Bantay Kita

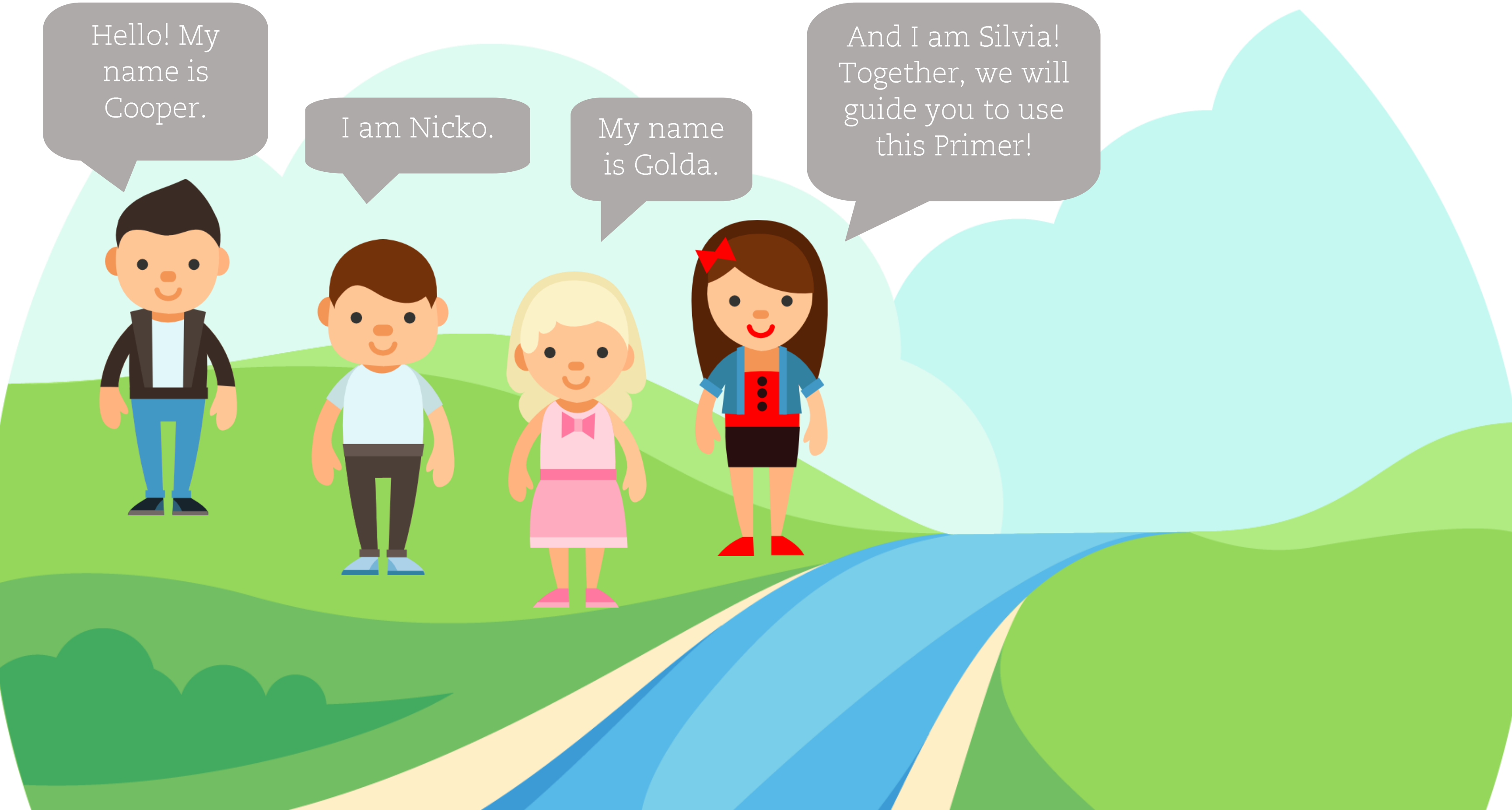
Foundation for the Philippine Environment

*Fostering Partnerships for the Environment*

# Environmental Monitoring Primer

a practical guide for affected communities in monitoring mining operations

# Why use the Environmental Monitoring Tool?


Hello! My name is Cooper.
I am Nicko.
My name is Golda.
And I am Silvia! Together, we will guide you to use this Primer!


The Philippines is very rich in mineral resources. At the same time, the country is a biodiversity hotspot; prone to natural disasters; and densely populated. There are 40 metallic mines currently operating.


Mineral extraction causes pollution especially when not mitigated and monitored well. Remember this?


If only there was a way to empower communities to monitor mining operations and collect and interpret related data.
Environmental monitoring capacity of impacted communities and grassroots organizations remains a challenge.


Communities can rely on Multi-Partite Monitoring Team reports conducted quarterly by local key stakeholders. Or...


They can use the Environmental Monitoring Tool of Bantay Kita which is a 7-step guide for communities who want to monitor environmental impacts of mining operations.

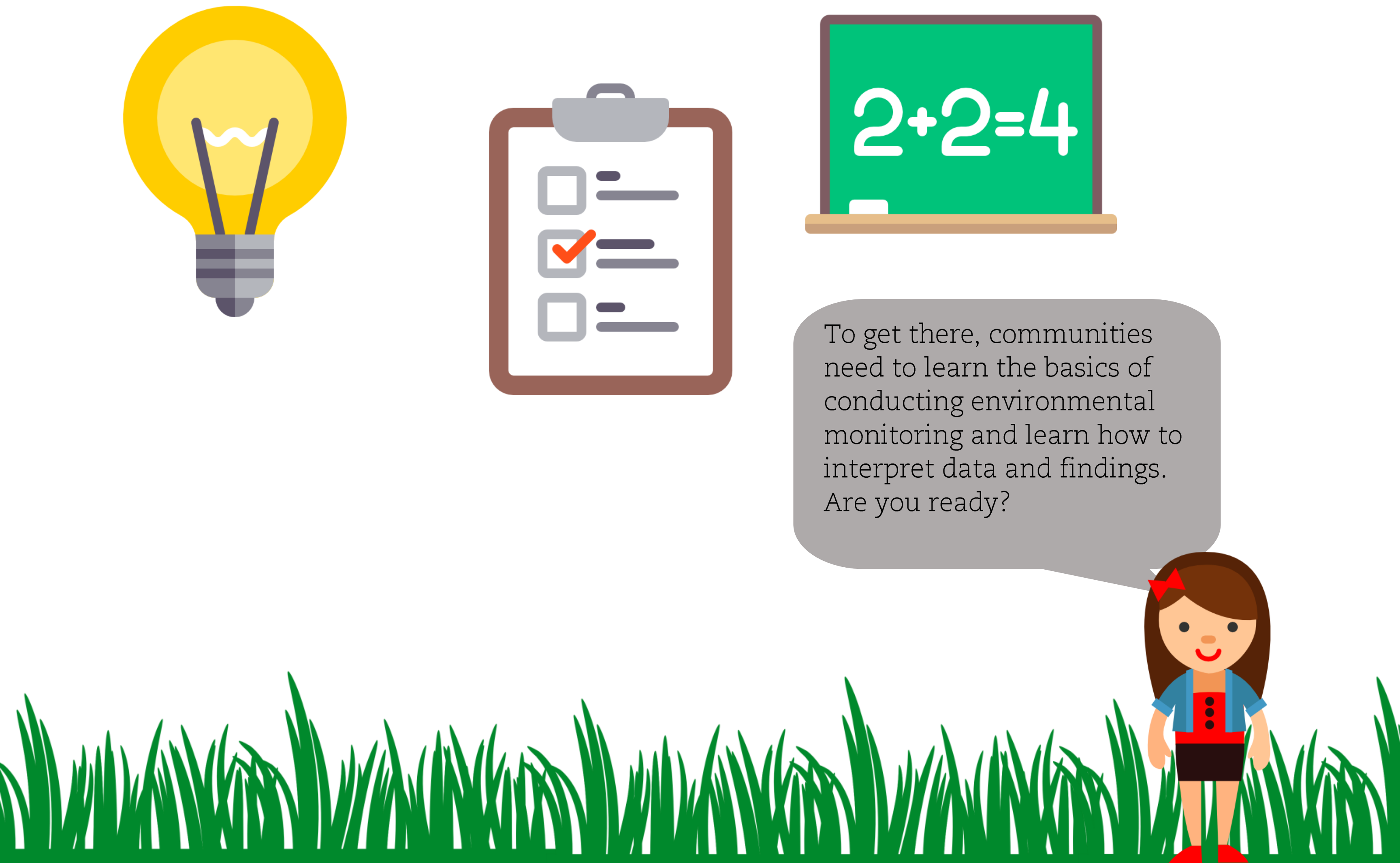

If communities can monitor and interpret the findings themselves, they can better engage with government and mining companies using evidence and data.

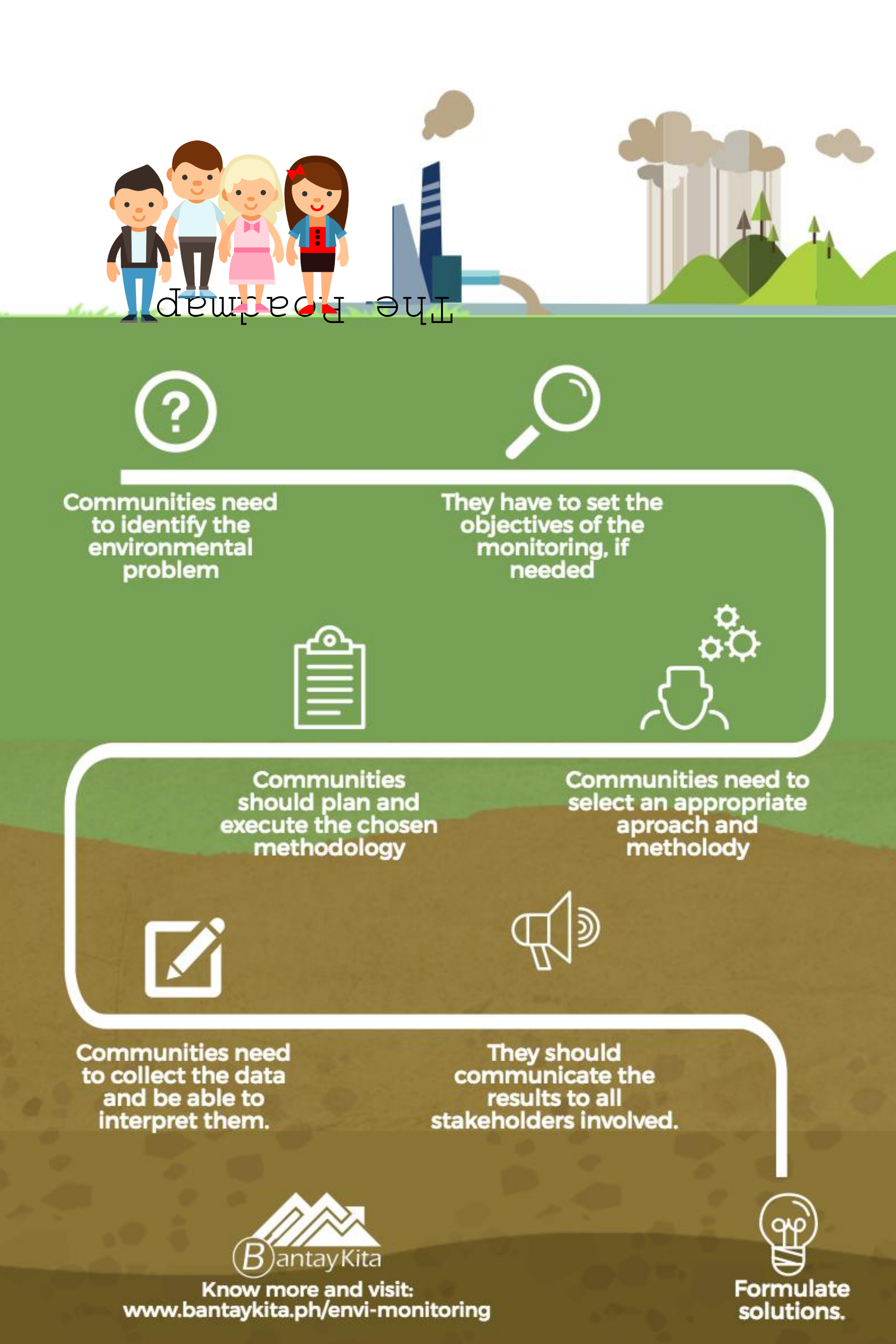

2+2=4
This will take time, effort, and commitment from communities and grassroots organizations. But if we do this right...


We can push for better governance in the mining sector in the Philippines! Are you ready?

# How to use the Environmental Monitoring Tool?


The Environmental Monitoring Tool wants to empower communities to do water and soil quality monitoring to make sure negative environmental impacts of mining are accurately accounted for.


2+2=4
To get there, communities need to learn the basics of conducting environmental monitoring and learn how to interpret data and findings. Are you ready?



The Roadmap
Communities need to identify the environmental problem
They have to set the objectives of the monitoring, if needed
Communities need to select an appropriate aproach and metholody
Communities should plan and execute the chosen methodology
Communities need to collect the data and be able to interpret them.
They should communicate the results to all stakeholders involved.
Formulate solutions.
BantayKita
Know more and visit: www.bantaykita.ph/envi-monitoring


Let's start our Environmental Monitoring!


First step, communities need to identify the problem. Why are we monitoring?

# 1. Identifying the Problem.

a. Hypothesis: What could be the possible pollution-type occurring in the impacted areas? Refer to Annex A for more information.

- ○ Siltation in Streams and Rivers
- ○ Acid Mine Drainage and and Metal Contamination in Streams and Rivers
- ○ Heavy metal contamination and acid contamination present in soil

b. What are the observable changes in the impacted area? Check all that applies.

- ○ Change in color of waters in river system
- ○ People start to get sick after drinking water or consuming aquatic animals

- ○ Animals start disappearing or dying
- ○ Plants started dying or manifesting irregularities in their parts

c. Were the changes already occurring before, or only after mine operations?

- ○ Changes occurred even before mine operations
- ○ Changes only occurred after mine operations started

d. If the changes occurred after mine operations:

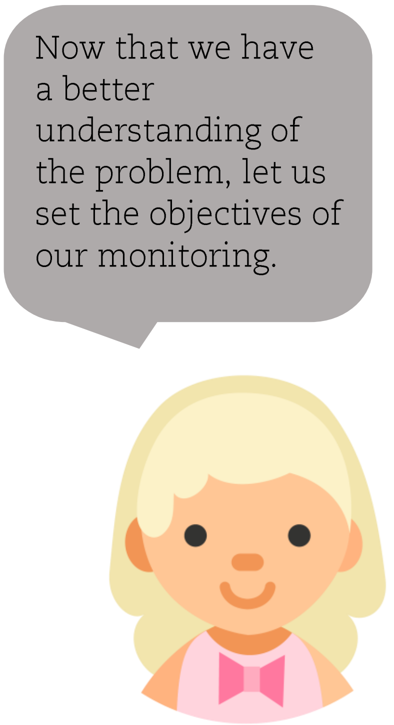
- ○ Who are affected?
    - ○ Children
    - ○ Farmers
    - ○ Women
    - ○ Indigenous Peoples
    - ○ Fisher folks

- ○ Where are the affected areas?
    - ○ ______________________
    - ○ ______________________
    - ○ ______________________
    - ○ ______________________
    - ○ ______________________
    - ○ ______________________
- ○ What does it affect?
    - ○ Health
    - ○ Agriculture
    - ○ Livelihood
    - ○ Culture

e. Other than mine operations, what are other activities in the area?

- ○ Deforestation
- ○ Agriculture
- ○ Subdivisions
- ○ Industrial

f. Can we point out or identify where exactly toxic materials or pollutants, if present, are coming from? Can we track down where toxic materials or pollutants, again if present, go after they are discharged/released? Use a community map in doing this.


Now that we have a better understanding of the problem, let us set the objectives of our monitoring.

## 2. Setting the Objectives. What are we trying to look for? Set the scope and limitations of the monitoring activity – remember, **you can't cover everything all at once. Check one or two.**

- Determine all possible sources of <u>siltation</u>, segregate which are possibly from mine sites, from agricultural and residential areas, and natural sources
- Determine if water quality parameters are still within allowable by the Department of Environment and Natural Resources
- Determine the source of acid mine drainage and heavy metals, which elements and compounds are present and quantify the <u>amount in stream waters</u>
- Determine the source of acid mine drainage and heavy metals, which elements and compounds are present and quantify the <u>amount in the soil</u>


Now that we know the problem and the objectives, we need to do some research and design a monitoring plan. Are there previous similar experiences from other communities?

## 3. Defining our monitoring methodology.

a) Are there similar experiences in other areas?

- ○ No, this is the first time this occurred
- ○ Yes. How did they approach the problem or what was their methodology: ______________________________

b) What is the methodology that we will use? Do not be limited to one methodology – sometimes, a hybrid of different methodologies is necessary to address the problem. Refer to Bantay Kita Environmental Monitoring Handbook for more information on commonly-used monitoring methodologies.

- ○ For soil quality monitoring: Soil Sampling and Laboratory Analyses
- ○ For siltation in streams and rivers: Rainfall monitoring, Water sampling, and laboratory analyses
- ○ For acid mine drainage and heavy metals: Rainfall monitoring, Water sampling, and laboratory analyses


Now let's plan our monitoring before we implement it. Here are some tips and reminders in doing our environmental monitoring.

## 4. Planning and Implementing our Environmental Monitoring.

a. What are areas crucial to the monitoring? Go back to your community map and label points with control site and experimental site.

   - Control Site/s:
   - Experimental Site/s:

b. Which parameters are we going to monitor? Refer to Annex B for parameters for water quality and soil quality.

   - List of parameters to measure: ______________________________
     ______________________________
     ______________________________
     ______________________________

c. What are materials and equipment needed for the monitoring? Refer to Annex C for more information.

- ○ List of equipment needed: ______________________________
  ______________________________
  ______________________________
  ______________________________

d. How long and often should we do the monitoring? Refer to Annex D for more information.

For Soil Quality:

- ○ Annual
- ○ Semi-annual
- ○ Quarterly
- ○ Monthly

For Water Quality

- ○ Dry Season Months: __________
  ______________________________
- ○ Wet Season Months: __________
  ______________________________

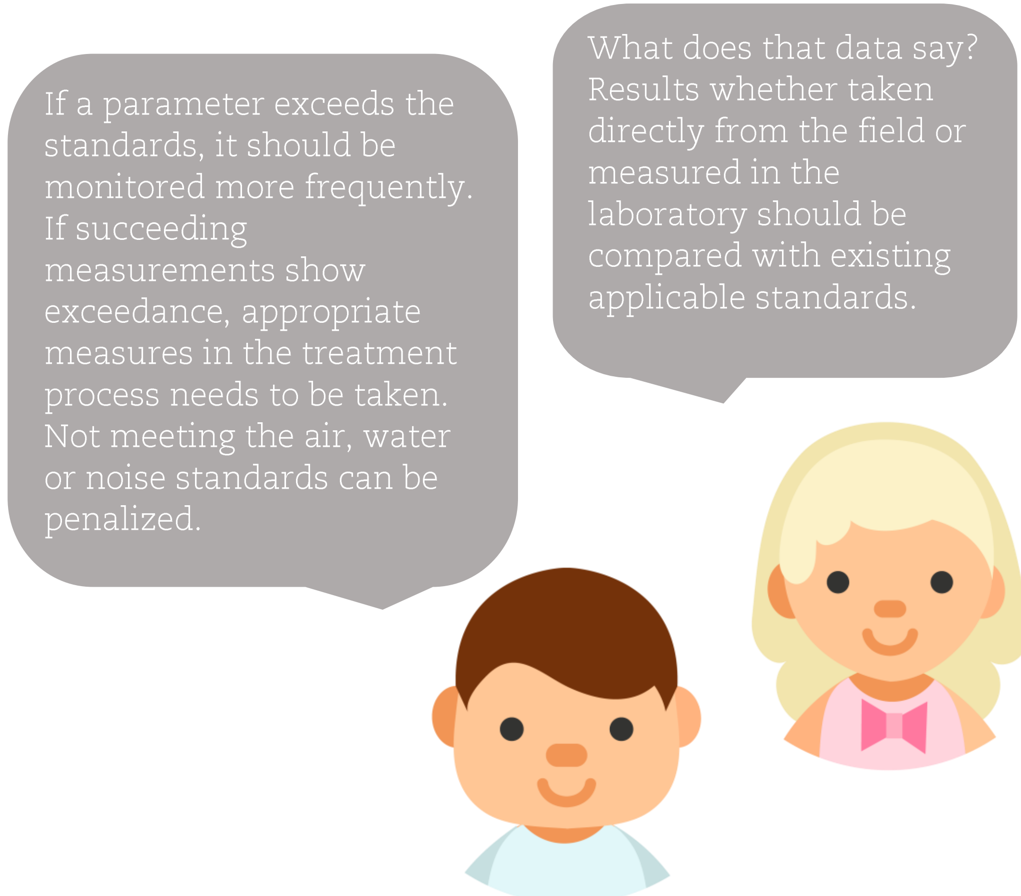

In implementing our plan, we need to record the data then we need to interpret them. Here is how:

## 5. Recording and Interpreting Monitoring Data.

Recording data collected requires careful labeling and inputting of data. Below are some tips on how to keep data from the field organized and reliable.

- Use one notebook to record all data and observations gathered from the field. A sample spreadsheet is provided under Annex E.
- Use oil-based ink, if possible, to protect it from possible erasure by water splashes from the field.
- Erasures are not avoidable and must be corrected by running a single strikethrough, countersigning just above the erroneous data, and writing the new data after the strikethrough.
- The following information must be present alongside the data gathered: date and time of activity, persons involved in the activity, objectives of the activity, observations

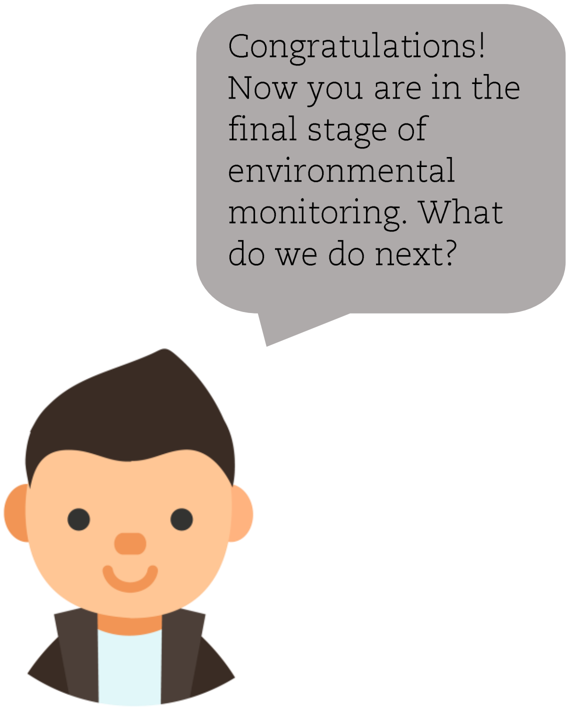
In interpreting the data, Bantay Kita's Environmental Monitoring Handbook has dedicated an entire chapter on classifying bodies of water and identifying allowable standards for air and water based on Philippine policies. This chapter also talks about the implications if a certain level is reached for a particular parameter. The whole chapter is from page 152-170.


If a parameter exceeds the standards, it should be monitored more frequently. If succeeding measurements show exceedance, appropriate measures in the treatment process needs to be taken. Not meeting the air, water or noise standards can be penalized.
What does that data say? Results whether taken directly from the field or measured in the laboratory should be compared with existing applicable standards.

## 6. Communicating our results.

Results of the Environmental Monitoring should be relayed to:

- Impacted Communities
- Mining companies
- Local Government Units
- Department of Environment and Natural Resources
- Mines and Geosciences Bureau


Congratulations! Now you are in the final stage of environmental monitoring. What do we do next?

## 7. After data has been acquired, interpreted and communicated, what's next?

a) Do we proceed to another monitoring phase?

- O Yes, to collect more evidence.
- O No, monitoring results are sufficient.

b) What remediation measures can we do? Refer to Annex F.

- O Short Term:
  1. ______________________________
  2. ______________________________
  3. ______________________________
- O Long Term
  1. ______________________________
  2. ______________________________
  3. ______________________________

# Annex A. Common Types of Pollution in Mining-Impacted Areas.

a. Siltation in rivers and streams. In nickel mining areas, the predominant

problem that may arise is siltation. Siltation is caused by the increase of concentration of particulate matter, most of which are in the size range of silt or clay (0.002 mm). The increase in turbidity will affect the physical characteristics of the water body such as color, temperature and pH. It will also affect the dissolved oxygen in the water which will affect the living organism living in the body of water. Other pollutants which can affect the water quality are heavy metal content and oil and grease from machineries.

b. Acid mine drainage and heavy metal contamination in rivers and streams. Acid mine drainage happens when the sulfides in rocks are exposed in air. This exposure in air causes the sulfides to oxidize. Dissolution of this sulfides in water produces the sulfuric acid which will then be carried by rainwater to surrounding water bodies thus degrading the water quality. Heavy metal contamination, on the other hand, happens when ores containing arsenic, cobalt, cadmium, copper, lead, silver, and zinc are exposed to water. These metals will be dissolved in the water causing pollution. Pollution due to processing chemicals are the most common in mines which does not conform to the water quality management. Leakage of chemicals used in the metal extraction can reach the bodies of water. Erosion and sedimentation is the disturbance of the soil and rock in the course of the mining process. When substantial amount of soil and rock particles being eroded settle in nearby water bodies, the sediments can clog rivers, destroy watershed vegetation and aquatic habitats.

b. Heavy metal and acid contamination present in soil. Mining is a very dynamic factor that affects soil quality. Soil contamination due to mining related activities can either result from windblown dust or chemical spill or residue. Soil pH, salinity and metal content that are necessary in allowing vegetation may not be attained. Common indicators of soil quality include: aggregate stability, available water capacity, bulk density, infiltration, slaking, soil crack, and soil structure.

   For example, in river systems, pollutants coming from a mine can potentially seep into soil that is found downstream and render it contaminated. Even worse is if the river serves as a source of irrigation for agricultural lands, soil pollution can render the local farms barren, or render their produce unsafe to consume.

# Annex B. Water Quality Parameters to Measure.

- pH refers to the acidity of the water, or its capacity to donate a proton (H+) ion. In copper/gold mines, the pH of water is usually low (acidic) due to the presence of sulfide minerals that react with surface and groundwater, hence leading in the formation of sulfuric acid.

- Temperature is the measure of amount of increase or decrease of heat in the water. It is measured in Degrees Centigrade (°C)

- Total Dissolved Solids and Total Suspended Solids refer to the amount of solid-phase materials/elements present in the water. The word “dissolved” refers to small amounts of salts and organic matter present in solution with the water, while “suspended” refers to solids that can be filtered using a 0.45mm filtration system. Often, TSS is correlated to the amount of siltation in water systems. The sum of TSS and TDS is called Total Solids (TS)

- Turbidity refers to the amount of light that can pass through the water. It is measured in nephelometric turbidity unit (ntu), which is a qualitative measure of how much light can penetrate in the water. Generally, waters that have high TSS and TDS also have high Turbidity readings; however, turbidity may vary across waters with different colors.

- Salinity refers to the amount of total dissolved salt compounds in water, specifically metal-chloride compounds as $MgCl_2$, NaCl, $CaCl_2$, KCl etc.

- Conductivity is the measure of a material's capacity to allow current flow. It is directly proportional to the water's salinity and amount of total dissolved solids. Highly conductive waters usually imply presence either of dissolved salts or dissolved metals.

- Dissolved Oxygen refers to the amount of oxygen gas ($O_2$) present in the water, and usually indicative of a water's taste and amount of bacterial activity. Stream waters typically have higher DO content than groundwater and other forms of stagnant waters. DO in mine-impacted streams are comparably lower than those unaffected by any activities.

- Oxidation-Reduction Potential (ORP) is the capability of water to either release or accept electrons during a reaction. A solution with a high positive ORP means it has a greater ability to oxidize a solution than a negative ORP. Usually, a negative ORP indicates a reductive solution, one with higher amount of metals or sulfides.

- Metals and Heavy Metals are elements characterized by their lustrous appearance, ductility and malleability, positive ionic charge, and ability to conduct electricity. The terms “metals” and “heavy metals” are used based on the crustal abundance (abundance on the Earth’s surface) and density of these elements. Both of these are important resources that are explored and exploited; however, high concentrations of these materials in soil and water pose adverse effects both in human health and the environment.

  Metals are more abundant on the Earth’s surface and are characteristically less dense than heavy metals. These include Iron (Fe), Nickel (Ni), Magnesium (Mg), Calcium (Ca), Sodium (Na), Potassium (K), Aluminum (Al).

  Heavy metals on the other hand, are lesser common and usually occur as traces on the Earth’s surface. They are characteristically denser, and small increases in the amount of heavy metals usually cause toxicity for living organisms. Heavy metals include Mercury (Hg), Cadmium (Cd), Arsenic (As), Chromium (Cr), Lead (Pb), Thallium (Tl), Platinum (Pt), Palladium (Pd), Zinc (Zn) and Copper (Cu)

- Anions are negatively-charged particles or compounds and are non-metallic. In mine-impacted areas, the most common anions analyzed in the laboratory are Sulfates, Nitrates, Phosphates, and Cyanides.

- Sulfates are compounds consisting of the elements Sulfur and Oxygen, and are naturally-occurring in rocks and sulfide minerals. Reaction of sulfate with water yields Sulfuric acid, a common pollutant in stream waters.

- Nitrates are compounds that consist of the elements Nitrogen and Oxygen. They are commonly a by-product of biological decomposition and indicative of high amounts of organic waste in water. Although often chemically unreactive, they are usually associated with bacterial activity in water, which converts nitrates into ammonia.

- Phosphates are compounds made up of phosphorus and oxygen, which, like nitrates, are common by-product of biological decomposition and soil degradation. Increased amounts of phosphates and nitrates in water promote bacterial activity, and causes deoxygenation.

- Cyanides are a group of compounds primarily composed of Carbon and Nitrogen +/- Sodium, Sulfur that are used mainly for extracting gold. Cyanide poisoning has been linked to cardiac and neural disorders, if not sudden casualty.

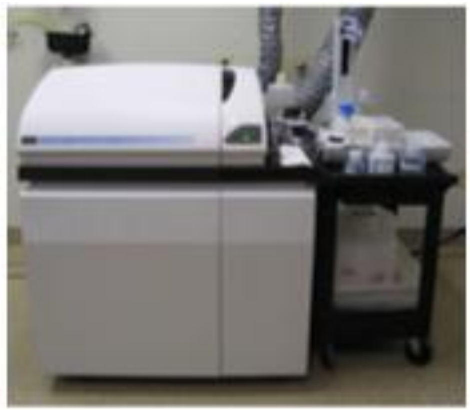
# Annex C. Commonly-Used Materials and Equipment in Environmental Monitoring.

500-ml Polyethylene (PET) bottle

500-ml Polytetrafluoroethylene (PTFE) bottle

In-situ Portable meter

Mass Spectrometer



# Annex D. Frequency of Monitoring

- For Soil Quality, monitoring may be monthly, quarterly, semi-annual, or annual depending on the rates of contamination while taking into consideration meteorologic factors such as weather, climate, and rainfall in an area; and
- For Water Quality, monitoring should be divided into two phases: the first conducted during the dry season (ideally March – May) and the second during the rainy season (June – November).

# Annex E. Sample Template Data Recording Sheet.

| Parameter | Label | Date Collected | Longitude | Latitude | Results | Remarks |
|---|---|---|---|---|---|---|
| | | | | | | |
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# Annex F. Remediation Measures

a. For siltation. Desilting of streams through:

- Installation of sediment-impounding facilities such as additional dams and use of geotextiles
- Slope stabilization to reduce scouring of rocks and soils that further contribute to siltation
- Reintroduction of vegetation to support the slopes

b. For acid mine drainage and metal contamination. Acid neutralization by introducing substances such as:

- Lime (which can be obtained from limestones or bivalve shells)
- Antacids (magnesium, sodium, or aluminum-based antacids)
- Use of coagulants to bind and precipitate metals
- Introduction of algae

c. For heavy metal and acid contamination present in soil. Remediation measures include:

- Introduction of metal-degrading plants and bacteria
- Addition of fertilizers to boost plant growth
- Metal immobilization and leaching