluation)

Mineral Prospect	Reserve and Grade	Recoverable Ore and Life of Mine	Locations	Coordinates	Area Affected by Mining, hectare *
BAUXITE	137,859,997 MT 42.99 % Al2O3	90,411,373 MT 21 Years	Onong, Salcedo, E.Samar Palomorag, Mercedes, E. Samar Campayong,Guiuan, E. Samar Concord, Hinabangan, W. Samar	11° 26"00'N- 125°28"45'E 11° 12"30'N- 125°13"45'E 11° 01"30'N- 125°44"00'E 11° 45"00'N- 125°12"00'E	324 324 324 3000
COPPER-PYRITE	1,424,973 MT 2.4% Cu 8,062,000 MT 35.46% S	1,252,476 MT 2.4% Cu 7,255,800 MT 35.46% S 11 Years	Bagacay, Hinabangan	11° 47"00'N- 125°15"00'E	648
NICKEL (Lateritic Nickel)	13,278,310 MT 0.58 % Ni	11,950,479 MT 12 Years	Hibacon, Borongan	11° 31"00'N- 125°24"00'E	648

* Area affected by Mining : include the mining area, milling area, community, tailings disposal area

Table 2 (cont.)
Summary of Mineral Resource Assessment of Samar Island
(Quantitative Evaluation)

Mineral Prospect	Mining Method	Processing Method	Environmental Consideration	NPV(12%) Pesos, IRR, %
BAUXITE	Open Pit Mining without the use of explosives	Bayer Process for the production of 99.5% Al_2O_3 *Digestion, Clarification Precipitation, Calcination Prod: Alumina	Red Mud Disposal Dusts & gas Emissions Water consumption	34,213,183,567 39%
COPPER-PYRITE	Open Pit Mining with the use of Explosives	Differential Sulfide Flotation * Comminution, Classification, Flotation, Thickening, Filtering Prods: Copper Conc. (35% Cu) Pyrite Conc.(55% S)	Tailings disposal Acid Mine Drainage	1,107,196,897 36%
NICKEL (Lateritic Nickel)	Open Pit Mining without the use of explosives	Flotation-Leaching Process * Ore preparation, Flotation, Leaching, metal recovery Prod: Ni Oxide (55%Ni)	Tailings disposal Dust & gas emission Water consumption	479,328,986 15%

**$1 - PhP 50

MINERAL RESOURCE ASSESSMENT (MRA) OF SAMAR ISLAND

1. INTRODUCTION

The significant contribution of mineral resources to society can be measured in many ways regardless of the measure used. However, an assessment of a country's mineral potential is an essential information specially if it seeks to develop a sustainable economy and an acceptable land-use program. This is the very essence of a Mineral Resource Assessment (MRA) Study.

In this study, Mineral Resource Assessment (MRA) is a scientific tool adopted by SAMBIO to evaluate the mineral prospects found within Samar Island in relation to biodiversity conservation and other potential land uses particularly within the proposed Samar Island National Park (SINP). It is then the aim of MRA to determine the net present value (NPV) of the different positive mineral prospects assuming that these mineral deposits would be subjected to mineral utilization in the future. Mineral utilization will include activities like exploration, development, mining, processing, and eventual marketing of derived valuable minerals/ metals.

Undoubtedly, Samar Island is one of the country's endowed islands in terms of natural resources. In particular, the mineral resources of Samar Island have caught the special attention of many for the last three (3) decades because of the existence of a very large volume of Bauxite deposits presently amounting to around 149 million MT. These bauxite deposits are also considered as world-class deposits for they contain very high levels of Al_2O_3 ranging from 42-50 %. Aside from bauxite, there are also potential deposits containing metallic mineral of copper, pyrite, nickel, iron, manganese, gold, silver, uranium, chromite, and platinum, and non-metallic minerals such as clay, coal, limestone, marble, gemstones, phosphate and guano.

1.1. Objectives of the Study

The main objective of the Mineral Resources Assessment (MRA) to be conducted on Samar Island is to determine the viability of pursuing mineral utilization activities and how these activities contribute to the efforts of conserving biodiversity. Specifically, the MRA involves the following components: (a) characterization of the mineral deposits in Samar island; (b) evaluation of the identified mineral deposits in terms of their mineral utilization potentials; (c) establishment of the value and cost of mineral utilization activities; and, (d) evaluate the inter-relationship of mineral utilization activities with other potential land uses within the Samar Island Forest Reserve (SIFR).

1.2. Methodology

Three (3) major activities where set in order to accomplish the objectives of the MRA: Qualitative Assessment, Quantitative Assessment, and Integration /Inter-relation Activity.

1.2.1. Qualitative Assessment

This activity involves the gathering and review of secondary data on the different mineral resources present in the whole island of Samar. Primary data were also gathered through fieldwork and key informant consultations to validate essential secondary data.

Review of Secondary Data: All pertinent materials that would give comprehensive information about the mineral resources of Samar Island were gathered from various sources, namely: (a) government agencies like the Department of Environment and Natural Resources, Central and Regional offices of the Mines and Geosciences Bureau, Environmental Management Bureau, and National Institute of Geological Studies (NIGS) of the University of the Philippines; (b) existing projects conducted by foreign funded studies like those of Asian Development Bank (ADB), World Bank (WB), and United Nations Development Program (UNDP); (c) concerned Non-Government Organizations (NGOs) and People's Organizations (POs). A thorough review of records, publications, geologic and mineral journals, scientific papers, technical articles, and magazines coming from the abovementioned sources was conducted. Topographic, geologic, and mineral maps served as special tools to verify gathered information about the different mineral deposits found in Samar Island. Video tapes, aerial photos, and photographs of existing vegetation covering the different mineral areas were also gathered.

Primary Data Gathering: A Mineral Resource Assessment team composed of mining engineers and geologists from the Regional MGB, was organized mainly to identify potential mineral areas and at the same time gather mineral samples for physical and chemical characterization. Pictures were also taken during fieldwork in the various mineral areas. Aside from validating secondary data, the following were deduced from this activity, namely; (a) the present status of vegetative covering within the mineralized area and the actual terrain surrounding the area which determines the possible mining method to be applied; and (b) the chemical and physical characterization will determine the most viable processing method to be applied to extract the valuable minerals or metals from the deposit.

1.2.2 Quantitative Assessment

At the outset, the main criteria used to determine which of the mineral deposits identified can be considered potential for commercial utilization were the availability of sufficient volume and the presence of ample valuable mineral/metal found.

In the absence of detailed exploration activities to fully define the complete dimensions of a positive or measured mineral prospect, an estimated percentage was derived from a projected geologic reserve to determine the reasonable volume that can be evaluated as a potential or positive mineral deposit. This positive mineral deposit can be considered as a measured or positive mineral prospect.

The valuation of a mineral prospect depends primarily on the quantity of valuable minerals or metal it contains and their prevailing prices. Direct extraction and environmental costs incurred in the course of exploration, development, exploitation and reclamation enter into a decision matrix. The evaluation of these costs involves the physico-chemical, biological, and socio-economic aspects covering the different stages of extracting the valuable minerals from the mineral prospect. Actual life of the mineral prospect depends on the volume of the ore reserve, the market prices of the minerals /or metals, the economic, environmental feasibility, and social acceptability of the mineral extraction and processing methods that will be adopted.

The Net Present Value (NPV) approach is used as the valuation method for mineral prospects, i.e. whether or not they have commercial potential. The NPV method consists of forecasting the stream of future net revenues that a mineral resource would generate if exploited optimally, and then discounting this revenue stream using an appropriate cost of capital[1].

1.2.3 *Integration/Inter-relation Activity*

The integration/ inter-relation of mineral utilization option with other alternative land – uses intended within the SINP can result in the formulation of specific strategies that would determine the actual role of mineral utilization with that of biodiversity.

2. QUALITATIVE ASSESSMENT

Identification of various mineral deposits and their distribution throughout the region, and classifying these reserves in terms of their potentials for mineral utilization are the initial steps for the qualitative assessment of the mineral resources of Samar Island. In particular, geological studies conducted by the Bureau of Mines and Geosciences on the different minerals of Samar gave invaluable information on the geological location, topography, mineralization, volume of reserve and the mineral/ metallic assays of both main and associated minerals.

2.1. *Location and Topography*[2]

Location: The island of Samar lies in the eastern periphery of the Visayas region between the 11th and 13th north parallel and the 124th and 126th east meridian. It is located together with Leyte, within the immediate vicinity of the Philippine rift zone (plate III) and the Philippine deep, two major geologic structures greatly influencing the geology of the Philippine Archipelago. The main tectonic line of the Philippine rift zone, a strike-slip fault system, extends through the entire length of the island of Leyte, with its splays and smaller tensional faults occurring in Samar. On the other hand, the Philippine deep is a submarine trench where an oceanic plate plunges westward under a sialic block constituting the archipelago. This narrow trench follows closely the eastern coast of Samar Island and continues downward to the eastern coast of Mindanao.

Topography: The topography of Samar Island is described to have no pronounced mountain ranges and specific drainage pattern. From coast to coast, the mountain ranges are generally characterized to be low but mostly rugged and steep. The highest mountain peaks follow a curved line that traverses predominantly north-south from the northwest coast bordering Samar Sea, and passing through the center portion of the island going to the south coast of Lauan Bay. The highest documented peak on the island is only 869 meters. There are very few lowlands and swamps and the average height of the island is well above sea level.

2.2. *General Geology of Samar Island*[1,2]

The geology of the Island of Samar is characterized by an extremely varied physiography, due probably to its complex mountain building process involving a series of differential diastrophisms. The central highlands with marked accordant peaks, is almost surrounded by a karst topography where sinkholes of different dimensions are widespread while the coastal area is noted for its gently rolling terrain.

Central Highlands: The central highlands of Samar consist of a peneplaned surface that has attained a minimum elevation of 600 meters above sea level. It is made up principally of an igneous complex intercalated with slightly metamorphosed sedimentary rock, dated as Cretaceous-Paleogene. As indicated by the presence of a thick mantle of laterite soil, the igneous rocks have been subjected to intense mechanical and chemical weathering. The drainage systems in the area are deeply incised into the bedrock with characteristic V-shaped valleys and broad-crested ridges. Most of the river courses are structurally controlled.

Karst Topography: The limestone that rims the central highlands displays various karst formations. This is evidently shown because of the presence of numerous sinkholes, caves adorned by stalagmites and stalactites in the early stages of formation, and underground solution channels. Various sinkholes of different dimensions have relatively flat bottoms with steep walls and are filled with reddish to yellowish brown soil. Some valleys of the main drainage systems are filled with soil and at times accumulated to a thickness of about ten (10) meters.

Coastal Topography: The coastline of Samar is very irregular. Areas that are partly submerged from in-land swamps, while areas that are being elevated form narrow strips of sand beaches. Along the northwestern areas, where relatively older rock types are exposed, steep sea walls define the coastline. Low rolling hills with elevation rarely exceeding 300 meters above sea level, characterized the coastal parts of the Island. It is underlain by a thick sequence of gently folded limestone interbedded with shale, silt stone and thin beds of calcarenite.

The lithographic units of Samar are classed under two general rock groups: (1) the group of igneous rocks of Cretaceous-Oligocene age, comprising the island's core; and (b) the clastic and non-clastic sequence of rocks dated from early Miocene to Pliocene, found surrounding the core.

2.3. *Mineral Resources of Samar Island*

Based on the geographic set-up of Samar Island, around 70% of the mineral deposits predominantly occur in Eastern Samar and the remaining 30% is evenly distributed between North and West Samar. This may be attributed to the fact that Eastern Samar has a more complex geologic structure.

The various mineral resources identified per geographic set-up are shown in ***Tables 3, 4, and 5.***

From the various deposits the distribution of mineral reserves in the whole Island of Samar is tabulated as shown in ***Table 6.***

3. QUANTITATIVE ASSESSMENT

The two (2) main criteria considered in initially evaluating mineral prospects are volume and the amount of valuable minerals or metals present in the mineral reserve. It is important to determine what portion of the ore reserve can be extracted by mining activities and can be processed to recover the valuable minerals/ metals. To do this, a complete delineation of the reserve must be conducted through extensive exploration operations to fully establish the size, composition, shape and grade of the deposits. Detailed exploration activities involve sampling methods like drilling, test pitting, and trenching, and subject the gathered samples through physical and chemical analyses. The distribution of mineral or metal values throughout the delineated deposit is an essential factor to consider because it dictates the sequence of mining or extraction operation.

For the purpose of this evaluation study, wherein the volume and the average grade of mineral reserves were obtained solely from geological studies conducted by the Mines and Geo-Sciences Bureau, it was essential to assume a percentage of these given reserves based on the extent of exploration activities conducted. The resulting volume of mineral reserve ready for mineral utilization can be referred to as a *positive mineral prospect*. ***Table 7*** shows the identified positive mineral prospects found within Samar Island which show some potential to be developed for commercial mineral utilization.

Other criteria for evaluation like environmental viability and social acceptance are incorporated in the overall inter-relationship and integration portion of the whole SAMBIO project. However, an estimation of the overall environmental costs (fixed capital or operating costs) that can be incurred during the overall mineral utilization activities for each of the above- mentioned minerals are incorporated in succeeding discussions.

3.1. Life of Positive Mineral Reserve

Taylor[10] provided a practical and useful formulation to determine the life (years) of a certain mineral reserve when subject to mineral extraction activities. From his extensive studies and researches of operating and planning mining projects, he found out that the extraction rates seemed proportional to three-quarters power of the ore tonnage rather than to two-thirds power. He deduced further that the designed lives were proportional to the fourth root of the tonnage. This leads to the formulation of the Taylor's Rule[10], a simple and useful guide that states:

$$\text{Life (years)} \cong 0.2 \times (\text{Expected ore Tonnage})^{1/4} \qquad [1]$$

This empirical formula generates the values presented in ***Table 8***.

The rule provides an appropriate provisional output rate for preliminary economic appraisal and a range of rates for comparative valuation at the intermediate stage after which a preferred single rate can be selected for use in a more detailed economic study, such as that of a full-blown feasibility study.

Table 9 shows the determined life of positive mineral prospects (years) and the rated daily production (TPD) for the various potential reserves classified for mineral utilization in Samar Island.

3.2. *Area Influenced by Mining Utilization Activities*

Only the bauxite deposits located at Concord, Hinabangan area can be directly delineated in a based topographic map in terms of the area that can be affected by mineral utilization activities because these deposits have undergone detailed exploration activities, which specifically defined the lateral extent of the deposits. The affected area refers to the area for actual mining, area for processing, area for tailings disposal, area for housing and community, and area for social activities. Bauxite deposits in Samar are generally described to be predominantly on the surface and they extend over a wider area compared to other mineralized deposits.

Figure 1 shows the distribution of the different bauxite deposits within the Concord, Hinabangan Area. It also shows the possible area (enclosed within the red line) that will be affected in case these deposits will be subjected to mineral utilization activities. The area that can be affected by mineral utilization activities was measured to be around 3000 hectares. On the average, each bauxite deposit corresponds to an area of 324 hectares, which is equal to one (1) meridional block. The area that will be affected by mineral utilization in various bauxite deposits is shown in ***Table 10***.

Table 11 shows the areas of positive mineral prospects that can possibly be affected by mineral utilization activities for the various deposits classified as potentials for mineral utilization in Samar Island.

3.3. *Method of Evaluation*

Economic evaluation of mineral deposits will be based on this fundamental equation:

$$V = (A \times B) - (p + q + r + ..) \qquad [2]$$

where: V = Value of the deposit; A = workable reserves of mineral/metal, metric ton; B = cost of metal/ mineral, \$; and p, q, r = mining, processing, environmental costs , etc...

3.3.1. *Gross Revenue Estimation*

The computation of the gross revenue per year of production as a result of the sale of mineral/ metal is,

$$R_G = C \cdot a \cdot p \qquad [3]$$

where R_G is the gross revenue from sale of mineral/metal during a particular production year, in $; C is the amount of concentrate product for sale, in MT; a is the grade or % mineral in the final product; and, p is the price of mineral /metal,

$$C = C_A + (C_B - C_E) \qquad [4]$$

$$C_A = (F \cdot f \cdot r) / a \qquad [5]$$

C_A is a function of the % recovery, r, realized after processing, and the amount of feed, F, in MT; the head assay, f, % of the mineral or metal; and, the amount of mineral/metal in the final concentrate product, a. C_B is the amount of beginning inventory of concentrate, and, C_E is the amount of the ending inventory of concentrate for a particular year.

3.3.2 *Cost Indices*

Cost index is the ratio of costs at a particular time at a specific base year. Where the price of an item at some time in the past is known, the current prices are estimated from,

$$cost\ now = (cost\ then)\ \frac{(costs\ index\ now)}{(cost\ index\ then)} \qquad [6]$$

Of the various cost indices available the Marshall and Swift Cost Index[13] is used for Mining and Processing cost estimations. The M&S Cost Index values for Mine/ Processing are shown in ***Appendix A***. To update estimates to the current M&S index, each estimate should be multiplied by the ratio (index now)/ 820. For the succeeding calculations, the index multiplier used will be 1.44 = 1,181/ 820.

3.3.3 *Exploration Expenditures*

The exploration stage involves activities aimed to ascertain the existence, location, extent or quality of the ore deposit. Exploration expenditures paid for or incurred before the beginning of the development stage of the mine may, for tax purposes be deducted from current income. If, however, a mine starts producing, these expenditures must be recaptured and capitalized. These are later recovered through either depreciation or cost depletion.

3.3.4 *Fixed Capital Cost Estimates (Mining and Processing)*

For open- pit mining, O'hara [8] suggests that a more accurate estimate of the mine capital costs is obtained by judging the influence of specific conditions unique to a given mine. The mining capital costs are distributed as follows:

1. Site preparation for processing plant and mine roads;
2. Pre-production stripping costs;
3. Open-pit mining equipment;
4. Open-pit maintenance facilities;
5. Power and water lines estimated as part of the processing plant costs;
6. Feasibility Studies: Design Engineering and Planning;
7. Project Supervision: contract management, expediting and general construction facilities including camp costs;
8. Administration: Accounting, Legal, Pre-production employment of key operating personnel.

Table 12 shows the summary of Open Pit Mine Capital Cost estimates.

Likewise, the estimation of mineral processing plant fixed capital costs can be divided into the following categories:

1. Plant-site clearing and mass-excavation
2. Concrete foundations and detailed excavations
3. Crushing Plant, coarse ore storage, conveyors
4. Processing building
5. Grinding section, Fine Ore Storage
6. Processing section
7. Thickening and filtration Section
8. Concentrate storage and Loading
9. Electrical power supply and distribution (mine and mill)
10. Tailings storage
11. Water supply (mine and mill)
12. General Plant services
13. Access road to main thoroughfare
14. Townhouse and housing
15. Feasibility studies, design engineering, technical planning
16. Project supervision, contract management, expediting and general construction facilities including camp costs
17. Administration, accounting, legal, pre-production employment of key operating staff

Table 13 shows the summary of Processing Plant Capital Cost estimates.

3.3.5 *Production / Operating Cost Estimation*

a. Estimating Personnel Requirements [3]

The number of open pit personnel, N_{op}, required to do mining activities using shovels and trucks for loading and hauling the extracted materials may be estimated depending on the type of rock dealt with,

$$N_{op} = 0.034\ T_p^{0.8} \quad \text{(for hard rock)} \qquad [7]$$

$$N_{op} = 0.024\ T_p^{0.8} \quad \text{(for competent soft rock)} \qquad [8]$$

Where T_p is the total tonnage of ore plus waste.

The number of personnel, N_{pr}, required to operate the processing plants treating T tons of ore may be estimated depending on the various treatments applied to complete the processing, from the equation,

$$N_{pr} = 5.90\ T^{0.3} \text{ (for leaching of precious metal ores)} \quad [9]$$

$$N_{pr} = 5.70\ T^{0.3} \text{ (for flotation of low grade base metal ores)} \quad [10]$$

$$N_{pr} = 7.2\ T^{0.3} \text{ (for gravity concentration of iron ores)} \quad [11]$$

The number of service personnel, N_{sv} required for open pit mining may be estimated as a percentage of the mine and processing personnel as,

$$N_{sv} = 25.4\ \%\ \text{of}\ (N_{op} + N_{pr}) \quad [12]$$

The number of personnel required for environmental measures and monitoring, N_{En} may be estimated as a percentage of the mining and processing personnel as,

$$N_{En} = 10\%\ \text{of}\ (N_{op} + N_{pr}) \quad [13]$$

The number of administrative and technical personnel N_{at} required for the mining and processing plant may be estimated as a percentage of the total required for the mining, milling, environment and services:

$$N_{at} = 11\%\ \text{of}\ (N_{op} + N_{pr} + N_{sv} + N_{En}) \quad [14]$$

The computed personnel requirements are only those directly related to mining, processing, and environmental considerations. The additional personnel required by refineries, mine town site services, concentrate transport, offsite offices, etc. may also be estimated from a percentage of the total required for mining, processing and environment.

b. Mine and Processing Total Production Cost Estimates

The total production costs can be divided into two (2) categories, namely, Operating Costs and Supplies, Administration and General Services.

Table 14 shows the summary of Mine-Processing Production Cost Estimates on a per day basis.

3.3.6 *Working Capital (Startup) Cost Estimation*

Invariably, working capital requirements are estimated on the assumption that startup will be relatively trouble free. O'hara[8] stresses that startup costs, which include operating costs, depend on fixed capital expenditure, newness of the process and the technology to the company, newness of the equipment, labor quantity and quality and the extent of inter-plant dependency. To estimate startup costs (equivalent to working capital), the following formula was used:

$$\text{Startup Costs} = A\,(0.1 + B + C + D + N \times E) \qquad [15]$$

Where:
A = Fixed capital costs (Mining, Processing, & Environment)
B = Factor for newness of process and technology (0.05 radically new)
C = Factor for newness of type of equipment (0.07 radically new)
D = Factor for labor supply (0.04 very short)
N = No. of plants or sections that make up the process chain
E = Factor for interplant dependence (0.04 very dependent)

3.3.7 Cash Flow

The components of the annual cash flow analysis for a mineral utilization operation is shown in ***Table 15***.

3.3.8 Net Present Value

The Net Present Value (NPV) approach was used as the evaluation method. This method forecasts the stream of future net revenues that a positive mineral resource would generate if utilized optimally, and then discounting this revenue stream using an appropriate cost of capital [1].

3.3.9 Basic Assumptions for the Evaluation of Mineral Resources

The basic assumptions used in evaluating the different positive mineral prospects for mineral utilization are as follows:

1. A three (3) year period is allotted for exploration and development before actual production;
2. Exploration cost is PhP 250,000 per hectare based on the area projected to be affected by mineral utilization activities;
3. A 50% factor is used to determine the recoverable ore for deposits that had undergone semi-detailed exploration and 90% factor for deposits which had undergone detailed exploration;
4. A constant process recovery of 80% is assumed;
5. A constant price of metal or mineral per MT is also assumed throughout the life of the mine;
6. An excise tax of 2% is applied to the gross revenue as a result of sale of either mineral concentrate or metal;
7. Depreciation and depletion were computed using the straight-line basis throughout the life of the mine;

8. Environmental cost is derived from a percentage, i.e. 10%, of both the mining and processing costs;
9. Income tax was assumed to be 35% of the net income before income tax;
10. The exchange rate for 1 US$ was pegged at PhP 50; and,
11. A 12% discount rate for NPV calculations.

3.4. *Valuation of Bauxite Mineral Prospects of Samar Island*

3.4.1 Background

It is worth noting that Samar Island has the only bauxite deposits in the Philippines. Moreover, these deposits have shown potential in terms of commercial development because of the presence of sufficient reserve or volume and high alumina/ aluminum content that could warrant its viability for many economic years. The valuation of these bauxite deposits through a Mineral Resource Assessment (MRA) study intends to provide the much needed information which could help decide what to do with this potential mineral deposit in the future.

It is then the aim of MRA to determine the net present value (NPV) of the different positive prospects of bauxite deposits assuming that these deposits undergo mineral utilization activities. These activities include exploration, development, mining, processing, and eventual marketing of derived valuable minerals/ metals.

Information in this report have been obtained from sources which include the Central and Regional Offices of the Mines and Geosciences Bureau (MGB) of the Department of Environment and Natural Resources, National Institute of Geological Studies (NIGS) of the University of the Philippines, and business and technical journals.

3.4.2 Bauxite Mineral Prospects

3.4.2.1 Bauxite Mineral

The name bauxite is applied to earthy deposits and rock principally composed of one or more hydrated aluminum oxide mineral species. Bauxite contains a large number of impurities such as silica, iron and titanium oxides, and various other elements mostly in minor or trace amounts.

The hydrated aluminum oxide minerals are gibbsite, boehmite and diaspore. Both boehmite and diaspore are monohydrate and have the same chemical compositions, but diaspore is harder and has a higher specific gravity than boehmite. The bulk density of most bauxites is between 1.3 and 1.9 but some are known to be as high as 3.7.

<u>*Properties, Uses and Specifications:*</u>

Bauxite is the main aluminum ore. Typical economic bauxite ores contain around 45% alumina, less than 12% iron oxides and less than 8% of combined silica. Mining locations are determined by the amount of ore that is present: It is economical to mine where aluminum oxides exceed 27% in the ore.

Bauxite ore is refined into alumina and calcined for feedstock to electrolytic smelters. Although other raw materials are used for aluminum ore their use is minor compared to bauxite.

Bauxite and alumina are also important in the manufacture of refractories, ceramics, chemicals, abrasives, pharmaceuticals, catalysts, cements and flame retardants. Refractory products made from bauxite are synthetic mullite, high alumina fire bricks, castables, monoliths, cement and ramming mixes used by the steel and cement industries.

Even though over 90% of alumina is refined into aluminum, it has other uses also. It is used as an abrasive, in the manufacture of ceramics and glass and as a refractory material. Other uses for hydrated alumina include: water purification, in pharmaceuticals, as a fire retardant in carpets, in detergents and in paper making.

Aluminum is a good conductor of electricity, lightweight and is resistant to atmospheric corrosion. Copper has almost totally been replaced by aluminum in high-voltage transmission lines. Aluminum also makes up most of our road signs.[7]

It is a good conductor of heat and is chemically stable. Most foods do react with it. Food and cool drink packaging also use aluminum. Aluminous salts such as aluminum sulfate and sodium aluminate are used for water treatment and aluminum chloride is used in refining crude petroleum.

Calcined alumina is used in the production of coated abrasives, sharpening stones and grinding wheels. Special grades of bauxite are used in the decolorization and classification of raw sugar and lubricating oils.

Major World Suppliers:

Bauxite is known to occur in all continents except Antarctica. Total annual world production of bauxite exceeds 100 million metric tons and Australia is the leading producer with an annual production of 36 million metric tons. This is followed by Guinea, Brazil and Jamaica.

About 90% of world bauxite production is used in the production of aluminum metal. The production of aluminum metal increased from 1.5 million MT in the 1960's to well above 17 million MT in 1990's and growth is expected to continue subject to market conditions. The world production of bauxite is shown in ***Figure 2*** (Source: US Bureau of Mines, 1995).

3.4.2.2 Bauxite Mineral Deposits of Samar

In compliance with Letters of Instruction Nos. 184 and 296, the search for bauxite deposits was undertaken by the Mines and Geosciences Bureau from April, 1974 to April, 1975. This paved the way for the additional detailed delineation and full documentation of new bauxite deposits within Samar Island. This activity was also conducted in collaboration with the Reynolds Aluminum Corporation, which involved the bauxite deposits within the Hinabangan area.

Mineral Reservation: After the collaborative efforts of conducting extensive exploration studies and identifying prospective bauxite deposits particularly in Samar Island, Presidential Proclamation No. 1615 dated February, 1977 was promulgated declaring all bauxite deposits and bauxite-bearing area in the mainland Samar and Batag Island, Laoang, Northern Samar as Bauxite Mineral Reservation Area for the purpose of developing, exploiting and utilizing these bauxite deposits. This means that these areas are set aside and reserved for industrial and commercial use in the interest of the Philippine Government. ***Figure** 3* shows the areas covered in the Bauxite Mineral Reservation.

Geology and Occurrences of Bauxite Deposits

Jagolino[14]1976 described in detail the general geology and different occurrences of bauxite deposits in Samar.

The different rock units in the island of Samar and the outlying islands are as follows:

- Recent Alluvium
- Raised Coral-Reef Limestone (Quaternary).
- Catbalogan Formation (Lower Miocene)
- Daram Formation (Lower Miocene)
- Basic Igneous and Metamorphic Complex

The different occurrences of bauxite deposits and the associated source rocks and locations are sited as follows.

Genetic Considerations: At the present stage of this study of aluminous laterite deposits in Central Samar, potential deposits usually occupy karst areas in limestone, although some sinkhole deposits yielded high silica. In this case, the laterite has not been transformed completely to bauxite apparently due to the fact that favorable conditions and time were not sufficient for the formation of bauxite.

Intermittent streams periodically inundating karst depressions must have deposited their suspended load derived from nearby areas of lateritic weathering of various source rocks. Then the circulating groundwater must have leached out or removed the silica and carbonate. The process of bauxitization, therefore, commenced from the nearby source rocks, then continued and was completed in the karst surfaces or pockets. The warm circulating groundwater fluctuated with the alternating dry and wet season present in Samar. The vacillating dry and wet seasons correspondingly caused the fluctuations of the pH from acidic to alkaline-acidic to leach the iron and alkaline at times to remove the silica. In the formation of bauxite, silica is the major constituent leached.

Absence of water in several test pits dug in the deposits of more than 9 meters in Gandara shows that the phreatic water table is deep.

Central Samar: The bauxite deposits are closely associated with the karst features of the tertiary limestone areas of the Daram formation. Sinkholes, solution channels and karstic surfaces of limestone afforded good accumulation sites of this deposit. The reconnaissance geological investigation as based on random auger drilling, test pitting and surface grab-sampling, in Central Samar delimited a potential area of 1,825 sq. km. (182,500 Ha). Samples taken from the area gave 26.6 to 53.2 % Al_2O and 1.5 to 10.77 % total SiO_2.

Gandara, Western Samar: In barrio Calundan, the bauxite deposit which overlies the limestone varies in color from dark to light yellowish brown from top to bottom. There is no sharp contact between layers of different color shades. Texture is fine to pulverulent when dry. Some sinkholes are rocky and with very thin soil cover.

Bagacay Area: In Ihe Kulayanan deposit, which is 2.5 km southwest of Concord, six (6) auger drill holes reportedly bored by Republic Bauxite and Mining Corporation (RBMC) and Engineering Geoscience, Inc. (EGI), yielded favorable Differential Thermal Analysis (DTA) curves. Also, a sinkhole in Pamatagan whose area is approximately 2 sq km gave good DTA results. In Sibalon sinkholes (1 sq km in area) six (6) test pits previously dug whose average depth is 9 meters were sampled and analyzed by DTA. All of the samples indicated the presence of gibbsite.

Guiuan: The bauxite deposit in Guiuan, Eastern Samar is reddish brown and occurs as an earthy pulverulent mass on the eroded surface of the limestone which has irregular openings and pockets. Samples taken from test pits at 500-meter intervals gave DTA curves indicating the presence of bauxite. The thickness ranges from 0.50 to 2.00 meters. It is underlain by limestone.

Can-iigot and Vicinity: The Can-iigot area about 5 km southeast of Matuguinao, Gandara has a deposit with the bauxite of yellowish brown to reddish brown color. The aluminous laterite is semi-plastic when wet to friable or pulverulent when dry. The average depth of the pits is 4 meters. There are many more sinkholes in the vicinity. Some are rocky and or with thin soil deposit.

Inaplakan Area: The aluminous laterite deposits in Inaplakan are in several sinkholes located 6 km east of Barrio Barog, Matuguinao and 2 km northeast of Can-iigot, These sinkholes range in area from 1 to 5 hectares. Some random samples from previously dug test pits yielded favorable DTA curves while others did not. The average soil thickness is 3.5 meters. The aluminous lateritic soil exhibits reddish brown to chocolate brown shades and are semi-plastic to pulverulent when dry. Farther north of Inaplakan, some sinkholes showed thin to no soil development.

Batag Island: Batag Island is an irregular island wholly underlain by rubbly coralline limestone believed to be uplifted coral reef. It is at the northeastern tip of Northern Samar province. There are two (2) types of bauxite in this island—the yellowish Brown and the brick red. The color variation is due to the difference in iron content, the darker brick red has more iron content (24.59 to 28.29 % Fe_2O_3) than the yellowish brown (18.23 to 19.97 % Fe_2O_3). The red brick red deposit is localized in the sitios of Pintanao and Baree, northern portion of barrio Cabandiagan: the yellowish brown deposits are widespread, covering barrios Cabadiangan, Onogis and part of Marubay.

The different bauxite deposits found in Samar Island are shown in ***Table 16***. The total bauxite deposit in Samar amounts to approximately **149,422,000 MT** with an average assay of **42.86 % Al_2O_3.**

3.4.3 Mining of Bauxite Deposits

3.4.3.1 Exploration and Development

Auger drilling and test pitting are the most practical methods of exploring and delineating a bauxite ore body. Using these methods to obtain data and samples for analyses can ascertain the existence, location, thickness, lateral extent of the ore body, and even the degree of bauxite mineralization. Since bauxite ores bodied in Samar generally occur near the surface and are described to be basically soft and having an earthy texture, obtaining samples for chemical and physical characterization was relatively easy.

Once a bauxite ore body is positively proven to have a sizeable volume and contains a sufficient and recoverable amount of valuable alumina minerals through ore reserve computation methods, the ore body is now ready for development to prepare the ore bauxite positive ore body for mining activities. Development usually entails activities like removal of vegetation cover and topsoil materials to expose the bauxite ore body.

Four (4) areas were identified with a total of 137,859,997 metric tons of bauxite containing an average of 42.99% Al_2O_3. However, for purposes of conservative valuation only 90,411,373 metric tons is considered as recoverable volume for mineral utilization, i.e., mining and processing. This conservative recoverable value is entirely based on the available volume, alumina assay and the extent of exploration conducted on the bauxite ore deposit. The breakdown of the ore reserves, locations, positive bauxite mineral prospect which are considered mineable and projected area to be affected by mineral utilization activities are shown in ***Table 17***.

3.4.3.2 Mining Method

It is essential that immediately prior to the actual mining of the bauxite deposit, the land is cleared and the topsoil, to a minimum of 2.5 to 4 centimeters, removed and stockpiled for later replacement when mining is completed.

The surface occurrence of bauxite ore bodies (usually less than 20 meters) makes the deposits suitable for mining by simple open cast methods. Due to the soft, earthy nature of the ore, no drilling or blasting is generally required.

A modified open cast mining method is proposed to be the scheme of mining bauxite ore deposits. This involves a progressive rehabilitation of mine-out areas alternating with the actual extraction of bauxite mineral. Initially, the ore body is subdivided into plots with predetermined volume, lateral area, and mineral/metal assay. The sequence of mining the different plots is then dictated based on the feed specifications required by the processing plant in terms of volume and assay. The proposed sequence of mining per plot is as follows: (1) Plot 1: Removal of top soil and then stockpiled; (2) Extraction of bauxite material from the deposit; (3) Stock piling of bauxite material and blending procedures; (4) After extracting the last quantity of bauxite in Plot I, start rehabilitating the mine-out plot 1 can take place, simultaneously with the opening of Plot 2; (5) Filling of the mine-out plot with tailing materials from the processing plant and later topsoil materials which was formerly stockpiled; and, (6) Finally, the revegetation/ reforestation of the mine-out area. This mining sequence will be followed up to the mining of the last Plot.

This scheme of mining aims to restore immediately the original form of the affected area in terms of vegetation or reforestation and land-form. In a way, it also restores or it can even enhance the original environmental conditions within the area in terms of its biodiversity.

3.4.4 *Processing of Bauxite to Alumina*

The material extracted through mining will be beneficiated and processed for the production of 99.5% alumina, Al_2O_3, which is the main raw material for production of aluminum metal by smelting.

The putting up of a smelting plant for the production of aluminum metal is not considered in this valuation report because of the absence of a very large power source within Samar Island. The smelting process of alumina to produce aluminum metal is known to be an extensive user of electrical power. Therefore, the option of just producing high-grade alumina, 99.5% Al_2O_3, from bauxite is considered. The technology for processing of bauxite into alumina is already a well-established process and the type of bauxite deposit found in Samar is suitable for this process. This process is known as the Bayer process.

The Bayer process, as shown in ***Figure 4***, involves basically four steps: digestion, clarification, precipitation, and calcinations [13].

Digestion: To start the process, the crushed bauxite is fed into a caustic soda solution. This slurry is then mixed and heated in digesters. It is kept at 143°C for 30 minutes at a pressure of 500 kilopascals. The aluminum oxide and caustic soda readily react with each other to produce 'green liquor'.

$$Al_2O_3{\cdot}3H_2O + 2NaOH \rightarrow 2NaAlO_2 + 4H_2O$$

Clarification: During clarification, the coarse sand and fine mud are separated from the alumina bearing 'green liquor' by settling and then passing it through filters. The settled material is washed and filtered to recover residual caustic soda. The coarse sand is waste containing undissolved iron oxides, silica and other trace materials. The fine mud is mostly iron oxide and fine quartz.

Precipitation: Alumina is removed from the liquor leaving alumina hydrate crystals. The liquor is cooled, seeded and cooled again in stages to precipitate the hydrate. It is separated by filtration and then washed to remove impurities.

$$2NaAlO_2 + 4H_2O \rightarrow Al_2O_3{\cdot}3H_2O + 2NaOH$$

The hydrate crystals ($Al_2O_3{\cdot}3H_2O$) are pumped as a slurry into large conical vessels called classifiers. The classifiers separate the crystals into big and small crystals. The classifier pulls out the big crystals, while the small crystals are returned to the tanks.

Calcination: The hydrate is then calcined (roasted) for conversion to alumina. The final product is a fine, white powder. The alumina is then cooled and conveyed using air slides to storage silos ready for rail loading.

$$Al_2O_3 \cdot 3H_2O \rightarrow Al_2O_3 + 3H_2O$$

3.4.5 Environmental Considerations

The different activities related to the mineral development and utilization of bauxite that would have significant environmental impact on biodiversity are as follows:

3.4.5.1 Mining and Processing

One of the major environment problems, which is considered to have a negative impact on the environment, is the disturbance and eventual damaging of the surrounding ecology (flora and fauna) during the actual development and mining of bauxite deposit. To address this impact, a modified-mining method can be adopted to at least minimize the effect and even probably enhance the past (before mining) environmental conditions of the affected area. The incorporation of a progressive rehabilitation/ reclamation activity going hand-in-hand with the actual extraction of bauxite mineral from the deposit would result in the immediate restoration of the original ecological set-up before mining came in.

The 'red mud' is the major waste material of the Bayer process. It is in a form of slurry, which contains the unwanted fine solids, chemical and wastewater. If not treated properly it will contaminate the nearby river and marine systems with suspended solid, heavy metal and chemicals. To address this problem, a solid/liquid separation and remediation scheme should be applied to treat the red mud. A series of settling ponds coupled with the introduction of treatment chemicals like flocculants, pH regulators and encapsulators to increase the rate of settling of suspended solids and at the same time causing the recovery of heavy metals would effect rapid and immediate separation of clarified water from the precipitated solid sludge. The clarified and neutralized water can be recycled into the process and the solid portion can be stored temporarily in a tailings pond. A remediation process can treat the stored solid in order to restore the original physical and chemical properties of the material. When these solids are fully treated they can be used as a rehabilitation material for mine-out areas of bauxite.

The emission of gas and dust during calcination operàtions can be remedied by the installation of dust collectors and electrostatic precipitator just before the gas is emitted into the atmosphere through a gas stack.

3.4.5.2 Rehabilitation/Reclamation Program

The immediate restoration of the deformed land mass and damaged vegetation necessitates the formulation of a strategy for comprehensive and progressive rehabilitation and reclamation programs. These programs should focus on the following: a) Proper solid and liquid disposal and management; b) Surface and subsurface soil stability; c) Water management which includes both surface and groundwater; d) Soil management and erosion prevention; e) Revegetation; and, f) Efficient monitoring.

The incorporation of environmental cost as a major expenditure in mineral utilization activities of a certain mineral prospect is an essential addition in the procedure of cost estimation in this valuation study.

The Philippine Mining Act of 1995 stipulates that: *"The contractor shall allocate for its initial environment-related capital expenditures an amount that shall approximate ten percent (10%) of the total capital/project cost or such other amount depending on the environmental/geological condition, nature and scale of operations and technology employed. Initial environment-related capital expenditures may include environmental studies and design cost, waste area preparation, tailings/slime containment/disposal system, mine waste disposal system, wastewater/acid mine drainage treatment plants, dust control equipment, air pollution control facilities, drainage system and other environment-related mitigating measures and capital expenditures."*

3.4.6. *Valuation of Bauxite Positive Prospects*

3.4.6.1 *Gross Revenue from Sale of Alumina*

Table 18
Gross Revenue from Sale of Alumina

	Symbol	Revenue
Annual Feed, MT	*F*	4,305,303 MT
Head Assay, % Al_2O_3	*f*	42.99 %
Recovery, %	*r*	80%
Alumina Grade of Conc. Product, % Al_2O_3	a	99.5%
Price of Alumina (f.o.b)- $ per MT (ave. value)	*p*	210
Amount of Conc. Product, MT	C_A	1,488,121
Beginning Inventory of Conc. Product, MT	C_B	0
Ending Inventory Of Conc. Product	C_E	124,010
Gross Revenue, $	R_C	$ 285,030,895
PhP		PhP 14,251,544,773

3.4.6.2 *Capital Investment Costs*

The total capital investment cost can be broken down into three (3) parts, namely: a) Capital Investment Cost - Open Cast Mining; b) Capital Investment Cost- Processing; and, c)

Capital Investment Cost- Environment. The capital investment costs were estimated based on a daily capacity of 12,000 MTPD of ore and 2,000 MTPD of overburden materials.

The summary of Open Cast Mine Capital Investment Cost Estimates is tabulated in ***Table 19***.

The summary of Bauxite Processing Capital Investment Cost Estimates is tabulated in ***Table 20***.

The Environmental Fixed Capital Investment Cost is estimated to be 10% of the combined Mining and Processing Capital Investment Costs. This is used for structural and non-structural measures to mitigate environmental problems as a result of bauxite mineral utilization. The Environmental Fixed Capital Investment amounts to PhP 1,212,843,395.

3.4.6.3 Production Costs

Production cost is divided into two categories, namely Operating Costs and Supplies, and Administration and General Services. This approach is very common in operating mines and mills in the mining industry.

a. *Personnel Requirement*: The number of technical and non-technical personnel required for mineral utilization activities are estimated and shown in ***Table 21***.

b. *Mine and Processing Total Production Cost Estimation*: The estimation of the total operation or production costs for Bauxite mineral utilization is shown in ***Table 22***.

3.4.6.4 Working Capital Cost Estimation

The estimated startup cost or working capital ideally for one month operation is **$100,492,537 (PhP 5 .02 Billion).**

3.4.6.5 Net Present Value (NPV) of Bauxite Mineral Utilization and Internal Rate of Return (IRR)

Using discounted cash flow analysis and assuming a discount rate of 12%, the net present value on the bauxite mine and internal rate of return (IRR) are tabulated in ***Table 23***.

Table 23
Net Present Value and Internal Rate of Return:
Positive Bauxite Mineral Prospects

NPV/IRR	Value
NET PRESENT VALUE of BAUXITE POSITIVE MINERAL PROSPECTS (12%)	***Thirty four billion, two hundred thirteen million, one hundred eighty three thousand, five hundred sixty seven pesos (PhP 34,213,183,567)***
Internal Rate of Return (IRR)	***Thirty nine percent (39%)***

3.4.6.6 Notes and Assumptions Underlying the Financial Projection

a. *Period Covered:* Projections were made over a twenty one (21) - year period to cover the life of a mine.

b. *Volume of Production and Sale:* The bauxite mine's rated capacity is assumed at 12,000 metric tons of ore per day or 4,305,303 metric tons per annum on a 360-day per year, 24-hours per day operation.

The average mill head of 42.99% Al_2O_3, is assumed to be uniform throughout the life of the mine, and also with a process recovery of 80%.

A concentrate grade of alumina product is constant to be at 99.5% Al_2O_3.

c. *Selling Price:* Price of Alumina used $ 210/MT (average price for the last six (6) years, 1994-1999).

d. *Excise Tax:* Assumed at 2% of the gross sales of alumina.

e. *Depletion and Depreciation:* The computation used the straight-line basis throughout the life of the mine.

f. *Income Tax:* Assumed at 35% of net income before income tax.

g. *Discounted Rate for NPV:* Twelve Percent (12%) is the discounted rate for NPV calculations.

3.4.6.7 Discounted Cash Flow Analysis

Table 24 shows the details for the discounted cash flow for the mineral utilization valuation of the bauxite deposits of Samar Island.

3.5 Valuation of Copper-Pyrite Mineral Prospect of Samar Island

3.5.1 Background

The copper-pyrite mineral prospect is part of the Bagacay Mine in Bagacay, Hinabangan, Western Samar. It was part of an old mining concession held by Marinduque Mining and Industrial Corporation (MMIC), which had been in active operation for almost twenty (20) years from 1957 to 1977. After its shutdown, however, MMIC still continued processing its remaining ore stockpile until it finally ceased operation in 1981. Bagacay Mines was foreclosed by the Development Bank of the Philippines (DBP) and the Philippine National Bank (PNB) in 1984 and then transferred to the Asset Privatization Trust (APT) for privatization under Proclamation No. 50 in 1986. On May 25, 1984, Philippine Phosphate Fertilizer Corporation (PHILPHOS) and its subsidiary, Philippine Pyrite Corporation (PPC) were granted by MMIC the right to develop and exploit the pyrite deposit in Bagacay. In 1989, the APT granted PHILPHOS/ PPC a similar right. In 1992, PHILPHOS/ PPC suspended operations in Bagacay.

Even with closure of both MMIC and PPC, they still reported a sizable volume of ore reserve left containing high levels of both copper and pyrite minerals. A potential mineral reserve of 1,424,973 MT containing 2.4% of copper and 8,062,000 MT containing 35.46% sulfur has been likewise documented by the Bureau of Mines and Geosciences.

Although the copper and pyrite deposits were operated separately in the past, this MRA study presents a valuation on the presumption that both copper and pyrite deposits can be subject to mineral utilization as one positive mineral prospect. Operating the existing mineral prospect would mean a form of a rehabilitation program that would cover both mining and processing of the remaining ore reserves and at the same time improving the overall environmental set-up of the area directly affected by the different activities of mineral utilization. This means that the valuation to determine the net present value (NPV) for both copper and pyrite deposits will incorporate environment as an essential component of mineral utilization activities.

Furthermore, the valuation takes into account the existence of both mining facilities and equipment from the previous operations that would significantly reduce the initial capital investment to start and make the mine operational again. A factor of around 15% of the fixed capital investment was considered to cover the existing facilities and equipment in the estimation of the fixed capital investment for mining and processing.

3.5.2 Copper and Pyrite Mineral Prospects of Samar

<u>Geology and Occurrences of Copper and Pyrite Deposits</u>

Muyco[7] described the general geology of the sulfide deposits in Bagacay as follows:

> *"The area in the immediate vicinity of the mine is underlain by highly argillized units of rhyolite-dacite volcanic agglomerates and tuffs, and andesitic dikes and sills. The rhyolite-dacite volcanic rocks are highly altered, light-colored rocks*

containing numerous scattered bipyramidal quartz crystals, these are overlain and interlayered with silicified pyritic portions containing some chert and jasper. The tuffs are well-bedded, welded and gently folded. The rocks are cut by dikes and sills of spilitic to porphyritic andesites.

There are two (2) types of deposits in Bagacay, namely, the complex massive sulfide ore and the carbonaceous sulfide ore. Both contain abundant sulfide mineralization such as pyrite, marcasite, chalcopyrite, bornite, chalcocite, digenite, covellite, sphalerite, galena, and trace minerals such as tetrahedrite, tennantite, gold, silver-gold and andesites.

The massive type with varying copper grade is classified into high, medium and low grade ores of 8-20% Cu, 4-8% Cu and 1-4% Cu, respectively. This type of ore is normally associated with gossan and massive pyrite. Beneath the massive pyrite is silicified rock with high pyrite disseminations. In some places where gossan is absent, massive high grade copper ore is on top gradually grading to low grade below, followed by massive pyrite and at the bottom is silicified rock with high pyrite and with copper grade averaging 0.22% Cu.

The size and shape of the ore deposit is highly variable but mostly in lenses and pockets, fissure fillings and breccia type."

The description of both Copper and Pyrite deposits found in Bagacay, Hinabangan, Western Samar is shown in ***Table 25***.

3.5.3 *Mining of Copper-Pyrite Positive Mineral Deposits*

After considering the extent of exploration activities that delineated the positive prospect for copper and pyrite deposits, a percentage was assumed to determine the positive mineral prospect or mineable reserve, as shown in ***Table 26***.

The mining method applicable for extracting the copper-pyrite ore is the open pit mining. Under this method, the ore is mined using drilling, blasting, loading and hauling. With a recoverable reserve of 8,538,276 MT, a daily mine production of 2,000 MT and an ore to waste ratio of 2:1 [11] can be projected.

The area affected by mineral utilization activities can be assumed to cover a total of 648 hectares for both copper and pyrite deposits. The area includes the open pit mine, processing plant, tailings dams, communities, offices, schools and hospitals, electrical power facilities, and environmental structures like treatment plants and monitoring facilities.

3.5.4 *Processing of Copper-Pyrite Ore*

The separation of copper and pyrite concentrates involves two (2) stages. First is the separation of both copper and pyrite minerals from the bulk of gangue minerals by bulk flotation. Second is the separation of copper mineral in a form of a concentrate from the pyrite concentrate by differential flotation [13]. The process flow of the mineral processing of copper-pyrite ore is illustrated in ***Figure 5***.

3.5.5 Environmental Considerations

The different activities related to the mineral utilization of copper-pyrite that would have significant environmental impact are as follows:

3.5.5.1 Mining and Processing

In the mining and processing of copper and iron sulfide metallic ores, there are two (2) environment problems of major concern: first, the voluminous generation of mine waste and mill tailings; and second, the occurrence of acid mine drainage (AMD).

Some of the feasible environmental mitigating measures to address these problems include the following: a) waste utilization; b) waste minimization through correct management and control; c) further recovery of valuable minerals and metals; and d) waste treatment.

3.5.5.2 Rehabilitation/Reclamation Program

The immediate restoration of the deformed land mass and damaged vegetation necessitates the formulation of a strategy for comprehensive and progressive rehabilitation and reclamation programs. These programs should focus on the following: a) Proper solid and liquid disposal and management; b) Surface and subsurface soil stability; c) Water management which include both surface and groundwater; d) Soil management and erosion prevention; e) Revegetation; and, f) efficient monitoring.

The incorporation of environmental cost as a major expenditure in mineral utilization activities of a certain mineral prospect is an essential addition in the procedure of cost estimation in the valuation study.

3.5.6 *Valuation of Copper-Pyrite Positive Prospects*

3.5.6.1 *Gross Revenue from Sale of Copper and Pyrite Concentrate*

Table 27
Gross Revenue from Sale of Copper and Pyrite Concentrate

	Symbol	Revenue
Annual Feed, MT	F	776,207MT
Head Assay, % Cu	f_{Cu}	2.4 %
% S	f_S	35.46%
Recovery, %	R	80%
Copper Grade of Conc. Product, % Cu	a_{Cu}	35.0%
Sulfur Grade of Conc. Product, % Cu	a_s	55.0%
Price of Cu Concentrate (f.o.b)- $ per MT (ave. value)	p_{Cu}	$195/ MT
Price of Cu Concentrate (f.o.b)- $ per MT (ave. value)	p_S	$55/MT
Amount of Cu Conc. , MT	C_{Cu}	42,580 MT
Amount of Cu Conc. , MT	C_S	400,353 MT
Beginning Inventory of Conc. Product, MT	C_B	0 (1st year)
Ending Inventory Of Conc. Product	C_E	40,267
Gross Revenue (Cu and Pyrite), $	R_C	**15,016,809**
PhP		**750,840,441**

3.5.6.2 *Capital Investment Costs*

The total capital fixed investment cost can be broken down into three (3) parts, namely: a) Capital Investment Cost - Open Cast Mining; b) Capital Investment Cost- Processing; and, c) Capital Investment Cost- Environment. The capital investment costs were estimated based on a daily capacity of 2,000 MTPD of ore and an assumed 1,000 MTPD of overburden materials.

The summary of Copper-Pyrite Open-Cast Mine Capital Investment Cost Estimation is tabulated in ***Table 28***.

The summary of Copper-Pyrite Processing Capital Investment Cost Estimation is tabulated in ***Table 29***.

The Environmental Capital Fixed Investment Cost is estimated to be 10% of the combined Mining and Processing Capital Investment Costs. This is used for structural and non-structural measures to mitigate environmental problems as a result of copper-pyrite mineral utilization. The estimate for Environmental Capital Fixed Investment amounts to PhP 51,495,375.

3.5.6.3 *Production Costs*

Production cost is divided into two categories, namely Operating Costs and Supplies, and Administration and General Services. This approach is very common in operating mines and mills in the mining industry.

a. *Personnel Requirements:* The number of technical and non-technical personnel required for mineral utilization activities are also estimated and shown in ***Table 30***.

b. *Mine and Processing Total Production Cost Estimation:* The estimation of the total operating or production costs for Copper-Pyrite mineral utilization is shown in ***Table 31***.

3.5.6.4 *Working Capital Cost Estimation*

The estimated startup cost or working capital ideally for one (1) month operation is **$4,263,817 (PhP 213.2 Million).**

3.5.6.5 *Net Present Value (NPV) of Copper-Pyrite Positive Mineral Prospect and Internal Rate of Return (IRR)*

Using discounted cash flow analysis and assuming a discount rate of 12%, the net present value of the copper-pyrite mine and internal rate of return (IRR) are tabulated in ***Table 32***.

Table 32
Net Present Value and Internal Rate of Return: Copper-Pyrite Positive Mineral Prospects

NPV/IRR	Value
NET PRESENT VALUE of COPPER-PYRITE POSITIVE MINERAL PROSPECT(12%)	*One billion four hundred seventy one million one hundred sixty one thousand eight hundred thirty seven (PhP 1,107,196,897)*
Internal Rate of Return (IRR)	*Thirty- five percent (36%)*

3.5.6.6 *Notes and Assumptions Underlying the Financial Projection*

a. *Period Covered:* Projections were made over an Eleven (11) – year period to cover the life of a mine.

b. *Volume of Production and Sales:* The copper-pyrite mine's rated capacity is assumed at 2,000 metric tons of ore per day or 711,523 metric tons per annum on a 360-day per year, 24-hours per day operation.

The average mill head assay of 2.4% Cu and 35.46% S and process recovery of 80%.. are assumed to be uniform throughout the life of the mine.

The concentrate grade of copper and pyrite products are 35% Cu and 55% S, respectively.

c. *Selling Price:* Price of Copper concentrate used is $ 300/ MT and the price of pyrite concentrate is $ 55/ MT (average prices for years, 1996-1997 [12].

d. *Exploration Cost:* Exploration cost is assumed to be PhP 250,000 per hectare of the area affected by mining.

e. *Excise Tax:* Assumed at 2% of the gross sales of Copper and pyrite concentrates.

f. *Depletion and Depreciation:* The computation used the straight-line basis throughout the life of the mine.

g. *Income Tax:* Assumed at 35% of net income before Income Tax.

h. *Discounted rate for NPV:* Twelve Percent (12%) is the discounted rate for NPV calculations.

3.5.6.7 *Discounted Cash Flow Analysis*

Table 33 shows the details for the discounted cash flow for the mineral utilization valuation of the Copper and Pyrite deposits in Bagacay, Hinabangan, Western Samar.

3.6. *Valuation of Nickel-Laterite Mineral Prospect of Samar Island*

3.6.1 *Background*

Nickel –Laterite ore is one of the main sources of nickel metal which is primarily used in the manufacture of steel alloys and has had a major role in the development of the chemical and aerospace industries. In most cases this type of ore is closely associated with the occurrence of other valuable metals like cobalt, platinum, and the compound ammonium sulfate.

In the Philippines, there are also known deposits of nickel-laterite of commercial quality like those in Surigao, Palawan, and in Mindoro.

3.6.2 Nickel Laterite Mineral Prospect of Samar

Nickel Laterite mineral deposit located in Hibacon, Borongan was found out to contain around 13,278,310 MT of ore with a grade of 0.58% Ni.

The possible formation of nickel laterite ores was described by Boldt as cited in Weiss[13]. When rocks are exposed to the atmosphere at the earth's surface, they gradually decompose. The continued chemical and mechanical action of air, water, and temperature changes break the rocks down to soil or clay. If the rock contains nickel, the weathering process may act to concentrate their nickel content to such a degree that the resulting deposits can be mined as nickel ore. Essentially, nickel is taken into solution in the ground water and redeposited in greater depth, producing a zone where the nickel content is abnormally high. The process is called lateritic weathering, hence the genetic term lateritic nickel ore for the deposits of Hibacon, Borongan. As the surface is lowered in the course of erosion, fresh acid ground water can attack the precipitated minerals which are already enriched in nickel, carrying their constituents deeper and precipitate them. The degree of enrichment needs to be substantial to result into an ore; starting with a rock containing 0.25% nickel, enriching in the ratio of 6 to 1 would produce higher percentage of nickel ore – a useful grade under favorable conditions for mining and treatment.

Given the grade of 0.58% Ni for the Hibacon deposit would probably mean that the laterization of the deposit is still at its early stage. The occurrence of the deposit in relation to the surface is still shallow with a relatively thin overburden.

This geologic information gives an idea on how to extract the ore from the mine and how to process the ore to recover the valuable Ni metal.

3.6.3 Mining of Nickel-Laterite Positive Mineral Deposits

Assuming that the extent of exploration activities that delineated the positive prospect for nickel laterite is quite extensive, 90% of the projected reserve can be considered recoverable by mining operations. Therefore, the positive mineral prospect has an ore reserve amounting to 11,950,479 MT.

The mining method applicable for extracting the nickel laterite ore is the open-pit or open-cut mining. Under this method, the ore is mined using shoveling, scraping, loading and hauling. With the computed recoverable reserve, a daily mine production of 3,000 MT and an ore to waste ratio of 3:1 [13] can be projected.

The area affected by mineral utilization activities can be assumed to cover a total of 648 hectares for Nickel-Laterite deposits. The area includes the open pit mine, processing plant, tailings dams, communities, offices, schools and hospitals, electrical power facilities, and environmental structures like treatment plants and monitoring facilities.

3.6.4 Processing of Nickel-Laterite Ore

The extraction of nickel from lateritic ore containing 0.5 to 1% Ni, is complex with a number of options available. The ore is subject to pressure acid leaching followed by solvent extraction to yield nickel metal. The process flow of the processing of nickel laterite ore to nickel metal is illustrated in ***Figure 6***.

3.6.5 Environmental Considerations

The different activities related to the mineral utilization of Nickel-Laterite that would have significant environmental impacts are as follows:

3.6.5.1 Mining and Processing

In the mining and processing of nickel-laterite ore, there are two (2) environment problems of major concern: first, the voluminous generation of mine waste and mill tailings; and second, possible contamination of surface and ground waters.

Some of the feasible environmental mitigating measures to address these problems include the following: a) waste utilization; b) waste minimization through correct management and control; c) further recovery of valuable minerals and metals; and d) waste treatment.

3.6.5.2 Rehabilitation/Reclamation Program

The immediate restoration of the deformed land mass and damaged vegetation necessitates the formulation of a strategy for comprehensive and progressive rehabilitation and reclamation programs. These programs should focus on the following: a) Proper solid and liquid disposal and management; b) Surface and subsurface soil stability; c) Water management which include both surface and groundwater; d) Soil management and erosion prevention; e) Revegetation; and, f) efficient monitoring.

The incorporation of environmental cost as a major expenditure in mineral utilization activities of a certain mineral prospect is an essential addition in the procedure of cost estimation in the valuation study.

3.6.6 *Valuation of Nickel-Laterite Positive Prospects*

3.6.6.1 *Annual Gross Revenue from Sale of Nickel Metal*

Table 34
Annual Gross Revenue from Sale of Nickel Metal

	Symbol	Revenue
Annual Feed, MT	F	995,873 MT
Head Assay, % Ni	f_{Ni}	0.58 % Ni
Recovery, %	R	80%
Metal Grade, % Cu	G_{Ni}	99.5% Ni
Metal Sales, MT	S_{Ni}	4,598 MT
Price of Nickel metal, $/MT	p_{Ni}	$ 5,537/MT
Gross Revenue from Sale of Ni Metal, $		**$ 25,330,440**
	PhP	**PhP 1,266,521,997**

3.6.6.2 *Capital Investment Costs*

The total fixed capital investment cost can be broken down into three (3) parts, namely: a) Capital Investment Cost - Open Cast Mining; b) Capital Investment Cost- Processing; and c) Capital Investment Cost- Environment. The capital investment costs were estimated based on a daily capacity of 3,000 MTPD of ore and an assumed 1,000 MTPD of overburden materials.

The summary of Nickel-Laterite Open-Cast Mine Capital Investment Cost Estimates is tabulated in ***Table 35.***

The summary of Nickel-Laterite Processing Capital Investment Cost Estimates is tabulated in *Table 36.*

The Environmental Fixed Capital Investment Cost is estimated to be 10% of the combined Mining and Processing Capital Investment Costs. This is used for structural and non-structural measures to mitigate environmental problems as a result of nickel-laterite mineral utilization. The environmental fixed capital invested was estimated to be PhP 231,869,232.

3.6.6.3 *Production Costs*

Production cost is divided into two categories, namely Operating Costs and Supplies and Administration and General Services. This approach is very common in operating mines and mills in the mining industry.

a. *Personnel Requirements:* The number of technical and non-technical personnel required for mineral utilization activities are estimated and shown in ***Table 37***.

b. *Mine & Processing Total Production Cost Estimation:* The estimation of the total operation or production costs for Nickel-Laterite mineral utilization is shown in ***Table 38***.

3.6.6.4 *Working Capital Cost Estimation*

The ideal estimated startup cost or working capital ideally for one month operation is **$19,198,772 (PhP 959.9 Million).**

3.6.6.5 *Net Present Value (NPV) of the Nickel Laterite Positive Mineral Prospect and Internal Rate of Return*

Using discounted cash flow analysis and assuming a discount rate of 12%, the net present value on the Nickel-Laterite positive mineral prospect and internal rate of return are tabulated in ***Table 39***.

Table 39
Net Present Value and Internal Rate of Return: Nickel Laterite Positive Mineral Prospects

NPV/IRR	Value
NET PRESENT VALUE OF NICKEL-LATERITE POSITIVE MINERAL PROSPECT (12%)	***Four hundred seventy nine million three hundred twenty eight thousand nine hundred eighty six pesos (PhP 479,328,986)***
Internal Rate of Return (IRR)	***Fifteen per cent (15%)***

3.6.6.6 *Notes and Assumptions Underlying the Financial Projection*

a. *Period Covered:* Projections were made over a twelve (12) – year period to cover the life of a mine.

b. *Volume of Production and Sales:* The Nickel-Laterite mine's rated capacity is assumed at 3,000 metric tons of ore per day or 995,873 metric tons per annum on a 360-day per year, 24-hours per day operation.

The average mill head assay of 0.58% and process recovery of 80%.. are assumed to be uniform throughout the life of the mine.

The final product is Nickel metal with a purity of 99.5% Ni.

c. <u>Selling Price:</u> Price of Nickel metal used is $ 5,537/ MT (average price of Nickel metal from 1990-1998 [3].

d. <u>Exploration Cost:</u> Exploration cost is assumed to be PhP 250,000 per hectare of the area affected by mining.

e. <u>Excise Tax:</u> Assumed at 2% of the gross sales of nickel metal.

f. <u>Depletion and Depreciation:</u> The computation used the straight-line basis throughout the life of the mine.

g. <u>Income Tax:</u> Assumed at 35 % of net income before Income Tax.

h. <u>Discounted rate for NPV:</u> Twelve Percent (12%) is the discounted rate for NPV calculations.

3.6.6.7 *Discounted Cash Flow Analysis*

Table 40 shows the details for the discounted cash flow for the mineral utilization valuation of the Nickel-Laterite deposit in Hibacon, Borongan, Eastern Samar.

4. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be drawn from this MRA study on various mineral prospects in the Island of Samar:

a. The Mineral Utilization of Bauxite in Samar should seriously be considered when deciding on the options for potential land –use within the SINP for the following reasons:

- The bauxite deposits in Samar are of world class in terms of volume and grade.
- The projected volume of bauxite in this study is only approximately one-tenth (1/10) of the actual bauxite reserve. This is considering the fact that only very limited exploration was conducted within the Bauxite Mineral Reservation Area.
- The NPV computed shows a clear indication on the potential that can be derived from the bauxite mineral resources for many economic years.
- The technology of mineral utilization of Bauxite in many parts of the world specially those of Australia and Jamaica has progressively been improving towards sustainable development and clean environment.
- The world demand for alumina and aluminum metal has been increasing steadily and it is probable that the Philippines will be a major source of raw bauxite material in the near future.

b. Aside from the unique presence of Bauxite in Samar Island there are other minerals that should be considered because initial studies show that they can also be developed commercially. These include deposits containing metallic minerals like copper, pyrite, chromite, manganese, gold, silver, and platinum, and non-metallic minerals like coal, limestone, clay, marble, and gemstones. More detailed exploration activities should be conducted to fully define and delineate the extent and quality of these resources. It is only then that proper valuation can be made and subsequently decisions drawn on how to utilize these mineral resources in the future.

c. Mineral Utilization of the mineral resources of Samar can be done only in a responsible and sustainable manner.

REFERENCES

[1]De Vera, B.M. and M.E.C. Bennagen. 2000. *Philippine Mineral Accounts*. Technical Paper. The Philippine Environmental and Natural Resources Accounting Project (ENRAP Phase IV). DENR and USAID, Philippines.

[2]Garcia, M.V. and J.M.O. Mercado. December 1981. "Geology and Mineral Deposits of Samar and Leyte Islands". *Journal of Geological Society of the Philippines*. Vol. 35, No.4.

[3]Guthrie, K.M. 1974. *Processing Plant Estimation, Evaluation and Control*. Craftsman.

[4]Jagolino, R.B. 1976. "Bauxite Deposits of Samar". *Journal of the Geological Society of the Philippines*. Vol. XXX. NSDB.

[5]Mines and Geosciences Bureau. Various years. Mining Division. Combined Metallic and Non-Metallic Mineral Reserves.

[6]Mular, A.L. 1980. *Mineral Processing Equipment Costs and Preliminary Capital Cost Estimates*. Special Volume 18 CIM.

[7]Muyco, J.D. 1986. "Massive Sulfide Deposits of Bagacay Mine, Samar, Philippines". *Geology and Mineral Resources of the Philippines*. Vol. II. Bureau of Mines.

[8]O'hara, T.A. and H.M. Feldman. 1980. "Quick Guides to the Evaluation of Orebodies". *CIM Bulletin* (814) 73: 73-80.

[9]Republic Act No. 7942. 1995. *An Act Instituting a New System of Mineral Resources Exploration, Development, Utilization, and Conservation*.

[10]Taylor, H.K. 1977. "Mine Evaluation and Feasibility Studies". *Mineral Industry Costs*. J.R. Hoskins and W.R, Green. (eds.) Spokane, WA: Northwest Mining Association.

[11]Ten (10)-Year Mine Development and Operating Plan. 1990. Philippine Pyrite Corporation.

[12]Tujan, A.A. Jr. and R.B. Guzman. 1998. *Globalizing Philippine Mining*. Ibon Foundation Inc. Databank and Research Center.

[13]Weiss, N.L. (ed.) 1985. *SME Mineral Processing Handbook*. Vol 1. Society of Mining Engineers of the AIMMPE, New York.

Table 3
Metallic and Non-Metallic Mineral Resources in Eastern Samar

Mineral	Location	Project	Mineral Reserve, MT	Grade %
BAUXITE	Onong, Salcedo	Mineral Reservation	10,658,160	42.44% Al_2O_3
BAUXITE	Palomorag, Mercedes	Mineral Reservation	47,858,400	42.44% Al_2O_3
BAUXITE	Campoyang	Mineral Reservation	25,640,000	42.44% Al_2O_3
CHROMITE	Gunidalitan, Maydolong	C. Lastimosa/ Maydolong Proj.	3,000	48.0% Cr_2O_3
CHROMITE	Antipolo, Llorente,Hemani	Heritage Res. Mng./ Pacific Sh.Proj.	364,000	41.0% Cr_2O_3
CHROMITE	Carapdapan, Salcedo	Integrated Chromite Proj	5,000	48.0% Cr_2O_3
COPPER	Lonoy-Bonot/ Sulat & San Juan	Trident Mng./Sulat Cu Proj.	7,500,000	0.96%Cu
NICKEL	Hibacon, Borongan	G.Y. Omopia, Hib, Ni. Proj.	13,278,310	0.58% Ni
NICKEL	Manicani Is., Guiuan	Hinatuan Mng. Ni. Proj.	1,717,000	2.41% Ni
COAL	Hucnan, Giporlos		123,145	7000 BTU

Table 4
Metallic and Non-Metallic Mineral Resources in Western Samar

Mineral	Location	Project	Mineral Reserve, MT	Grade %
COPPER	Bagacay, Hinabangan	MMIC, Bagacay Mine	1,424,973	2.4 %Cu
BAUXITE	Concord, Hinabangan	Mineral Reservation	53,703,437	43.46% Al_2O_3
BAUXITE	Paco, Jos Rono, Conc., Wright	Mineral Reservation	544,115	46.06% Al_2O_3
MANGANESE	San Jose de Buan	Rizal Explor./ Sn Jose de Buan	3,680	35.00% Mn
MANGANESE	Tinambacan, Calbayog City	Phil. Base Metals/Pena Mn Proj	14,890	32.0% Mn
LIMESTONE/ MARBLE	Osmena, Marubut	Leysam Mining Corp.	283,760,800 cu.m.	
SULFUR/ PYRITE	Bagacay, Hinabangan	Phil. Pyrite Corp.	8,062,000	35.46 % S

Table 5
Metallic Mineral Resources in Northern Samar

Mineral	Location	Project	Mineral Reserve, MT	Grade %
BAUXITE	Batag Island	Mineral Reservation	11,017,950	43.46% Al_2O_3

Table 6
Distribution of Mineral Reserves in Samar Island

Mineral Resource	Location	Percentage, %	Mineral Reserve, MT	Mineral/Metal Grade, %
Bauxite	Mineral Reservations	81.47 %	149,422,000	41.38 % Al_2O_3
Nickel Laterite	Eastern Samar	8.18 %	14,995,310	0.78 % Ni
Copper	E. & W. Samar	4.87 %	8,924,973	1.2 % Cu
Pyrite	Western Samar	4.40 %	8,062,000	35.46 % S
Chromite	Eastern Samar	0.02 %	372,000	41.15 % Cr_2O_3
Manganese	Western Samar	0.01 %	18,570	32.59% Mn
Others (coal, marble, gold)				

Table 7
Potential Positive Mineral Prospects for Mineral Utilization

Mineral Prospect	Location	Reserve, MT	Percentage Mineable	Positive Mineral Prospect	Grade, %	Remarks (Extent of Exploration Activity)
Bauxite	Concord, Hinabangan	53,703,437	90%	90,411,373	42.99% Al_2O_3	Detailed
	Guiuan Areas	84,156,560	50%			Semi-detailed
Copper & Pyrite	Bagacay, Hinabangan	1,424,973	90%	8,538,276	2.4 % Cu	Detailed
		8,062,000	90%		35.46% S	
Nickel Laterite	Hibacon, Borongan	13,278,310	90%	11,950,479	0.58% Ni	Detailed

Table 8
Mine Life as a Function of Ore Tonnage (Taylor, 1977)

Expected Ore, (10^6 MTons)	Median Life, (years)	Range of Lives, (Years)	Median Output, (TPD)	Range of Outputs (TPD)
0.5	3.5	4.5-3.0	80	65-100
1.0	6.5	7.5-5.5	450	400-500
5.0	9.5	11.5-8.0	1,500	1,250-1,800
10	11.5	14.9-5.0	2,500	2,100-3,000
25	14	17-12	5,000	4,200-6,000
50	17	21-14	8,400	7,000-10,000
100	21	25-17	14,000	11,500-17,000
250	26	31-22	27,500	23,000-32,500
350	28	33-24	35,000	30,000-42,000
500	31	37-26	46,000	39,000-55,000
700	33	48-28	60,000	50,000-72,000
1,000	36	44-30	80,000	65,000-95,000

Table 9
Life of Potential Positive Mineral Prospects for Mineral Utilization

Mineral Prospect	Location	Mineable Reserve, MT	Life of Mine, Years	Daily Tonnage, TPD
Bauxite	Concord, Hinabangan & Guiuan Areas	90,411,373	21	12,000
Copper and Pyrite	Bagacay, Hinabangan	8,538,276	11	2,000
Nickel Laterite	Hibacon, Borongan	11,950,479	12	3,000

Table 10
Areas Affected by Mineral Utilization Activities (Bauxite Deposits)

Location	Average Grade, % Al_2O_3	Mineable Ore, MT	Area Affected by Mining Activities
Onong, Salcedo, E.Samar	42.44	5,329,080	324 hectares
Palomorag, Mercedes, E. Samar	42.44	23,929,200	324 hectares
Campayong, Guiuan, E. Samar	42.44	12,820,000	324 hectares
Concord, Hinabangan, W. Samar (5 sites)	43.46	48,333,093	3000 hectares
Total		**90,411,373**	**3,972 hectares**

Table 11
Approximate Areas Affected by Mineral Utilization Activities for Potential Mineral Prospects in Samar Island

Mineral Prospects	Location	Mineable Reserve, MT	Approx. Area affected, ha.
Bauxite	Concord, Hinabangan & Guiuan Areas	90,411,373	3,972
Copper and Pyrite	Bagacay, Hinabangan	8,538,276	648
Nickel Laterite	Hibacon, Borongan	11,950,479	648

Table 12
Summary of Open Pit Mine Capital Cost Estimates (O'hara, 1980)

Cost Item	Cost Parameters	Cost Equation		Comments
1. Site preparation: Plant/pit roads	T = Ton/ day of ore and waste	$C_{11} = 2832\ T^{0.5}$ $C_{12} = 7080\ T^{0.5}$		For flat terrain; lightly vegetated For rugged terrain; heavily vegetated
2. Pre-Production Stripping	T_o = tons of Overburden	$C_{21} = 1133\ T_o^{0.5}$ $C_{22} = 12035\ T_o^{0.5}$		For soil overburden For rock overburden
3. Open-Pit equipment	S = shovel size, cu. yd. t = truck size, tons	$C_{31} = 325664\ Ns\ S^{0.73}$ $C_{32} = 12743\ N_t t^{0.85}$ $C_{33} = 2.27\ C_{31}\ T^{-0.2}$	$S = 0.13T^{.4}$ $Ns = 0.007(1/S)T^{.8}$ $T = 8S^{1.1}$; $N_t = 0.2(1/t)T^{0.8}$	Shovel fleet; Ns = No. of shovels Truck fleet: N_t = No. of trucks Drilling equipment
4. Maintenance facilities	T = Tons/ day of ore and waste	$C_4 = 212389\ T^{0.3}$		Includes maintenance equipment
5. Power, water, transmission				Estimate as part of Processing plant
6. Feasibility, Engineering, Planning	4 to 6% of $(C_{11} + C_{12} + C_{21} + C_{22})$ plus 6 to 8 %$(C_{31} + C_{32} + C_{33} + C_4)$			
7. Supervision, Management, Camp, Construction facilities	8 to 10% of $(C_{11} + C_{12} + C_{21} + C_{22} + C_{31} + C_{32} + C_{33} + C_4)$			
8. Administration, Accounting, Legal and Key Staff.	4 to 7% of $(C_{11} + C_{12} + C_{21} + C_{22} + C_{31} + C_{32} + C_{33} + C_4)$			

*Actual Cost Estimate – (Index Multiplier) (Cost Equation)

Table 13
Summary of Processing Plant Capital Cost Estimates (O'hara, CIM Bulletin, 1980)

Cost item	Parameter	Cost Equation	Comment	Factors
1) Clearing, excavation	T = Capacity TPD	$C_1 = 56637\ Fs\ T^{0.3}$	Fs = Site Factor	= 1.0(flat sites; less than 10 3 meters of overburden) = 1.5 (moderate slopes; some blasting required) = 2.5 (steep slopes; extensive blasting required)
2) Foundation & Details	T = Capacity TPD	$C_2 = 28319\ FcT^{0.5}$	Fc = Rock Factor	= 1.0(Solid rock for foundation support) = 1.8 (gravel/ sand as support) = 3.5 (Moist soil as support: piled foundation)
3) Crushing & Conv.	T = Capacity TPD	$C_3 = 63717\ T^{0.5}$		
4) Mill Building	T = Capacity TPD	$C_4 = 42478\ Fw\ T^{0.5}$	Fw = Climate Factor	= 1.0 (Mild Climate) = 1.8 (Cold Climate) = 2.5 (Severe Climate)
5) Grinding, Storage	T = Capacity TPD	$C_5 = 11328\ Fg\ T^{0.7}$	Fg = Grind Factor	= 1.0 (soft ores; 55%-200 mesh; work index under 12) = 1.5 (medium ores; 70 % -200 mesh; work index = 15) = 1.8 (hard ores; 80% -200 mesh; work index = 17)
6) Main processing	T = Capacity TPD	$C_6 = 3540\ Fp\ T^{0.7}$	Fp = processing factor	= 1.0 (Au ores; cyanidation); = 1.2 (flotation; coarse low grade Cu ore); = 1.6(flotation; high grade Cu/Zn ores); = 2.0 (selective flotation); = 3 (complex Au ores; float, roast, cyanide); = 5 (gravity concentration).

Table 13 (cont.)
Summary of Processing Plant Capital Cost Estimates (O'hara, CIM Bulletin, 1980)

Cost item	Parameter	Cost Equation	Comment	Factors
7) Thickening and Filtration	T = Capacity TPD	$C_7 = 7080\ Ft\ T^{0.5}$	Ft = Processing factor	= 1.0(low grade ores); = 1.6 (high grade ores); = 2.0 (complex ores); = 3(cyanided/ leached ores)
8) Conc. Storage	Tc = Capacity TPD of Conc.	$C_8 = 5664\ Tc^{0.8}$	Tc = Ff /cR	F = feed ; f = feed grade; c = concentrate grade; R = recovery
9) Power, lines	P = peak load in KW M = miles of lines	$C_{91} = 65133\ P^{0.6}$ $C_{92} = 6372\ P^{0.8}$ $C_{93} = 496P^{0.8} + 495\ M$ $C_{94} = 850\ P^{0.8}$	$P = 136\ T^{0.5}$	-Coal Fired - Diesel generator - Utility substation - low volt lines
10) Tailings Pond	T = Capacity TPD	$C_{10} = 4248T^{0.5}$		For Dam; flat terrain
11) Water Supply	Q = water IGPM	$C_{111} = 496\ LQ^{0.9}$ $C_{112} = 3257\ Q^{0.6}$ $C_{113} = 4248\ Q^{0.6}$	$Q = 12T^{0.6}$ $Q = 2.5T^{0.6}$ $Q = 0.026T^{0.6}$	Plentiful water; 1 mile away ; L = miles of pipe Scarce supply: open pit, high tonnage Reclaim when fresh supply scarce
12) Plant Services	N = No.of Employees	$C_{12} = 11328\ N^{0.8}$		
13) Access Road	R = miles of road b = length of bridges, ft	$C_{131} = 424779\ R$ $C_{132} = 184\ b^{1.5}$		Road (miles of Road) Bridge s built (No. of Feet)
14) Townsite, Housing	N = No.of Employees	$C_{141} = 28319\ N$		Bank house camp
15) Feasibility, plan, design	4 to 6% of (1) +(2) + 13 plus 6 to 8 % of sum of items (3) to (12) and item (14)			
16) Supervision, Camp	8 to 10% of sum of items (1) to (14)			
17)Admin., Key Staff	4 to 7% of sum of items (1) to (14)			

*Actual Cost estimate = (index multiplier) (Cost equation)

Table 14
Summary of Mine-Processing Total Production Cost Estimates

Cost Activity	Item	Cost Equation
1. Operating Costs; Supplies; power, $ / D		T_p = TPD ore + waste; T = TPD milled
a. Open Pit Mining	Labor	$C_{11} = 93.352\,T_p^{0.5} + 5.724\,T_p^{0.7}$
	Supplies	$C_{12} = 18.97\,T_p^{0.5} + 1.756\,T_p^{0.7} + 1.274T_p^{0.8}$
b. Processing plant	Labor	$C_{21} = 127.5\,T^{0.5}$ (Simple base metal ores)
		$C_{21} = 148.3\,T^{0.5}$ (Complex Base metal ores)
		$C_{21} = 154.6\,T^{0.5}$ (Gold ores)
	Supplies	$C_{22} = 26.6\,T^{0.7}$ (Simple base metal ores)
		$C_{22} = 30.44T^{0.7}$ (Complex Base metal ores)
		$C_{22} = 21.5\,T^{0.7}$ (Gold ores)
c. Environmental Measures and	Labor	$C_{31} = 10\% (C_{11} + C_{21})$
Monitoring	Supplies	$C_{32} = 10\% (C_{12} + C_{22})$
d. Power		$C_4 = 145.1\,T^{0.5}$ (Diesel)
		$C_4 = 54.34\,T^{0.5}$ (Utility)
		$C_4 = 102\,T^{0.5}$ (Coal)
e. Supplies-General Plant Services		$C_5 = 8.5\,T^{0.5}$
2. Wages/ General Plant Services		N_{tot} = Total No. of personnel
a. Electrical services (35% fringe benefits)		$C_6 = 1.35\,(108.4\,N_e)$; $N_e = 0.05\,N_{tot}$
b. Surface Plant services (35% f.b.)		$C_7 = 1.35\,(108.4\,N_{Ps})$; $N_{Ps} = 0.04\,N_{tot}$
c. Townsite Employees (35% fringe benefits)		$C_8 = 1.35\,(108.4\,N_{Te})$; $N_{Te} = 0.03\,N_{tot}$
d. Townsite Operating Costs		$C_9 = 20.7\,N_{tot}$
3. Wages/ Administration Expenses		
a. General Admin. Wages		
b. General Expenses		$C_{10} = 1.35\,(9.49\,N_{tot})$
		$C_{11} = 6.38\,N_{tot}$
Total Operating Costs		$C_{11} + C_{12} + \ldots\ldots\ldots C_{10} + C_{11}$

Table 15
Components of an Annual Cash Flow Analysis for Mineral Utilization Operation

Calculation	Component
	Gross revenue
Less	2% Excise tax
	Net Revenue
Less	**Operating Costs**
Equals	Net income before Depreciation and Depletion
Less	**Depreciation and Depletion**
Equals	Net taxable Income
Less	Income Tax (35%)
Equals	Net Profit after Tax
Add	Depreciation
Add	**Depletion**
Equals	Operating Cash Flow
Less	Capital Expenditures
Less	**Working Capital**
Equals	Net Annual Cash Flow

Table 16
Bauxite Deposits in Samar Island

Location		Project/ Proponent	Mineral Reserve, MT	Assay, % Al_2O_3	Status
Western Samar	Concord, Hinabangan (5 sites)	Mineral Reservation	53,703,437	43.46	Detailed Exploration conducted
	San Jose de Panangan, Gandara				Presence of bauxite reported
	Malapgap, Gandara				Presence of bauxite reported
	Paco, Jose Rono, Concepcion, Wright		544,115	46.06	No detailed exploration conducted reported
	Bagacay, Hinabangan				Presence of bauxite reported
Eastern Samar	Carbon, Magsaysay, Mac Arthur				Presence of bauxite reported
	Onong, Salcedo	Mineral Reservation	10,658,160	42.44	No detailed exploration conducted reported
	Palomorag, Mercedes	Mineral Reservation	47,858,400	42.44	
	Campoyang, Guiuan	Mineral Reservation	25,640,000	42.44	
Northern Samar	Batag Island	Mineral Reservation	11,017,950	43.00	Detailed Exploration conducted
	San Isidro, Allen, Cavizares Caghilot, Silvino, Lobos Catotoogan, Las Navas				Presence of bauxite reported

Table 17
Positive Bauxite Prospects in Samar Island

Location	Bauxite Reserve, MT	Ave. Grade, % Al_2O_3	% Recoverable by Mining	Positive Prospect or Recoverable Ore, MT	Projected Area Affected by Mining Activities, in Hectares
Onong Salcedo, E, Samar	10,658,160	42.44 %	50%	5,329,080	324
Palmorag, Mercedes, E. Samar	47,858,400	42.44 %	50%	23,929,200	324
Campayong, E. Samar	25,640,000	42.44 %	50%	12,820,000	324
Concord, Hinabangan, W. Samar	53,703,437	43.46%	90%	48,333,093	3000
Total	**137,859,997**	**42.99 %**		**90,411,373**	3,972

Table 19
Summary of Bauxite Open-Cast Mine Capital Investment Cost Estimates

Cost item	Cost Parameter	Cost Estimation, $	Comments
1. Site Preparation; Plant /pit roads	Tons of ore + wastes /day	465,051	Generally within flat terrain, lightly with trees
2. Pre-production Stripping	Tons of overburden	51,602	For soil overburden
3. Open-Cast Mining Equipment	Tons of ore + wastes /day	5,204,481	- Shovel fleet: 3 shovels @ 6 Cu.Yd capacity
		4,170,944	- Truck Fleet: 7 trucks a@ capacity of 60 MT per truck
	S = Shovel size T = truck size	1,279,067	- Boring equipment @ 50% of the overburden and ore
4. Maintenance Facilities	Tons/day of ore +wastes	5,245,067	Includes maintenance equipment
5. Feasibility, Engineering, Planning		1,138,828	5% of items (1) & (2) + 7% of (3) & (4)
6. Supervision, Management, Camp, Construction Facilities		1,477,493	9% of items (1) to (4)
7. Administration, Accounting, Key staff, and Legal		902,912	5.5% of items (1) to (4)
Total Fixed Capital Investment Cost (Open-Cast Mining), $		**$ 19,935,822**	
PhP		**PhP 996,791,080**	

Note: Cost Formula: Cost Estimate = (Multiplier Index)(Cost Equation)

Table 20
Summary of Bauxite Processing Plant Capital Cost Estimates

Cost Items	Cost Parameters	Cost Estimation, $	Comments
1. Clearing Excavation	Capacity MT/day	1,365,497	Fs=1 (site factor) for flat site: less than 10 ft of overburden
2. Foundation & Details	Capacity MT/day	15,637,691	Fc=3.5 (rock factor) for moist soil as support; piled foundation
3. Grinding Plant, Ore Storage & Conveyors	Capacity MT/day	11,695,429	Fg =1.0 (Grind factor) soft ore; 55%-200 mesh; Wi= under 12
4. Processing Building	Capacity MT/day	16,754,472	Fw=2.5 (climate factor) Severe climate
5. Digestion Section, Slurry Preparation	Capacity MT/day	10,964,465	Fp=3.0 (process factor)-Digestion of ores
6. Processing Section, Leaching and Precipitation	Capacity MT/day	12,791,875	Fp=3.5 (process factor)-leaching and precipitation
7. Calcination Section	Capacity MT/day	14,619,286	Fp=4.0 (process factor)-calcination or roasting
8. Thickening & Filtering	Capacity MT/day	2,234,035	Ft=2.0(process factor) Solid-liquid for complex ores
9. Calcine Storage and Loading	MTD of conc.	6,377,167	Tc (Conc. Tonnage)= 4,134
10. Power Lines	Peak load per KW	29,930,560	Coal Fired
11. Tailings Storage	Capacity MT/day	1,340,421	Tailings Ponds
12. Water Supply	Water in GPM	592,400	Reclaim when fresh water supply is scarce
13. Plant Services	No. of Employees	2,938,984	N (no. of Employees)= 632
14. Access Road	Miles of Road	31,109,699	50 miles plus 200 ft of Bridges

Table 20 (cont.)
Summary of Bauxite Processing Plant Capital Cost Estimates

Cost Item	Cost Parameters	Cost Estimation, $	Comments
15. Townsite Housing		10,971,506	Family town site
16. Feasibility ,Planning, Design		10,768,179	5% of item (1 to 2 + 14) plus 7% items (3 to 12 and 15)
17. Supervision, management, construction facilities including camp		15,073,339	9% of sum of items (1) to (15)
18. Administration, accounting, legal, key operating staff		9,211,485	5.5% of sum of items (1) to (15)
Total Processing Capital Investment Costs, $		**$ 222,632,857**	
PhP		**PhP 11,131,642,86**	

Note: Cost Formula: Cost Estimate = (Multiplier Index)(Cost equation)

Table 21
Estimation of Personnel Requirements (Bauxite)

Cost item	No. of Employees	Remarks
Operating Costs: Supplies and Power		
a. Open-Cast Mining	47	Consider the MTPD of ore and overburden
b. Processing Plant	100	
c. Environment Maintenance & Monitoring	22	Consider the MTPD of ore only
General Plant Services Emp.	38	
a. Electrical Services		
b. Surface Plant and Road Maintenance Services		
c. Town-site Employees		
Administrative Employees		
a. General Administration	21	
Others (Environ., Misc..)	426	Non- technical
Total Employees	**654**	

Table 22
Estimation of Production Costs for the Bauxite Mineral Utilization

Cost item	Production Cost,$	
	Per day ,$	Total, per year, PhP
Operating Labor		
a. Open-Cast Mining		478,916,746
Labor	19,669	
Supplies	6,937	
b. Processing Plant		986,845,457
Labor	23,397	
Supplies	31,427	
c. Environment		146,576,220
Labor	4,307	
Supplies	3,836	
d. Power	16,093	289,667,216
Coal		
	1,341	
e. Supplies- Gen. Plant Services		24,138,925
Wages/ General Plant Services		464,131,617
a. Electrical Services (35% fringe benefits)	7,588	
b. Surface Plant Services (35% f.b.)	2,597	
c. Townsite Employees (35% f.b.)	2,169	
d. Townsite Operating Costs	13,071	
Wages/ Administrative Services		217,917,236
a. General Admin. Wages (35% f.b.)	8,082	
b. General Expenses	4,025	
Total Production Costs	**$136,757**	**PhP 2,608,193,427**

Table 24
Discounted Cash Flow Analysis for Bauxite

	Remarks	1st Year Dev.	2nd Year Dev.	3rd. Year Dev.
Bauxite Reserves, beg				
Bauxite Reserves, ending				
Mine Production (Annual)				
Millhead Grade	Assumed uniform			
Recovery, Al2O3	Assumed uniform			
Calcine Grade, Al2O3				
Mill Concentrate Prod. (mt)				
Add: Beginning Inventory (mt)				
Less: Ending Inventory (mt)				
Concentrate Sales (mt)				
Price of Alumina /mt (USD)	Assumed uniform			
Sale of Alumina Product (Dollar)				
Sale of Alumina Product (pesos)				
Less: Excise Tax				
Net Sales				
Less:				
Exploration Costs (P250,000/Ha)	(1,000,000,000.00)	(333,333,333.33)	(333,333,333.33)	(333,333,333.33)
Mining Costs				
Processing Costs				
Environmental Costs (% Min & Mill)				
Power				
General Supplies				
General Wages				
Operating Income				
Less:				
Depletion	(2,693,548,603.02)	(897,849,534.34)	(897,849,534.34)	(897,849,534.34)
Depreciation of Mine, Mill, Environ, Equipment	(11,254,150,436.55)	(3,751,383,478.85)	(3,751,383,478.85)	(3,751,383,478.85)
Net Income bef. Inc. Tax				
Less:				
Income Tax				
Net Income				
Add Back:				
Depletion				
Depreciation				
Working Capital (1 month)	5,021,171,654.25			(5,021,171,654.25)
Net Cashflow	(19,968,870,693.82)	(4,982,566,346.53)	(4,982,566,346.53)	(4,982,566,346.53)
NET PRESENT VALUE, 12%, PhP	34,213,183,567			
INTERNAL RATE OF RETURN	39%			

Table 24 (cont.)
Discounted Cash Flow Analysis for Bauxite

	1 st Year Prod.	2nd Year Prod.	3rd Year Prod.	19th Year Prod.	20th Year Prod.	21st Year Prod.
Bauxite Reserves, beg	90,411,373.30	86,106,069.81	81,800,766.32	12,915,910.47	8,610,606.98	4,305,303.49
Bauxite Reserves, ending	86,106,069.81	81,800,766.32	77,495,462.83	8,610,606.98	4,305,303.49	(0.00)
Mine Production (Annual)	4,305,303.49	4,305,303.49	4,305,303.49	4,305,303.49	4,305,303.49	4,305,303.49
Millhead Grade	42.99%	42.99%	42.99%	42.99%	42.99%	42.99%
Recovery, Al2O3	80%	80%	80%	80%	80%	80%
Calcine Grade, Al2O3	99.50%	99.50%	99.50%	99.50%	99.50%	99.50%
Mill Concentrate Prod. (mt)	1,488,120.58	1,488,120.58	1,488,120.58	1,488,120.58	1,488,120.58	1,488,120.58
Add: Beginning Inventory (mt)	0.00	124,010.05	124,010.05	124,010.05	124,010.05	124,010.05
Less: Ending Inventory (mt)	124,010.05	124,010.05	124,010.05	124,010.05	124,010.05	0
Concentrate Sales (mt)	1,364,110.53	1,488,120.58	1,488,120.58	1,488,120.58	1,488,120.58	1,612,130.63
Price of Alumina /mt (USD)	210.00	210.00	210.00	210.00	210.00	210.00
Sale of Alumina Product (Dollar)	285,030,895.47	310,942,795.05	310,942,795.05	310,942,795.05	310,942,795.05	336,854,694.64
Sale of Alumina Product (pesos)	14,251,544,773.28	15,547,139,752.67	15,547,139,752.67	15,547,139,752.67	15,547,139,752.67	16,842,734,732.06
Less: Excise Tax	285,030,895.47	310,942,795.05	310,942,795.05	310,942,795.05	310,942,795.05	336,854,694.64
Net Sales	13,966,513,877.81	15,236,196,957.61	15,236,196,957.61	15,236,196,957.61	15,236,196,957.61	16,505,880,037.42
Less:						
Exploration Costs (P250,000/Ha)	(47,619,047.62)	(47,619,047.62)	(47,619,047.62)	(47,619,047.62)	(47,619,047.62)	(47,619,047.62)
Mining Costs	478,916,746.36	478,916,746.36	478,916,746.36	478,916,746.36	478,916,746.36	478,916,746.36
Processing Costs	986,845,456.70	986,845,456.70	986,845,456.70	986,845,456.70	986,845,456.70	986,845,456.70
Environmental Costs (% Min & Mill)	146,576,220.31	146,576,220.31	146,576,220.31	146,576,220.31	146,576,220.31	146,576,220.31
Power	289,667,215.85	289,667,215.85	289,667,215.85	289,667,215.85	289,667,215.85	289,667,215.85
General Supplies	24,138,934.65	24,138,934.65	24,138,934.65	24,138,934.65	24,138,934.65	24,138,934.65
General Wages	682,048,853.06	341,024,426.53	341,024,426.53	341,024,426.53	341,024,426.53	341,024,426.53
Operating Income	11,405,939,498.50	13,016,647,004.83	13,016,647,004.83	13,016,647,004.83	13,016,647,004.83	14,286,330,084.63
Less:						
Depletion	(128,264,219.19)	(128,264,219.19)	(128,264,219.19)	(128,264,219.19)	(128,264,219.19)	(128,264,219.19)
Depreciation of Mine, Mill, Environ, .Equipment	(535,911,925.55)	(535,911,925.55)	(535,911,925.55)	(535,911,925.55)	(535,911,925.55)	(535,911,925.55)
Net Income bef. Inc. Tax	10,741,763,353.76	12,352,470,860.09	12,352,470,860.09	12,352,470,860.09	12,352,470,860.09	13,622,153,939.89
Less:						
Income Tax	3,759,617,173.82	4,323,364,801.03	4,323,364,801.03	4,323,364,801.03	4,323,364,801.03	4,767,753,878.96
Net Income	6,982,146,179.94	8,029,106,059.06	8,029,106,059.06	8,029,106,059.06	8,029,106,059.06	8,854,400,060.93
Add Back:						
Depletion	128,264,219.19	128,264,219.19	128,264,219.19	128,264,219.19	128,264,219.19	128,264,219.19
Depreciation	535,911,925.55	535,911,925.55	535,911,925.55	535,911,925.55	535,911,925.55	535,911,925.55
Working Capital (1 month)						5,021,171,654.25
Net Cashflow	7,646,322,324.68	8,693,282,203.80	8,693,282,203.80	8,693,282,203.80	8,693,282,203.80	9,518,576,205.67
NET PRESENT VALUE, 12%, PhP						
INTERNAL RATE OF RETURN						

Table 25
Copper-Pyrite Deposits in Bagacay, Hinabangan, Western Samar

Mineral Prospect	Location	Mineral Reserve, MT	Assay, %
Copper	Bagacay, Hinabangan	1,424,973	2.4% Cu
Pyrite	Bagacay, Hinabangan	8,062,000	35.46% S
	Total	**9,486,973**	

Table 26
Positive Copper-Pyrite Mineral Prospects of Bagacay, Hinabangan, Western Samar

Mineral Prospect	Location	Mineral Reserve, MT	Percentage Mineable, %	Mineable Reserve, MT	Status
Copper	Bagacay, Hinabangan	1,424,973	90%	1,282,476	Detailed exploration
Pyrite	Bagacay, Hinabangan	8,062,000	90%	7,255,800	Detailed exploration
	Total	**9,486,973**		**8,538,276**	

Table 28
Summary of Copper-Pyrite Open-Cast Mine Capital Investment Cost Estimates

Cost item	Cost Parameter	Cost Estimation, $	Comments
1. Site Preparation; Plant /pit roads	Tons of ore + wastes /day	33,511	Generally within flat terrain, lightly with trees
2. Pre-production Stripping	Tons of overburden	7,740	For soil overburden
3. Open-Cast Mining Equipment	Tons of ore + wastes /day	387,107	- Shovel fleet: 2 shovels @ 4 Cu.Yd capacity
	S = Shovel size	237,045	- Truck Fleet: 4 trucks a@ capacity of 40 MT per truck
	T = truck size	38,279	- Drilling & Boring equipment
4. Maintenance Facilities	Tons/day of ore +wastes	506,752	Includes maintenance equipment
5. Feasibility, Engineering, Planning		12,586	5% of items (1) & (2) + 7% of (3) & (4)
6. Supervision, Management, Camp, Construction Facilities		16,341	9% of items (1) to (4)
7. Administration, Accounting, Key staff, and Legal		9,986	5.5% of items (1) to (4)
Total Fixed Capital Investment Cost (Open-Cast Mining), $		**$ 1,249,346**	
PhP		**PhP 62,457,319**	

Note: Cost Formula: Cost Estimate = (Multiplier Index)(Cost Equation)

Table 29
Summary of Copper-Pyrite Processing Plant Capital Cost Estimates

	Cost Items	Cost Parameters	Cost Estimation, $	Comments
1.	Clearing Excavation	Capacity MT/day	179,485	Fs=1 (site factor) for flat site: less than 10 ft. of overburden
2.	Foundation & Details	Capacity MT/day	957,609	Fc=3.5 (rock factor) for moist soil as support; piled foundation
3.	Grinding plant, ore storage & conveyors	Capacity MT/day	500,497	Fg =2.5 (Grind factor) soft ore; 55%-200 mesh; Wi= under 12
4.	Processing Building	Capacity MT/day	1,025,998	Fw=2.5 (climate factor) Severe climate
5.	Processing section, Bulk and Differential Flotation	Capacity MT/day	547,419	Fp=3.5 (process factor)- Flotation of complex ores
6.	Thickening & Filtering	Capacity MT/day	136,806	Ft=2.0 (process factor) Solid-liquid for complex ores
7.	Concentrate storage and Loading	MTD of conc.	956,575	Tc (Conc. Tonnage)
8.	Power Lines	Peak load per KW	132,443	Utilities
9.	Tailings Storage	Capacity MT/day	547,225	Tailings Ponds
10.	Water supply	Water in GPM	24,459	Reclaim when fresh water supply is scarce
11.	Plant services	No. of Employees	425,848	N (no. of Employees)= 356
12.	Access Road	Miles of Road	277,772	3 miles plus 20 ft of Bridges
13.	Townsite Housing		3,058,970	Family town site
14.	Feasibility ,Planning, Design		87,852	5% of items (1 to 2 +14) plus 7% items (3 to 12 and 15)
15.	Supervision, management, construction facilities including camp		118,410	9% of sum of items (1) to (15)
16.	Administration, accounting, legal, key operating staff		72,362	5.5% of sum of items (1) to (15)
Total Processing Capital Investment Cost	$		$ 9,049,729	
	PhP		PhP 452,486,434	

Table 30
Estimation of Personnel Requirements (Copper-Pyrite)

Cost item	No. of Employees	Remarks
Operating Costs: Supplies and Power		
a. Open-Cast Mining	21	Consider the MTPD of ore and overburden
b. Processing Plant	58	
c. Environment Maintenance & Monitoring	12	Consider the MTPD of ore only
General Plant Services Emp.	19	
a. Electrical Services		
b. Surface Plant and Road Maintenance Services		
c. Town-site Employees		
Administrative Employees		
a. General Administration	11	
Others (Misc..)	235	Non- technical
Total Employees	356	

Table 31
Estimation of Production Costs for the Copper-Pyrite Mineral Utilization

Cost items	Production Cost, $	
	Per day ,$	Total, per year, PhP
Operating Labor		
a. Open-Cast Mining		31,490,259
Labor	1,338	
Supplies	412	
b. Processing Plant		49,998,639
Labor	1,433	
Supplies	1,345	
c. Environment		12,223,335
Labor	416	
Supplies	264	
d. Power	985	17,738,422
Utility	82	
e. Supplies- Gen. Plant Services		1,478,202
Wages/ General Plant Services		
a. Electrical Services	569	
(35% fringe benefits)	222	
b. Surface Plant services (35% f.b.)	163	
c. Townsite Employees (35% f.b.)	1,343	
d. Townsite Operating Costs		41,336,285
Wages/ Administrative Services	830	22,388,757
b. General Admin. Wages (35% f.b.)	413	
c. General Expenses		
Total Production Costs	**$9,815**	**Php 176,662,895**

Table 33
Discounted Cash Flow Analysis for Copper and Pyrite

	Remarks	1st Year Dev.	2nd Year Dev.	3rd. Year Dev.
Copper and Pyrite Reserves, beg				
Copper and Pyrite Reserves, ending				
Mine Production (Annual)				
Millhead grade, Cu Ore				
Millhead Grade, Pyrite Ore	Assumed uniform			
Mill recovery, Cu and S	Assumed uniform			
Cu Conc. Produced, MTY				
Pyrite Conc Produced, MTY				
Grade of Copper conc,%Cu				
Grade of Pyrite Conc, % S				
Add: Beginning Inventory (mt)				
Less: Ending Inventory (mt)				
Concentrate Cu Sales , MT				
Concentrate Pyrite Sales, MT				
Sale for Cu and Pyrite Product ($)				
Total Sales for Cu and Pyrite Product (PhP)				
Less: Excise Tax (2%)				
Net Sales				
Less:				
Exploration Costs (P250,000/Ha)	(162,000,000.00)	(54,000,000.00)	(54,000,000.00)	(54,000,000.00)
Mining Costs				
Processing Costs				
Environmental Costs (% Min & Mill)				
Power				
General Supplies				
General Wages				
Operating Income				
Less:				
Depletion	(55,436,873.68)	(18,478,957.89)	(18,478,957.89)	(18,478,957.89)
Depreciation of Mine, Mill, Environ, Equipment	(536,759,942.38)	(178,919,980.79)	(178,919,980.79)	(178,919,980.79)
Net Income bef. Inc. Tax				
Less:				
Income Tax				
Net Income				
Add Back:				
Depletion				
Depreciation				
Working Capital (1 month)	213,190,853.78			(213,190,853.78)
Net Cashflow	(967,387,669.84)	(251,398,938.69)	(251,398,938.69)	(251,398,938.69)
NET PRESENT VALUE, 12%, PhP	1,107,196,897.07			
INTERNAL RATE OF RETURN	36%			

Table 33 (cont.)
Discounted Cash Flow Analysis for Copper and Pyrite

	1 st Year Prod.	2 nd Year Prod.	3 rd Year Prod.	9 thYear Prod.	10th Year Prod.	11th Year Prod.
Copper and Pyrite Reserves, beg	8,538,275.70	7,762,068.82	6,985,861.94	2,328,620.65	1,552,413.76	776,206.88
Copper and Pyrite Reserves, ending	7,762,068.82	6,985,861.94	6,209,655.05	1,552,413.76	776,206.88	(0.00)
Mine Production (Annual)	776,206.88	776,206.88	776,206.88	776,206.88	776,206.88	776,206.88
Millhead grade, Cu Ore	2.40%	2.40%	2.40%	2.40%	2.40%	2.40%
Millhead Grade, Pyrite Ore	35.46%	35.46%	35.46%	35.46%	35.46%	35.46%
Mill recovery, Cu and S	80%	80%	80%	80%	80%	80%
Cu Conc. Produced, MTY	42,580.49	42,580.49	42,580.49	42,580.49	42,580.49	42,580.49
Pyrite Conc Produced, MTY	400,353.40	400,353.40	400,353.40	400,353.40	400,353.40	400,353.40
Grade of Copper conc,%Cu	35.00%	35.00%	35.00%	35.00%	35.00%	35.00%
Grade of Pyrite Conc, % S	55.00%	55.00%	55.00%	55.00%	55.00%	55.00%
Add: Beginning Inventory (mt)	0	40,266.72	40,266.72	40,266.72	40,266.72	40,266.72
Less:Ending Inventory (mt)	40,266.72	40,266.72	40,266.72	40,266.72	40,266.72	40,266.72
Concentrate Cu Sales , MT	2,906,118.57	2,906,118.57	2,906,118.57	2,906,118.57	2,906,118.57	2,906,118.57
Concentrate Pyrite Sales, MT	12,110,690.25	12,110,690.25	12,110,690.25	12,110,690.25	12,110,690.25	12,110,690.25
Sale for Cu and Pyrite Product ($)	15,016,808.82	15,016,808.82	15,016,808.82	15,016,808.82	15,016,808.82	15,016,808.82
Total Sales for Cu and Pyrite Product (PhP)	750,840,440.92	750,840,440.92	750,840,440.92	750,840,440.92	750,840,440.92	750,840,440.92
Less: Excise Tax (2%)	15,016,808.82	15,016,808.82	15,016,808.82	15,016,808.82	15,016,808.82	15,016,808.82
Net Sales	735,823,632.10	735,823,632.10	735,823,632.10	735,823,632.10	735,823,632.10	735,823,632.10
Less:						
Exploration Costs (P250,000/Ha)	(14,727,272.73)	(14,727,272.73)	(14,727,272.73)	(14,727,272.73)	(14,727,272.73)	(14,727,272.73)
Mining Costs	31,490,259.20	31,490,259.20	31,490,259.20	31,490,259.20	31,490,259.20	31,490,259.20
Processing Costs	49,998,638.88	49,998,638.88	49,998,638.88	49,998,638.88	49,998,638.88	49,998,638.88
Environmental Costs (% Min & Mill)	8,148,889.81	8,148,889.81	8,148,889.81	8,148,889.81	8,148,889.81	8,148,889.81
Power	17,738,421.85	17,738,421.85	17,738,421.85	17,738,421.85	17,738,421.85	17,738,421.85
General Supplies	1,478,201.82	1,478,201.82	1,478,201.82	1,478,201.82	1,478,201.82	1,478,201.82
General Wages	63,725,041.79	63,725,041.79	63,725,041.79	63,725,041.79	63,725,041.79	63,725,041.79
Operating Income	577,971,451.47	577,971,451.47	577,971,451.47	577,971,451.47	577,971,451.47	577,971,451.47
Less:						
Depletion	(5,039,715.79)	(5,039,715.79)	(5,039,715.79)	(5,039,715.79)	(5,039,715.79)	(5,039,715.79)
Depreciation of Mine, Mill, Environ, Equipment	(48,796,358.40)	(48,796,358.40)	(48,796,358.40)	(48,796,358.40)	(48,796,358.40)	(48,796,358.40)
Net Income bef. Inc. Tax	524,135,377.29	524,135,377.29	524,135,377.29	524,135,377.29	524,135,377.29	524,135,377.29
Less:						
Income Tax	183,447,382.05	183,447,382.05	183,447,382.05	183,447,382.05	183,447,382.05	183,447,382.05
Net Income	340,687,995.24	340,687,995.24	340,687,995.24	340,687,995.24	340,687,995.24	340,687,995.24
Add Back:						
Depletion	5,039,715.79	5,039,715.79	5,039,715.79	5,039,715.79	5,039,715.79	5,039,715.79
Depreciation	48,796,358.40	48,796,358.40	48,796,358.40	48,796,358.40	48,796,358.40	48,796,358.40
Working Capital (1 month)						213,190,854.00
Net Cashflow	394,524,069.42	394,524,069.42	394,524,069.42	394,524,069.42	394,524,069.42	607,714,923.42
NET PRESENT VALUE, 12%, PhP						
INTERNAL RATE OF RETURN						

Table 35
Summary of Nickel Laterite Open-Cast Mine Capital Investment Cost Estimates

Cost item	Cost Parameter	Cost Estimation, $	Comments
1. Site Preparation; Plant /pit roads	Tons of ore + wastes /day	116,084	Generally within flat terrain, lightly with trees
2. Pre-production Stripping	Tons of overburden	23,221	For soil overburden
3. Open-Cast Mining Equipment	Tons of ore + wastes /day	1,161,321	- Shovel fleet: 2 shovels @ 4 Cu.Yd capacity
	S = Shovel size	759,856	- Truck Fleet: 4 trucks @ capacity of 40 MT per truck
	T = truck size	325,248	- Boring equipment for the overburden and ore
4. Maintenance Facilities	Tons/day of ore +wastes	1,657,290	Includes maintenance equipment
5. Feasibility, Engineering, Planning		126,101	5% of items (1) & (2) + 7% of (3) & (4)
6. Supervision, Management, Camp, Construction Facilities		163,742	9% of items (1) to (4)
7. Administration, Accounting, Key staff, and Legal		100,065	5.5% of items (1) to (4)
Total Fixed Capital Investment Cost (Open-Cast Mining), $ PhP		$ 41,940,919 PhP 2,097,046,936	

Note: Cost Formula: Cost Estimate = (Multiplier Index)(Cost Equation)

Table 36
Summary of Nickel-Laterite Processing Plant Capital Cost Estimates

	Cost Items	Cost Parameters	Cost Estimation, $	Comments
1.	Clearing Excavation	Capacity MT/day	405,401	Fs=1 (site factor) for flat site: less than 10 ft of overburden
2.	Foundation & Details	Capacity MT/day	3,518,480	Fc=3.5 (rock factor) for moist soil as support; piled foundation
3.	Grinding plant, ore storage & conveyors	Capacity MT/day	1,994,282	Fg =1.0 (Grind factor) soft ore; 55%-200 mesh; Wi= under 12
4.	Processing Building	Capacity MT/day	3,769,756	Fw=2.5 (climate factor) Severe climate
5.	Slurry preparation (digestion)	Capacity MT/day	1,558,033	Fp=3.0 (process factor)-Digestion of ores
6.	Processing section, leaching and precipitation	Capacity MT/day	2,181,246	Fp=3.5 (process factor)-leaching and precipitation
7.	Drying section	Capacity MT/day	1,869,640	Fp=3.0 (process factor)-drying or roasting
8.	Thickening & Filtering	Capacity MT/day	502,658	Ft=2.0(process factor) Solid-liquid for complex ores
9.	Metal storage and Loading	MTD of conc.	1,994,282	
10.	Power Lines	Peak load / KW	4,443,031	Utility
11.	Tailings Storage	Capacity MT/day	301,595	Tailings Ponds Safety factor + 50%
12.	Water supply	Water in GPM	98,253	Reclaim when fresh water supply is scarce
13.	Plant services	No. of Employees	1,277,543	N (no. of Employees)= 632
14.	Access Road	Miles of Road	2,782,308	10 miles plus 50 ft of Bridges
15.	Townsite Housing		11,599,614	Family town site
16.	Feasibility ,Planning, Design		1,145,972	5% of items(1 to 2 +14) plus 7% items (3 to12 and 15)
17.	Supervision, management, construction facilities including camp		1,550,993	9% of sum of items (1) to (15)
18.	Administration, accounting, legal, key operating staff		947,829	5.5% of sum of items (1) to (15)
Total Processing Capital Investment Costs,	**$**		**$ 41,940,919**	
	PhP		**PhP 2,097,045,936**	

Note: Cost Formula: Cost Estimate = (Multiplier Index)(Cost Equation)

Table 37
Estimation of Personnel Requirements (Nickel Laterite)

Cost Item	No. of Employees	Remarks
Operating Costs: Supplies and Power		
a. Open-Cast Mining	26	Consider the MTPD of ore and overburden
b. Processing Plant	66	
c. Environment Maintenance & Monitoring	14	Consider the MTPD of ore only
General Plant Services Emp.	20	
a. Electrical Services		
b. Surface Plant and Road Maintenance Services		
c. Town-site Employees		
Administrative Employees		
a. General Administration	12	
Others (Environ., Misc..)	262	Non-technical
Total Employees	400	

Table 38
Estimation of Production Costs for the Nickel-Laterite Mineral Utilization

Cost items	Production Cost,$	
	Per day ,$	Total, per year, PhP
<u>**Operating Labor**</u>		
a. Open-Cast Mining		110,860,683
Labor	4,682	
Supplies	1,477	
b. Processing Plant		191,220,258
Labor	5,264	
Supplies	5,359	
c. Environment		30,208,094
Labor	995	
Supplies	684	
d. Power	3,621	65,175,124
Utility		
e. Supplies- Gen. Plant Services	302	5,431,260
<u>**Wages/ General Plant Services**</u>		50,590,670
a. Electrical Services (35% fringe benefits)	759	
b. Surface Plant services (35% f.b.)	296	
c. Townsite Employees (35% f.b.)	279	
d. Townsite Operating Costs	1,477	
<u>**Wages/ Administrative Services**</u>		24,627,633
a. General Admin. Wages (35% f.b.)	913	
b. General Expenses	455	
Total Production Costs	**$24,884**	**PhP 478,113,722**

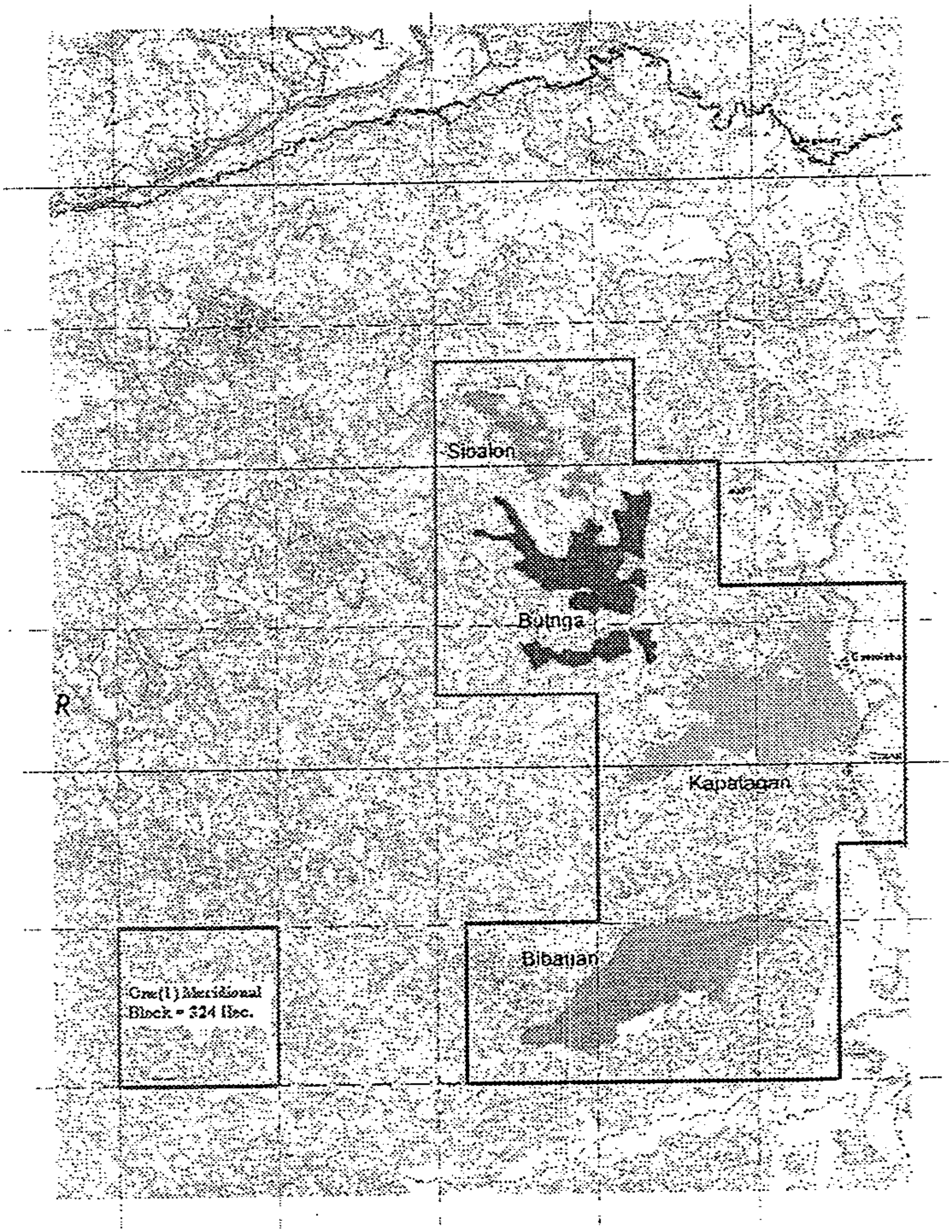
Table 40
Discounted Cash Flow Analysis of Nickel Laterite

	Remarks	1st Year Dev.	2nd Year Dev.	3rd. Year Dev.
Laterite Nickel Reserves, beg				
Laterite Nickel Reserves, ending				
Mine Production (Annual)				
Millhead Grade	Assumed uniform			
Recovery, Nickel Metal	Assumed uniform			
Nickel metal grade,%				
Metal Sales (MT)				
Price of Nickel Conc./mt (USD)	Assumed uniform			
Sale of Nickel Metal (Dollar)				
Sale of Nickel Metal (PhP)				
Less: Excise Tax				
Net Sales				
Less:				
Exploration Costs (P250,000/Ha)	(162,000,000.00)	(54,000,000.00)	(54,000,000.00)	(54,000,000.00)
Mining Costs				
Processing Costs				
Environmental Costs (% Min & Mill)				
Power				
General Supplies				
General Wages				
Operating Income				
Less:				
Depletion	(336,774,714.85)	(112,258,238.28)	(112,258,238.28)	(112,258,238.28)
Depreciation of Mine, Mill, Environ, Equipment	(2,329,721,451.68)	(776,573,817.23)	(776,573,817.23)	(776,573,817.23)
Net Income bef. Inc. Tax				
Less:				
Income Tax				
Net Income				
Add Back:				
Depletion				
Depreciation				
Working Capital (1 month)	959,938,619.95			(959,938,619.95)
Net Cashflow	(3,788,434,786.47)	(942,832,055.51)	(942,832,055.51)	(942,832,055.51)
NET PRESENT VALUE, 12%, PhP	479,328,985.56			
INTERNAL RATE OF RETURN	15%			

Table 40 (cont.)
Discounted Cash Flow Analysis of Nickel Laterite

	1st Year Prod.	2nd Year Prod.	3rd Year Prod.	10th Year Prod.	11th Year Prod.	12th Year Prod.
Laterite Nickel Reserves, beg	11,950,479.00	10,954,605.75	9,958,732.50	2,987,619.75	1,991,746.50	995,873.25
Laterite Nickel Reserves, ending	10,954,605.75	9,958,732.50	8,962,859.25	1,991,746.50	995,873.25	-
Mine Production (Annual)	995,873.25	995,873.25	995,873.25	995,873.25	995,873.25	995,873.25
Millhead Grade	0.58%	0.58%	0.58%	0.58%	0.58%	0.58%
Recovery, Nickel Metal	80%	80%	80%	80%	80%	80%
Nickel metal grade,%	99.50%	99.50%	99.50%	99.50%	99.50%	99.50%
Metal Sales (MT)	4,597.75	4,597.75	4,597.75	4,597.75	4,597.75	4,597.75
Price of Nickel Conc./mt (USD)	5,537.00	5,537.00	5,537.00	5,537.00	5,537.00	5,537.00
Sale of Nickel Metal (Dollar)	25,330,439.93	25,330,439.93	25,330,439.93	25,330,439.93	25,330,439.93	25,330,439.93
Sale of Nickel Metal (pesos)	1,266,521,996.62	1,266,521,996.62	1,266,521,996.62	1,266,521,996.62	1,266,521,996.62	1,266,521,996.62
Less: Excise Tax	25,330,439.93	25,330,439.93	25,330,439.93	25,330,439.93	25,330,439.93	25,330,439.93
Net Sales	1,241,191,556.69	1,241,191,556.69	1,241,191,556.69	1,241,191,556.69	1,241,191,556.69	1,241,191,556.69
Less:						
Exploration Costs (P250,000/Ha)	(13,500,000.00)	(13,500,000.00)	(13,500,000.00)	(13,500,000.00)	(13,500,000.00)	(13,500,000.00)
Mining Costs	110,860,663.19	110,860,663.19	110,860,663.19	110,860,663.19	110,860,663.19	110,860,663.19
Processing Costs	191,220,258.16	191,220,258.16	191,220,258.16	191,220,258.16	191,220,258.16	191,220,258.16
Environmental Costs (% Min & Mill)	30,208,092.14	30,208,092.14	30,208,092.14	30,208,092.14	30,208,092.14	30,208,092.14
Power	65,175,123.57	65,175,123.57	65,175,123.57	65,175,123.57	65,175,123.57	65,175,123.57
General Supplies	5,431,260.30	5,431,260.30	5,431,260.30	5,431,260.30	5,431,260.30	5,431,260.30
General Wages	75,218,302.63	75,218,302.63	75,218,302.63	75,218,302.63	75,218,302.63	75,218,302.63
Operating Income	776,577,856.71	776,577,856.71	776,577,856.71	776,577,856.71	776,577,856.71	776,577,856.71
Less:						
Depletion	(28,064,559.57)	(28,064,559.57)	(28,064,559.57)	(28,064,559.57)	(28,064,559.57)	(28,064,559.57)
Depreciation of Mine, Mill, Environ, Equipment	(194,143,454.31)	(194,143,454.31)	(194,143,454.31)	(194,143,454.31)	(194,143,454.31)	(194,143,454.31)
Net Income bef. Inc. Tax	554,369,842.83	554,369,842.83	554,369,842.83	554,369,842.83	554,369,842.83	554,369,842.83
Less:						
Income Tax	194,029,444.99	194,029,444.99	194,029,444.99	194,029,444.99	194,029,444.99	194,029,444.99
Net Income	360,340,397.84	360,340,397.84	360,340,397.84	360,340,397.84	360,340,397.84	360,340,397.84
Add Back:						
Depletion	28,064,559.57	28,064,559.57	28,064,559.57	28,064,559.57	28,064,559.57	28,064,559.57
Depreciation	194,143,454.31	194,143,454.31	194,143,454.31	194,143,454.31	194,143,454.31	194,143,454.31
Working Capital (1 month)						959,938,620.00
Net Cashflow	582,548,411.72	582,548,411.72	582,548,411.72	582,548,411.72	582,548,411.72	1,542,487,031.72
NET PRESENT VALUE, 12%, PhP						
INTERNAL RATE OF RETURN						

Figure 1
Possible Areas Affected by Mineral Utilization of Bauxite within the Concord, Hinabangan Area



Note: The area is enclosed by the line. It is approximately 3000 hectares. One (1) Meridional Block is approximately equal to 324 ha.

Figure 2
Bauxite World Production

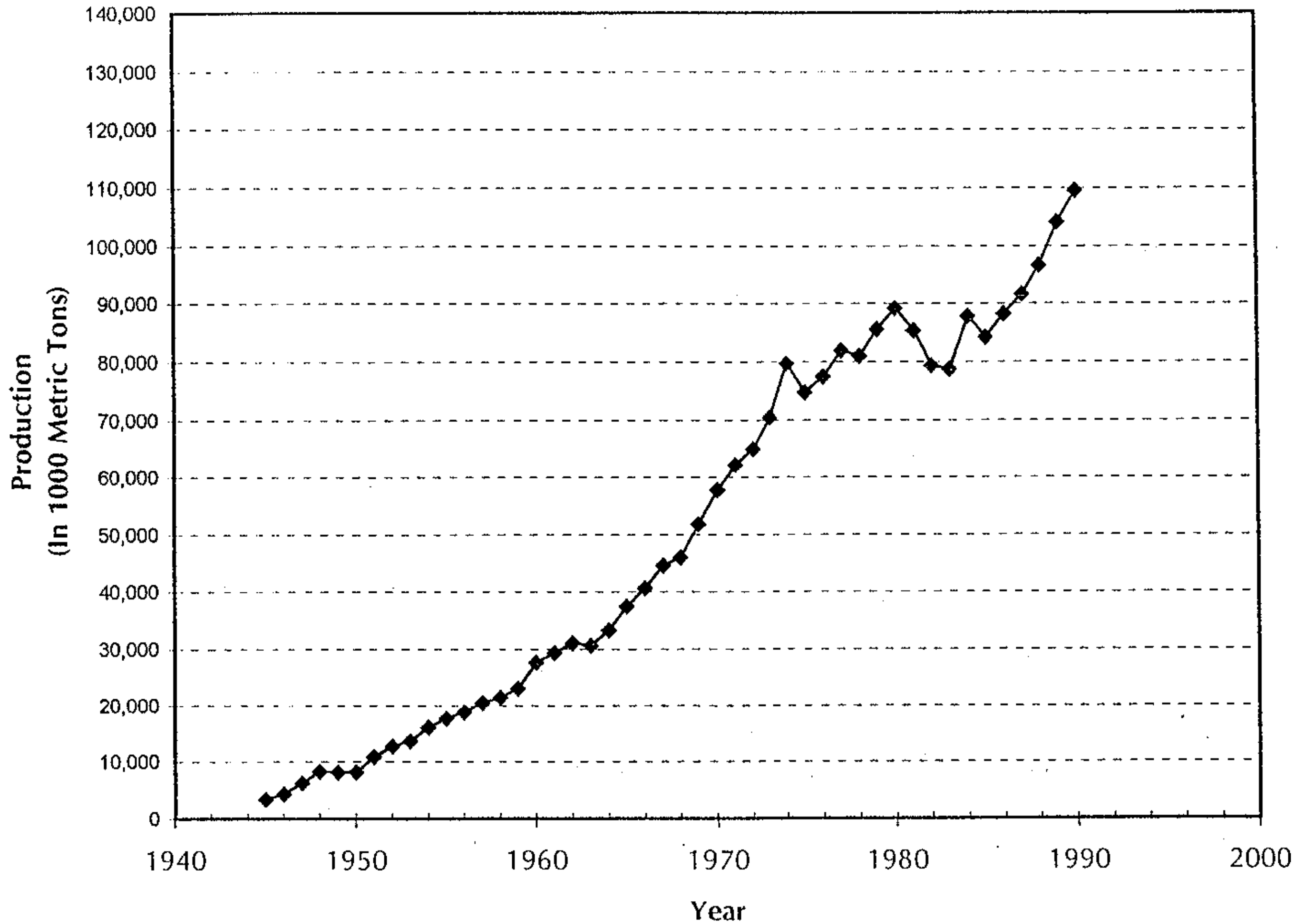
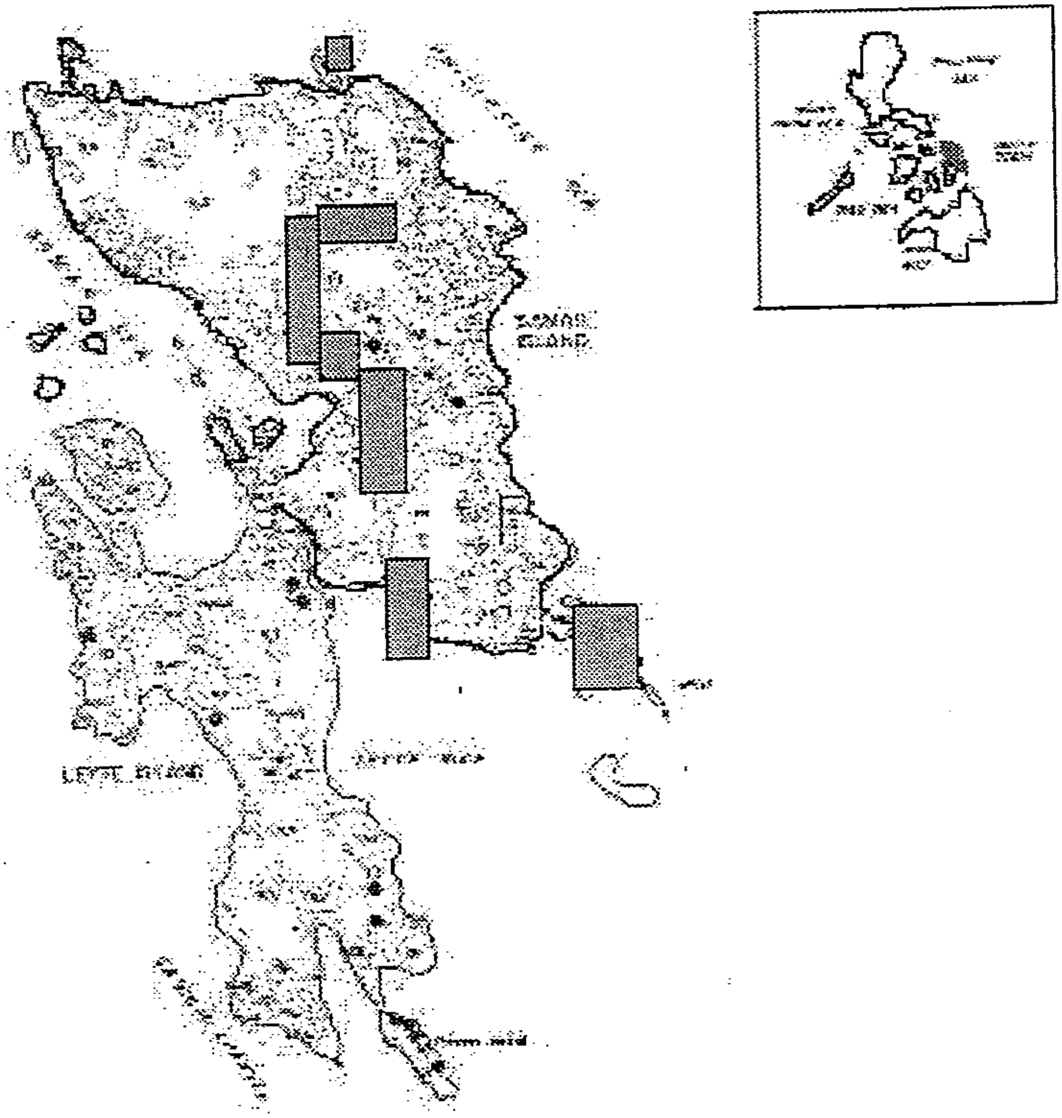


Figure 3
Bauxite Mineral Reservation Map (with Coordinates)



Coordinates of the Bauxite Mineral Reservation (Proc. No. 1615)

Latitudes		Longitudes	
12°35'30"	12°41'30"	125°05'30"	125°05'00"
11°50'45"	12°12'30"	124°55'00"	125°00'00"
12°09'00"	12°14'15"	125°00'00"	125°12'00"
11°48'00"	11°55'00"	125°00'00"	125°06'30"
11°30'00"	11°49'30"	125°06'00"	125°13'15"
11°05'00"	11°20'00"	125°10'15"	125°17'00"
11°22'00"	11°30'00"	125°27'30"	125°30'00"
11°00'00"	11°30'00"	125°39'00"	125°49'00"

Figure 4
Processing of Bauxite Ore by the Bayer Process

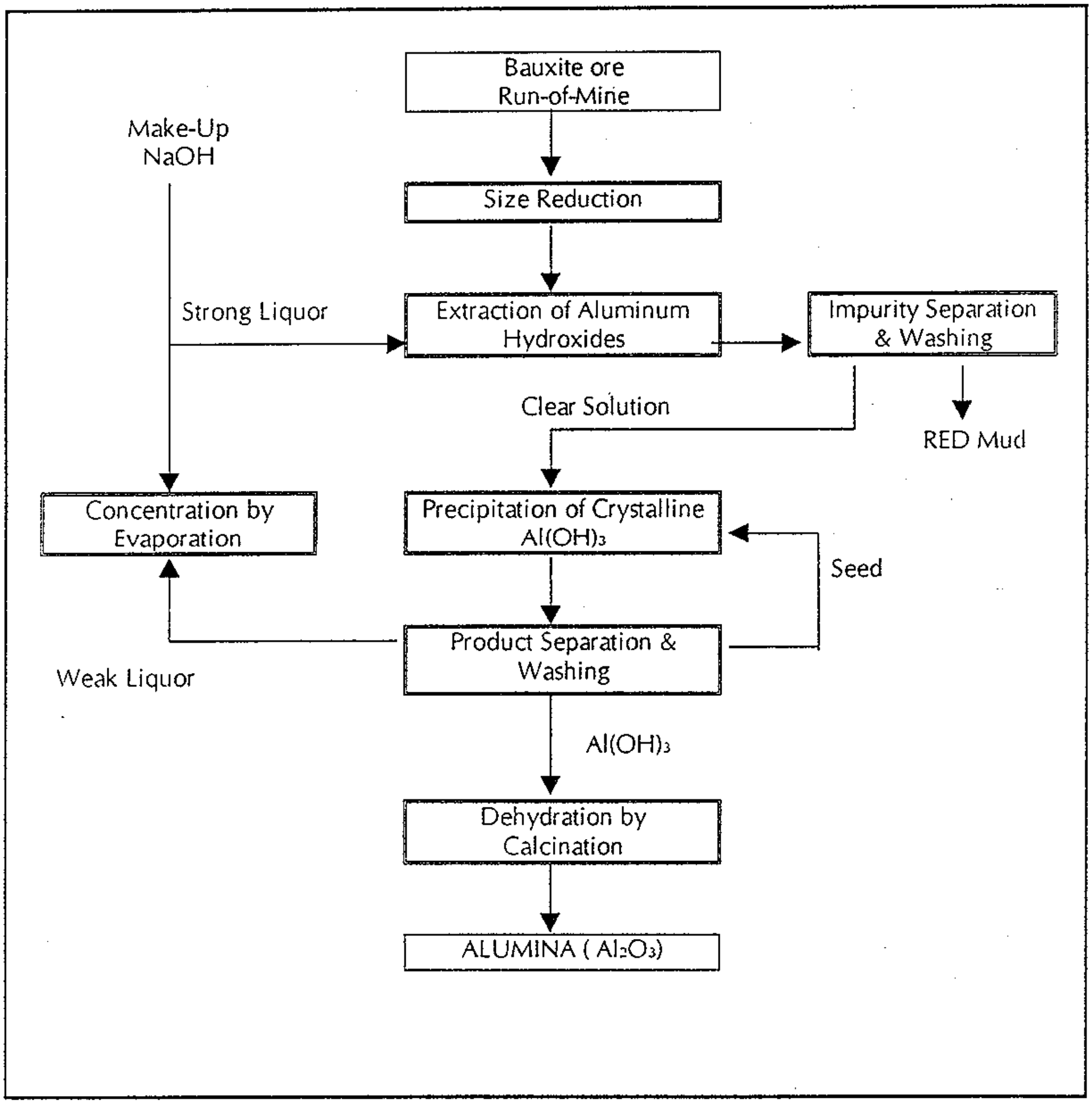


Figure 5
Mineral Processing of Copper-Pyrite Ore

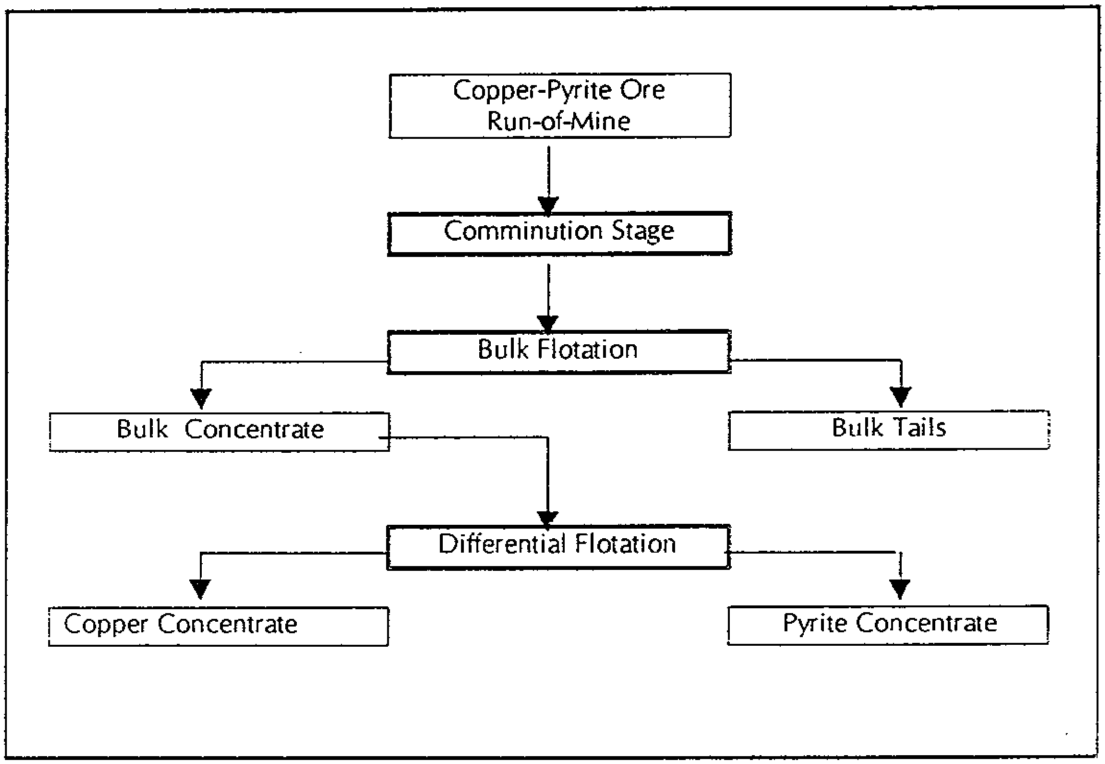
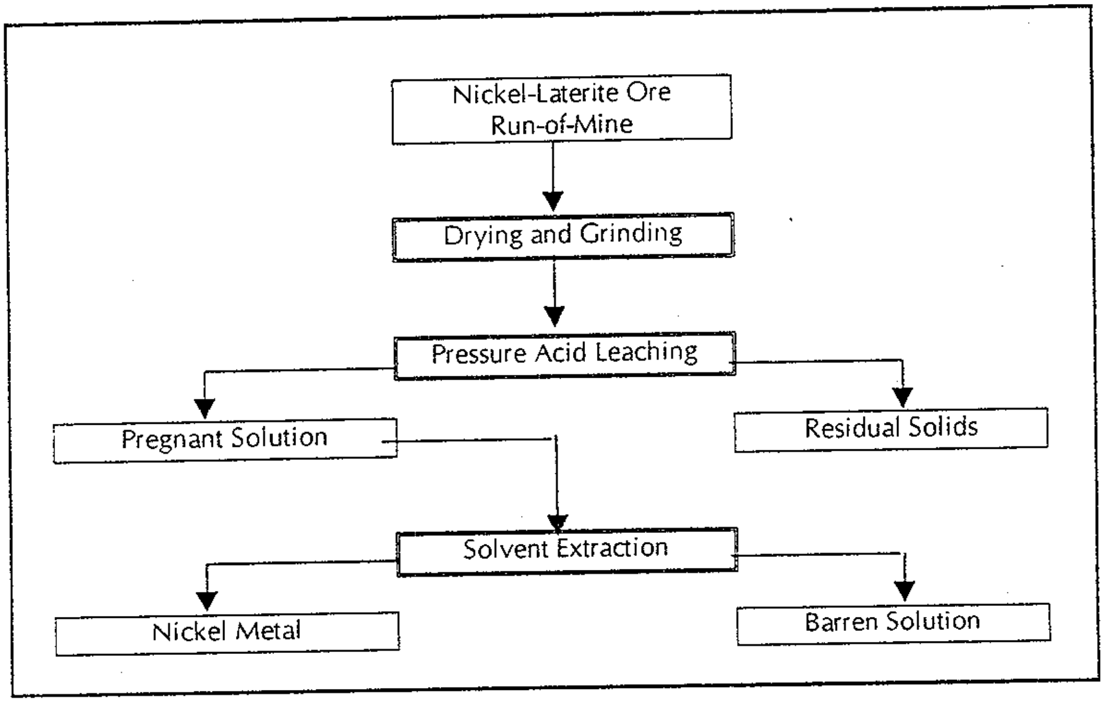


Figure 6
A Simplified Flow for the Processing of Nickel-Laterite Ore



Appendix A
Marshal & Swift Cost Indices for Mining and Processing of Minerals

Year	M&S Costs Index	Year	M&S Costs Index
1950	156.00	1989	746.81
1951	162.40	1990	777.41
1952	169.05	1991	809.26
1953	175.97	1992	842.41
1954	183.18	1993	876.92
1955	190.69	1994	912.85
1956	198.50	1995	950.25
1957	206.63	1996	989.18
1958	215.10	1997	1029.71
1959	223.91	1998	1071.89
1960	233.09	1999	1115.81
1961	242.63	2000	1181.52
1962	252.57	2001	1209.11
1963	262.92	2002	1258.64
1964	273.69	2003	1310.21
1965	284.91	2004	1363.89
1966	296.58	2005	1419.76
1967	308.73	2006	1477.93
1968	321.38	2007	1538.48
1969	334.55	2008	1601.51
1970	348.25	2009	1667.12
1971	362.52	2010	1735.42
1972	377.37	2011	1806.52
1973	392.83	2012	1880.53
1974	408.93	2013	1957.58
1975	425.68	2014	2037.78
1976	443.12	2015	2121.26
1977	461.27	2016	2208.17
1978	480.17	2017	2298.63
1979	499.84	2018	2392.81
1980	520.32	2019	2490.84
1981	541.64	2020	2592.88
1982	563.83	2021	2699.11
1983	586.93		
1984	610.97		
1985	636.00		
1986	662.06		
1987	689.18		
1988	717.42		