Types of Disposal

A number of mining waste disposal methods are used worldwide. The commonly used ones are Tailings dam (Figure 6), Landfill, Backfill, Riverine, Submarine Tailings Disposal (STD)/ Deep Sea Tailings Placement (DSTP), and Thickened Tailings.

Onland Waste Disposal

Generally, the type of waste management that ought to be used for a mining operation is specifically designed to suite that particular site (site-specific). This is mainly due to natural events and conditions, of which tectonic activities (e.g. earthquakes and landslides), high rainfall, rugged topography, and rock type competency problems are the notable ones in the Pacific that usually affect efforts to construct proper waste storage facility. In addition, social issues such as community re-location, contamination of water sources, land ownership and access problems may also impact on the choice of waste disposal option.

Figure 6. Google Earth satellite image (May 2004) of onland tailings storage facility at the Vatukoula Gold Mine in Fiji.

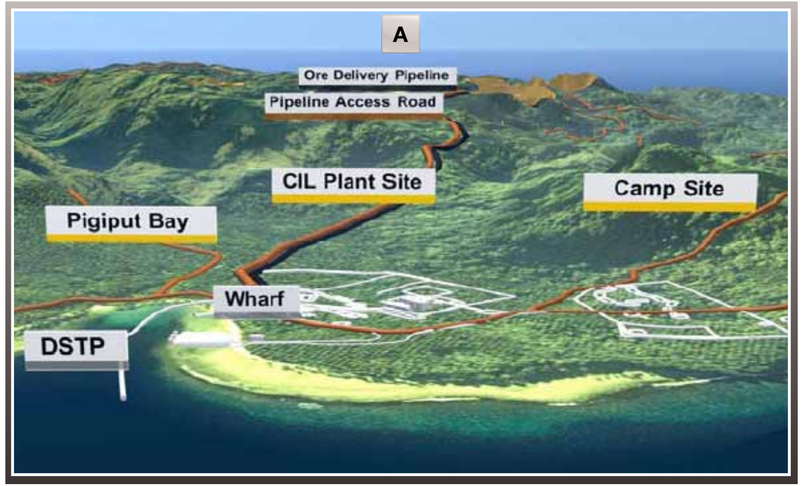
In some instances, mine wastes are disposed in rivers and streams, coastal zones and the deeper part of the near-shore environment. Significant environmental damages have been reported to be associated with improper dumping of mining waste.

Submarine Waste Disposal

The mining industry has a long history of dumping waste into the sea. Submarine waste disposal encompass both the direct dumping of waste rock and the discharge of tailings via pipelines into the sea. The dumping of mining waste in the marine environment may only be considered and used where on-land disposal options are problematic due to the factor(s) highlighted above.

Submarine Tailings Disposal (STD) is simply the dumping of tailings into the marine environment. With new technological innovation and increasing concerns of environment impacts, the use of a disposal system known as Deep Sea Tailings Placement (DSTP) is reported to have been used in various regions including the Pacific (Figure 7a). This method of waste disposal, where tailings are discharged through a submerged pipe into the marine environment below the primary productivity zone (euphotic zone) of the surface water (Figure 7b), is generally considered to be environmentally safe. These discharged tailings are expected to be permanently deposited in a deep-water environment. Hundreds of million tonnes of tailings are discharged into the marine environment annually from any mine operation that uses the DSTP system.

However, the impacts of this "out-of-site" waste disposal system are arguably not fully understood due to limited scientific knowledge and data. This method may have serious long term environmental ramifications hence environment conservation groups have called for independent reviews of studies conducted by consultants that were contracted by mining companies.



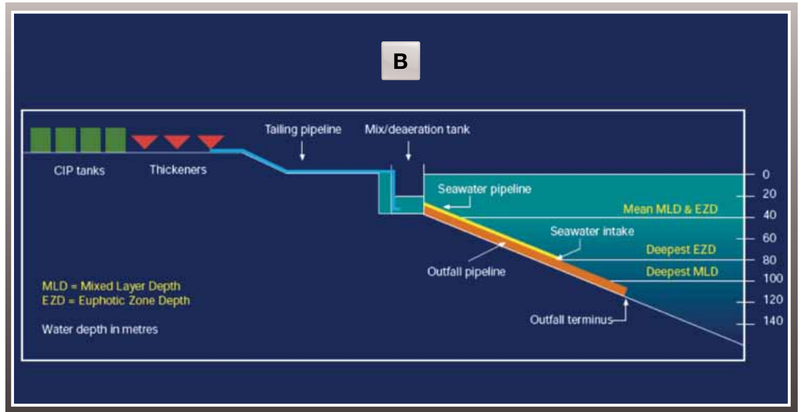


Figure 7. Submarine tailings disposal: (A) Simberi Gold Mine layout in PNG that includes the use of a DSTP system[3]; (B) a schematic cross section of the DSTP system[4].

[3] Jan Hope & Partners. 2005. Press Release on Optimised Feasibility Study completed for Simberi Oxide Gold Project.

[4] Mining, Minerals and Sustainable Development. 2002. Large Volume Waste Working Paper. Report No. 31.

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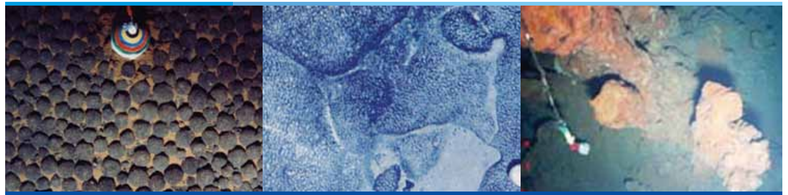

Information Brochure 5
Mining Waste and Disposal

Mining produces significant volume of waste materials that need to be moved and managed. Safe disposal of mining waste is generally recognized as the single largest environmental challenge facing the mining industry worldwide and a major expense for mining companies. Similarly if deep seabed mining commences within the Pacific Islands region, the management of mining waste will pose the greatest challenge for any environmental protection initiatives.

Historically, environmental impacts emanating from onland mining waste can be widespread and may continue to affect livelihoods, health and the environment long after the mining has ceased. Some common impacts are forest clearance, land disturbance and removal, change of landscape due to excavation (Figure 1), disposal of significant amount of waste material, and pollution of watershed and nearby areas.

Mining waste poses an environmental threat not only through its volume but also because of its toxicity. It is the major product of any mining operations for metallic minerals representing around ninety nine percent (99%) or more of the total materials produced in the form of waste rock and tailings (Figure 2). Adverse impacts emanating from the disposal of this waste are often externalized, that is, they are passed from the operators to other parties or the public.

If not properly managed mining waste, can result in short and long-term impacts such as the smothering of surface waters and/ or the release of hazardous substances (i.e. heavy metals and sulphide minerals from which sulphuric acid can be formed) that can cause significant environmental damage with potential adverse consequences on livestock and human health.

Figure 1. Google Earth satellite image (June 2006) of the Lihir open pit Gold Mine in PNG that demonstrates significant onland footprint.

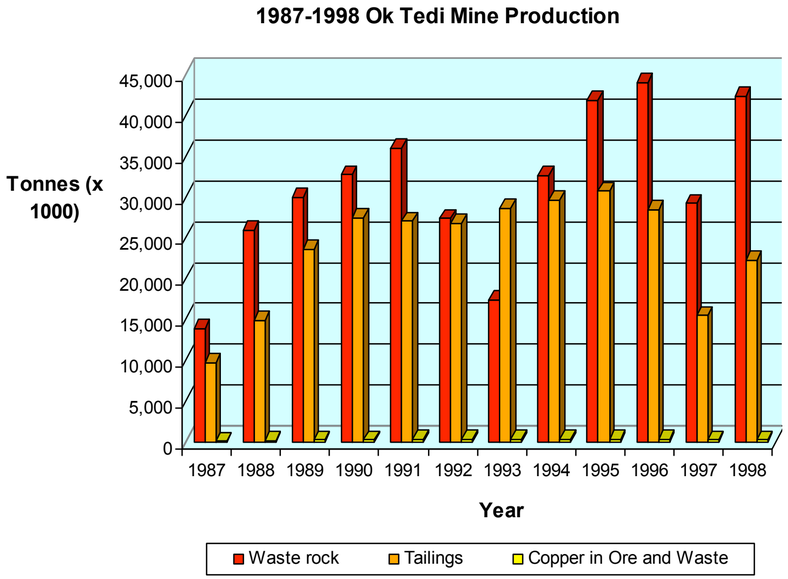

Figure 2. 1987-1998 Ok Tedi Mine waste production compared to copper estimates[1].

A concerted effort by key stakeholders of the industry is needed to better manage mining waste in order to avoid or minimise environmental impacts. Environmental regulations are being modernised, placing more stringent requirements on the mining industry, particularly with regard to waste disposal practices. This ultimately places added pressure on the operators to ensure proper methods of waste disposal and waste water management are implemented and monitored regularly.

Mining Waste Disposal

Mining waste can be defined as waste materials that result from the exploration, mining and ore processing. It may consist of natural material without any modification other than crushing or of natural material processed to varying degrees during the ore processing phase, and possibly containing chemical, inorganic and organic components. Overburden and waste rock are largely produced during the mining phase whereas tailings and processing waste are generated during the ore processing stage (Figure 3). There are other waste categories that are associated with mining such as sulphur and gases produced during ore processing, waste water, mechanical waste (fuel / oil / grease), and sewage.

The amount and behaviour of waste rock products that are generated during any mining operation depend largely on the geological characteristics of the orebody and host rock, type of mining used (i.e. underground, open pit or shallow water), and the scale of production.

[1] Mining, Minerals and Sustainable Development. 2002. Ok Tedi Reverine Disposal Case Study. Report No. 68a.

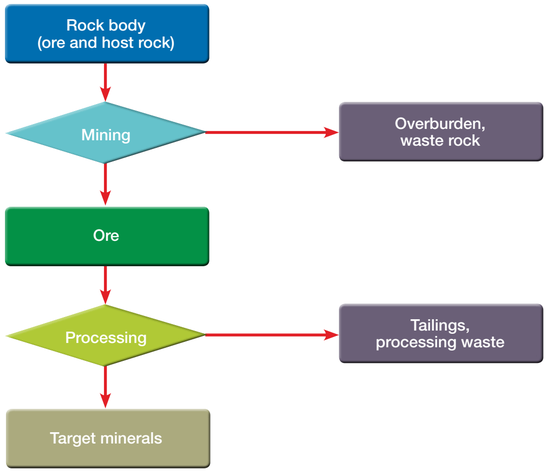

Figure 3. A flow chart that demonstrates where mining wastes are produced during any mining process.

Overburden and Waste Rock

Mine overburden is the top soil and/or rock that overlie an orebody. Waste rock is any rock material produced during a mining operation that contains minerals of no economic value. Generally, mine overburden and waste rock are removed to allow access to the orebody.

Intact rocks are broken into smaller pieces in mines (underground and open pit) by blasting using explosives. Broken rocks are removed from the mining area using loaders and trucks (Figure 4A). Ore materials are taken to the processing plant while waste rocks are transported and disposed at an identified storage facility (Figure 4B). Mine overburden and waste rocks are used, to construct waste disposal facilities and as aggregates (i.e. crushed sand and gravel) for construction purposes.

Figure 4. Waste management at Sinivit Gold Mine, East New Britain, PNG[2]: (A) loading of waste, (B) waste dumping.

[2] New Guinea Gold Corporation. 2009. Presentation to Shareholders.

Waste rocks contain hard and soft rock materials including low concentrations of targeted minerals (e.g. gold, copper and silver) that are uneconomic to process, and measureable concentrations of other metals such as arsenic, cobalt, nickel, mercury, lead, zinc, and other minerals. Waste rock may incorporate other waste materials such as soil, water, fuel, oil and remnants of used explosives.

Mine Tailings

Tailings can simply be defined as the mine waste, predominantly crushed rock materials, produced after the extraction of wanted minerals during ore processing. They are usually transported from the processing plant via pipeline to a final storage area commonly known as a Tailings Storage Facility (TSF) or Tailings Dam (Figure 5A).

Figure 5. Mine tailings storage: (A) Gold Ridge Mine tailings dam in the Solomon Islands; (B) discharge of tailings as slurry into the tailings dam.

Tailings contain crushed rocks (mainly mud, silt and sand), water, low concentrations of targeted minerals (e.g. gold, copper and silver) that are uneconomic to process, and measureable concentrations of other metals such as arsenic, cobalt, nickel, mercury, lead, zinc, and other minerals. Processing wastes such as sodium cyanide (used for gold and silver ore processing), lime, acids, and water are discharged as part of the tailings, normally as slurry into the Tailing Dam (Figure 5B).

Tailings are generally stored on the surface in retaining structures but can also be used as backfill materials in mined out areas underground. Backfilling can provide ground and wall support in any underground operation and also provide an alternative to surface tailings storage.