Nkamouna Project
Environmental and Social Assessment
Waste Management Plan

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List of Abbreviations and Acronyms

CCD	counter current decant
ESAP	Environmental and Social Action Plan
ESIA	Environmental and Social Impact Assessment
GeoCam	Geovic Cameroon PLC
IFC	International Finance Corporation
MSDS	Material Safety Data Sheet
mtpd	metric tonnes per day
NCTSF	Napene Creek Tailing Storage Facility
PUG	Physical Upgrade Plant

Nkamouna Project
Environmental and Social Assessment
Waste Management Plan

1.0 Introduction

This Waste Management Plan was prepared for the Nkamouna mine site and describes the procedures, systems, equipment, and structures specific to waste management and disposal. Waste generation should be limited at all levels of the operation in order to decrease the produced volumes and make waste disposal more manageable. The plan also defines responsibility for developing and implementing the plan and reporting requirements. Adjustments will need to be made to this plan as changes occur during mining operations. (Geovic Cameroon PLC (GeoCam), as the owner/operator of the project will consider national and international laws, regulations, and best practice in the design and management of waste containment facilities.

1.1 Legislation

This Waste Management Plan has been developed in accordance with national and international regulations and guidelines as discussed in the following sections.

1.1.1 Law N^{o} 96/12 Environmental Management Law

The Environmental Management Law states that any person producing waste shall eliminate or recycle it and is required to inform the public of the effects of waste production, elimination, or recycling on the environment and public health.

1.1.2 The Mining Code of April 16, 2001

The Mining Code of April 16, 2001 for Cameroon establishes general guidelines for protection of the environment. These guidelines state that holders of mining titles are responsible for:

- Preventing or minimizing the discharge of waste into the environment.
- Promoting or maintaining the general health of the population.
- Reducing waste as much as possible.
- Disposing of non-recycled waste in such a manner as to ensure the safety of the environment.

1.1.3 Law 89/027

Law 89/027 forbids the introduction, production, storage, transportation and disposal of hazardous waste in Cameroon. However, it makes provision for projects that generate such waste. The project owner is required to declare the volume and nature of waste production and to ensure its elimination without danger to man and his environment. The maximum penalty in case of infraction is the death penalty.

1.1.4 International Finance Corporation Guidelines for Waste Facilities

In addition to the Environment Protection Act, the Nkamouna Project will follow the International Finance Corporation (IFC) 1998 Environmental, Health and Safety guidelines for waste management facilities (Appendix A) as stated in Article 23 of the Mining Convention between the Republic of Cameroon and GeoCam. Waste management facility guidelines include the following:

- Surface and subsurface investigations of geology, soils, groundwater, and surface water resources will be conducted to determine leachate migration potential and the need for additional design requirements.
- Waste management facilities and access routes will be designed to minimize impacts to air, surface water, groundwater, sensitive ecosystems, natural resources, cultural resources, and land-use patterns.
- Waste management facilities will include gas control systems when required to minimize the potential for explosions or toxic conditions from the accumulation of waste disposal gas and protect soil-stabilizing vegetation (that is, revegetated areas along the facilities).
- Containment cells will be covered with soil or other suitable material at the end of each working day to minimize odors and prevent scavenging by animals.

GeoCam will implement these guidelines during the construction and management of the waste facilities at the Nkamouna Project.

1.2 Identification of Waste Streams

Waste streams likely to be generated during the operational phase of the mining operations include the following:

- Mining/Processing wastes (overburden and process tailing).
- Hazardous wastes (waste oils, solvents, laboratory wastes, and medical wastes).

- Domestic wastes (inert wastes such as plastic, glass, and construction materials).
- Organic wastes (food and plant material).

Management of each waste stream is discussed in subsequent sections of this plan.

1.3 On-Site Disposal Facilities

Waste disposal facilities at the Nkamouna Project will include the following:

- Backfilled mined panels and the Napene Creek Tailing Storage Facility (NCTSF).
- Hazardous Waste Facility.
- Domestic Waste Facility.
- Bioremediation Facility.
- Composting Facility.

Composting, recycling and the reuse of materials will be carried out so as to minimize refuse volumes to be disposed of in waste facilities.

1.4 Reuse, Recycling and Minimization of Waste Generation

GeoCam will establish programs for material recycling and reuse to reduce the volume of materials deposited in the waste facilities. Local communities may be interested in reusing building debris, scrap materials from the processing plant, wood and steel, used tires, used vehicle parts, and other materials. These materials can be offered to local communities for reuse through public consultation meetings and interviews to identify which materials can and cannot be beneficially used by the communities.

Making waste materials available to local communities is preferred over disposal if such availability does not cause conflict. When materials are determined to be suitable for reuse or salvage, a recycling program will be established to include the following:

- Identification of wastes to be recycled.
- Provision of cleaning and treatment as needed to make wastes suitable for recycling.
- Designation of a storage area for recyclable materials, segregated from other waste materials, and located for easy access.

- Identification of local residents who have been authorized to collect, recycle, and salvage materials.

Recycling programs will not be run for profit. Local residents who have been authorized to collect materials from the site will be identified and their roles in the recycling program coordinated through the Community Development Program.

1.5 Organizational Responsibilities

Key GeoCam managers will have specific duties associated with waste management. As shown in Table 1, managers who will play a strategic role in the implementation of the Waste Management Plan include the Environmental, Health and Safety Manager; the Technical Services Manager; and the Engineering Manager. Key responsibilities for these managers are summarized in Table 1. The table is provided as an overview of key responsibilities and is not a complete list of responsibilities for each position. When construction and mining operations start, responsibilities may be altered to better accommodate the manager or facilitate a duty process.

2.0 Mining/Processing Wastes

2.1 Background

The Nkamouna Project will use conventional surface-mining techniques to mine high-grade cobalt and nickel deposits. The current plan of operations envisions mining 7,000 dry metric tonnes per day (mtpd) ore and 11,000 dry mtpd of waste for the first two years of production. The mining rate will double in the third year of operations should there be sufficient demand for cobalt.

2.2 Mining and Processing Wastes

2.2.1 Mining Waste Overburden and Intraburden

Mining wastes that will be generated include approximately 11,000 mtpd of overburden with minor intraburden (non-economic laterite). Materials testing of these wastes indicate that they have little or no potential to leach metals or to generate acid (ESIA – Volume 1). The overburden and intraburden will be used as backfill in mined panels and as construction materials to build embankments for the NCTSF and within a certain number of mined panels for the containment of middlings and manganese precipitate as described in the ESIA (Volume 1). Coarse breccia waste and granular overburden laterite will be used for surfacing project roads.

2.2.2 Processing Wastes

The mined material will be trucked to a physical upgrade plant (PUG) where the ore will be crushed, scrubbed, and sized to separate the +48 mesh fraction from rejected -48 mesh materials. The -48 mesh rejected material will be further sized into middlings (-48 mesh to +200 mesh), which may average 0.3 percent cobalt and fines tailing (-200 mesh fine rejects).

The +48 mesh product from the PUG Plant will be conveyed and fed to a grinding mill, leached in agitated tanks and washed and thickened in a counter-current decantation circuit to separate solution that contains all recoverable metal values and solid waste tailings slurry that will then contain barren solution. The acidic barren solution and waste solid in the CCD underflow will be neutralized and disposed with PUG fine rejects in the NCTSF.

The waste streams from the PUG plant include:

- -48 to + 200 mesh middlings tailing containing up to 0.3 percent cobalt.
- -200 mesh fine waste tailing.

The waste streams produced from the Leach Plant include:

- Neutralized leach tailing (material sized at 80% < 100 mesh).
- Neutralized Mn precipitate contained in raffinate from the stage I solvent extraction circuit.

A number of chemical reagents, including sulfuric acid, hydrochloric acid, and solvent extractant, will be used for mineral processing as shown in Table 2, which includes recommended disposal methods for each chemical. The chemicals will be kept in dedicated storage sites, which will be clearly signposted. The Emergency Response and Contingency Plan includes copies of the Material Safety Data Sheets (MSDS) for the chemicals, which will be used at the Nkamouna Project.

The fines tailing and leach tailing will be mixed and piped for storage in the NCTSF. The middlings tailing will be piped and stored in separate compartments within several of the mined panels for possible future retrieval and processing. Separate lined repositories will be built in mined out panels adjacent to the process facilities to store the manganese precipitate from the raffinate solution.

GeoCam will limit unauthorized access to the tailing repositories to the extent possible. Potential seepage from the repositories will be monitored for contaminants in surrounding surface water and groundwater under the supervision of the Environmental, Health and Safety Manager. Water monitoring is addressed in the Environmental and Social Action Plan (ESAP).

As mine panels are filled, they will be revegetated to prevent erosion and the land will be returned to forest/wildlife habitat. The NCTSF will be reclaimed at the end of operations at Nkamouna. The Environmental, Health and Safety Manager will be responsible for reclamation efforts, which are addressed further in the Mine Reclamation and Closure Plan (MRCP). The Processing Manager is responsible for processing plant operations and disposal of the tailing produced by the plant.

2.3 Tailing Management

The Processing Manager is responsible for the tailing disposal and will ensure wastes generated from the PUG and Leach Plants are disposed of in the proper manner and location. At a minimum, the duties of the Processing Manager will include the following:

- Provide the manpower and equipment needed to construct embankments and inspect and maintain tailing repositories.
- Give clear instructions to the employees on how and why tailing must be managed according to the engineering designs.
- Give clear instructions on what is and is not acceptable for disposal in the tailing repositories.
- Confirm that employees charged with managing tailing disposal systems understand why wastes must be disposed of in this manner.
- Follow IFC requirements for tailing facilities liquid effluent discharge (Table 3).
- Enforce a fair but aggressive disciplinary procedure for employees who disregard waste disposal instructions.
- Prevent to the extent possible public access to the tailing repositories prior to their complete reclamation.

The Processing Manager will also be responsible for collecting the following information on tailing disposal:

- Volume of material being placed in the disposal areas.
- Special handling or treatment processes that are required for the placement of the waste.
- Observation of the physical condition of the tailing repositories and perimeter embankments, including evidence of seepage, movement, or unusual conditions.
- Identification of any other materials, debris, or chemicals placed into the tailing facilities.

The Technical Services Manager is responsible for carrying out the ongoing waste characterization and monitoring program to confirm that the proposed waste management practices are appropriate to contain the waste being generated. This program is described in the ESAP (Volume 2). The Technical Services Manager will communicate the results of these monitoring programs to the Environmental, Health and Safety Manager and the Process Manager so that both are aware of any changes that may be needed due to the characteristics of the waste being generated.

The Environmental, Health and Safety Manager will collect the recorded information for reviewing and interpreting purposes. The Environmental, Health and Safety Manager will also be responsible for collaborating with the Technical Services Manager and Processing

Manager in implementing any additional mitigation measures that may be required. The data results will be stored in a sensible and retrievable manner as required by the ESAP.

3.0 Hazardous Wastes

This section addresses hazardous waste identification and management. The hazardous waste plans and designs developed for the project must be reviewed and approved by the appropriate government authorities and project lenders prior to its construction.

3.1 Waste Identification

Hazardous wastes are materials considered reactive, flammable, radioactive, corrosive and/or toxic. The use of these materials should be limited to the extent possible; however, if their use is unavoidable, GeoCam will adopt procedures for documentation and labeling as well as the safe storage, handling, and disposal of these materials.

Hazardous wastes at the mine site may include the following:

- Waste oils and solvents.
- Fuel and oil filters.
- Laboratory and acidic wastes.
- Batteries.
- Aerosol cans.
- Antifreeze.
- Petroleum-contaminated soils.
- Emergency response wastes.

Table 4 shows where the above hazardous wastes are likely to be generated as well as their management, which may include recycling or reuse. Hazardous wastes that are not recycled or reused will be disposed of in a hazardous waste facility or transported offsite to an appropriate facility. The hazardous waste facility will be designed and maintained to protect groundwater, surface water, and soil resources. The hazardous waste facility will also be constructed to limit impacts and risk to humans, wildlife and domestic animals and the environment.

3.1.1 Waste Oils and Solvents

Waste oils and spent solvents will be generated by the ongoing maintenance activities being performed in the heavy equipment workshop and central workshop. Engineering designs will

be developed for the safe and stable storage of waste oils and solvents. These materials will be stored in collection tanks in the vicinity of the facilities. Tank storage areas will be equipped with berms to contain any spillage that may occur from the tanks. The suppliers of oils and solvents will be required to construct an appropriate supply and waste material storage area as a condition of contract. Alternative solvents that are less toxic, such as citric acid based solvents, will be used where feasible.

The Engineering Manager's responsibilities include ensuring that oil, fuel, and solvent wastes generated are recycled or disposed of in an appropriate manner. GeoCam will recycle as many materials as possible to minimize wastes and intends to use waste oils as supplemental fuel for the combined heat and power (CHP) units. Wastes will be collected in the holding tanks either for beneficial use on site or for removal off site by the supplier as a condition of contract.

The Engineering Manager's responsibilities include but are not limited to the following:

- Identify the manpower and equipment needed to inspect and maintain the waste oil and solvent storage tanks and surrounding areas in good working order.
- Explain procedures on proper management, handling, and disposal of waste oils and solvents.
- Explain what is and is not acceptable disposal of waste oils and solvents.
- Explain procedures for managing recycling tanks and proper disposal of used fuels.
- Enforce fair, but aggressive, disciplinary procedures for employees who disregard the precautionary measures.

The Engineering Manager will also be responsible for collecting the following information regarding the waste oil and solvent recycle tank area:

- Estimating the volume of material inputs and outputs to the recycle tanks.
- Observing the physical condition of the tank storage area and containment structures, including evidence of spills, damage to berms, or tank leakage.
- Performing a monthly audit of the material inputs and outputs to each storage tank.

3.1.2 Fuel and Oil Filters

Waste fuel and oil filters from mobile equipment will be generated throughout the mine life. Handling of these materials will be the responsibility of the Engineering Manager and they will be disposed of by:

- Puncturing the filters and allowing them to drain for 8 hours.
- Collecting the drained fuel or waste oil.
- Placing waste oil in the waste oil recycling tank described in the previous section or properly storing for later removal from the mine site.

Reuse is the preferred method for the recovered fuels and oils. Once puncturing and draining of the filter itself is completed, it will be disposed of in the domestic waste facility. The Engineering Manager will be responsible for reuse, disposal, and record keeping of fuel and oil filters.

3.1.3 Laboratory Acids and Acidic Wastes

Laboratory wastes will be limited to the extent possible, and consequently are expected to be generated in small quantities. These wastes will be disposed of in a manner that is appropriate for the characteristics of the waste. These wastes are likely to fall generally into one of the following four categories:

- Acidic wastes.
- Metallic wastes.
- Organic wastes.
- Heavy media liquids.

Laboratory-grade acids are generally pure reagents that, when neutralized to circum-neutral pH, are suitable for disposal into a sanitary wastewater disposal system. However, it is important that qualified individuals adequately neutralize the acids to ensure that the substance discharged is appropriate for the disposal method.

Metallic, organic, and heavy media liquid (e.g., bromoform or tetrabromoethane) wastes as well as wastes exhibiting hazardous characteristics such as toxicity, reactivity, ignitability, or corrosivity will be reduced in volume to the extent practical through drying, evaporation, or

other suitable means specific to the substance. Where appropriate, these wastes may be amenable to stabilization using lime or cement to render them in solid form for disposal.

Liquid wastes must be carefully placed into primary packaging and then in a secondary containment drum containing absorbent or desiccating material that is chemically compatible with the waste being disposed. When the waste is a solid, the secondary containment drum need not contain absorbents or desiccating materials but will need to be adequately padded with compatible interstitial materials sufficient to assure the integrity of the packs. Filled drums will be tightly sealed and placed in an upright position into the hazardous waste landfill. Laboratory packs of solid and liquid wastes will not be mixed in a single secondary containment drum (only solids with solids, liquids with liquids). Drums containing compatible liquid and solid waste laboratory packs may be placed in the same landfill cell.

3.1.4 Batteries

A variety of batteries, vehicle and non-vehicle, will be used throughout the life of the mine. Used batteries will be accumulated and stored in an area that has a concrete floor with toe berms and is sheltered from the weather. The Engineering Manager will be responsible for investigating the availability of off-site recycling options for batteries. If recycling is unavailable, batteries will be permanently disposed of in the hazardous waste facility.

3.1.5 Aerosol Cans

The mine will routinely generate aerosol cans containing paints, cleaning agents, and other sprays. Aerosol cans should be properly depressurized before being disposed of to prevent harm to area personnel. The empty cans will be disposed of in the following ways:

- Crushing/puncturing the cans under non-hazardous conditions prior to disposal.
- Draining any excess contents in the cans into a collection system.
- Placing crushed cans in the domestic waste facility.

Each department manager will be responsible for arranging the proper disposal of aerosol cans in his/her area. The Environmental, Health and Safety Manager will coordinate the training of personnel on proper disposal techniques.

3.1.6 Antifreeze

Antifreeze will be generated at the central workshop and other ancillary mine facilities and is only needed where equipment manufacturers require its use in cooling systems, not because of freezing at the project site. Used antifreeze will be recycled on site or shipped off site for recycling. The recycling units will be located in the automotive and equipment maintenance facilities. The purification process of filtering and/or distilling the ethylene glycol and water mixture will produce a minor amount of sludge waste. This waste will be disposed of in the hazardous waste facility.

3.1.7 Petroleum-Contaminated Soils

Petroleum-contaminated soils may occur at the central workshop and other mine facility areas. The soils will be removed and either land-treated on the mine site or placed in the hazardous waste facility.

Land-treatment results in the biological and chemical degradation of organic waste constituents and immobilizes inorganic waste constituents. Land-treatment requirements, in accordance with the Safe Disposal of Hazardous Wastes Volume II (Batstone et al., 1989), include the following:

- Diversion of run-on from active portions of the site.
- Collection of runoff from active portions of the site and disposal in an environmentally sound manner.
- Periodic analysis of applied waste.
- Records of the application dates, rates, quantities, and location of applied wastes.
- Preparation and implementation of a closure and post-closure plan.

The Environmental Health and Safety Manager will be responsible for designing and maintaining the land-treatment area.

3.1.8 Emergency Response Wastes

A variety of wastes could be generated from accidental spills or emergencies. Emergency response wastes are addressed in the Emergency Response and Contingency Plan.

3.2 Hazardous Waste Handling Procedures

To ensure the safety of mine employees and local communities, hazardous waste handling and management procedures and other pertinent information will be placed in mine site areas

or buildings where hazardous materials are found. Employees will also be trained in the courses as identified in Section 6.3. The Environmental, Health and Safety Manager will be responsible for a training program for the following hazardous waste procedures:

- Posting emergency contact information in all necessary buildings in case of a fire or hazardous waste spill (Emergency Response and Contingency Plan).
- Posting MSDSs in French and English in areas where these materials are used or stored.
- Performance of regular inspections for container leaks, corrosion, rupture, or other failures.
- Proper handling procedures for hazardous wastes.
- Proper storage of hazardous materials so they do not react with one another.
- Proper disposal of hazardous waste materials.

All new employees will be required to submit to training programs and annual refresher courses will also be required for all mine employees. In addition, each department will be responsible for implementing its own job-specific safety training program.

3.3 Hazardous Waste Facility

Those hazardous wastes that result from operations, following efforts to minimize their volumes and neutralize/stabilize their hazardous characteristics, must be disposed of in a safe manner consistent with long-term protection of the human population and the environment in general. The most common method of disposal is placement into a secure chemical landfill designed specifically for the subject hazardous wastes and local conditions. In view of the small volume and limited variety of hazardous waste that will be generated by GeoCam's operation and also the shallow water table and low topographic relief of the area, a near-surface, lined disposal facility will be designed and constructed to meet the objectives of secure chemical landfills. This facility will provide for subsurface containment of packaged (e.g., drummed) wastes in reinforced concrete vaults that will, upon filling, be securely capped with concrete and buried.

3.3.1 Site Selection

Selecting a suitable site is important to the successful performance of the facility. Site selection criteria will include:

- Proximity of Groundwater – Groundwater table elevation fluctuations at the selected site must not allow the saturated zone to contact the hazardous waste disposal facility under reasonably foreseeable scenarios.

- Proximity to Population Centers – A location will be sought that is relatively remote from population centers and heavily traveled routes, yet sufficiently convenient to waste-generating locations to assure utilization of the disposal facility.

- Hydrologic Relationship to Groundwater Users – Acceptable locations for a storage facility will not be directly up-gradient of groundwater users.

- Soil/Bedrock Stability – Soil and bedrock conditions must be suitable to support the anticipated load of the concrete structures that will comprise the secondary containment facility.

- Proximity to the plant site to provide security and management

3.3.2 Design Considerations

The engineering design of hazardous waste facilities must consider the following:

- Surface Water Diversion Structures – The site will be graded to divert surface water runoff away from the facility. Ditch and drain structures will be installed as appropriate to facilitate drainage.

- Primary Containment – Primary containment will be chosen according to the hazardous waste handling plan to be compatible with the subject waste and any co-disposed waste. Primary containers may include bottles, bags, boxes or cans constructed of steel, plastic, or glass, as appropriate. Additional packaging to assure their integrity during placement in the facility will protect breakable primary containers.

- Secondary Containment – Secondary containment will be provided by steel or plastic drums equipped with appropriate sorbent/neutralizing material(s). Drum compositions must be compatible with the contained hazardous waste and drums may be placed in overpack drums as appropriate.

- Tertiary Containment – Steel-reinforced concrete vaults will provide tertiary containment. Vaults may be constructed in-place or manufactured off-site and installed. In-place construction will follow standard foundation practices to assure minimum porosity and general integrity of the concrete. The interior of the vault will provide a sump in one corner of the vault and allow free drainage of any leakage to that sump. The sump will be fitted with a straight and vertical riser capable of being extended through the vault lid and to the surface following burial. The riser will serve as the leak-detection piezometer and access to the sump should pumping to remove leakage become necessary.

- Landfill Trench – The concrete vaults will be put into an excavated landfill trench that is sufficiently engineered to provide an adequate foundation for the vaults. To minimize unwanted accumulations of water in the excavation during construction and operation, the bottom of the trench will be lined with gravel and equipped with a drainage system. The drainage system will be designed to either be free draining, or to convey water to a sump fitted with a pump, or topographic low point outside the excavation.

- Closure/Burial – Upon filling, each vault will be capped with a pre-formed steel-reinforced concrete lid of sufficient mass to require equipment similar to a backhoe for removal. Sealed vaults will be buried beneath local soil and the site graded and vegetated as appropriate.

- Leak Detection – A leak detection piezometer will be installed in the tertiary sump and can serve as a leakage removal well if necessary.

- Gas Venting – Each vault will be equipped with a vent pipe near the top of the vault that is connected to a gas venting manifold and riser stack with security devices.

3.3.3 Waste Compatibility

Waste compatibility is the responsibility of the Environmental, Health and Safety Manager. Figure 1 shows the compatibility between selected chemicals. This figure can be used as a general guide in assessing the compatibility of wastes. However, wastes may contain a number of constituents and, therefore, the Environmental, Health and Safety Manager should be consulted prior to formalizing any waste disposal decisions. In accordance with the Safe Disposal of Hazardous Wastes Volume II (Batstone et al, 1989), the following steps will be taken to prevent co-deposition of incompatible wastes:

- Prior knowledge of the constituents in a waste.

- Disposing of non-compatible wastes in separate cells of waste facility.

- Clear labeling of trenches where liquid waste containers are stored.

- Competent supervision of the placement of wastes into the disposal facilities.

Hazardous waste should only be generated in small quantities due to the effective implementation of recycling and waste minimization programs. The hazardous waste disposal facility will be operated under the direct supervision of the Environmental, Health and Safety Manager, who will be responsible for ensuring that wastes placed into a given cell are compatible with the other materials stored in that cell. Staff will be instructed on waste compatibility and on procedures for packaging, labeling, and temporarily storing hazardous wastes in storage containers but will not oversee the placement of the packed drums into the

hazardous waste landfill. Fully packaged, labeled, and inventoried drums of hazardous waste will be accumulated in a designated area equipped with spill containment structures. Wastes will only be placed into the landfill under the direct supervision of the Environmental, Health and Safety Manager, who will be responsible for maintaining the facility inventory and records.

3.3.4 Operation, Monitoring and Record Keeping

During normal operations, the reinforced concrete caps will be in-place over each of the vaults. Only when vaults are actively being filled will the caps be removed. This will prevent unauthorized access into the landfill vaults as well as the accumulation of rainfall in the vault. GeoCam will accumulate drum packages (primary and secondary containment) in a lined, protected accumulation area and will dispose of the drums into the vaults at times of minimal precipitation.

An inventory of all materials will be maintained of the types and approximate amounts of wastes stored in accumulation areas and placed in various vaults along with construction and closure records of the vaults. During operations, monitoring of the sump will be performed according to the monitoring plans that will be developed as part of the engineering design and approved by the government agencies and project lenders.

3.3.5 Responsibility

The Environmental, Health and Safety Manager will be responsible for the siting, design, construction, operation, monitoring, and closure of the hazardous waste storage facility. He/she will also be responsible for coordinating the siting and design information with appropriate government agencies and project lenders to assure that the design conforms to applicable laws and guidelines prior to construction. The Environmental, Health and Safety Manager will be responsible for maintaining operational and post-operational records, arranging for post-operational monitoring, and initiating actions if leaks are detected.

4.0 Domestic Wastes

GeoCam will compost and recycle, when possible, domestic wastes to reduce the volume of waste that reports to the domestic waste facility. Domestic wastes not suitable for composting or recycling will be collected and placed directly into the domestic waste facility under the direction of the Environmental, Health and Safety Manager.

4.1 Domestic Waste Materials

A variety of domestic waste materials may be generated at the mine site. These materials include, but are not limited to, the following:

- Aluminum, glass, plastic, paper, wire, light bulbs and cardboard.
- Benign filtrates from water treatment systems or other mining processes.
- Latex painting wastes.
- Rubber from conveyer belts, vehicles, or other process parts.
- Spray cans and fuel/oil filters which have been punctured, drained, and segregated from other solid waste as described in previous sections.
- Shredded tires (to reduce waste facility space) from mobile equipment and vehicles.
- Putrescible materials that cannot be composted such as meat, bones, and food wastes cooked with oils.

These materials will be taken to the domestic waste facility if recycling or reuse is not practical. Hazardous wastes will not be allowed in the domestic waste facility (Section 3.0).

4.2 Domestic Waste Handling Procedures

The following handling procedures, developed based on the IFC's guidelines for Waste Management Facilities (1998), will be adopted as part of the Nkamouna Project's waste management program. Waste collection, handling, and transport guidelines include the following:

- A routine schedule will be established for domestic waste collection and disposal.
- Waste generators will be provided with appropriate waste disposal containers.

- Enclosed refuse vehicles or vehicles equipped with tarpaulins will be used for the domestic waste collection.
- Waste handling will be minimized during operations.
- Waste containment will be maximized during operations.

Odors and the loss of wastes will be minimized at all waste loading and unloading facilities. Fugitive refuse (i.e., plastic bags and paper) around the waste facility will be picked up, disposed of in the waste facility, and properly covered.

4.3 Domestic Waste Facility

The domestic waste facility will include putrescible materials and non-degradable wastes generated throughout the area. These wastes may include paper, cardboard, plastic, rubber, and food refuse. Some of these materials can be recycled to reduce wastes in the facility. The Environmental, Health and Safety Manager will be responsible for the supervision of the domestic waste facility. With the assistance of the Engineering Manager, the Environmental, Health and Safety Manager will also be responsible for developing and implementing recycling programs (except waste oil and solvent recycling, which is the responsibility of the Engineering Manager). The general guidelines for the waste facility design and operation will include the following:

- The domestic waste facility will be designed to minimize impacts to air and water.
- The domestic waste facility design will include a compacted soil cover as part of final closure. The final cover will be vegetated and shaped to promote drainage of surface runoff.
- The domestic waste facility design will include a gas control and monitoring system to minimize the potential for the accumulation or incompatible reaction of toxic gases.
- A separate receiving area will be established for domestic wastes.
- Air quality control measures will be used to control fugitive dust and odors.
- An adequate area will be constructed for wastes that require temporary storage prior to disposal.
- All containment cells will be covered with soil or other suitable material at the end of each working day to minimize odors.
- An appropriate monitoring program will be established to detect any fugitive solutions from gas migration.

The monitoring program, including recommendations for sampling and analytical profiles, will be included with the engineering siting and design study for the facility. GeoCam will coordinate with the appropriate government agencies and project lenders to assure that the applicable laws and guidelines are addressed by the design prior to construction. The Environmental, Health and Safety Manager will be responsible for the siting, design, construction, and day-to-day operation of the domestic waste facility and for inspecting the facility on a regular basis to confirm its performance relative to the design. Repairs will be performed in a timely manner to minimize potential risks and to maintain the integrity of the facility.

4.4 Sanitary Wastes

A sewage treatment plant will be constructed to treat sewage from the mine village, offices, and plant areas. The system will be a full gravity-based system comprising a sewage treatment plant and pond system that allows for heat treatment to enable use as organic fertilizer in reclaimed areas. A combination of package treatment plants with absorption fields (suburb and plant sites), or compost toilets, aquatic solar treatment, and gray water recycling, low-water use apparatuses), will be part of an integrated plan for more efficient and sustainable sewage disposal (Buckovic, 2004).

The Engineering Manager will be responsible for the construction, commissioning, operation, maintenance, and ongoing monitoring of these systems. Each system will be reconstructed in such a way that it will minimize impacts to surrounding surface waters or groundwater. The project sewage treatment systems will operate within the limits of the IFC's liquid effluent guidelines. The Engineering Manager will be responsible for collecting effluent samples according to the schedule established in the ESAP (Volume 2). Table 3 lists these effluent guideline limits for domestic sewage treatment systems.

5.0 Organic Wastes

Wastes generated from food (examples listed below) or other biodegradable materials will be composted or recycled depending upon volume and suitability. Recycling may also include disposal of the food as animal feed as local animal husbandry programs are developed in the area.

Composting of wastes will serve as an effective, sanitary method for disposal of waste food that will provide a useful soil amendment to low nutrient soils during reclamation. Knowledge and experience gained in composting practices by locally employed mine workers can be developed, with the encouragement of GeoCam, as an agricultural tool to be transferred to the local agricultural community to enhance crop and garden production.

Workers involved in the composting operation will require proper training and adequate safety clothing. The Environmental, Health and Safety Manager will be responsible for training employees on which materials can be composted. The Environmental, Health and Safety Manager will also be responsible for determining that the composting process has been completed for each batch of composted material before it is released for use. The finished compost product will be used for on-site reclamation efforts.

5.1 Composting Materials

Composting materials may include the following:

- Rotting fruits and vegetables.
- Egg shells.
- Coffee grinds and tea bags.
- Wood ashes and sawdust.
- Chicken, duck, and rabbit manure (mainly herbivore animals).
- Plant material (i.e., leaves, stems) and grass.
- Shredded newspaper.

Materials that should not be composted include the following:

- Meat (raw and cooked) and bones.

- Cat and dog manure (carnivorous animals).
- Dairy products.
- Foods that have been cooked with oils.

The materials listed above can reduce the overall effectiveness of the composting microorganisms and, therefore, should be disposed of in the domestic waste facility.

5.2 Composting Procedures and Facility

Composting test plots will be constructed and evaluated under the management of the Environmental, Health and Safety Manager. These test plots will be constructed in fenced areas to limit intrusion by scavenging animals. Composting at the Nkamouna Project will consist of the following steps.

- Material to be composted will be identified in advance (i.e., food scraps, paper, plant material, wood chips).
- Receptacles will be provided for the separate collection of compost and domestic wastes.
- Placement and formation of the compost piles will be the responsibility of the Environmental, Health and Safety Manager.
- A good carbon/nitrogen ratio should be formed. Nitrogen rich materials include food or plant materials and carbon rich materials like dry leaves or wood chips. Compost should be layered alternating wet materials (i.e., food waste, plant materials) and dry materials (i.e., newspaper, sawdust, wood ash). Appendix B provides some examples of carbon/nitrogen ratios.
- Water will be added for moisture (consistency of a squeezed sponge).
- Weekly aeration and turning of compost will be done to accelerate decomposition.
- Generation and distribution of the final compost product will be the responsibility of the Environmental, Health and Safety Manager.

Composting often requires a degree of trial and error. It is expected that some experimenting will be required before the composting system is optimized. However, once the system is properly in place, it can provide a regular input of organic matter that could be used as part of the site reclamation program.

5.3 Troubleshooting

Some of the common issues that may need to be addressed as part of the trial process include the following:

- Rotten Odor – There may be extra moisture in the compost pile causing an anaerobic condition. Compost should be turned to aerate the pile. Dry materials, such as dried leaves or woodchips, should also be added to the pile.
- Ammonia Odor – There may be too much nitrogen or green material (i.e., grass clippings, manure). Carbon or brown material such as dried leaves or woodchips should be added and the compost aerated.
- High Temperature – There may be too much material and not enough air. The compost pile should be aerated or reduced.
- Pests – There may be too much food wastes if rodents and insects are increasing. Food should be covered with other materials (i.e., plant material, wood chips, leaves).

An active compost-monitoring program will need to be established to identify and correct these issues as they arise.

6.0 Waste Management

The Environmental, Health and Safety Manager will maintain records and report on any significant environmental matters, including monitoring data, accidents, and occupational illnesses related to waste management. The managerial staff, including the General Manager, will review the records and reports to improve the effectiveness of the Waste Management Plan. Table 1 describes managerial responsibilities in relation to waste management.

6.1 Waste Facility Record Keeping

The Environmental, Health and Safety Manager will be responsible for maintaining records regarding active and inactive cells for the domestic waste and hazardous waste facilities. The Environmental, Health and Safety Manager will be responsible for maintaining records on the inactive and active compost cells. These records will include the following:

- Volume estimates of material inputs and outputs to the cell.
- Types of materials placed in the storage cell.
- Observation of volume and quality information of leachate emanating from the collection system.
- Observation of the physical condition of the system, noting olfactory conditions associated with the gas emission system.
- Any deterioration of the hazardous waste facility embankments, liners, and cap, as well as the measures taken to correct these deteriorations.

The Environmental Health and Safety Manager will be responsible for ensuring daily compaction and covering activities of the domestic waste facilities.

6.2 Management Training Responsibilities

Properly trained employees are necessary for the safe and effective operation of any facility. Training programs will reflect the level and type of expertise necessary for a given position. Safety precautions will also include protective clothing pertinent to the work activity, area, and schedule. Clothing may include such items as hard hats, hard-toe boots, safety glasses, reflective outerwear, and hearing protection. General safety rules will be posted in strategic locations at the mine site to describe general safety requirements for waste disposal facilities and equipment.

The Environmental, Health and Safety Manager will be responsible for the training of waste disposal employees on the safe and proper disposal of wastes generated at the mine site. At a minimum, the Environmental, Health and Safety Manager will:

- Provide the manpower and equipment needed for waste disposal.
- Give clear instructions to employees on how and where to dispose of waste materials, along with any special handling that may be required.
- Confirm that employees charged with waste placement understand why waste must be disposed of in this manner.
- Prevent unauthorized personnel from entering dangerous or restricted areas through signs, fences or guards.
- Enforce a fair but aggressive disciplinary procedure for employees who disregard waste disposal instructions.

New employee training programs and annual refresher courses on proper waste management and disposal will be required for mine employees under the direction of the Environmental, Health and Safety Manager.

6.3 Training Programs

GeoCam employees will be trained in the following safety topics before employment commences and will also be reminded in annual refresher courses to limit the potential for accidents. These courses will be developed and implemented by the Environmental, Health and Safety Manager:

- Safe job practices and procedures.
- Accident prevention.
- Differences between wastes streams and an overview of incompatible wastes.
- Safe lifting practices.
- How to read and understand Material Safety and Data Sheets (MSDS).
- Safe material and waste handling practices.
- Proper control and maintenance of equipment and waste facilities.

7.0 Monitoring and Safety

7.1 Monitoring

A waste disposal monitoring program will be developed for environmental and non-environmental features during development, operations, closure, and post-closure phases of mining operations. The following monitoring will be accomplished and appropriate records kept:

- Refuse quantity and material delivered to the domestic waste facility, hazardous waste facility, and composting facility.
- Surface water and groundwater monitoring.
- Waste facility gas control devices.
- Surrounding vegetation and soils around waste facilities and waste tailing.
- Non-environmental features such as fences, roads, and signs.

Signs and notices should be placed around the domestic waste facility and the hazardous waste facility to promote worker and resident safety. These signs will include identification of waste categories and disposal sites. The Environmental, Health and Safety Manager will be responsible for distributing and maintaining these signs.

7.2 Waste Facility Security

Waste facilities will be maintained with security to prevent unauthorized access to the site. The perimeters of the domestic waste facility, hazardous waste facility, and composting facility will be delineated with a wire or wooden fence with a lockable access gate. Security may also include a guard for the waste facilities if vandalism or scavenging develops. The three main reasons for maintaining security at the waste facilities include:

- Prevention of people from wandering into the waste facility and becoming harmed by wastes or equipment.
- Protection of equipment from damage.
- Prevention of scavengers from carrying off contaminated materials.

Personnel who notice security issues related to waste disposal practices must immediately report these findings to the Environmental, Health and Safety Manager and mine security.

References

Batstone R., E. Smith Jr., and D. Wilson (eds.), 1989, "The Safe Disposal of Hazardous Wastes. The Special Needs and Problems of Developing Countries, Volume I1," World Bank Technical Paper, 0253-7494, No. 93.

Buckovic, W.A. (2003). Geovic Cobalt-Nickel Project, Cameroon, Africa. Technical Report.

International Finance Corporation, 1998, *Environmental, Health and Safety Guidelines for Waste Management Facilities*.

The World Bank Group, 1995, *World Bank Environment, Health and Safety Guidelines, Mining and Milling – Open Pit*.

Tables

Table 1
Nkamouna Project Waste Management Plan
Waste Management Responsibility Descriptions

Manager	Duty Descriptions
Manager Environmental, Health and Safety	Construction, supervision and record-keeping of domestic, designated, and composting facilities
	Domestic waste disposal
	Recycling programs for domestic and designated wastes
	Train employees on waste disposal procedures and other safety training courses
	Reclamation/revegetation
	Waste compatibility
	Composting facility
	Surface and groundwater monitoring for backfilled pits
	Maintaining waste facilities signs and fences
	Train employees on disposal necessities associated with the Processing Plant
	Covering and compaction of waste facilities
Manager Processing	Tailing Disposal
Manager Technical Services	Embankment Safety
Manager Engineering	Responsible for recycling and/or disposal oil, fuel, and solvent wastes
	General maintenance of sewage treatment system and septic tanks

Figure

Figure 1
Nkamouna Project Waste Management Plan
Compatibility of Selected Hazardous Wastes [1]

1	Oxidizing Mineral Acids	1										
2	Caustics	H	2									
3	Aromatic Hydrocarbons	H, F		3								
4	Halogenated Organics	H, F, GT	H, GF		4							
5	Metals	GF, H, F			H, F	5						
6	Toxic Metals	S	S				6					
7	Sat Aliphatic Hydrocarbons	H, F						7				
8	Phenols and Cresols	H, F							8			
9	Strong Oxidizing Agents		H, GF	HF		H, F		H		9		
10	Strong Reducing Agents	H, F, GT			H, GT				GF, H	H, F, E	10	
11	Water and Mixtures Containing Water	H			H, E		S				GF, GT	11
12	Water Reactive Substances	← Extremely reactive, do not mix with any chemical or waste material →										12

E	Explosive
F	Fire
GF	Flammable Gas
GT	Toxic Gas
H	Heat Generation
S	Solubilisation of Toxins

[1] From Batstone R, Smith Jr. E, Wilson D (eds.) (1989). The Safe Disposal of Hazardous Wastes. The Special Needs and Problems of Developing Countries, Volume I1. World Bank Technical Paper, 0253-7494, No. 93.

Appendix A

IFC Environmental, Health and Safety Guidelines for Waste Management Facilities

International Finance Corporation

Environmental, Health and Safety Guidelines for

Waste Management Facilities

These guidelines are for the design, construction and operation of facilities for the management of hazardous and non-hazardous wastes, including landfills, incinerators, solvent recovery systems, and other waste management systems. The guidelines incorporate the general provisions of the World Bank policies for cultural properties, indigenous peoples, involuntary resettlement, biodiversity, water resources management and wildlands. Environmental issues that are identified by the project sponsor or other interested parties, but not addressed by World Bank policies or guidelines, must be brought to the immediate attention of IFC for consideration and guidance.

Project Siting

The principal elements of World Bank policy regarding siting, land acquisition and development of waste management facilities and associated project features are summarized below. Sites should be chosen through a systematic, documented process that includes consideration of alternatives and their environmental impacts. The sponsors must provide information regarding project siting, addressing the following guidelines:

a) The site and access routes must be selected taking environmental factors into consideration in a manner which will minimize, to the extent possible, impacts to natural resources, land use patterns, sensitive ecosystems and cultural resources.

b) A surface and subsurface investigation of geology, soils, groundwater and surface water resources should be conducted to determine leachate migration potential and the need for additional design requirements.

c) Special consideration should be given to site proximity to developed areas and potential impacts resulting from air emissions, odor, contamination of water resources (i.e., groundwater and/or surface water), vector attraction, noise and truck traffic.

d) The project site should include enough land area to provide a buffer zone to minimize aesthetic impacts.

e) Land acquisition must be carried out in accordance with World Bank resettlement policy which requires quantification of impacts on land-based livelihood, and fair compensation to landowners and people relying on the land for their residence and/or livelihood.

f) Selection of the site should be made after consultation with government agencies, affected communities and concerned nongovernmental organizations.

Project sponsors must provide IFC with a complete record of the process by which the site was selected, including the analysis of alternative sites, and the consultation with government agencies, affected communities and nongovernmental organizations.

Erosion and Sediment

Project sponsors should develop an erosion and sediment control plan to minimize erosion in construction areas and along access roads, reduce the risk of sediment discharge to nearby streams, and provide for long-term maintenance and operation practices that will control erosion

and sedimentation. The control plan should include, but should not be limited to, the following measures.

a) The area cleared of vegetation to accommodate construction of should be minimized and slopes should be stabilized to prevent erosion.

b) Cleared areas should be promptly revegetated with native grasses, shrubs and trees.

c) Overland drainage should be controlled to prevent channeling and sediment transport by diverting flows from areas where soils are exposed, and/ or by providing filter barriers or settling basins to remove sediment before the runoff is discharged to surface waters.

d) Revegetated areas and areas subject to erosion should be monitored and maintained during project operation.

Waste Collection, Handling and Transport

Project sponsors must conduct a survey to assess the waste management requirements of its service area and develop a compatible program for the collection, handling and transportation of wastes. The program should include the following measures to mitigate potential adverse impacts to the environment, as well as public and employee health and safety.

a) Ensure scheduled collection services and public awareness of such services.

b) Provide waste generators with appropriate refuse containers to segregate hazardous and non-hazardous wastes.

c) Provide enclosed refuse collection vehicles or cloth tarps to cover open vehicles.

d) Minimize waste handling and maximize waste containment during all operations.

e) Control odors and the loss of wastes during transportation and at loading and unloading areas.

f) Include materials recovery facilities in the project to receive, separate, process and market or reclaim materials where possible.

g) Ensure proper maintenance of collection vehicles to ensure safe collection and transport of wastes.

General Environmental Requirements

a) Project facilities must be designed to minimize impacts to air and water resources, and may include, where appropriate: venting and gas collection systems; adequate depth between the bottom of waste piles, landfills and the top of the aquifer; adequate horizontal distance between waste treatment facilities and the nearest surface water; stormwater runoff control systems; and leachate collection and treatment systems.

b) Prior to construction, project sponsors must devise a program to: survey, identify and assess cultural resource sites within the project area; train construction personnel in the identification of cultural resources; and mitigate adverse impacts resulting from project development.

c) The potential impacts to vegetation and wildlife habitat as a result of the project should be assessed and a plan established to mitigate the impacts.

d) Landfill design must include gas control systems to protect deep-rooted vegetation in the project area and minimize the potential for explosions or toxic conditions from the accumulation of landfill gas in buildings.

Project Operations

a) Facilities should have separate receiving and handling areas for hazardous and non-hazardous wastes.

b) Wastes should be analyzed prior to disposal for compatibility with treatment and disposal methods.

c) Air quality control measures must be implemented to minimize fugitive dust from materials loading/unloading, and odors from land disposal sites and composting systems.

d) Adequate and environmentally sound and contained storage areas must be available for materials that cannot be treated or disposed of immediately upon arrival to the facility.

e) All containment cells should be covered with soil or other suitable cover material at the end of each working day to minimize odors and infringement by animals.

f) Waste should be composted whenever possible.

g) A monitoring program should be implemented to detect any groundwater contamination or gas migration as a result of project operations.

h) Treated leachate and other liquid effluents from the waste management facility and associated project facilities must meet the requirements for liquid effluents in the General Environmental Guidelines.

i) Maintenance practices should include routine checks for failure of spill containment facilities, air quality controls and emergency devices.

Incinerator Stack Emissions

Concentrations of contaminants emitted from the stacks of incinerators, or other significant sources of air emissions, including boilers, furnaces, and electrical generating equipment should not exceed the following limits:

Parameter/Pollutant	*Maximum Value*
Particulate Matter	100 mg/Nm^3
Nitrogen Oxides, as NO_2	
Coal fired	750 mg/Nm^3
Oil fired	460 mg/Nm^3
Gas fired	320 mg/Nm^3
Sulfur Dioxide	2,000 mg/Nm^3
Dioxin	1 ng/Nm^3
Furan	1 ng/Nm^3

Hazards Protection

a) Waste management facilities should be located, to the extent possible, to minimize potential risks from earthquakes, tidal waves, floods and fires from surrounding areas.

b) Buildings and other support structures must be designed to criteria appropriate to the local seismic risk, wind and snow loading, and any other dynamically imposed loads associated with climatic and geological factors inherent at the location; certification of the design criteria used must be provided by the structural engineers or architect.

Employee Health and Safety

Project sponsors must develop an Employee Health and Safety Program that includes the following:

a) Employees working in hazardous waste facilities must undergo a medical examination when they are hired and, at a minimum, every two years thereafter.

b) Emergency escape routes should be provided for all employees in the event of fire, toxic gas emissions, explosions, radiation and other hazards exposure.

c) Firewalls and other fireproof structures should be incorporated into the facility design.

d) No smoking, eating or drinking rules should be strictly enforced in all work areas.

e) Unauthorized personnel should be prevented from entering hazardous or restricted areas.

f) An operations and public emergency response program should be implemented for spills, fires and major accidents, including emergency equipment and trained personnel, and critical components of the program tested on a regular basis.

Training

a) Personnel involved in the construction and operation of the project must be trained on the hazards, safety procedures and emergency response plan associated with their tasks in accordance with the General Health and Safety Guidelines and the General Environmental Guidelines.

b) Training should incorporate information from the Material Safety Data Sheets (MSDSs) for potentially harmful materials.

c) Personnel should be trained in environmental, health and safety matters including accident prevention, safe lifting practices, the use of MSDSs, safe waste handling practices, and proper control and maintenance of equipment and facilities.

d) Project sponsors must provide training for monitoring and mitigating the effects of the project on environmental and sociocultural resources.

Record Keeping And Reporting

a) The sponsor must maintain records of significant environmental matters, including monitoring data, spills, occupational accidents and illnesses, and fires and other emergencies.

b) Records of public complaints and accidents involving the general public must be maintained.

c) The above information must be reviewed and evaluated to improve the effectiveness of the environmental, health and safety program, and an annual summary provided to IFC.

Appendix B

Carbon/nitrogen Ratios for Various Organic materials

C/N ratio for various organic materials	
Urine	0,8
Manure leachate	1,9 - 3,1
Mixed abattoir wastes	2
Blood	2
Human feces	5 - 10
Green plant matter (no stalks)	7
Humus	10
Grass	10
Chicken manure	10
Pet manure	15
Legume leaves	15
Fresh manure (low straw content)	20
Kitchen wastes	10-25
Potato peels	25
Leaves	20-60
Green plant waste (mixed stalks and leaves)	20-60
Cereal straw	50 - 150
Bark	100-150
Wheat straw	150
Paper	150
Decomposed sawdust	200
Green tree sawdust	150 - 500