1.0 INTRODUCTION

1.1 RATIONALE

Mining is known to be a major industry in the Philippines ever since Spanish colonizers opened the first commercial mines in Benguet over 100 years ago. At its peak in the early 1980s, the industry accounted for almost a fourth of the country's total export earnings and contributed a significant share to the gross domestic product. The mining industry plays a vital role in shaping the country's economy.

The Mines and Geosciences Bureau (MGB) of the Department of Environment and Natural Resources (DENR) has been tasked to guide the mining industry in the Philippines towards sustainable development. To accomplish the task is always a challenge since most reserves happen to be located near forests, habitats and indigenous communities. Mines must operate with little disturbance to these resources as much as possible.

The mining operations are currently being forced to respond to questions regarding their benefits weighed against their social and ecological costs, and other underlying issues. These questions are so serious that some groups have gone as far as appealing for the abandonment of all mining activities in the Philippines. Such issues are addressed in the new Mining Act of the Philippines and its implementing rules and regulations.

Even mines operating with safe, clean and legitimate operations will eventually face resource depletion or nonviability.

Since the operation of mine sites have great impact on the environment, MGB is now trying to assess the environmental effects of mining operations that have already been abandoned or inactive. Most of these mine sites are old and were operated at a time when the protection of the environment is not yet a great concern. During those times, pollution control technologies were not yet well developed. Although these mine sites no longer operate, the risks they pose to rivers, coastal areas, terrestrial resources, and community health are not yet determined.

Thus, MGB commissioned Tetra Tech EM Inc. to undertake the conduct of preliminary site assessment of selected abandoned mines in the country.

The site assessment identifies, assesses and predicts the environmental effects of the abandoned mine sites to its surrounding biophysical and socio-economic environment. This will provide scientific information on the adverse or beneficial environmental consequences, which will facilitate the inclusion of appropriate remediation/mitigating measures at the outset of the project rehabilitation. Economic benefits will therefore be maximized while the corresponding environmental damages will be minimized. Moreover, the site assessment will provide decision makers a basis for whatever policy recommendations they will formulate on the abandoned mine sites.
1.2 OBJECTIVES

The general objective is to conduct semi-detailed assessment of selected abandoned/inactive mines in the Philippines targeting all medium to large-scale abandoned/inactive mines producing gold, copper, chromite, mercury, silica and marble located in various parts of the country.

Specifically, the study was guided by the following objectives:

- Conduct a semi-detailed assessment of various abandoned/inactive mine sites
- Define current conditions of the abandoned mine sites in terms of the following:
  - Land use, land viability and productivity
  - Visual and aesthetic appearance of sites
  - Water pollution
  - Water availability and hydrological impacts
  - Air pollution, radiation and geological hazards
  - Secondary and tertiary effects on vegetation and biodiversity
  - Quality of life and cultural values.
- Identify the human health, ecological and social risks
- Document lessons learned and provide policy recommendations
- Estimate costs of rehabilitation and remediation measures

1.3 SCOPE AND LIMITATIONS

The full characterization of the environmental hazards posed by a mining facility, given the typical geographic extent of its operations and potential impacts, requires time, effort and resources, which at present are not available to MGB when this project was realized. But due to the urgency of this need, the MGB chose to initiate a preliminary study with moderate resources, relying on a focused methodology and expert observation to prepare for a more extensive and a better-funded effort. Given the limited time allocated for the conduct of the preliminary site assessment, the study focused on mining and milling activities of the mining operations. It also covered mainly the barangay within the immediate downstream of the mine sites, presumed to be the immediate impact area.

The team was required to be highly selective in gathering environmental samples and relied mostly on an expert evaluation of the sites. The emphasis was placed on identifying the presence of chemical contaminants and their associated ecological and human health risks. Although samples were quantitatively analyzed, no attempt was made to quantify the exact extent of the chemical contamination. Detailed engineering and structural studies were not undertaken.

The funding limitations for this project called for judicious use of time and effort, the study was limited to the 22 priority mine sites listed in Table 1-1 and shown in Figure 1-1. The team did not conduct site assessment for Heritage Mining Corporation – Alamag Processing Group and Batong Buhay Gold Mines Inc. due to existing insurgency and political problems.
### TABLE 1-1
PRIORITY LIST OF ABANDONED/INACTIVE MINING COMPANIES

<table>
<thead>
<tr>
<th>Company</th>
<th>Mineral Extracted</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acoje Mining Company, Inc. (AMCI)</td>
<td>Metallurgical Chromite</td>
<td>Sta. Cruz, Zambales</td>
</tr>
<tr>
<td>2. Barlo Mining Corporation (BMC)</td>
<td>Copper</td>
<td>Mabini, Pangasinan</td>
</tr>
<tr>
<td>4. Benguet Corp. - Antamok Mines (BC-BAGO)</td>
<td>Gold</td>
<td>Iligon, Benguet</td>
</tr>
<tr>
<td>5. Benguet Consolidated Mining Corp. (BCMC)</td>
<td>Gold</td>
<td>Iligon, Benguet</td>
</tr>
<tr>
<td>7. Masinloc Chromite Mines – Benguet Corporation (MCM-BC)</td>
<td>Refractory Chromite</td>
<td>Masinloc, Zambales</td>
</tr>
<tr>
<td>8. Benguet Exploration Mine (BEM)</td>
<td>Gold</td>
<td>Tuba, Benguet</td>
</tr>
<tr>
<td>9. Black Mountain Inc. (BMI)</td>
<td>Gold</td>
<td>Tuba, Benguet</td>
</tr>
<tr>
<td>10. Filminera Resources Corporation (FRC) formerly Banahaw Mining and Development Corp.</td>
<td>Gold</td>
<td>Rosario and Bunawan, Agusan del Sur.</td>
</tr>
<tr>
<td>11. CDCP-Basay Mine (CDCP-Basay)</td>
<td>Copper</td>
<td>Basay, Negros</td>
</tr>
<tr>
<td>12. Ino and Capayang Mines (ICM)</td>
<td>Copper</td>
<td>Mopog, Marinduque</td>
</tr>
<tr>
<td>13. Heritage Mining Corp. Alamag Processing Group</td>
<td>Chemical Chromite</td>
<td>Llorente, Eastern Samar</td>
</tr>
<tr>
<td>14. Hixbar Gold Mining (HIXBAR)</td>
<td>Gold</td>
<td>Rapu-Rapu Island, Albay</td>
</tr>
<tr>
<td>15. Romblon Marble Mining (RMM)</td>
<td>Marble</td>
<td>Romblon</td>
</tr>
<tr>
<td>16. Palawan Quicksilver Mines (PQM)</td>
<td>Mercury</td>
<td>Palawan</td>
</tr>
<tr>
<td>17. Philippine Iron Mines (PIM)</td>
<td>Iron</td>
<td>Jose Panganiban, Camarines Norte</td>
</tr>
<tr>
<td>18. Philippine Pyrite Corporation (PPC).</td>
<td>Pyrite</td>
<td>Bagacay, Samar</td>
</tr>
<tr>
<td>19. Silica Sand Mine (SSM)</td>
<td>Silica</td>
<td>Palawan</td>
</tr>
<tr>
<td>20. Surigao Consolidated Mining Co., Inc. (SURICON)</td>
<td>Gold</td>
<td>Siana and Mapawa, Surigao del Norte</td>
</tr>
<tr>
<td>21. United Paragon Mining Corporation (UPMC)</td>
<td>Gold</td>
<td>Paracale, Camarines Norte</td>
</tr>
<tr>
<td>22. Vulcan Mining Corporation (VMC)</td>
<td>Gold</td>
<td>Cordon, Isabela</td>
</tr>
</tbody>
</table>
1.4 REPORT ORGANIZATION

This report presents the executive summary of the semi-detailed assessment. It is organized into seven sections briefly described below.

- **Section 1. INTRODUCTION** – Presents the purpose of the report, scope and limitations and report organization.
- **Section 2. METHODOLOGY** – Describes the general procedures used for the conduct of the study
- **Section 3. CURRENT MINE STATUS** – Presents the status of the 20 abandoned/inactive mine sites
- **Section 4. SITE CHARACTERIZATION AND IMPACT ASSESSMENT** – presents the characterization summary and their impact to the environment.
- **Section 5. RISK ASSESSMENT OF ABANDONED MINES** – Presents the summary of the risk assessment of the abandoned mines.
- **Section 6. RISK-BASED PRIORITIZATION STRATEGY** – Presents the risk ranking results of the 20 abandoned mines.
- **Section 7. REHABILITATION AND REMEDIATION MEASURES** – Presents the summary of available rehabilitation and remediation technologies
- **Section 8. CONCLUSION** – Presents the overall findings of the assessed 20 mine sites including lessons learned
- **Section 9. RECOMMENDATION** – Discusses immediate/short and long term action which may be considered in addressing the issues of the abandoned mine sites
2.0 METHODOLOGY

The following subsections describe the methodologies used in the conduct of preliminary mine site assessment. The methodologies explain how primary and secondary data were gathered and collected, and how the data were processed, analyzed and evaluated.

2.1 GATHERING OF SECONDARY DATA AND DESK REVIEW

All relevant records about the mine sites available in MGB central and regional offices and the Environmental Management Bureau (EMB) were gathered and evaluated. These include mine site profiles and mine status reports submitted to MGB.

The desk review provided the following basic information:

- Mine site location and description
- Company name, contact person and address
- Previous results of monitoring activities by MGB
- Surrounding environmental conditions
- Locations of direct impact barangay(s)

2.2 FIELD WORK AND PRIMARY DATA GATHERING

Prior to the conduct of primary data gathering and site visit, Tetra Tech in coordination with the MGB Central Office made advance arrangement with MGB Regional Offices and with the company management (if the company still exists). The MGB Regional Office designated representative/s to assist the team on the conduct of fieldwork activities.

The primary data collected include the following:

- Water parameters
- Soil, sediment and waste rock parameters
- Biological parameters
- Socio-economic parameters
- Current condition of the mine site

The details of data collection are described below.

2.2.1 Collection of Water, Sediment, Soil and Waste Rock Data

Water, sediment, soil and waste rock samples were collected in order to identify the evidence of release of the chemicals of concern (COCs) as a result of the mining activity. These samples will verify if the identified COCs had affected the possible receptors of the mining operation.
2.2.1.1 Collection of Water Samples

This is necessary in order to:

- Characterize the existing water quality in terms of its physical, biological and chemical characteristics and the concentrations of water born constituents;
- Determine the effects of wastewater on receiving water bodies;
- Compare existing water quality with regulatory standards.

The team used grab-sampling method for the collection of water samples wherein sample bottles were directly submerged into the water. This method was applied for the collection of water samples from the point sources and receptors.

For the collection of groundwater samples, the team looked for any available deep well being used by the community as sources of potable water. Each well was purged for about 10 minutes prior to sampling in order to ensure that the samples collected are representative of what is being discharged.

2.2.1.2 Collection of Sediment, Soil and Waste Rock Samples

Except for RMM and SSM, sediment, soil and waste rock samples were collected. Sediment samples were collected in order to determine the presence of COCs at the bottom of riverbeds or at any water body identified as receptors of the mining activity. Any settled chemicals may adversely impact aquatic organisms and water quality over the long term.

Sediment samples were collected from the same location where the water samples were collected. Soil and waste rock samples were collected from locations that were identified by the team based on direct observations of any likely evidence of contamination.

The team used a stainless steel shovel in collecting sediment, soil and waste rock samples. The collected sediment, soil and waste rock samples were placed in ziplock bags and coolers for sample preservation.

2.2.1.3 Chemicals of Concern

The COCs analyzed in water, sediment, soil and waste rock samples collected include the following: Zinc (Zn), Copper (Cu), Lead (Pb), Cadmium (Cd), Mercury (Hg), Arsenic (As), Total Oil and Grease (TOG), Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) for all sites except for RMM and SSM. For the two sites, only water samples were collected and were analyzed for TDS, TSS and Oil and Grease. For BCD and PQM, the following additional parameters were tested in groundwater and some soil samples:

- Total Petroleum Hydrocarbons (TPH)
- Benzene, Toluene, Ethylbenzene and Xylene (BTEX)
- Polynuclear Aromatic Hydrocarbons (PAH)


2.2.1.4 Equipment Used in Collecting Water, Sediment, Soil and Waste Rock Samples

The following were the equipment used in collecting water, sediment, soil and waste rock samples:

- Global Positioning System (GPS) Instrument
- Peristaltic pump
- Compositing jug
- Laboratory-cleaned sample containers
- Coolers with ice
- Water quality checker used in measuring pH, dissolved oxygen (DO), conductivity, salinity, and temperature
- Victoreen Radiation Meter
- Stainless steel shovel
- Sample labels, indelible pens, and clear tape
- Field logbook
- Boat

2.2.1.5 Handling of Samples and Field Documentation

Before the collection of samples, plastic and glass containers to be used were properly labeled. This was undertaken in order to obtain accurate and representative environmental samples. The labels consist of the following:

- Name of person who collected the samples
- Date and time of sampling
- Source and location of sample
- Parameters to be analyzed in the laboratory

A field logbook was used to document the characteristics of each of the sample collected in terms of its pH, conductivity, temperature, DO and other pertinent information.

2.2.1.6 Decontamination Procedure

As part of the samples quality assurance and control, decontamination process was undertaken to all of the equipment used. Reusable-sampling equipment was decontaminated before and after use. Decontamination procedures applied were based on existing guidelines for low-level contamination. The team used the following procedures:

- The equipment was scrubbed with a stiff brush and soapy water containing a trisodium phosphate detergent.
- When oily wastes adhered to the sampling equipment, the equipment was rinsed with denatured alcohol or hexane, and then scrubbed again with soapy water.
- The equipment was then totally rinsed with potable water, and then rinsed again with deionized water.
- Decontaminated equipment was allowed to air dry on plastic sheeting, and wrapped in tin foil until use.
2.2.1.7 Collection of Quality Assurance and Quality Control (QA/QC) Samples

The team also collected a duplicate as part of QA/QC measures. QA/QC samples were collected on the same sites where the water sediment and soil samples were collected.

2.2.1.8 Preservation of Collected Samples

The samples collected from the field were placed in coolers, which are filled with ice. This was undertaken in order to preserve the samples collected prior to analyses. Upon arrival at the Tetra Tech office, all samples collected were segregated for laboratory analyses. Table 2-1 presents the Sample Preservation Handling Summary used by the Team.

### TABLE 2-1
SAMPLE PRESERVATION HANDLING SUMMARY

<table>
<thead>
<tr>
<th>Analytical Parameter</th>
<th>Matrix</th>
<th>Holding Time</th>
<th>Type of Container</th>
<th>Preservatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead, Cadmium, Arsenic, Zinc, Copper</td>
<td>Waste Rock, Soil, Sediments</td>
<td>6 months</td>
<td>Ziplock</td>
<td>Cool to 4°C</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td></td>
<td>1 L plastic bottle</td>
<td>Nitric acid, cool to 4°C</td>
</tr>
<tr>
<td>Mercury</td>
<td>Waste Rock, Soil Sediments</td>
<td>6 months</td>
<td>Ziplock</td>
<td>Nitric acid, cool to 4°C</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td></td>
<td>1 L plastic bottle</td>
<td>Nitric acid, cool to 4°C</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>Water</td>
<td>24 hours</td>
<td>1 L glass jar</td>
<td>Sulfuric acid, cool to 4°C</td>
</tr>
<tr>
<td>TDS/TSS</td>
<td>Water</td>
<td>7 days</td>
<td>1 L plastic bottle</td>
<td>Cool to 4°C</td>
</tr>
<tr>
<td>TPH (C₆ to C₉)</td>
<td>Water</td>
<td>Extract within 7 days, analyze within 40 days</td>
<td>40 mL vials</td>
<td>HCl, cool to 4°C</td>
</tr>
<tr>
<td>BTEX</td>
<td>Soil</td>
<td>Extract within 14 days, analyze within 40 days</td>
<td>250 mL solvent washed glass</td>
<td>Cool to 4°C</td>
</tr>
<tr>
<td>TPH (C₁₀ to C₃₆)</td>
<td>Water</td>
<td>Extract within 7 days, analyze within 40 days</td>
<td>1 L solvent washed amber bottle</td>
<td>Cool to 4°C</td>
</tr>
<tr>
<td>PAH</td>
<td>Soil</td>
<td>Extract within 14 days, analyze within 40 days</td>
<td>250 mL solvent washed glass</td>
<td>Cool to 4°C</td>
</tr>
</tbody>
</table>

2.2.2 Collection of Biological Data

The team conducted a walkthrough within the mine site area to observe the existing vegetation and the presence of any wildlife species. All dominant flora and fauna species were identified and listed.
2.2.3 Collection of Socio-Economic Data

With the assistance of designated MGB Regional Office representative, the team collected relevant mine documents and other information available at the MGB Regional Office, Provincial Environment and Natural Resources Office (PENRO), Municipal Planning and Development Office (MPDO) and Barangay Office. Some of the important documents gathered by the team include the following:

- Mining operation description including maps
- Results of previous monitoring reports
- Municipal and barangay profiles which include health and socio-economic data

Interviews were conducted with informants, which include the barangay captain, municipal planning and development officer, a resident company representative, and former mine employees. The interview was guided by the key informant guide questions prepared specifically for the project.

2.3 DATE ANALYSIS AND EVALUATION

Prior to the conduct of chemical analyses for the samples collected in the field, chain of custody forms for water, sediment, soil and waste rock samples were prepared by each team. Water, sediment and soil samples to be analyzed for lead, copper, arsenic, mercury, cadmium, zinc, cyanide, TOG and TDS/TSS were sent to the MGB laboratory.

The results of the laboratory analyses were compared to existing environmental standards that include the following:

- DAO 35 Effluent Standards for point sources
- DAO 34 Water Quality Criteria for the receiving water bodies
- National Drinking Water Standards for drinking water
- Freshwater Sediment Metal Screening Values\(^1\) for sediments
- Preliminary Remediation Goals (PRG) Screening Level (Residential) for soil and waste rocks
- PRG Screening Level (Industrial) for soil and waste rocks
- PRG (Chronic HQ=1) Residential for TPH, BTEX and PAH analyses
- Phytotoxicity Metal Concentration Screening Values for soil and waste material samples\(^2\)

The results of the analyses were used for the determination of chemical and human risk associated with the mine site. Sources of chemical, exposure pathways, exposure routes and exposed population were identified. Chemicals of potential concern produced by the mine that could be deleterious to public health were also identified. The magnitude, frequency, duration and route of exposure of population to the chemicals of potential concern were estimated qualitatively and quantitatively. Chemical intakes of exposed population were estimated.

Carcinogenic and non-carcinogenic effects of the chemicals were calculated. Summation of risks using results of exposure and toxicity assessments was also quantified. Identification of options for mitigating risk by affecting the source, the pathway, or the receptor was undertaken.

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\(^1\) Washington State Department of Ecology; Persaud et al. 1993 and Ingersoll et al. 1996

\(^2\) Efroymson et al. 1997
Physical risk assessments were also undertaken based on the physical hazards identified by the team during the conduct of the site assessment. Event-tree analyses were used to illustrate and analyze the exposure scenario of the people and its environment.

A risk ranking criteria through the use of Risk Based Prioritization Strategy (RBPS), developed specifically for the project, was used as a basis of comparison among the abandoned mines in this study. It focuses on the extent of damage and risk posed by the concerned mine site to the people and environment.

Mitigation/corrective actions were formulated based on the laboratory analyses results and environmental risk assessments undertaken.
3.0 CURRENT MINE STATUS

This section contains the brief descriptions of the 20 mines currently. Detailed discussions were presented in the final reports. From the 20 mine sites inspected, four are copper mines, eight are gold mines, three are chromite mines, and one for mercury, iron, silica, pyrite and marble.

Tables 3-1, 3-2A, 3-2B, 3-3 present a summary of the status of the 20 inactive/abandoned mine sites.
4.0 SITE CHARACTERIZATION AND IMPACT ASSESSMENT

This section presents the characterization summary of the 20 abandoned mine sites.

4.1 WASTE CHARACTERIZATION

Samples were taken from all mine wastes to establish the potential sources of site contaminations. The mine waste samples include liquid wastes, tailings sediments, and waste rocks.

4.1.1 Liquid Wastes

Samples from liquid waste streams at the mine sites were collected from 16 sites. No liquid waste samples were collected from four sites, BCMC, SSM, BMI and AMCI, because they were not available.

Wastewater samples were analyzed for the following: oil and grease, Zn, Cu, Pb, Hg, As, Cd, pH, TDS, and TSS. Results were evaluated using DAO 35 Effluent Standards.

Summary of the results in Figure 4-1 indicates that only six sites complied with DAO 35 Effluent Standards for all parameters. In addition, most sites failed to comply with the standard for pH, TSS, and TDS.

![Figure 4-1: Results of Wastewater Sampling (Mine Pits, Tailings Ponds, Settling Ponds)](image-url)
4.1.2 Tailings Pond Sediments

Tailings pond sediments were collected from 15 sites. No tailings pond sediment samples were collected from UPMC, HIXBAR, and ACMI because tailings ponds are either not located or has already dried up. No samples were also collected from RMM and PQM because these two are non-metal sites.

Summary of the results in Figure 4-2 shows that tailings pond sediments of 15 sites failed to meet the screening values for all metals analyzed. Only BCMC complied with the screening values for all the heavy metals. Most sites met the screening criteria for cadmium.

4.1.3 Waste Rock

Waste rock samples were collected from 12 mine sites. No waste rock samples were collected from RMM and SSM because these two mine sites have no waste dumpsites. As for the other six mine sites where no waste rocks were also collected, the waste dumps of these mine sites were not located during the assessment.

Summary of the results in Figure 4-3 shows that most of the 12 mine sites have exceeded the Phytotoxicity Metal Concentration Screening Value for Zn, Cu and Hg.
4.2 CHARACTERIZATION OF POTENTIAL PATHWAYS/RECEPTORS

Samples were collected from potential environmental pathways and receptors such as rivers, lakes, seas, springs and groundwater to determine the extent of contamination due to mining activities.

4.2.1 Freshwater Samples

Freshwater samples were collected from the 20 mine sites. Samples were analyzed for oil and grease, Zn, Cu, Pb, Hg, As, Cd, pH, TDS and TSS, except for SMM and RMM. Only TSS, TDS, and pH were analyzed for the two sites. These sites are not known to contribute significant amounts of heavy metal contaminants since the operation mainly involves quarrying.

Summary of the results in Figure 4-4 shows that surface water from all sites comply with DAO 34 Water Quality Criteria for all heavy metals. However, most of the sites failed to meet the criteria for TSS, TDS, and pH.

PPC, SURICON, BMC, and AMCI complied with the DAO 34 Water Quality Criteria for all parameters tested.
4.2.2 Freshwater Sediment Samples

Freshwater sediment samples were collected from 17 sites and analyzed for heavy metal constituents. In the absence of Philippine standards for sediments, Tetra Tech evaluated the results based on the US EPA accepted Freshwater Sediment Metal Screening Values developed by the Washington State Department of Ecology.

Summary of the results in Figure 4-5 shows that freshwater sediments from most sites failed to comply with the standard. These results indicate that metal contaminants may have accumulated in the sediments of the receiving bodies of water.
4.2.3 Spring/Groundwater Samples

Spring/groundwater samples were collected from 16 sites and were analyzed for (Total Oil and Grease) TOG, Zn, Cu, Pb, Hg, As, Cd, TDS, TSS, and pH. Results were evaluated based on the Philippine Standards for Drinking Water 1993 (PSDW).

Summary of the results in Figure 4-6 indicates that spring/groundwater from all sites are in compliance with the PSDW for metals however, other parameters such as pH, TDS and TSS have been exceeded.
### 4.2.4 Soil Samples

Soil samples were collected from 12 mine sites. None were collected from the remaining mine sites because it was not applicable.

Summary of the results in Figure 4-7 shows that most of the 12 mine sites exceeded the Phytotoxicity Metal Concentration Screening Value for Zn, Cu, Pb and As. Many mine sites also exhibited exceeding values for Hg while none exceeded the standard for Cd.
4.3 IMPACTS TO PHYSICAL/GEOLOGICAL ENVIRONMENT

4.3.1 Topography

The mining operation had caused pronounced transformation on the original features of mine sites specifically those areas designated as tailings pond and mine area. Severe excavations produce artificially steep slopes, which are prone to erosion and scouring action specifically during windy days and adverse weather conditions.

4.3.2 Air

The primary sources of air contamination at mine sites are dust emission coming from areas such as the mine pits, overburden waste rocks and haul roads. Air may provide additional exposure routes through deposition on surrounding soils and/or local surface water.

4.3.3 Land Use

Mining operations had brought tremendous transformation on the mine sites original land use. With the presence of abundant vegetation before mining activities started, the areas were now characterized by unsightly depressions and mounds. The mine pit and tailings ponds created lagoons of stagnant water, which could become breeding places for insect vectors. Some portions are barren and heavily planted with cogon grass and less important plant species. The areas formerly dominated by trees became built-up areas with mine structures established such as buildings and housing facilities. Natural vegetation was
totally removed from the areas covered by the mine sites. An intensive reforestation program was not conducted as exhibited by presence of barren areas and limited number of trees planted along the mine site.

4.4 TERRESTRIAL ECOLOGY

The mining operation, its activities from exploration, site preparation, construction of access road, buildings, tailings ponds, altered the flora and fauna compositions of the environment in the mine sites. The disturbance and loss of species composition and abundance is negligible and produces significant impacts to the overall diverse characteristics of the areas. Likewise, productivity and nutrient cycling and other ecosystem processes were severely affected.

Flora and fauna species can be found in the mine sites and their surrounding areas.

4.4.1 Demography

Abandoned mining operations affected the demographic profile of the areas through financial and economic opportunities that created. Upon their abandonment, sudden decrease in population was experienced as migrants returned to their respective provinces or left the areas to look for job other opportunities elsewhere.

4.4.2 Employment

Employment in the mining company gives people a steady source of income. The existence of the mining operations also provided employment opportunities to the local inhabitants who possessed skills that suited the needs of the mining industry.

The closure of the mining operations significantly decreased and limited the availability of employment opportunities in the area. Most of the former employees returned to their respective provinces and migrated to other mining companies to look for available sources of livelihood. Residents in the area returned to their usual farming and fishing activities.

4.4.3 Trade and Commerce

The existence of mining operations attracted small-scale businesses to invest in the area. These include grocery stores and service shops catering to the employees of the mines.

4.4.4 Infrastructures and Road Network Systems

The existence of the mining operations had brought about the construction of various infrastructure to the mine site areas, which include a road network system. Most of the mining companies had provided housing facilities, medical facilities, chapels as well as recreational and educational facilities.

Upon their closure, the infrastructures provided by the companies specifically the various buildings constructed were already abandoned. Recyclable materials were found to have been gathered by adjacent communities while others were left in the mine sites. Other infrastructures in the mine sites are being used by people who decided to stay in the area while others are donated to adjacent barangays or communities.
4.5 PRESENT PERCEPTIONS ABOUT THE MINING OPERATIONS

The key informants interviewed expressed their openness to the resumption of mining operations. They believed that some of them might be able to work again if it will be re-opened.

On the other hand, the key informants also believe that mining operations may cause environmental damage to the natural features of the site through various wastes that they produce which contain hazardous chemicals. However, they also believed that these could be mitigated through proper tailings disposal and continuous revegetation measures.
5.0 RISK ASSESSMENT OF ABANDONED MINES

This section presents the summary results of the ecological, human health and physical risk assessment of the 20 mine sites.

5.1 ECOLOGICAL RISK

An ecological risk assessment evaluates the potential adverse effects that human activities have on the plants and animals that make up ecosystems. The risk assessment process provides a way to develop, organize and present scientific information so that it is relevant to environmental decisions. When conducted for a particular place such as a watershed, the ecological risk assessment process can be used to identify vulnerable and valued resources, prioritize data collection activity, and link human activities with their potential effects. Risk assessments can also provide a focal point for cooperation among local communities and state and federal government agencies. Risk assessment results provide a basis for comparing different management options, enabling decision-makers and the public to make better informed decisions about the management of ecological resources.

The risk assessment performed for this investigation reaches only the second step of the Eight-step Ecological Risk Assessment Process for Superfund (US EPA). The screening-level exposure estimate and risk calculations comprise the second step in the ecological screening for a site. Risk is estimated by comparing the maximum documented exposure concentration with the exotoxicity values. At the conclusion of Step 2, it will be decided whether the screening-level ecological risk assessment is adequate to determine that ecological threats are negligible or is the process should continue to a more detailed ecological risk assessment (Steps 3 through 7). If the process continues, the screening-level assessment serves to identify exposure pathways and preliminary contaminants of concern for the baseline risk assessment by eliminating those contaminants and exposure pathways that pose negligible risks.

Exposure Parameters

Conservative assumptions were used for this particular risk assessment. These parameters were provided in the Ecological Risk Assessment Guidance for Superfund: Process for Designing Ecological Risk Assessments. Such parameters are listed below:

- **Area-use Factor** - For terrestrial animal, it was assumed that the home range of one or more animals is entirely within the contaminated area, and thus the animals are exposed 100 percent of the time.
- **Bioavailability** - Bioavailability of contaminant at the site is 100 percent.
- **Life Stage** – Animals were at its most sensitive life stage.
- **Body Weight and Food Ingestion Rate** – The US EPA’s Wildlife Exposure Factors Handbook (US EPA, 1993a,b) was used as a source of information.
- **Bioaccumulation** – The most conservative bioaccumulation factor was used as obtained from various literatures available.
- **Dietary Composition** – The diet is composed entirely of whichever type of food is most contaminated.

The succeeding section presents the ecological risk assessment per chemical of concern.
5.1.1 Copper

Based on Figure 5-1, the scenario most potentially affected by copper is the aquatic communities through the sediment pathway. It can be seen that most of the mines, with the exception of AMCI, may contribute risks associated with copper contamination in the sediments.

Copper contamination may also pose risks to plants. Fourteen out of the eighteen mine sites may pose threats to this part of the ecosystem in the surrounding areas. At the same time, the three sites, CDCP-Basay, BMC and AMCI, may have effects on birds that are living in their surrounding areas.

5.1.2 Cadmium

Based on Figure 5-2, the ecological receptor that maybe potentially affected by cadmium that surrounds the mine site are aquatic organisms and plants. Aquatic organisms near most of the mine sites listed may be threatened by the contamination of cadmium in the sediments. Vegetation near SURICON, BEM, HIXBAR and PPC may also be at risks from exposure to cadmium. Cadmium has minimal risks in the surrounding areas of BCD, CDCP-Basay, MCM-BC, AMCI, PQM and PIM. The cadmium level on all sites posed no threats to any terrestrial wildlife.
5.1.3 Arsenic

Based on Figure 5-3, arsenic poses minimal potential risks to the surroundings of MCM-BC and AMCI. However, the aquatic life of the surrounding areas of most of the mine sites may be threatened by the presence of arsenic in sediments. In addition to the potential risks to aquatic communities, arsenic also poses risks to the plants of nearby surroundings of majority of the mine sites. Furthermore, the arsenic contamination of some sites may also threaten the mammals thriving in the contaminated mine sites particularly for PPC and BMC.
5.1.4 Lead

Based on Figure 5-4, the plants and the aquatic communities thriving in the surroundings of the mine sites may be affected by lead. It can be seen that 14 out of the 18 mines may threaten the vegetation surrounding them due to lead contamination while 13 mines may threaten the aquatic communities of surrounding areas through sediment pathway. The lead level can pose risk to birds on SURICON while fowls on PIM are at risk from lead exposure.
5.1.5 Mercury

Figure 5-5 shows that mercury poses risk to nearby species of fowls, birds, aquatic life and plants at PQM may occur. On the other hand, effect of mercury to the surroundings of BEM, BMI, CDCP-Basay, MCM-BC and AMCI may be minimal. Mercury may also be a potential risk to plants and aquatic lives of the surrounding areas of some of the mine sites. Mercury level can pose threat to fowls on UPMC and SURICON.
FIGURE 5-5
RESULTS OF CHEMICAL RISK ASSESSMENT FOR MERCURY

5.1.6 Zinc

Based on Figure 5-6, zinc may be a threat to plants and aquatic lives. Only two mine sites, PQM and AMCI, give minimal effects to surrounding ecosystems due to zinc contamination. 16 out of the 18 sites may give potential risks to plants of surrounding areas. On the other hand, only 13 sites may pose threat to aquatic lives near their areas due to contamination of metal in the sediments. The zinc level for all mine sites does not pose any potential risk to terrestrial wildlife.
5.2 STREAMLINED HUMAN HEALTH RISK ASSESSMENT

A screening level human health risk assessment was conducted for the 21 mine sites as part of the activities performed for this study. The risk assessment was conducted using current guidance set forth by: “Risk-Based Cleanup Guidelines for Abandoned Mine Sites” (Tetra Tech 1996); and guidance established by EPA (1989a).

The assessment involved five steps: (1) hazard identification; (2) exposure assessment; (3) toxicity assessment; (4) risk characterization; and (5) calculation of risk-based cleanup goals. A detailed discussion of these five steps is presented in each individual report.

The calculated health risk/hazard index (HI) can be used to determine whether human receptors are potentially exposed to harmful doses of site-related contaminants via the high-use recreational scenarios evaluated. An HI greater than 1 indicates a potential risk to human receptors. The risk values summarized for the 20 mine sites in Figure 5-7 indicates that HI for cadmium, lead, mercury, zinc and arsenic for most sites is greater than one and, hence, of potential concern.
Table 5-1 presents the summary of the physical hazards posed by the 20 abandoned mines to the surrounding population and environment.
### TABLE 5-1
SUMMARY MATRIX OF THE RESULTS OF PHYSICAL RISK ASSESSMENT FOR THE ABANDONED MINE SITES

<table>
<thead>
<tr>
<th>Mine Site</th>
<th>Physical Hazards</th>
</tr>
</thead>
</table>
| BCD       | • The tailings dam manifested signs of damages that may eventually lead to the discharge of the tailings wastes directly into the Mapanuepe Lake.  
  • The Kaline Pit is currently filled with water and is continuously discharging to a creek nearby which eventually drains to the Mapanuepe Lake. The water within the pit is yellowish in color. A sign of eroded portion was also observed. |
| BMC       | • Soil erosion along the mine waste dumpsite was pronounced. |
| CDCP-Basay| • The tailings ponds are unstable.  
  • Unstable slopes are prone to erosion and landslides.  
  • Potential accidents may happen in the abandoned mine and mill facilities due to unstable structures. |
| HIXBAR    | • Two waste dumps located near Pula Creek and its tributaries were found not protected from erosion.  
  • The white stockpile of quartz sericite materials located near the old crushing plant was easily eroded.  
  • A huge junk of metal scrap probably a part of a trommel of a washing circuit was found lying along the slope. The scrap metal was found lying precariously near the edge of a ridge.  
  • The access roads have been eroded and narrowed by high-energy runoff.  
  • Two abandoned shafts and two adits were found. |
| AMCI      | • The tailings ponds are damaged. |
| ICM       | • The open mine pit is water-filled.  
  • Metal and iron scraps, spent/unused chemicals, corroded drums, roofing and wall panels, including equipment and machinery were left scattered in the mill plant area. |
| PIM       | • Ventilation shafts and manholes for the underground mines pose a safety risk for the people of Larap as they are commonly hidden under thick grasses and bushes. |
| MCM-BC    | • No perceived physical hazards |
| PQM       | • No observed physical hazards |
| VMC       | • Water-filled open pits were found. A hole that probably resulted from collapsed underground opening, was observed between the said shaft and the former fine ore bin. |
### TABLE 5-1
SUMMARY MATRIX OF THE RESULTS OF PHYSICAL RISK ASSESSMENT FOR THE ABANDONED MINE SITES (Cont.)

<table>
<thead>
<tr>
<th>Mine Site</th>
<th>Physical Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRC</td>
<td>• No perceived physical risks</td>
</tr>
</tbody>
</table>
| SSM       | • There are areas left unbackfilled/unrestored.  
           |   • There is an apparent transformation of the flat-lying lowlands into waterlogged areas and ponds with highly undulated and hummocky terrain. |
| BC-BAGO   | • Inactive underground mine openings are present.  
           |   • Steep slopes may slide or erode.  
           |   • The unused mine facilities may collapse. |
| BCDC      | • Underground openings are present.  
           |   • Unmaintained facilities may deteriorate and collapse.  
           |   • Tailings ponds may give way.  
           |   • Steep slopes may cause landslides and erosion. |
| BMI       | • No observed physical hazards |
| SURICON   | • A tunnel just above the water level in the mine pit was excavated and its collapse may cause harm to the small-scale miners operating in the area.  
           |   • Tailings Pond # 3 was found to have signs of collapse, which threatens nearby residents of Siana, Mainit. |
| RMM       | • No observed physical hazard |
| PPC       | • Dilapidated mill and laboratory facilities may collapse and cause harm.  
           |   • Steep slopes in Mine Pit #1 are unstable and may cause erosion.  
           |   • The walls of tailings ponds 1, 6, 7 and 8 may collapse and cause spillage of its contents.  
           |   • The remaining walls of tailings ponds 2, 3, 4 and 5 may give way and cause landslides, flash floods and mudslides.  
           |   • The continuing discharge of tailings is causing siltation of the drainage systems. |
| BEM       | • No observed physical hazards |
6.0 RISK-BASED PRIORITIZATION STRATEGY

Tetra Tech employed a Risk Based Prioritization Strategy (RBPS) to rank the sites according to their impacts and risks to human health and the environment. The framework of RBPS was based on the National Regional Ranking Industry Prioritization Strategy (NRIPS) that Tetra Tech developed for DENR to prioritize industries. The NRIPS was revised to adapt to the requirements of the abandoned mine sites to develop RBPS.

The RBPS considered four major criteria:

- Waste generation and management
- Pathways
- Receptors
- Compliance

Distinct score was assigned per line item of the criteria, which adds up to 100. The one with a higher score indicates a higher risk.

Figure 6-1 shows the ranking of the 21 sites while the detailed evaluation scoresheet is attached as Attachment A. Except for Acoje, all sites have a score of more than 50%. The figure also indicates that BCD has the highest score. Thus, it can pose the highest risk to human health and the environment compared to the other mine sites. PPC and PQM ranked second and third. Of the nine gold mine sites, SURICON is considered as the site that poses the highest risk. Please refer to Attachment A for the results of RBPS.
FIGURE 6-1
RISK RANKING OF ABANDONED MINES

MINE SITES

- Waste Generation and Management (33)
- Pathways (21)
- Receiving Media/Receptors (34)
- Noncompliance (12)
7.0 REHABILITATION AND REMEDIATION MEASURES

This section presents the summary of rehabilitation and remediation measures that may be applicable to the 20 abandoned mine sites studied. For more specific discussion, please refer to the final reports.

Table 7-1 shows the summary of the types of technology used, their descriptions and their estimated costs. The costs are estimated based on U.S. rate.

**TABLE 7-1**

**SUMMARY OF APPLICABLE REHABILITATION/REMEDIATION TECHNOLOGIES**

<table>
<thead>
<tr>
<th>General Response Actions</th>
<th>Reclamation Technology</th>
<th>Process Options</th>
<th>Description</th>
<th>Estimated Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTITUTIONAL CONTROLS</td>
<td>Access Restrictions</td>
<td>Fencing/Barrier</td>
<td>Install fences around waste areas to limit access.</td>
<td>Site Specific</td>
</tr>
<tr>
<td></td>
<td>Land Use Control</td>
<td></td>
<td>Implement restrictions to control current and future land use.</td>
<td>Site Specific</td>
</tr>
<tr>
<td>ENGINEERING CONTROLS</td>
<td>Surface Controls</td>
<td>Consolidation, Grading, Revegetation, Erosion Protection</td>
<td>Combine similar waste types in a common area; level out waste piles to reduce slopes for managing surface water infiltration, runoff, and erosion; add amendments to waste and seed with appropriate vegetative species to establish an erosion-resistant ground surface</td>
<td>Site Specific</td>
</tr>
<tr>
<td></td>
<td>Containment</td>
<td>Earthen Cover</td>
<td>Apply soil and establish vegetative cover to stabilize surface.</td>
<td>The cost varies and depends on construction material availability and design requirements at various sites.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Earthen and Geomembrane Cap</td>
<td>Install geomembrane with soil/vegetation over surface; waste materials are left in place</td>
<td>The average cost is approximately $225,000 per acre.</td>
</tr>
<tr>
<td>On-Site Disposal</td>
<td>Earthen Cover</td>
<td></td>
<td>Excavate waste materials and deposit on site in a constructed repository with an earthen cover.</td>
<td>The cost varies and depends on construction material availability and design requirements at various sites.</td>
</tr>
</tbody>
</table>
### TABLE 7-1
SUMMARY OF APPLICABLE REHABILITATION/REMEDIATION TECHNOLOGIES (Cont.)

<table>
<thead>
<tr>
<th>General Response Actions</th>
<th>Reclamation Technology</th>
<th>Process Options</th>
<th>Description</th>
<th>Estimated Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Geomembrane lining with earthen cover.</td>
<td>Excavate waste materials and deposit on site in a constructed repository with geomembrane lining and cap and earthen cover.</td>
<td>The average cost is approximately $225,000 per acre.</td>
<td></td>
</tr>
<tr>
<td>Off-Site Disposal</td>
<td>Solid Waste Landfill</td>
<td>Excavate and dispose of nonhazardous solid wastes permanently in a solid waste management facility</td>
<td>Site Specific</td>
<td></td>
</tr>
<tr>
<td>EXCAVATION AND TREATMENT</td>
<td>Fixation/ Stabilization</td>
<td>Cement/Silicates</td>
<td>Incorporate hazardous constituents into non-leachable cement or pozzolanic solidifying agents</td>
<td>The average cost, including excavation, is approximately $110,000 per metric ton.</td>
</tr>
<tr>
<td></td>
<td>Reprocessing</td>
<td>Milling/Smelter</td>
<td>Ship wastes to existing milling/smelter facility for economic extraction of metals</td>
<td>Site specific</td>
</tr>
<tr>
<td></td>
<td>Physical/ Chemical Treatment</td>
<td>Soil Washing</td>
<td>Separate hazardous constituents from solid media via dissolution and subsequent precipitation</td>
<td>The average cost, including excavation, is approximately $170,000 per ton. The cost depends on site-specific conditions and the target waste quantity and concentration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Acid Extraction</td>
<td>Mobilize hazardous constituents via acid leaching and recover by subsequent precipitation</td>
<td>The estimated cost ranges from $110,000 to $440,000 per metric ton. The cost depends on the volume of soil treated.</td>
</tr>
<tr>
<td>IN-PLACE TREATMENT</td>
<td>Physical/ Chemical Treatment</td>
<td>Stabilization</td>
<td>Stabilize waste constituents in place when combined with injected stabilizing agents</td>
<td>The average cost, including excavation, is approximately $110,000 per metric ton.</td>
</tr>
</tbody>
</table>
## TABLE 7-1
**SUMMARY OF APPLICABLE REHABILITATION/REMEDIATION TECHNOLOGIES (Cont.)**

<table>
<thead>
<tr>
<th>General Response Actions</th>
<th>Reclamation Technology</th>
<th>Process Options</th>
<th>Description</th>
<th>Estimated Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solidification</td>
<td>Use solidifying agents in conjunction with deep soil mixing techniques to facilitate a physical or chemical change in mobility of the contaminants</td>
<td>The average cost, including excavation, is approximately $110,000 per metric ton.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soil Flushing</td>
<td>Acid/base reagent or chelating agent injected into solid media to solubilize metals; solubilized reagents are subsequently extracted using dewatering techniques</td>
<td>The average cost ranges from $25 to $250 per cubic yard. The cost of soil depends greatly on the type and concentration of surfactants used.</td>
<td></td>
</tr>
<tr>
<td>Thermal Treatment</td>
<td>Vitrification</td>
<td>Subject contaminated solid media to extremely high temperature in place; during cooling, material is vitrified into non-leachable form</td>
<td>The average cost ranges from $30 to $130 per cubic meter.</td>
<td></td>
</tr>
</tbody>
</table>
8.0 CONCLUSION

This semi-detailed assessment showed that all the 21 abandoned mine sites pose environmental risks of varying degrees. Land and water media are impacted with chemical contaminants, which may harm human health and the aquatic, terrestrial and wild lives. Unless proper mitigation and corrective actions are undertaken, the surrounding population and receiving environment will be continuously exposed to both chemical and physical risks.

Exposure is influenced by the activities of human receptors in relation to the possible existing chemicals and minerals present within and around the abandoned mines. Contaminated wastewater can gain access to surface water through overflow and surface run-off while surface spillage or infiltration/leakage can contaminate the soil and reach the groundwater. The contaminated groundwater may affect human receptors through direct ingestion from the surface water (rivers and streams) and subsurface water (deep wells, springs). The fishes and water plants can be contaminated with chemicals, therefore, may serve as medium for transfer of toxic chemicals to humans through uptake. Dermal contact through bathing, washing and laundry activities in the rivers, streams and in water from deep wells and springs is another route for contamination.

The mining operations had tremendously altered the original structures and compositions of the land where they had operated. They have created highly undulated and hummocky terrain, lagoons and barren areas. Slope management measures were not implemented, thus, some areas are highly prone to soil erosion, degradation and landslides. The various excavations and lagoons created by mining operations became artificial man-made ponds and habitats of disease carrying insects such as mosquitoes.

There were substantial changes on the floral and faunal compositions of the areas due to the loss of habitats caused by tree cutting and logging activities for the purpose of clearing the areas. The remaining vegetation mostly consists of grasses, coconuts and diversified crops.

For the socio economic environment, the mining operations had brought both positive and negative impacts to the physical and socio-economic environment of the areas.

The existence of mining operations provided employment opportunities in the areas and nearby towns, especially to the local inhabitants who had the various skills that suited the needs of the mining industry. In places where fishing and agriculture were the major occupations, employment in the mining company gave them a more stable source of livelihood, thus, uplifting their socio-economic conditions. This was the major reason why the people who were interviewed clamored for the reopening of the mining operations in abandoned sites.

Congruently, mining operations had an effect on the demographic profile of the areas where they operated. The increase in population caused the convergence of migrants and local inhabitants in a place to indulge in various economic activities that catered to the needs of the growing population; hence, the eventual creation of a mining town which invited business-oriented individuals.

When mining operations ceased, people returned to their hometown/province, and or transferred to other mining companies to look for other sources of livelihood while some returned to their traditional fishing and farming activities.

There were various reasons why the mine sites were abandoned. These included economic losses, insurgency problems, and disapproved MPSA applications. In some mine sites, the unexpected closure
left their employees unpaid of their salaries and other social benefits that the mining companies promised to provide.

In some areas, the existence of mining operations brought the development of various infrastructure facilities (road, bridges, housing units, schools and hospitals), health and major social services (electricity, education and medical services). Both mining employees and local inhabitants benefited from these facilities and services.
9.0 RECOMMENDATIONS

This section presents the recommendations based on the semi-detailed assessment conducted on the 21-abandoned/inactive mine sites. The recommendations also incorporate lessons learned as documented during the study. In addition, the recommendations are guided by the following premises:

- Resources available to respond to the environmental damage contributed by the mining industry is limited
- The Bureau has no legal basis to enforce the preparation and implementation of rehabilitation for the abandoned mine sites because these started operations way before the new mining act was promulgated. The “old” mining act has no provision for the mining companies to prepare and implement rehabilitation plans.
- Shifting regulatory structure from dominantly command-and-control to careful introduction of market-based instruments and information-based strategies.

The proposed recommendations are categorized into the following: Short Term/Immediate actions and Short to Long Term Actions.

9.1 IMMEDIATE AND SHORT TERM ACTIONS

Cognizant to the fact that MGB has no legal right to run after the owners/claimants of the sites considered as abandoned, and while clear policies are yet to be developed to address this, certain immediate action has to be done to minimize the exposure of the surrounding populations and environment to the chemical and physical risk at the site.

- **Conducting dialogues with the past owners of the sites.** A dialogue with the past owner of the 21 abandoned mine sites to present and explain the result of the study should be conducted. It is aimed that the past mine owners after knowing the risk that their sites pose to human health and environment may consider volunteering to address such risk. It is possible that through this dialogue, MGB may leverage from the past owners, at least a detailed site characterization and detailed ecological and health risk assessment be conducted, especially to the priority sites. This detailed study is needed to delineate the extent of contamination and for the preparation of a detailed engineering and rehabilitation plan.

- **Declaring limited access to the mine sites and the immediate surrounding areas shown to be contaminated.** As part of the goal to limit the exposure of the surrounding population to the mine sites, especially those ranked to have the most risk to human health, site restriction should be immediately implemented. A close coordination with the local government units, especially the Planning and development office is necessary to ensure that those affected sites will not be declared/zoned as residential areas, unless further study shows that the hazards exposure is reduced and that the site no longer poses risk to human health.

- **Implementation of some engineering controls to selected sites.** Although detailed rehabilitation and full implementation of engineering technology to address chemical and physical risk is not yet feasible at this time for lack of policy and complete data, there are however selected controls that need to be implemented especially for some sites that poses high physical risk to the surrounding population. Engineering technologies identified include
structural enhancement of tailings pond and dikes to prevent collapse and containment of waste rock to reduce acid mine drainage. Detailed discussion of this is presented in each individual report.

9.2 MEDIUM TO LONG TERM ACTIONS

These actions are aimed towards addressing policy and enforcement vacuums that will enable MBG to provide clear directions in addressing the issue of developing appropriate remediation/rehabilitation plans. These actions also aimed at ensuring that existing operating mine sites and even future mine site operators will address the issue of abandonment as part of their environmental management plan.

The recommended short to long term actions include policy and regulatory reforms, information-based strategies, Information Education campaign, and Research and Development

9.2.1 Policy and Regulatory Reforms

Recommended policy and regulatory reforms aim to provide clear guidelines in addressing the issues of abandoned mine sites, delineating clear responsibilities, and providing proactive mechanisms for the existing operating mining companies to address the issue of rehabilitations/remediation.

- **Policy Providing a Clear Definition of Abandoned Mine Sites.** The basic policy loophole is that there is no definite and clear definition of abandoned mine site. Abandoned areas usually refer to no claimant at all. This definition, however, does not apply to most mine sites since most of them are being managed and owned/claimed. Providing a clear definition of what constitute an abandoned mine site can pave the way in truly determining the status of each considered abandoned mine site.

- **Policy Review of All Mining Laws and Other Related Environmental Regulations.** The abandoned mine sites are covered by old mining and environmental laws. It is claimed that these old mining and environmental laws are inadequate in providing guaranteed mechanisms for mine rehabilitation. This is true because there is no definite policy on rehabilitation of abandoned mine sites. The policy review may address the existing perceived “vacuum” in the provision of guaranteed mechanism for mine rehabilitation.

- **Formulation of Guidelines for Mine Site Assessment and Rehabilitation.** There is no existing guideline that can help the mining companies in developing appropriate rehabilitation plan. A guideline that will address the issue of providing scientific basis in delineating the extent of rehabilitation is clearly needed.

- **Evaluation of the Existing EGF Mechanism.** A need to evaluate the existing mechanism for EGF, specifically budgeting and allocation is certainly needed. This study can be an input to the proposed evaluation study. Though limited in scope, an estimate on the needed financial requirements to rehabilitate of one abandoned mine site can be derived from this study. It can then be compared to the existing EGF allocation and assess whether the existing EGF allocation is in truth sufficient to cover such rehabilitation.
9.2.2 Information-based Strategies

This type of strategy aims to promote voluntary compliance without threat of sanction or the promise of economic gains, but aims at changing company culture and influencing consumer behavior.

Awards and Recognition. To provide positive reinforcement to mining sites that have ongoing rehabilitation’s / revegetation plans to serve as models for others to emulate.

Information and Education Campaign. There is a need to raise the people’s awareness of the environmental issues brought about by the operation of the mining companies. These shall include:

- Enhancing the communities knowledge on the various ecological risk can make them more vigilant and better vanguards of the environment
- Involving the communities in planning and participating in mine rehabilitation activities will allow them to appreciate the good intention of mining operations and at the same time educating them.
- Strengthening the capabilities of LGUs, through training since they now have responsibility for the management and regulation of activities related to monitoring of mine activities.
- Link with multilateral and bilateral organizations to have access to the latest information on mining rehabilitation and remediation technologies.

Conduct of Site and Ecological Risk Assessment. The importance of understanding the source, pathway and exposure scenario of potential contaminants is highlighted in this study. Although limited in application, it has led to the identification of hot spots - receptors that are potentially at risk. A full-blown site and ecological risk assessment to be conducted after a certain number of years in operation may lead to early detection of potential environmental damage.

Adoption of Environmental Management System. The benefits of adopting EMS are well documented. Adoption of EMS should be encouraged as a strategy to manage pollution and its associated risk and promote compliance

9.2.3 Research and Development

A close interagency coordination with the Departmental of Science and Technology (DOST) – Industry Development Institute will help in clearly identifying and verifying the best available technology in rehabilitating/remediating the contaminated mine sites. It can also help address determined new mining processes that include designs for the environment.
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RBPS EVALUATION SCORESHEET