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What is a green mining concept and how can it be implemented or further implemented in Guyana?

Mining is the extraction of valuable minerals, metals or other geological materials from the Earth. Green mining is defined as practices, mine processes and technologies that are implemented as a means to reduce the environmental impacts associated with the extraction and processing of metals and minerals. The green mining concept is a notion that promotes energy, resource and mineral efficiency of mining operations; so as to reduce the environmental footprint of mining. Green mining aims to ensure the availability of mineral resources for future generations, allows the recovery of all useful minerals while minimising mining waste and most importantly minimising adverse environmental and social impacts in all stages of the operations. It also aims to operate in a way that is safe and meaningful to employees, and harmless to local residents and the environment. This strategy also takes into consideration previous areas that were recklessly mined; by enacting the "after mine closure" plan which helps to restore the mining areas to make them safe, promote reforestation and to allow other types of land use. This strategy plays major role in the sustainable development of developing countries. Green mining requires long-term investment into exploration supported by geoscientific mapping, mineral systems research, environmental protection strategies and the development of safer and more efficient exploration techniques. Green technologies are especially needed to address the tremendous amount of energy and water used by traditional mining methods.

The Ministry of Natural Resources, Guyana Geology and Mines Commission (GGMC), Conservation International Guyana, the World Wildlife Fund (WWF) and the Guyana Gold and Diamond Miners Association (GGDMA) are the major organisations responsible for regulating mining in Guyana. Mining in Guyana is mainly managed by the Guyana Geology and Mines Commission (GGMC) under the mining act of 1989. The Mining Act is the main legislative instrument for managing mining in Guyana including its occupational health and safety and environmental impacts. The Act establishes the right of the State to minerals and outlines the provisions for licensing or permitting the right to mine on private, state and government lands.

Guyana is a mineral rich country that permits numerous mining sectors to flourish; these include gold, bauxite, semi-precious stones, precious stones, radioactive minerals, and other minor industries. Mining opportunities are available for artisanal, small, medium and large scale miners. Large scale mining is usually undertaken by big companies using many employees and a huge labour force. These companies mine at large sites and continues the operations until the mineral or metal is completely excavated. Large scale mining should be encouraged more in the mining industry, due to the ability to regulate a few large companies than compared to numerous small scale miners. Additionally, in order for medium and large scale miners to apply for a mining licence they will have to submit a technical and economic feasibility study, a mine plan and an environmental plan. Large scale mining is efficient, in that they are able to extract large quantities of minerals in short periods of time but their ability to completely excavate is also a major environmental problem. Large scale mining requires major land rehabilitation while small scale mining requires more monitoring to ensure no harmful or illegal extraction methods are utilised. Brownfield exploration should be encouraged among small scale miners. While large scale mining companies are more likely to operate a greenfield exploration of one mineral, onsite exploration to find additional resources in an already developed mine should be made compulsory. With one company extracting more than one minerals or metals it saves energy from having to re-excavate an already mined area to look for a different mineral; therefore onsite exploration is energy efficient. Some onsite minerals are copper, molybdenum, tungsten, iron and nickel.

According to the Guyana Bureau of Statistics 2012, the gold and bauxite mining industries made up over 60% of all exports. These mining activities are a crucial part of Guyana's economy, representing 21% of GDP in 2012 (Guyana Bureau of Statistics 2012) but studies conducted showed that increased mining activity accounted for majority of deforestation, more specifically 93% of deforestation between 2009 and 2011. In Guyana, the largest and most profitable mining industry is the gold sector with currently two major mines in development: Aurora Gold Mine under the Guyana Goldfields and the Karouni Gold Mine under Troy Resources. These companies were allocated mineral rich plots of land, under the conditions that they abide by the 1989 Mining Act and the more modern green mining strategy. Although the Environmental Protection Agency of Canada in 1999 stated that extracting gold from the Earth inevitably means destroying the natural environment in some way. Since 2013, Guyana has been taking steps towards the green mining strategy by regulating and limiting the use of mercury in gold mining. In 2017, President David Granger stated that the Government intends to not just reduce, but to eliminate the use of mercury in the mining industry. In 2018 during Guyana Mining week the Conservation International and WWF shared their upcoming project, this Eldorado Gold Project will work with artisanal and small-scale miners in Regions Eight and Nine to explore mercury-free mining by 2025. With the impending ban on the use of mercury, it is imperative that mercury-free technology be promoted. Studies conducted by staff of

the GGMC revealed that mercury-free technologies, such as the Knelson Concentrator are financially feasible and environmentally friendly.

After gold the next largest and profitable mining sector is the bauxite industry. Sadly, the environmental effects of bauxite mining are vast; including land degradation, air pollution due to bauxite dust, contamination of drinking water and the leaching of bauxite into water sources thus affecting agricultural food products and aquatic life. Bauxite occupational exposure affects the health of miners, and has negative consequences on the health of surrounding communities, such as increased respiratory symptoms like asthma and potential health risks from ingestion of bauxite and heavy metals and, including noise-induced hearing loss and mental stress. Two currently operational major bauxite mines in Guyana are Rusal and Bosai. These two large scale companies should cooperate with the World Wildlife Fund and the Ministry of Health to perform yearly inspections of the mining environment and nearby communities to ensure that a certain health standard is maintained of both the water and air. Measures should also be put in place to reduce the amount of sound produced during processing and to contain the expulsion of dust particles.

Most mining industries are faced with the same problem which is the rehabilitation of the land after complete excavation. In Canada the Mining Regulations of 2005 require the submission of a Mine Reclamation Plan and Closure Plan. Similarly, in Guyana Progressive reclamation and re-vegetation should be promoted and made mandatory by law. One loop hole in Canada's regulation is that it is not compulsory for small-scale miners to reclaim or re-vegetate the mine site after ceasing operations but this is where educating the small scale miners on the importance of environmental protection and training them in environmentally friendly practices comes to play. In order to make major strides towards green mining we first need to educate both officials and miners in the Research and Development of Green Mining Technology. This can be done by hosting a one week seminar in which a trained individual in this field explains safe and modern techniques and technologies in mining. The Research and Development of Green Mining Technology should also be a course offered at the Guyana Mining School. Implementing recently discovered green mining technologies are to be made compulsory for all miners, giving them a one year period to update all equipment and techniques. Since the destruction (flooding and erosion) of the small mining community of Coomackaas in Region 10 Guyana as an accumulated result of decades of unregulated bauxite-mining there, authorities have intervened and shut down many illegal and unregulated mines throughout Guyana. Monitoring techniques such as Geographic information systems (GIS) should be implemented to regulate and monitor the land usage and conditions during and after mining. Repercussions such as fines and suspended mining licenses should be implemented once these regulations are broken and the health and safety of the environment is jeopardized.

The measures stated above will ensure that Guyana adapts to and implements the Green Mining concept, thus moving towards sustainable mining development and fulfilling the green agenda.