SECOND
ANNUAL REPORT ON THE MONITORING AND ANALYSIS
OF THE WATER QUALITY

“CURRENT SITUATION OF THE WATER IN THE TZALA AND QUIVICHIL RIVERS IN THE INFLUENCE AREA OF THE MARLIN MINE, LOCATED IN THE MUNICIPALITIES OF SAN MIGUEL IXTAHUACAN AND SIPAKAPA, DEPARTMENT OF SAN MARCOS, GUATEMALA”

COMISION PASTORAL PAZ Y ECOLOGIA
COPAE
Diocese of San Marcos

San Marcos, Guatemala, July 2009
# Second annual report on the monitoring and analysis of the quality of waters around Marlin Mine, located in the Municipalities of San Miguel Ixtahuacán and Sipakapa, Department of San Marcos, Guatemala

## INDEX

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>02</td>
</tr>
<tr>
<td>2. Background</td>
<td>03</td>
</tr>
<tr>
<td>2.1. Reference Framework</td>
<td>03</td>
</tr>
<tr>
<td>2.1.1. Description of the Study Site</td>
<td>03</td>
</tr>
<tr>
<td>2.2. Conceptual Framework</td>
<td>06</td>
</tr>
<tr>
<td>2.2.1. Law Parameters</td>
<td>06</td>
</tr>
<tr>
<td>2.2.2. Legal Basis</td>
<td>06</td>
</tr>
<tr>
<td>2.3. Monitoring Work carried out by COPAE in the Area</td>
<td>06</td>
</tr>
<tr>
<td>3. Justification</td>
<td>08</td>
</tr>
<tr>
<td>4. Objectives</td>
<td>08</td>
</tr>
<tr>
<td>5. Methodology</td>
<td>10</td>
</tr>
<tr>
<td>5.1. Selection of Sampling Points</td>
<td>10</td>
</tr>
<tr>
<td>5.2. Sampling</td>
<td>14</td>
</tr>
<tr>
<td>5.2.1. In situ data collection</td>
<td>14</td>
</tr>
<tr>
<td>5.2.2. Sampling Process</td>
<td>14</td>
</tr>
<tr>
<td>5.3. Laboratory Analysis</td>
<td>15</td>
</tr>
<tr>
<td>5.3.1. Equipment Calibration</td>
<td>15</td>
</tr>
<tr>
<td>5.3.2. Physical-Chemical Analysis</td>
<td>15</td>
</tr>
<tr>
<td>5.4. Interpretation of Results</td>
<td>16</td>
</tr>
<tr>
<td>5.5. Sample Analysis in External Laboratory</td>
<td>16</td>
</tr>
<tr>
<td>6. Results and Discussion</td>
<td>17</td>
</tr>
<tr>
<td>7. Conclusions</td>
<td>29</td>
</tr>
<tr>
<td>8. Recommendations</td>
<td>30</td>
</tr>
<tr>
<td>9. Bibliography</td>
<td>32</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

The open cut mining of metals is an industrial activity that extracts products (metals) that are below the surface of the ground, that is why it is also known as open-pit mining. This is one of the industries ranked with the highest risk in the world, both for those that work in it, among other things due to the inputs used in the different processes, as for the external impacts that it generates for the people that live in nearby communities, because of the irrational use of certain natural resources, for example, water. Therefore said activity produces profound environmental, economic, social, and cultural impacts as it involves a change in the use of the soil and water, the destruction of ecosystems, and changes in the habits of the people who live near the places where mining activities are carried out.

For several years, due to its mining resources, Guatemala has not escaped from the interest of mining companies carrying out the extraction of several minerals in various regions of the country. Such is the case of the Marlin mining project, located between the municipalities of San Miguel Ixtahuacan and Sipakapa, in the department of San Marcos, where they extract precious metals such as gold and silver. In the process, the project uses enormous quantities of water (250,000 liters/ hour; 66,000 gallons/ hour), as well as the use and production of diverse dangerous chemical compounds that also contaminate the water that is used, putting the nearby communities at risk, both in terms of water availability as in terms of water quality.

Because of this, the population of these communities began to get worried, and through their parishes requested support to independently monitor the quality of water sources located in the area of influence of the Marlin Mine.

In response to this request, La Comisión Pastoral Paz y Ecologia (COPAE-- The Pastoral Commission for Peace and Ecology) of the San Marcos diocese, since the year 2007 began monitoring the quality of surface waters in order to determine the presence of heavy metals in them, as well as the behavior in their concentrations over time. This monitoring is carried out in the Tzala and Quivichil rivers, located around the operation center of the Marlin Mine.

In COPAE’s monitoring system, physical and chemical aspects of the aforementioned water bodies were studied, with the objective of getting first-hand and reliable data to know what is happening. Community members are involved throughout the monitoring process, and can testify for the procedures used.

The current report presents the results obtained during the period between April 2008 and April 2009 (second year of monitoring) of the surface waters of the said rivers.
2. BACKGROUND

2.1. Reference Framework

2.1.1. Description of the study site

2.1.1.1. Location

The Marlin Mine is located in the municipalities of San Miguel Ixtahuacan and Sipakapa, in the department of San Marcos, in the western highlands of Guatemala. The mine is located 48 km (30 miles) south-west from the capital of the department of Huehuetenango and 275 km (171 miles) from Guatemala City, the capital of the Republic of Guatemala.

2.1.1.2. Climate

The area of study presents elevations between 1,600 and 2,300 meters above sea level (between 5,250 and 7,546 ft), registering an annual average temperature of 20 degrees Celsius (70 degrees Fahrenheit). The rainy season usually occurs between May and November and the average annual precipitation is roughly 1,000 mm (40 inches) (EIA 2003).

2.1.1.3. Hydrography

The Marlin Mine is located on the basin of the Cuilco River, one of 34 basins in Guatemala. The basin has an area of 2,274 square km (878 square miles) (www.insivumeh.gob.gt/hidrologia).

The permanent river Tzala and the seasonal stream Quivichil flow into the Cuilco River and both pass around the Marlin Mine (see Map 1). The Cuilco River begins to develop in the departments of Quetzaltenango and San Marcos, from which it follows its natural bed through four municipalities in Huehuetenango, those of San Gaspar Ixil, Colotenango, Ixtahuacan, and Cuilco. This river passes from Guatemala to Mexico, where its name changes to the Grijalva River, until it ends in the Gulf of Mexico. Before the confluence of the Tzala River, the Cuilco River receives water from the Rio Grande with a watershed of 450 square km (174 square miles), and from the Ixchol River with a watershed of 90 square km (35 square miles) (EIA 2003).

The water flow of the Tzala River varies significantly between the dry and rainy seasons, from as little as 0.5 to as much as 7 cubic meters/second (18 to 248 cubic feet/second) with an average flow of 1.31 cubic meters/second (46 cubic feet/second). The Quivichil stream is intermittent and seasonal, with low flow during the dry months and the volume varies between 0 and 0.70 cubic meters/second (0 and 25 cubic feet/second), and an average flow of 0.13 cubic meters/second (5 cubic feet/second) (EIA 2003).
The rainy season usually occurs from May to November and it is more intense during some months.
Table 1: Basic Characteristics of the rivers

<table>
<thead>
<tr>
<th>RIVER</th>
<th>AREA (sq. km)</th>
<th>DISCHARGE IN WINTER (l/s)</th>
<th>DISCHARGE IN SUMMER (l/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quivichil Stream</td>
<td>18</td>
<td>680</td>
<td>0</td>
</tr>
<tr>
<td>Tzala River</td>
<td>60</td>
<td>6680</td>
<td>300</td>
</tr>
<tr>
<td>Cuilco River</td>
<td>2274</td>
<td>31,680</td>
<td>3,200</td>
</tr>
</tbody>
</table>

Source: CAO 2005; EIA 2003; and INSIVUMEH

“The quantity of water in both rivers is usually good for aquatic life; there is no evidence of toxicity. The aquatic life in the rivers is characterized by the presence of macro-invertebrates and one or two species of fish, depending on the season of the year,” (EIA 2003).

2.1.1.4. Human Settlements

“The mining project is located in the San Jose Nueva Esperanza settlement (population 107), the Agel village (population 931) and San Jose Ixcanichel (population 370) that belong to the San Miguel Ixtahuacan Municipality where there are two ethnic groups, Mam Maya (99.31%) and Ladino (non-indigenous) (0.69%). The predominant language is Mam, and the second language is Spanish,” (EIA, 2003) not spoken by everybody.

2.1.1.5. Productive Aspects

In the area, the land possession is approximately 0.7 hectares per family, who dedicate themselves to the production of annual crops such as maize and beans, along with ayote, lima beans, zucchini, güisquil [type of squash], native herbs, wheat in small quantities, barley, perennial crops (coffee in the lowlands; deciduous fruits such as apples, peaches, and avocado), pasture for both major and minor livestock feed (sheep, cows, pigs, poultry), and above all they conserve their pine, holm oak, oak, alder, madroña and cypress forests.
2.2. Conceptual Framework

2.2.1. Law Parameters

First of all is the use of the national rules and regulations established by the Ministerio de Ambiente y Recursos Naturales- MARN- (the Ministry of the Environment and Natural Resources) on Descargas y Reuso de Aguas Residuales y Disposición de Lodos (Discharge and Reuse of Residual Waters and Disposal of Mud), and the Norma Guatemalteca Obligatoria de Agua Potable (Obligatory Guatemalan Norm on Potable Water -- COGUANOR), that mining enterprises must comply with when they operate within the country.

Second, the compliance with the international standards established by the World Bank for open-pit mining, the guidelines of the World Health Organization (WHO) for potable water, the values of the United States Environmental Protection Agency (US EPA), as well as the water quality Canadian limits.

The standards established by Canada and the United States have been used because they are the countries of origin of the mining company, where the standards have to be used equally at international level as well as in Guatemala.

Table No. 2 shows the guidelines for industrial effluents. For this study only those parameters that are being monitored, evaluated, and analyzed have been considered, because of insufficient financial resources to carry out a study of all the chemical substances that are generated by the mining enterprise.

2.2.2. Legal Basis

According to Articles 97, 127, and 128 of the Constitución Política de la República (Constitution of the Republic of Guatemala), Article 1 of the Ley de Protección y Mejoramiento del Medio Ambiente Decreto No. 90-2000 (Law for the Protection and Improvement of the Environment, Decree 90-2000), the State of Guatemala is forced to guarantee the people the right to a Healthy Environment, and the right to water, in accordance with the existing legal regulation (Decree 68-86; Constitution of the Republic of Guatemala).

2.3. Monitoring Work carried out by COPAE in the Area

In April of 2007, the Comisión Pastoral Paz y Ecología COPAE (Pastoral Commission for Peace and Ecology), of the San Marcos Diocese, in response to the request from the communities in the area and concerned by the presence of the Marlin mining enterprise in the area, began a monitoring process of the surface waters quality around the Marlin
Second annual report on the monitoring and analysis of the quality of waters around Marlin Mine, located in the Municipalities of San Miguel Ixtahuacan and Sipakapa, Department of San Marcos, Guatemala

Mine. Said monitoring began with the sampling of surface waters in five points located on the Tzala and Quivichil rivers around the Marlin Mine.

In April 2008 the first year of water monitoring was ended and the report was published on October first of the same year in a conference held for the press and national and international guests.

Table 2: Law Parameters for superficial and potable water quality.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit of Measure</th>
<th>World Bank for open-pit mining</th>
<th>WHO Guidelines</th>
<th>US EPA Guidelines</th>
<th>Canadian Limits for Water Quality</th>
<th>MARN Regulations</th>
<th>Guatemala Potable Water Standard *** (COGUANOR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>6.0-9.0</td>
<td>6.5-8.5</td>
<td>6.5-8.5**</td>
<td>6.5-8.5</td>
<td>6.0-9.0</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>6.0-9.0</td>
<td>6.5-8.5**</td>
<td>6.5-8.5</td>
<td>6.5-8.5</td>
<td>6.0-9.0</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>Electric Conductivity</td>
<td>µS/cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1-1500</td>
</tr>
<tr>
<td>Chemical Parameters (Heavy Metals)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>mg/L</td>
<td>0.1</td>
<td>0.5</td>
<td>0.05-0.2**</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Arsenic</td>
<td>mg/L</td>
<td>0.1</td>
<td>0.010</td>
<td>0.01</td>
<td>0.025</td>
<td>1</td>
<td>0.01</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/L</td>
<td>0.5</td>
<td>1.5</td>
<td>1.3</td>
<td>1.0</td>
<td>4.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/L</td>
<td>3.5</td>
<td>0.1</td>
<td>0.3**</td>
<td>0.3</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/L</td>
<td>0.05</td>
<td>0.05**</td>
<td>0.05</td>
<td>0.05</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Total Zinc</td>
<td>mg/L</td>
<td>2.0</td>
<td>1.5</td>
<td>5.0**</td>
<td>5.0</td>
<td>10.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Other Parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cyanide</td>
<td>mg/L</td>
<td>1.0</td>
<td>0.2</td>
<td>0.2</td>
<td>6.0</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Sulfates</td>
<td>mg/L</td>
<td>250.0</td>
<td>250.0</td>
<td>250.0**</td>
<td>200.0</td>
<td>250.0</td>
<td></td>
</tr>
<tr>
<td>Nitrate</td>
<td>mg/L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

* TCR = Temperature of the receiving body (initials in Spanish)
** Belonging to the list of secondary regulations for potable water from the US EPA
*** Maximum Permissible Limit

SOURCE:
- [Www.who.int](http://Www.who.int). World Health Organization
- Natural Water Quality: Canadian Limits for water quality (5th edition).
3. JUSTIFICATION

Due to the chemical process and leaching method used to separate metals from mountain rocks that results in generating environmental contamination, and because MARN does not carry out an ongoing water quality study, the communities located in the area of operations of the Marlin Mine become concerned.

Based on the above, and considering that those communities directly depend on these sources of water for their diverse activities, COPAE sees the need of carrying out an independent study to determine the presence of contamination in the water sources in the area of influence of the Marlin Mine.

During the first year of monitoring, tests proved the presence of heavy metals such as iron, aluminum, manganese, and arsenic, which were found in the water at sample points SW1 (lower Tzala River), SW2 (lower Quivichil stream), and SW3 (Quivichil downstream from the tailings dam), all of which are located below the operation center of the Marlin Mine. Hence, COPAE considers it necessary to continue monitoring for the duration of the Marlin Mine operation.
4. OBJECTIVES

4.1. General

Generate a data base that describes the behavior over time of the water quality in the Quivichil and Tzala Rivers, in the municipalities of San Miguel Ixtahuacan and Sipakapa, San Marcos.

4.2. Specifics

- Determine the presence and concentration of heavy metals in the upper and lower parts of the Quivichil and Tzala Rivers.

- Give continuity to the monitoring carried out during the period between April 2007 and April 2008.

- Make available a technically reliable report to the communities and national and local authorities, so that they make the pertinent decisions and precautions.
5. METHODOLOGY

The study was carried out during the period between June 2008 and April 2009, and it was developed in five phases:

5.1. Selection of Sampling Points

Five surface water sampling points were selected for the Tzala and Quivichil Rivers (see Box 1), according to the following criteria:

- 3 points below the operation center of the mine
  - The first point (SW1) was located on the lower part of the Tzala River, since it is below the rock discard deposit of the mine, it runs the risk of being contaminated by an acid drainage.
  - The other two points (SW2 and SW3) are below the tailings dam and before joining the Cuilco River, since they would be the first to receive contamination when a discharge, leakage, leaching, or infiltration occurs from the dam.

- 2 points above the mine’s operation center, where there are no chemical discharges, to compare the results with the water below the mine (SW5 and SW6).

During the first year of monitoring the water source for point SW4 dried up, therefore a new sampling point was chosen in one of the effluents that feed the upper part of the Quivichil stream, and that does not have direct influence from the mine’s operations.

Box 1: Description of Monitoring Points

<table>
<thead>
<tr>
<th>SW-1</th>
<th>Tzalá River (below the operation center of the Marlin Mine). Salem Village, Sipakapa, San Marcos.</th>
</tr>
</thead>
</table>
|       | Latitude: 15°13.76’ North  
|       | Longitude: 91°39.319’ West  
|       | Altitude: 1,735 meters above sea level                                                         |

<table>
<thead>
<tr>
<th>SW-2</th>
<th>Quivichil Stream (below the operation center of the Marlin Mine, before flowing into the Cuilco). Siete Platos Village, San Miguel Ixtahuacán, San Marcos. The Quivichil is defined as a stream, which means Small River with a low water flow.</th>
</tr>
</thead>
</table>
|       | Latitude: 15°15.879’ North  
|       | Longitude: 91°40.415’ West  
|       | Altitude: 1,669 meters above sea level                                                                                                                                                        |

1 SW stands for: Surface Water
Second annual report on the monitoring and analysis of the quality of waters around Marlin Mine, located in the Municipalities of San Miguel Ixtahuacán and Sipakapa, Department of San Marcos, Guatemala

**SW-3**  
**Stream below the tailings dam.** San José Ixcanichel Village, San Miguel Ixtahuacán, San Marcos.  
Latitude: 15° 15.134' North  
Longitude: 91° 40.761' West  
Altitude: 1,834 meters above sea level

**SW-5**  
**Tzalá River (above the operation center of the Marlin Mine).** Chininguiltz Village, San Miguel Ixtahuacán, San Marcos.  
Latitude: 15° 12.8’ North  
Longitude: 91° 45.019’ West  
Altitude: 2,285 meters above sea level

**SW-6**  
**Upper Part of the Quivichil Stream.** (Effluent that is part of the Quivichil, known as “Canshac” or “Q’an shaq” and does not show influence from mining operations). San José Ixcanichel Village, San Miguel Ixtahuacán, San Marcos.  
Latitude: 15° 15’31.7” North  
Longitude: 91° 41’24.8” West  
Altitude: 1,800 meters above sea level
Second annual report on the monitoring and analysis of the quality of waters around Marlin Mine, located in the Municipalities of San Miguel Ixtahuacan and Sipakapa, Department of San Marcos, Guatemala
5.2. Sampling

Sampling was carried out once a month, with the support of community promoters trained in as follows:

5.2.1. In Situ Data Collection

- With field measuring equipment (conductivity meter, pH meter, and thermometer) the following information was taken at the water body:
  - Temperature
  - Electric conductivity
  - pH level

- Through direct observation the following were described:
  - Presence of sun
  - Transparency
  - Odor
  - Presence of foam
  - Presence of insects and fish

5.2.2. Sampling process

- Look for the point in the river with most current
- Using sterile latex gloves, take a sterile plastic jar and rinse it twice (filling and emptying it) with river water, putting the mouth of the jar against the current to avoid its contamination by the latex gloves.
- Collect the sample in the same way, filling the jar again.
- Repeat the procedure with another jar, adding 15 drops of nitric acid (HNO3).
- Label the jar with the following data:
  - Name of sampling point
  - Date
  - Hour
  - Annotate the addition of nitric acid (if applicable)

The data collected from the samples is annotated in the field verification surface water quality notebook of the five monitoring points.

The collected samples were stored in a freezer at an average temperature of 5 degrees centigrade, later to be transferred to the capital of the department of San Marcos, where the analysis phase was done.
5.3. Laboratory Analysis

The analyses were done in COPAE's laboratory in the capital of the department of San Marcos one day after taking the samples.

5.3.1. Equipment Calibration

Before beginning the physical-chemical analyses, each measuring instrument was calibrated as follows:

- The conductivity meter with a calibrating solution of 1314 µS/cm
- The pH meter with a regulating solution (phosphate) pH 7, regulating solution pH 4.01, and regulating solution (borate) pH 10.

5.3.2. Physical-Chemical Analyses

5.3.2.1. Physical Analyses

With the previously calibrated equipment the following data were taken:

- pH
- Electric conductivity
- Temperature

5.3.2.2. Chemical Analyses

Using the method recommended by the US EPA standards, with a Hach brand DR 2800 spectrophotometer and the corresponding reagents, it was possible to determine the presence and concentration of the following heavy metals in the different water samples:

- Iron
- Copper
- Zinc
- Nitrate
- Sulfate
- Manganese
- Aluminum

Alkalinity was measured by a colorimetric method and arsenic by paper quick test kits.
An analysis of heavy metals (iron, copper, zinc, manganese, arsenic, and aluminum) was done on the samples conserved with nitric acid (HNO3); the samples that did not have any additives were analyzed for sulfates, nitrates, alkalinity, pH, and electric conductivity. It is important to mention that the analyzed samples were not filtered.

5.4. Data Interpretation

The interpretation of the results obtained through physical-chemical analyses followed the parameters established by national and international laws and standards.

5.5. Analysis of samples in an external laboratory

In the months of August and December 2008, samples were sent to an external laboratory in the department of Quetzaltenango, in order to have a counter-analysis to compare with the results obtained by COPAE.
6. RESULTS AND DISCUSSION

The following results are based on the study done during the period between June 2008 and April 2009.

The maximum permissible limits that appear in the graphs were taken from the values established by the Guidelines of the World Bank for open-pit mining and some from the Environmental Protection Agency of the United States.

The tables with the results are annexed to the present document.

6.1. Temperature

The temperature varies according to the geographic region and climate. In Graph No. 1, the behavior of the temperature in the water of the rivers in the five sampling points can be clearly seen, it follows the annual pattern of environmental temperature, that drops in the coldest period of the year in the department of San Marcos, this usually occurs in November, December, January, and February. However, at point SW3 the temperature remains high throughout the year, compared to the other monitoring points due to the low volume of water in this stream and to the fact that the samples were taken at mid-day (the warmest time of the day). Point SW5 maintains lower temperatures than the other monitoring points because the monitoring place is located in one of the highest regions, very near to the spring of the river.

Graph 1: Temperature Measured at the 5 Monitoring Points
6.2. Hydrogen Potential (pH)

The results of the monitoring points, in graph 2 (field data) as in graph 3 (pH at the laboratory) present a similar behavior regarding their pH.

Graph 2: pH at the 5 monitoring points as measured in the field

NOTE: The maximum and minimum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

Graph 3: pH at the 5 monitoring points as measured at the COPAE laboratory

NOTE: The maximum and minimum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

The pH at the five monitoring points is within the limits established by the World Bank for open-pit mining, and by MARN of Guatemala; however, they are not within the limits of the
standards for potable water. Therefore, the water is not fit for human consumption, because the limits surpassed 8.5.

The points SW1, SW2, and SW3, which are below the operations center of the Marlin Mine, always presented a higher pH compared to the other monitoring points above the mine. The same results were presented in the last report. This tendency towards an increase of the pH level is possibly due to: the water being influenced by the pH of the soil and probably by the liberation of calcium from the rock; or a leak of water from the tailings dam, which should be very alkaline in order to prevent the volatilization of cyanide.

6.3. Electric Conductivity (EC) in the field

Electric conductivity presents itself in the same way in the field as in the laboratory, therefore the data is reliable. Results of EC at point SW5 (high part of the Tzalá river) have always been lower than at point SW1 (lower part of the Tzalá river) which indicates that there is a larger content of macro-ions in the lower part which come from the rock in that place, which is exposed to the weather.

Graph 4: EC of the 5 monitoring points as measured in the field

Graph 5: EC of the 5 monitoring points as measured at the COPAE laboratory
The EC at the five monitoring points went down between the months of June and October, which could be due to the intense rains that occurred in those months, causing the flow of the rivers to increase with the resulting dilution in the concentration of ions per cubic meter, and hence the reduction of EC.

6.4. Copper

In Graph 6 (samples analyzed in the laboratory) a considerable increase in the presence of copper can be seen at point SW3 (downstream below the tailings dam) between the months of June and August, which is also confirmed by the counter-analysis performed in the external laboratory (Graph 7). These values exceed the maximum permissible limit of the World Bank for open-pit mining.

Likewise, at point SW2, an increase in the copper content is observed in the months of August and September, that also exceeds the maximum permissible limit of the World Bank for open-pit mining. A considerable increase is also present during the month of September 2008, at point SW5.

**Graph 6: Copper concentrations at the 5 monitoring points as measured at the COPAE laboratory**

**NOTE:** The maximum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.
Graph 7: Copper concentrations at the 5 monitoring points as measured at the External Laboratory

![Copper Concentrations Graph]

**NOTE:** The maximum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

### 6.5. Iron

In Graph 8 it can be seen that during the months of June and August, the iron content at point SW1 (lower part of the Tzalá river) exceeds the maximum limits permitted by the World Bank for open-pit mining.

Graph 8: Iron concentrations at the 5 monitoring points as measured at the COPAE laboratory

![Iron Concentrations Graph]

**NOTE:** The maximum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

Graph 9, corresponding to the external laboratory analyses, shows how the results of the five monitoring points during the month of August are above the values permitted by the World Bank and the national and international agencies. The highest values correspond to the rivers located below the operation center of the mine.
Graph 9: Iron concentrations at the 5 monitoring points as measured at the external laboratory

NOTE: The maximum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

6.6 Aluminum

Graph 10 shows that the aluminum content at point SW1 exceeds, from June 2008 to January 2009, the limits established by the World Bank, with a tendency to go down. The high content of aluminum during these months could be due to two factors:

- The soils in this location are of volcanic origin, making it very likely that the rock contains aluminum and that it naturally dissolves in the water.

- As a consequence of the first factor, the waste rock deposit of the mining enterprise is liberating aluminum through what is known as acid drainage.

Likewise, in the month of June 2008 a very high level of aluminum is present at point SW3; this could have happened by a water discharge or leak in the tailings dam, because this was one of the rainiest months of the year.
Graph 10: Aluminum Concentrations at the 5 monitoring points as measured at the COPAE laboratory

Graph 11: Aluminum Concentrations at the 5 monitoring points as measured at the external laboratory

NOTE: The maximum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

The analyses performed by the external laboratory in the months of August and December show that there is no high presence of the aluminum metal during those months.

6.7. Arsenic

As observed in Graph 12, the same as during the study period 2007-2008, once again arsenic was found at point SW3 and it begins to be observed in the month of November 2008, at the start of the dry season. The concentration of this metal increases gradually until it reaches its highest value in the month of March 2009, at which point the concentration is above the parameters permitted by the World Bank for open-pit mining, reaching a value of 0.12 mg/L.
Graph 12: Arsenic Concentration at the 5 monitoring points as measured at the COPAE laboratory

NOTE: The maximum limits presented in the graph correspond to the established standards of the Environmental Protection Agency of the United States for potable water.

6.8. Manganese

As can be seen in Graph 13, the values of manganese content were high at the five sampling points, above the limits permitted by the Environmental Protection Agency of the United States.

The manganese concentration behavior varied from higher to lower, presenting the highest values between the months of June and October 2008 (rainy season). A new increase at point SW2 was seen during the month of January 2009, and during April of the same year at point SW5.

Based on this we can say, in general terms, that during the rainy season the concentrations of manganese tend to increase and during the dry season they tend to decrease.

The behavior of the presence of manganese is higher at points SW1, SW2, and SW3, which are in the low part of the operations center of the Marlin mining project.

In Graph 14, that corresponds to the analyses performed by the external laboratory, the results show the same behavior as those performed by COPAE, being even higher than the standards established by the Environmental Protection Agency of the United States.
Graph 13: Manganese concentrations at the 5 monitoring points as measured at the COPAE laboratory

![Graph 13: Manganese concentrations at the 5 monitoring points as measured at the COPAE laboratory](image)

**NOTE:** The maximum limits presented in graphs 13 and 14 correspond to the established standards of the Environmental Protection Agency of the United States.

Graph 14: Manganese concentrations at the 5 monitoring points as measured at the external laboratory

![Graph 14: Manganese concentrations at the 5 monitoring points as measured at the external laboratory](image)

**NOTE:** The maximum limits presented in graphs 13 and 14 correspond to the established standards of the Environmental Protection Agency of the United States.

### 6.9 Zinc

In the case of zinc, the quantities are below the maximum limits permitted by the World Bank for open-pit mining. However, in the month of September at point SW2, there was an increase in the presence of zinc in the water sample, without exceeding the established standards. The same results were found in the analyses performed at the external laboratory, with similar results.
Graph 15: Zinc concentrations at the 5 monitoring points as measured at the COPAE laboratory

NOTE: The maximum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

Graph 16: Zinc concentrations at the 5 monitoring points as measured at the external laboratory

NOTE: The maximum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

6.10. Sulfate

In the case of sulfate, the quantities are below the maximum limits permitted by the World Bank for open-pit mining (see Graph 17). However, as of November, there was an increase in the presence of sulfate in the analyzed water samples at points SW2 and SW3, without exceeding the established standards.

As shown in Graph 18, the results of the analyses performed at the external laboratory are similar to those analyzed by COPAE.

Graph 17: Sulfate concentrations at the 5 monitoring points as measured at the COPAE laboratory
Second annual report on the monitoring and analysis of the quality of waters around Marlin Mine, located in the Municipalities of San Miguel Ixtahuacán and Sipakapa, Department of San Marcos, Guatemala

NOTE: The maximum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

Graph 18: Sulfate concentrations at the 5 monitoring points as measured at the external laboratory

NOTE: The maximum limits presented in the graph correspond to the established standards of the World Bank for open-pit mining.

6.11. Nitrate

In Graph 19 it can be observed that in the month of July 2008, the nitrate concentration present at point SW3 is above the range established by the Environmental Protection Agency of the United States, and the Guatemalan standards for potable water. Likewise, in February 2009 the values at points SW1, SW2, and SW3 (below the operation center of the mine) also surpass the established limits. The external laboratory results coincide with those analyzed by COPAE.
Second annual report on the monitoring and analysis of the quality of waters around Marlin Mine, located in the Municipalities of San Miguel Ixtahuacán and Sipakapa, Department of San Marcos, Guatemala

Graph 19: Nitrate concentrations at the 5 monitoring points measured at the COPAE laboratory

NOTE: The maximum limits presented in the graph correspond to the established standards of the Environmental Protection Agency of the United States, and to the Guatemalan standards for drinking water (Normas Guatemaltecas para Agua Potable).

Graph 20: Nitrate concentrations at the 5 monitoring points measured at the external laboratory

NOTE: The maximum limits presented in the graph correspond to the established standards of the Environmental Protection Agency of the United States, and the Guatemalan standards for potable water (Normas Guatemaltecas para Agua Potable).
7. CONCLUSIONS

7.1. The results show that a presence of heavy metals and nitrate exists in the three monitoring points that are located below the center of operations of the Marlin Mine.

7.2. High levels of iron, aluminum, manganese, and nitrate have been found in the lower part of the Tzalá River (point SW-1).

7.3. High levels of copper, aluminum, manganese, and nitrate have been found in the lower part of the Quivichil stream (point SW-2).

7.4. High levels of copper, iron, aluminum, arsenic, manganese, and nitrate have been found in the Quivichil stream below the tailings dam (point SW-3).

7.5. The high levels registered at points SW1, SW2, and SW3 surpass the limits permitted by the established standards of the World Bank for open-pit mining, the established standards of the Environmental Protection Agency of the United States (US EPA), the standards of the Guatemalan Environmental and Natural Resources Ministry (Ministerio de Ambiente y Recursos Naturales (MARN) de Guatemala), and the Canada, Guatemala, and United States drinking water standards.

7.6. There is a recurrence of the presence of metals found in the previous study (2007-2008 period), whose concentrations exceed national and international standards.

7.7. There is an increase in the copper and nitrate concentrations.

7.8. According to the data and levels of heavy metals found, it can be concluded that the water is not fit for human consumption.

7.9. There is a recurrence of a presence of high concentrations of arsenic at point SW-3 (down stream from the tailings dam), that are even higher than the previous year.

7.10. The results obtained indicate that the inhabitants of the communities, their economic activities as well as the other forms of life that are in the area of influence of the Marlin Mine Project, continue at high risk of contamination, which violates the human rights to a healthy environment, to water, and food, amongst other things.
8. RECOMMENDATIONS

8.1. To the institutions of the State of Guatemala in general:

- Not continue promoting the mining industry, as it has been shown that human rights to a healthy environment and water are subjected to high risk.

8.2. To the Ministry of the Environment and Natural Resources, Ministerio de Ambiente y Recursos Naturales (MARN):

- That as the responsible entity and rector of the environmental subject, it should carry out totally independent studies of the mining company, publish the results and take pertinent actions.

- As a governmental institution, it must reform and apply the regulations for discharge of industrial waters into natural water bodies of public use, making them stricter and in accordance with international standards.

- Carry out an independent monitoring of underground waters to determine the source of the metals found as well as a study of the quantity of water (water volume), and its behavior during the different seasons of the year to determine the causes for the scarcity of water in the region. As well as a study of the air quality near the tailings dam, to determine the levels of contamination caused by chemical elements that provoke serious damages to human health and to the environment.

- In the area of influence of the mine, not permitting water discharges or leaks from the tailings dam into nearby rivers that are for public use.

8.3. To the Congress of the Republic of Guatemala:

- Carry out a cost-benefit study of the Marlin mining project so far, to make the pertinent amendments to the mining law.

- Reform the mining law, putting special emphasis on the following subjects: environmental and water regulations; harmonizing the law to human rights standards, especially to guarantee the rights of indigenous people to their natural resources.

8.4. To the World Bank:

- Again it is recommended to carry out an independent study on the quantity and quality of water in the area, since it is directly responsible for having financed the mining operation.

8.5. To the Municipal Authorities and the Population in General:

- That the population, communities directly and indirectly affected by the mining
enterprise pay attention to the changes that may occur in the quality and quantity of water, so that they may denounce these changes to the corresponding authorities.

8.6. To Human Rights Defense Organizations:

- Support the communities in their accusation and access to the justice system, to combat impunity.
9. BIBLIOGRAPHY


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Web pages consulted:

- www.insivumeh.gob.gt/hidrologia