

**Nkamouna Project  
Environmental and Social Assessment  
Mine Reclamation and Closure Plan**

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# Nkamouna Project Environmental and Social Assessment Mine Reclamation and Closure Plan

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## **List of Abbreviations and Acronyms**

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2.0H to 1.0V	2 horizontal to 1 vertical
CDP	Community Development Plan
CHP	combined heat and power unit
cm	centimeter(s)
ERCP	Emergency Response and Contingency Plan
ESAP	Environmental and Social Action Plan
ESIA	Environmental and Social Impact Assessment
GeoCam	Geovic Cameroon PLC
ha	hectare(s)
km	kilometer(s)
m	meter(s)
m <sup>3</sup>	cubic meter(s)
mm	millimeter(s)
MRCP	Mine Reclamation and Closure Plan
PUG	physical upgrade
NCTSF	Napene Creek Tailing Storage Facility

NTFP                    non-timber forest product  
WMP                    Waste Management Plan

# **Nkamouna Project Environmental and Social Assessment Mine Reclamation and Closure Plan**

## ***1.0 Introduction***

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This Mine Reclamation and Closure Plan (MRCP) was developed to outline the general closure and reclamation programs for the Nkamouna mine site. The plan includes descriptions of surface preparation, soil material placement, seeding and planting, soil global amendments, and monitoring of revegetation success. Reclamation strategies for specific sites are also provided as part of this plan.

Mine reclamation and closure is an integral part of the Nkamouna Project. Geovic Cameroon PLC (GeoCam) is committed to careful mine reclamation and closure planning in order to establish and continually improve the program success over the life of the project. As required by the Mining Convention, GeoCam will set aside the necessary funds to assure successful mine reclamation and closure.

For the purposes of this document, closure activities are generally performed to stabilize the site. Closure of the mine will include efforts required to stabilize the site chemically, remove aboveground structures, including processing facilities, and reclaim the tailing repositories.

Reclamation activities are implemented to reestablish a suitable post-mining land use. Based on the results of the public consultation process, the preferred post-mining use at Nkamouna is to reclaim the land to a forest/wildlife habitat. Reclamation activities will include regrading disturbed areas to provide topographic relief that blends with the surrounding areas and will include applying soil amendments (if appropriate), seed bed preparation, planting, and performance monitoring.

Where practical, closure and reclamation activities will be performed concurrently with mining activities. Concurrent closure and reclamation will allow for most work to be completed during mine operations, thereby reducing reclamation costs at the end of the project as well as developing and improving reclamation techniques that can be continually improved over the life of the project to maximize revegetation success and productivity.

### **1.1 Objectives**

The objective of the mine reclamation and closure program is to reestablish forest on mined lands. Following cessation of mine operations, disturbed areas will be stabilized and reclaimed to a forest/wildlife habitat. Should the public consultation programs indicate an evolution in the current desire of the authorities and local population to see the forest reestablished, the MRCP will be adapted accordingly.

### **1.2 General Site Ecology**

The only plant community represented within the project area is tropical broadleaf deciduous forest.

### **1.3 Mining Convention**

This MCRP has been developed in accordance with the Mining Convention between the Republic of Cameroon and Geovic Cameroon S.A. Articles 6.2, 6.3, and 23 address GeoCam's obligations for reclamation and rehabilitation of mined areas. Specific obligations included in this section that pertain to reclamation include the following:

- With effect from the Commencement of Operations, GeoCam shall undertake to furnish the guarantees necessary to ensure the rehabilitation of the site, in accordance with the conditions provided for in the Environmental Management Plan.
- If mining operations should at any time whatsoever come to an end, the Parties shall review the status of rehabilitation in order to determine whether any rehabilitation remains to be done following the initial program. Where necessary, the guarantee shall be applied to this end upon mutual agreement of the parties.

In the event that the guarantee is in the form of a bank account, the balance of the account shall be returned to GeoCam once the work has been accepted by the State, according to applicable legislation.

The mining standards applicable under this Convention shall be World Bank standards or standards that can be demonstrated as generally applicable in the international mining industry, or, if none, the standards established by applicable legislation in Cameroon.

## ***2.0 General Closure and Reclamation Methods***

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General closure and reclamation activities relevant to the Nkamouna Project are discussed in this section as follow:

- Facility Salvage, Demolition, and Disposal.
- Tailing repositories.
- Surface Grading.
- Sediment and Erosion Control.
- Soil Global Stockpiling and Redistribution.
- Domestic and Hazardous Waste Facilities.
- Seed Mixtures.
- Plant Propagation.
- Seedbed Preparation.
- Seeding Methods.
- Tree and Shrub Planting.
- Fertilizer Application.
- Irrigation.
- Revegetation Tests.
- Management of Exotic Species.
- Revegetation Monitoring.

### ***2.1 Facility Salvage, Demolition, and Disposal***

After mining has been completed, buildings, equipment, and infrastructure will be managed for closure. For the purposes of this MRCP, it is assumed that all buildings and improvements will be removed and salvaged or closed and reclaimed in place. Stakeholder input will be used to determine the final disposition of mine facilities.

Where deemed appropriate by GeoCam, salvaged materials may be made available to the public. Following salvage, demolition, and disposal activities, the area will be graded to create a natural final topographic relief. The only material to be included in regrading the mine facilities will be inert material such as concrete, stone, and brick used for foundations. Other materials will be taken to either the Domestic Waste or Hazardous Waste Facility in accordance with the Waste Management Plan (WMP). Compacted surfaces will be ripped to relieve compaction and reduce surface runoff and sediment transport.

During facility closure, confirmation sampling and testing of the soils will be completed as needed to verify that areas have not been impacted by hydrocarbons or other potentially hazardous substances. In the case where hazardous substances are identified, the contaminated areas will be remediated in accordance with the Emergency Response and Contingency Plan (ERCP).

## ***2.2 Tailing Repository Development and Reclamation***

Mining and tailing storage operations will result in changes to the local landscape. However, disturbed areas will be re-profiled to match the pre-existing topography to the extent possible. Upon completion of mining by panels, they will be backfilled with waste rock, PUG plant middlings and manganese raffinate precipitate. These waste materials will be backfilled in separate panels.

Overburden generated from panel excavation will be used to construct the controlled fill embankment in those select panels to be backfilled with manganese precipitate. The resulting structure will be an embankment built predominantly inside each mining panel, against the panel walls, and around its perimeter. The resulting perimeter embankment will provide for storage of manganese precipitate in a four-sided tailing repository. Development of adjacent panels will result in separate repositories whose perimeter embankments abut against one another.

The majority of the body of each perimeter embankment will not project above the pre-mining ground surface. The majority of the precipitate will, therefore, be stored below the pre-mined ground surface. Variations in embankment height, as measured above the original, pre-mined ground surface, depend on panel size and ground surface slope but will range between about 4 and 8 m. The perimeter embankment slopes will not exceed a 2 horizontal to 1 vertical (2:1) slope.

The remaining panels will be backfilled with overburden and waste rock or PUG plant middlings and require no embankments. Backfilling will aim to return these panels to their original topography. Middlings tailing will be placed into mined panels, separate from the other mine wastes, for possible future retrieval and processing.

Fine tailings from the PUG Plant and leach tailing from the Leach Plant will be commingled (mixed) and placed into the Napene Creek Tailing Storage Facility (NCTSF), a standalone embankment dam about 66m high, after a flocculant has been added to the commingled tailing to increase settling rate. Decant water will be collected and recycled to the treatment plants.

As mining advances, concurrent reclamation of the mined panels will involve establishing a vegetative cover and stabilizing the panel surface. The upper 50 to 100 centimeters of material placed therein will include growth media to advance stabilization and expedite plant growth, and will likely be a mixture of wood ash from the CHP units, compost and mine waste. By doing this, a portion of the reclamation work will be an operations effort. Seeding the surface will follow with additional vegetation to proceed after an adequate root mat and vegetative cover have been established.

In the panels backfilled with manganese precipitate, sections of perimeter embankment crests will be removed to allow drainage of precipitation and runoff from the reclaimed panel surfaces. These sections will be sufficiently wide to permit low-velocity flow through them and over the revegetated embankment slopes. Channels needed to remove this water will be sized to handle expected flows and will be lined or otherwise protected against erosion. Runoff will be directed through the site erosion and sediment control system.

Backfilling will in general have been carried out so that the resulting surface slopes from the upgradient to downgradient sides of the mined panels, similar to the existing, pre-mining topography. With vegetation established on this very gently sloping surface, this will provide excellent protection against erosion and allow for low-velocity flows of runoff across the tailing surface to promote drainage.

Reclamation of the NCTSF would be initiated during the last months of deposition to include placement of growth media of similar composition to that used in the backfilled panels in the last several meters of deposited tailing. Then, once sufficient volunteer vegetation has established

itself, tree seedlings grown in GeoCam's nursery and from other sources will be planted. It is anticipated that this process will begin around the outside edge of the deposited tailing and continue to move to the center of the area as the vegetation establishes itself.

In addition a drainage channel will be established over the embankment and down the downstream face to Napene Creek to remove runoff from the surface of the stored tailing.

### **2.3 Surface Grading**

Site grading is an initial step toward achieving long-term site stability and toward limiting erosion potential. Site grading will also reduce visual impacts of past mining activities by blending the affected topography with the surrounding landscape. During grading, additional disturbance will be limited to the maximum extent practical. Sediment and erosion control measures will be implemented as part of the site grading work.

In general, areas will be regraded to slope in the direction of the natural drainage. Slopes will be no steeper than 2:1 to reduce erosion potential and to maintain slope stability. Slopes will also be regraded to prevent ponding of water. Prevention of ponded water will be important to limiting potential mosquito breeding areas.

### **2.4 Sediment and Erosion Control**

Sediment and erosion control is used to reduce overland flow, limit sediment contributions to downstream receiving waters, and establish site-wide erosion and sedimentation rates that are consistent with development of vegetation cover. At the Nkamouna Project, both short-term and long-term sediment control techniques will be employed.

Short-term sediment control will include implementation of a number of control techniques such as surface roughening, mulching, and installation of silt fences and rock filter barriers. The implementation of these practices will reduce erosion and sedimentation rates during vegetation establishment. These sediment control structures will require regular inspection and maintenance until vegetation becomes adequately established.

In a number of African countries, vetiver grass has been used effectively as a method for short-term erosion control. Vetiver grass (*Vetiveria zizanioides*) is an introduced species that does not spread on its own. When used as an erosion control, vetiver grass has to be planted in very thick

rows. Areas between the rows are then seeded. The vetiver grass acts to reduce overland flow and facilitate establishment of seeded vegetation. On-site specialists will evaluate the feasibility of using vetiver grass as a short-term erosion control method.

Long-term sediment control plans will establish drainage and flood control techniques that will be employed to prevent inundation of lower lying areas during the wet season. Areas will be regraded to blend with existing topography, promote natural drainage, and reduce overland flow velocities. Diversion channels will be constructed to divert water around areas susceptible to erosion. Storm water controls that may be implemented for roads include water bars, slope reduction, and armoring areas susceptible to erosion.

### ***2.5 Soil Salvage and Redistribution***

Although topsoil is thin and limited in volume, a soil-stockpiling program will be implemented at commencement of construction. Topsoil from areas such as the plant and mine village sites, open pits, diversion canals, and pond sites will be removed and stockpiled for later use in reclamation efforts.

Several general guidelines will be followed for stockpiling soils. The stockpiles will be as close as possible to the site of their final disposition in order to limit repeat handling. The height of stockpiles will be limited to the extent possible to reduce compaction and to maintain the integrity of soils. Soil material will be placed in vertical lifts to limit handling and degradation of soil structure. Soil handling should be limited to the extent practical when it is either too wet or too dry. Handling wet soils often results in the creation of mud that can harden and create a dense, brick-like layer with low permeability. Handling extremely dry soils can result in degradation of soil structure and loss of organic matter by breaking up soil aggregates.

Stockpiled soils will be redistributed as part of reclamation activities. For areas that lack suitable plant growth materials, additional stockpiled soil will be used to create an adequate plant growth. Where possible and appropriate, stockpiled soil materials will be replaced to approximate topsoil depths. Soil material will not be screened to remove stones or rocks prior to placement. The use of heterogeneous materials will help to reduce erosion potential and also provide microsites to promote vegetation establishment.

## **2.6 Domestic and Hazardous Waste Facilities**

The closure of the Domestic and Hazardous Waste Facilities will include a soil cover as described in the WMP. The cover helps limit water infiltration into these facilities. The Domestic and Hazardous Waste Facilities will include hydrologic control structures that mitigate the potential for erosion due to storm water run-on and runoff.

## **2.7 Seed Mixtures**

The goal of this reclamation program is to return disturbed lands to forest. As such, seed mixes will comprised local plant species identified in the flora inventory and valuable timber or non-timber forest product (NTFP) species based on stakeholder preferences.

The use of native species in revegetation projects is generally preferred as non-native species may also out-compete native species and thus inhibit the reestablishment of native plant communities.

## **2.8 Plant Propagation**

A seed collection and cuttings program will be implemented to generate plant material for reclamation. Seed collections and vegetative cuttings should focus on obtaining samples from “mother plants” from viable populations to help maintain genetic heterogeneity. Non-destructive propagation methods, such as seed collection and cuttings, will also be used to collect plant material. For areas that will be disturbed, removal and transplanting of entire plants is a viable option. If plants are removed, the disturbance to natural communities and large-scale removal of entire plants should be avoided until absolutely necessary.

A greenhouse or lathe house will be established for plant propagation. Lathe houses are common to warmer climates and are constructed using wood flats with spacing in between the flats to provide increased air circulation and light penetration. The primary issue related to greenhouse or lathe house design will be adequate cooling. An open greenhouse design with roll-up plastic side walls may allow for adequate cooling. A lathe house also may provide an inexpensive facility that would provide adequate cooling and environmental protection. The facility should be large enough to accommodate the projected reclamation needs. The final design choice, however, should be based on local climatic conditions.

GeoCam will also establish an on-site plant nursery to raise plants that will later be used for reclamation activities. The Manager of Environmental, Health and Safety will oversee nursery and greenhouse/lathe house operations.

As an alternative to a GeoCam-managed greenhouse/nursery complex, GeoAid will investigate the possibility of using micro-credit loans to establish a greenhouse/nursery run by members of the local population as discussed in the Community Development Plan (CDP).

### ***2.9 Seedbed Preparation***

Seedbed preparation utilizes a number of techniques to prepare the soil physically for planting by removing compaction, breaking-up large soil aggregates, and developing a firm, but not compacted, seedbed. Seedbed preparation increases availability of water to plants, improves root penetration, removes competing vegetation, and promotes contact between planted seeds and the surrounding soil. Depending on the nature of the soil material, seeding and planting methods, and climate, a number of techniques can be used for seedbed preparation.

Seedbed preparation techniques can be divided into primary and secondary tillage operations. Primary tillage is commonly used to reduce compaction in deep layers but also leaves the surface relatively rough. Secondary tillage is used to reduce surface roughness and to create a firm seedbed.

Ripping, chisel plowing, and disking are the most common primary tillage techniques. Heavily compacted areas will be ripped prior to application of plant growth material. Potentially compacted areas include roads, trails, equipment storage areas, and other areas of equipment operation. Areas where vehicles with rubber tires have been operated can become severely compacted and may require ripping to greater depths than other compacted areas.

Rippers are used to break up highly compacted layers at both deep and shallow depths. Ripping can improve root and water penetration and reduce slippage at the contact between the placed soil and the underlying material. Subsoilers are another form of ripping equipment comprising small ripper-type shanks that break up medium-depth compaction while minimizing disturbance to surface layers. Chisel plows can be used with normal farm equipment to “cut” through heavy soils and break up compacted topsoil. Disking can also be used to break up heavy soils and is effective in mulching crop residues because it “mixes” vegetation cover with underlying soils.

Common secondary tillage methods include harrowing, packing, and rolling. Tooth harrowing, which involves raking the surface layers to a relatively shallow depth, is one of the most commonly used harrowing methods. Harrowing is an effective method of seedbed preparation because it breaks up the large aggregates and crusts and also closes air pockets present in surface soil layers. Cultipackers are toothed rings or tires on a shaft that are used to firm (pack) and smooth the seedbed. Rolling is also used both before and after planting to create a firm seedbed and establish good seed/soil contact.

### ***2.10 Seeding Methods***

There are two basic seeding techniques for reclaiming sites: drill-seeding and broadcast-seeding. Although settling of the tailing in the tailing repositories will be enhanced by the addition of a flocculant, insufficient consolidation will have occurred to allow the use of heavy equipment in the early stages of reclamation; therefore, broadcast seeding will be the most suitable technique. This will also be beneficial from the employment perspective.

### ***2.11 Tree and Shrub Planting***

Trees will be planted by first excavating a 30- to 45-centimeter (cm)-wide area to a depth necessary to properly position seedlings. Seedlings will be placed into the hole in as nearly a vertical position as possible. Depending on the soil quality, fertilizer packs may also be planted with seedlings to provide nutrients during initial establishment. After placement, the hole will be partially backfilled, and the soil material will be partially packed. The hole will then be filled with water and backfilled using the remaining soil. In areas of poor soil quality, stockpiled topsoil may also be placed into the hole.

A small collection basin will then be formed around the seedling stem to catch water. Once the seedling has been transplanted, mulch will be applied to the area. A shingle or slat may then be placed adjacent to the seedling in a position that will decrease incident solar radiation and, as a result, decrease the potential for water loss via evaporation and transpiration. The installation of tubes or cages may be considered to protect the seedlings until they have become well established.

### ***2.12 Fertilizer Application***

Mineral fertilizers leach readily from soils and can inhibit the establishment of native plants and germination of leguminous species. Consequently, organic fertilizers will be used as needed and

in the place of mineral fertilizers, where possible. A number of organic fertilizers are available for soil amendment.

Compost can be used as an organic fertilizer amendment. A composting program will be implemented as part of the WMP. Compost is an excellent organic fertilizer that will be used to amend soils with poor nutrient quality. Ash from the combined heat and power unit (CHP) plants may be an option for soil amendments as well. Horse and cow manure is not available as these animals are not raised in the area at the current time.

Numerous commercially available organic fertilizer products are also now available and represent viable alternatives to using mineral fertilizers. GeoCam will conduct soil tests to determine the most suitable fertilizer treatments. Care will be taken so that areas are not over-fertilized because high rates of fertilizer application are expensive and encourage establishment of weedy species.

### **2.13 Irrigation**

The Nkamouna area is characterized by high rainfall (over 1,700 millimeters [mm] per year) as described in the Environmental and Social Impact Assessment (Volume 1), which will preclude the need for irrigation.

### **2.14 Revegetation Tests**

Where practical, tests will be conducted to evaluate alternative revegetation strategies. Such tests could be used to evaluate more viable and economic strategies for revegetating potential problem areas such as tailing repositories. The concurrent reclamation of the tailing areas offers good opportunities to test and demonstrate the comparative success of a variety of reclamation strategies. Other studies may include evaluation of alternative fertilizer and mulch treatments. The results of these tests will be used to modify the revegetation program as appropriate.

### **2.15 Management of Exotic Species**

A weed management program will be implemented as part of operations to control the establishment of exotic plant species at the project site. Exotic species of concern include *Cecropia peltata*, which is already established in certain parts of Cameroon, lantana (*Lantana camara*), and Siam weed (*Chromolaena odorata*). Although Lantana and Siam weed are not currently a problem in the project area, they are problem species in other areas of Africa,

particularly western Africa. Siam weed is a perennial shrub native to south and central Asia and has become a serious pest in Africa. The weed spreads rapidly in areas used for forestry and agriculture, pasture, and plantation areas. Siam weed is known to be present in Cameroon. Once this species is established, it is difficult to eradicate.

To limit the potential introduction of exotic plant species to disturbed sites within the project area, a weed management program, which will include burning, will be implemented during operations. The weed management program will include surveys to identify exotic species and the use of physical, mechanical, or chemical control treatments.

### ***2.16 Revegetation Monitoring***

Following completion of revegetation activities, seeded and planted areas will be monitored to determine seedling survival and overall revegetation success. Monitoring will include field reconnaissance during the first growing season to evaluate seedling emergence. The establishment of weeds will also be monitored for at least a two-year period. In the case that weeds are observed, they will be physically, mechanically, or chemically treated to limit their establishment. Monitoring will also be used to identify areas that may require supplemental irrigation.

In general, post-reclamation monitoring will be performed four times per annum, at the end of each wet and dry season, for a minimum two-year period following completion of reclamation activities. Post-reclamation monitoring will begin once site grading and revegetation is completed. Monitoring data will be reviewed to determine if reclamation objectives have been achieved. Based on the results of this review, the various programs will be continued or modified, as required. The two-year period should be adequate for documenting compliance with reclamation objectives; reclamation monitoring will be terminated once the reclamation objectives have been achieved.

### **3.0 Specific Mine Closure and Reclamation of Affected Areas**

This section discusses specific mine reclamation and closure activities for the Nkamouna Project and describes the aerial extent of the surface disturbances and the proposed reclamation methods (Section 2.0) that have been used to develop the closure and reclamation cost estimates. The surface disturbances for each area are summarized in Table 1. These areas correspond to the aerial extent of disturbance used in the budget calculation presented in Table 2.

The Environmental, Health and Safety Manager will be responsible for the planning, development, implementation, monitoring, and continuous improvement of closure and reclamation activities.

#### **3.1 Open Pits**

Reclamation of the mined pits includes backfilling of separate pits with either mine waste, PUG plant middlings or manganese precipitate concurrent with operations, as described in Section 2.2 above and in the Environmental and Social Impact Assessment (Volume 1). After backfilling, revegetation will be started to form a root mat capable of stabilizing the surface sufficiently for planting trees. Wood ash/chips and seed may be added to the last fill layer to advance stabilization and expedite plant growth. Assuming that initial revegetation efforts can be accomplished within a 180-day period, one year would be required to mine, backfill, and reclaim a typical panel to its final landform.

#### **3.2 Roads and Trails**

The project will reclaim a total of approximately 8 hectares (ha) of roads and trails. The only roads through the mine area will be those allowing access to mine operations. Roads requiring closure will be ripped to remove compaction. Once ripped, roads will be regraded to blend with the local topography, limit erosion, and promote natural drainage.

Culverts will be removed where necessary and the disturbed area regraded to allow for unobstructed drainage. Water bars, or small berms, approximately 25 cm tall will be built as needed along regraded road surfaces to reduce overland flow. The water bars will also allow flow away from the water bar toward a natural draw or channel.

In addition to the roads, trails on site must also be reclaimed. Only minor scarification, regrading, and revegetation will be required to return trails to their natural topography and to provide proper drainage. Stockpiled soils will be pulled back over the regraded road surface. Stockpiled soils will be placed to an average depth of 50 mm. The areas will have seedbeds prepared and will subsequently be seeded. Application of mulch will follow seeding. As required, storm water controls, slope reductions, or armoring will be used to control storm water and erosion.

### ***3.3 Domestic and Hazardous Waste Facilities***

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. The Domestic Waste Facility will include a compacted soil cover (600 mm) as part of final closure. Final closure of the Hazardous Waste Facility will also require a soil cover that will be vegetated and shaped to promote drainage of surface runoff. It is noted that the primary, secondary, and tertiary containment for hazardous waste will be included in the concrete containment vaults described in the WMP. This allows the reclamation program to cover the landfill vaults without a prescriptive capping system because adequate hazardous waste containment is already provided with the vault system.

### ***3.4 PUG and Leach Plants and Ancillary Facilities***

Closure of the site will include the decommissioning, demolition, relocation or disposal of the PUG and Leach Plants and ancillary facilities, which have a footprint of approximately 30 ha. Remaining facilities after relocating plant and equipment will be completely demolished and removed at the end of mining operations.

Salvaging of equipment and facilities will be encouraged. Disposal of various plant components will follow the guidelines of the WMP (Volume 2). Following disposal of the Plants, the entire area will be ripped, graded to blend with the surrounding topography, and vegetated.

### ***3.5 Napene Creek Tailings Facility***

As described in Section 2.2 above and in the Environmental and Social Impact Assessment (Volume 1), the NCTSF will be reclaimed by adding wood ash/chips and seed to the last fill layer to advance stabilization and expedite plant growth. Once an adequate vegetation cover is established, tree seedlings will be planted.

### **3.6 Monitoring**

Closure and post-closure monitoring will document the progress of the closure/reclamation effort. The elements of the closure and post-closure monitoring programs will include the following:

- Confirm the long-term stability of reclaimed tailing repositories.
- Evaluate the success of revegetated areas using ground cover, species diversity, and productivity (in reclaimed areas) as measurement tools.
- Assess the adequacy and performance of drainage structures and sediment control systems.
- Demonstrate that water quality objectives are met.

Monitoring and control programs will be conducted four times per year during operations, at the end of each dry and wet season, as described in the Environmental and Social Action Plan (ESAP – Volume 2). These programs will also be conducted during the closure and post-closure periods. In the event that deficiencies in vegetation establishment are identified, appropriate mitigation measures will be taken to correct these deficiencies. Post-closure monitoring will continue until a self-sustaining forest is established.

Monitoring will include field reconnaissance during the first growing season to evaluate revegetation success. The establishment of exotic plant species will also be monitored. In the event that exotic plants are observed, they will be physically, mechanically, or chemically removed or treated to limit their establishment. Monitoring will also be used to identify areas that may require supplemental irrigation or nutrients.

## ***4.0 Implementation of Schedule and Costs***

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The project development plan calls for a fixed amount of disturbance for mine area facilities, the processing plant, pipelines, the Napene Creek tailing storage facility, and related infrastructure. Given the long mine life and planned reclamation schedule, the reclamation bond estimate will be based on a revolving amount of annual disturbance as each mine pit is developed and partially reclaimed. Following initial disturbance for fixed facilities required for exploitation, an estimated 20 hectares will be reclaimed annually within each 30 hectare pit. The contractor construction camp and laydown yard will be reclaimed once facility construction is completed. Table 1 lists the annual disturbed and reclaimed areas. This approach provides incentive for GeoCam to complete concurrent reclamation activities in a timely fashion for operational reasons while limiting the amount of their financial assurance and reclamation obligations.

### ***4.1 Costs***

For the purposes of estimating the financial assurance, costs were taken from Means CostWorks 2004 and converted into the metric equivalent. Costs are based upon U.S. union labor costs and U.S. equipment costs. The basic assumption is that the high productivity in the U.S. offsets differences in labor and equipment costs for working overseas so that the unit costs are essentially equivalent. All revegetation costs were based on \$0.78/m<sup>2</sup>, which is based on a cost from the Castle Mountain Mine, where reclamation was particularly difficult. Reclamation costs are estimated to be US\$ 14 million (see Table 2).

### ***4.2 Reclamation Plan***

A discussion of the reclamation and closure plan by area as listed in the financial assurance cost estimate follows.

#### ***4.2.1 Earthworks***

##### ***4.2.1.1 Roads***

There are two types of roads considered in the reclamation plan: haul roads and service or access roads. Road reclamation of both types of roads is assumed to be similar and consist of ripping the road to relieve compaction and then pulling the berms back across the road for use as growth media. Haul roads are assumed to have a nominal 2-m-high berm on both sides of the road and to be approximately 25 m wide. It is further assumed that the roads would be ripped to a depth

of 0.5 m. The total estimated volume of earthworks to reclaim a hectare of haul roads is 7,400 cubic meters (m<sup>3</sup>).

#### **4.2.1.2 Drill Sites and Drill Hole Abandonment**

It is assumed that the exploration and associated disturbance will occur within the disturbance limits of the pits and will either be mined out or reclaimed with the pit areas. As a best management practice, GeoCam may plug and abandon all drill holes before the drill rig is moved to the next drill site. Dry holes will be plugged to a nominal 1 m below the collar, and a bentonite-cement grout will be used to plug the top 1 m of the hole. Wet holes will be reclaimed by plugging the hole from the bottom to the top with an appropriate well plugging grout. The top 1 m of the hole will have a bentonite-cement grout placed in it. Grout will be placed in holes and pressed flush with the ground surface. Permanent identification monumentation in the form of a metal tag will be set into the cement. Drill holes will be plugged at the end of each drill campaign.

#### **4.2.1.3 Pits and Trenches**

The pits and trenches will be reclaimed concurrently with the mining operations. There are no adits or underground workings proposed for the project since the ore deposit is located relatively near the surface.

#### **4.2.1.4 Process Ponds**

The costs for reclaiming process ponds are based on detoxification and disposal of wastes. The process and storm water ponds will be reclaimed by removing any toxic sludge and disposing of the material appropriately, cutting, folding, and burying in place any liners and backfilling the pond to prevent ponding of water.

#### **4.2.1.5 Heaps**

There are no proposed heap leach facilities associated with the Nkamouna Project.

#### **4.2.1.6 Dumps**

The Nkamouna Project has one solid waste landfill. It is assumed that the landfill will be operated similar to a Class-III landfill with only construction, office, and other non-hazardous waste being placed disposed of in the landfill. The landfill will be regraded and covered with a minimum of 1 m of cover soil and revegetated.

In addition to the waste/overburden that is placed in the pits, approximately 15 acres of disturbance will be associated with the storage of waste rock and overburden from the pits. The additional waste rock storage areas will be regraded and covered with 0.5 m of growth media or cover soil.

#### ***4.2.1.7 Tailing***

Costs for the reclamation of the NCTSF include intermixing of wood chips and ash with the tailings during the last two years of operation to develop a growth medium for revegetation, the earthworks required for construction of a spillway over the dam and planting of tree seedlings after the establishment of an adequate vegetation cover.

#### ***4.2.1.8 Structure and Building Areas***

Reclamation of the structure and building areas involves the breaking and demolition of any building foundations and containment areas. After the foundations and containment areas have been broken and piled together, the areas will be covered with a minimum of 0.5 m of growth media and revegetated.

#### ***4.2.1.9 Storage and Equipment Areas***

Storage and equipment areas include stockpile areas and construction lay-down areas, equipment ready lines, and other miscellaneous areas. For the purposes of the cost estimate, it is assumed that stockpiles will be consumed prior to the area being reclaimed. Reclamation will involve ripping and scarifying to relieve compaction and covering with 0.5 m of growth media.

#### ***4.2.1.10 Drainage Control***

It is estimated that two hectares of temporary diversion ditches will be constructed during the first four years of operations. For the purposes of the cost estimate, it was assumed that the ditches will be excavated and the material placed along the down-gradient embankment. It is assumed that the diversion would be 8 m wide with 2.5:1 (horizontal:vertical) side slopes. The diversion ditches are assumed to be 1.5 m deep, which includes 0.5 m of freeboard. Reclamation will consist of pushing the stockpiled down-gradient material into the ditch followed by reseeding.

Permanent diversion ditches will be constructed to a final stable configuration and will not require reclamation.

#### **4.2.1.11 Mobilization and Demobilization**

Mobilization and demobilization costs are calculated as a percentage of the total operating costs consistent with current industry financial assurance estimating practices.

#### **4.2.2 Revegetation and Stabilization**

Consistent with GeoCam's support of sustainable development, revegetation plans call for the project site to be revegetated with grasses to control erosion along with the planting of appropriate tree types.

The majority of the revegetation costs involves the use of a tractor and mechanical broadcaster to seed the disturbed areas with an appropriate, approved seed mixture. It is anticipated that much of the area will actually be seeded by hand broadcasting with seeds harvested onsite. This will reduce the actual operational costs for GeoCam. Consistent with industry practice, costs are used for the tractor and mechanical broadcaster assuming that a third party would be hired in case of a default on the reclamation obligations.

For the purpose of the cost estimate, it is assumed that commercial grade trees would be planted from 0.5-m bare root stock in rows spaced 8.3 m apart. It is further assumed that the tree spacing within each row would be 3 m. This provides 396 trees per ha. The tree spacing is based upon industry practices for planting of orchards and woodlands.

#### **4.2.3 Detoxification, Water Treatment, and Disposal of Wastes**

##### **4.2.3.1 Process Pond Sludge**

For the purposes of calculating the financial assurance, it was assumed that the process ponds would have 0.25 m of sludge in the bottom that would need to be properly disposed of during reclamation. The sludge would be removed and hauled and placed in a mined out pit. It was assumed that the purified pond and storm water ponds would not have any toxic sludge that would require special handling during reclamation.

##### **4.2.3.2 Heaps, Dumps, and Tailing**

Based on GeoCam's current plans, there are no anticipated detoxification, water treatment, or disposal costs associated with heaps, waste rock storage facilities (dumps), the landfill, or the tailing.

#### **4.2.3.3 Surplus Water Disposal**

Based on current anticipated processing rates and anticipated storm events, it is estimated that up to 6,128,790 gallons of water may require disposal through enhanced evaporation. Costs have been included to cover the disposal of the anticipated surplus water.

#### **4.2.3.4 Monitoring Costs**

Costs for monitoring of the reclaimed areas for three years have been included based on a cost of \$18,000 per year to have a consultant perform a site review and document reclamation progress for release of the financial assurance.

#### **4.2.3.5 Hazardous Materials, Chemicals, and other Reagents**

These costs cover the disposal or removal of any hazardous materials, chemicals, and reagents that may be left at the site upon closure. These costs have been estimated at 5 percent of the process pond sludge removal and surplus water disposal costs.

#### **4.2.4 Structure, Equipment, and Facility Removal Costs**

Costs for the demolition of the buildings and structures are included in this section. It is assumed that the debris from the building demolition will be disposed of on site in the landfill. It was assumed that the majority of the buildings will be small, one-story buildings. The cost includes an estimated 32 buildings located in the man camp.

#### **4.2.4.1 Operational Costs**

This section is the subtotal of the direct operational costs for performing the reclamation work. Mobilization and demobilization costs are calculated here as a percentage of the operational costs.

#### **4.2.4.2 Administrative Costs**

Administrative costs such as detailed reclamation and closure plan development costs, contingency, insurance, performance and payment bonds, contractor profit, and contract administration are calculated percentages of the operational costs are included in this section.

A general reclamation schedule has been developed for the Nkamouna Project. The schedule (Figure 1) shows the projected timing for both concurrent and final reclamation programs. In general, concurrent reclamation will begin immediately following completion of construction

activities. As areas are no longer required to support the mine operations, they will be reclaimed. Concurrent reclamation will continue throughout the life of the project as areas are no longer needed. These areas will be monitored on a quadri-annual basis as discussed in Section 4.0 above.

## ***5.0 Public Involvement***

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The public consultation process will provide local communities with an opportunity to become involved in the various stages of reclamation planning. Local communities will be consulted to determine post-mining land uses in order to determine any changes in preferences.

## Tables

**Table 1**  
**Nkamouna Environmental and Social Action Plan**  
**Initial and Total Disturbance and Reclamation Areas**  
**(A) = Annual Disturbance (L) = Long Term Disturbance**

	4,000 T Cobalt/Yr		8,000 T Cobalt/Yr		Total Project	
	Disturbance Hectares	Reclaimed Hectares	Disturbance Hectares	Reclaimed Hectares	Disturbance Hectares	Reclaimed Hectares
<b>MINE:</b>						
Pit (A)	30	20	60	45	660	660
Haul Roads (L)	2	0	4	0	10	10
Stream Diversions (L)	2	0	3	0	3	3
Waste Dumps (L)	5	0	10	0	30	30
Ore Stockpiles (L)	1	0	2	0	3	3
Service/Repair Shops (L)	2	0	2	0	3	3
<b>PROCESS PLANT:</b>						
PUG & Leach Circuits (L)	20	0	20	0	20	20
Napene Tailing Storage (L)	70	0	70	0	200	200
<b>WATER SYSTEMS:</b>						
Process Pipelines (L)	5	0	5	0	5	5
Fresh Water Pipelines (L)	2	0	2	0	3	3
<b>INFRASTRUCTURE:</b>						
Expatriate Village (L)	10	0	10	0	10	10
Sewage Leach Field (L)	1	0	1	0	2	2
Service Roads (L)	5	0	5	0	8	8
Electricity Distribution (L)	2	0	2	0	5	5
Aggregate Stockpile (L)	1	0	1	0	2	2
Solid Waste Disposal (L)	1	0	1	0	2	2
Airplane Landing Strip (L)	20	0	20	0	20	20
<b>CONSTRUCTION:</b>						
Contractor Camp (A)	3	3	3	3	3	3
Construction Laydown (A)	3	3	3	3	3	3
<b>TOTAL (hectares)</b>	<b>185</b>	<b>26</b>	<b>224</b>	<b>51</b>	<b>992</b>	<b>992</b>
<b>Net Unreclaimed/Year</b>		<b>159</b>		<b>173</b>		<b>0</b>

The Nkamouna project could possibly disturb 1,350 hectares if additional resources are mined and if the project is expanded to largest extent foreseeable.

**Table 1 - Nkamouna Project  
Reclamation Cost Model  
Reclamation Cost Estimate Summary**

Item	Hectares	Quantity	Unit	Cost/Unit	Total	Comments
<b>A. Earthwork/Recontouring</b>						
1. Roads						
a. Haul Roads	10	74,000	cubic meter	\$2.51	\$185,740	Est. vol. earthwork per ha of road is 7,400 m <sup>3</sup> .
b. Service Roads	8	5,555	linear meter	\$4.36	\$24,220	
2. Pits	40	200,000	cubic meter	\$5.49	\$1,098,000	Cover - 0.5 m, regrade
3. Waste Rock Facilities and Landfills						
a. Waste Rock Facilities (Dumps)	30	300,000	cubic meter	\$5.49	\$1,647,000	Cover - 1 m, regraded
b. Solid Waste Landfill	2	20,000	cubic meter	\$5.49	\$109,800	Cover - 1 m, regraded
4. Tailing Storage Facility						
a. Surface Treatment	200					tailings during the last two years of operation to develop a growth medium for revegetation. Unconsolidated tailings will be prevent the use of equipment on the surface.
b. Earthwork		3,000	cubic meter	\$5.49	\$16,470	Concrete spillway and related water control structures
c. Concrete		1,100	cubic meter	\$500.00	\$550,000	
5. Structure & Building Areas						
a. Service Repair Shops	3	15,000	cubic meter	\$5.49	\$82,350	Cover - 0.5 m, regraded
b. PUG & Leach Circuits	20	100,000	cubic meter	\$5.49	\$549,000	Cover - 0.5 m, regraded
c. Expatriate Village	10	50,000	cubic meter	\$5.49	\$274,500	Cover - 0.5 m, regraded
d. Sewage Leach Field	2	10,000	cubic meter	\$5.49	\$54,900	Cover - 0.5 m, regraded
e. Electricity Distribution	5	25,000	cubic meter	\$5.49	\$137,250	Cover - 0.5 m, regraded
f. Landing Strip	20	100,000	cubic meter	\$5.49	\$549,000	Cover - 0.5 m, regraded
g. Contractor Camp	3	15,000	cubic meter	\$5.49	\$82,350	Cover - 0.5 m, regraded
h. Process Pipelines	5	25,000	cubic meter	\$5.49	\$137,250	Cover - 0.5 m, regraded
i. Fresh Water Pipelines	3	15,000	cubic meter	\$5.49	\$82,350	Cover - 0.5 m, regraded
6. Storage & Equipment Areas						
a. Ore Stockpiles	3	15,000	cubic meter	\$2.51	\$37,650	Scarify and regrade
b. Aggregate Stockpiles	2	10,000	cubic meter	\$2.51	\$25,100	Scarify and regrade
c. Construction Laydown	3	15,000	cubic meter	\$2.51	\$37,650	Scarify and regrade
7. Drainage Control						
a. Stream Diversions	3	26,000	cubic meter	\$5.49	\$142,740	Excavation of bank and Regrading
<b>Subtotal "A"</b>	<b>372</b>				<b>\$5,823,320</b>	

**Table 1 - Nkamouna Project  
Reclamation Cost Model  
Reclamation Cost Estimate Summary**

Item	Hectares	Quantity	Unit	Cost/Unit	Total	Comments
<b>B. Revegetation/Stabilization</b>						
1. Roads						
a. Haul Roads	10	100,000	square meter	\$0.78	\$78,000	
b. Service Roads	8	80,000	square meter	\$0.78	\$62,400	
2. Pits	40	400,000	square meter	\$0.78	\$312,000	
3. Waste Rock Facilities and Landfills						
a. Waste Rock Facilities (Dumps)	30	300,000	square meter	\$0.78	\$234,000	
b. Landfills	2	20,000	square meter	\$0.78	\$15,600	
4. Tailings	200	2,000,000	square meter	\$0.78	\$1,560,000	
5. Structure & Building Areas						
a. Service Repair Shops	3	30,000	square meter	\$0.78	\$23,400	
b. PUG & Leach Circuits	20	200,000	square meter	\$0.78	\$156,000	
c. Expatriate Village	10	100,000	square meter	\$0.78	\$78,000	
d. Sewage Leach Field	2	20,000	square meter	\$0.78	\$15,600	
e. Electricity Distribution	5	50,000	square meter	\$0.78	\$39,000	
f. Landing Strip	20	200,000	square meter	\$0.78	\$156,000	
g. Contractor Camp	3	30,000	square meter	\$0.78	\$23,400	
h. Process Pipelines	5	50,000	square meter	\$0.78	\$39,000	
i. Fresh Water Pipelines	3	30,000	square meter	\$0.78	\$23,400	
6. Storage & Equipment Areas						
a. Ore Stockpiles	3	30,000	square meter	\$0.78	\$23,400	
b. Aggregate Stockpiles	2	20,000	square meter	\$0.78	\$15,600	
c. Construction Laydown	3	30,000	square meter	\$0.78	\$23,400	
7. Drainage Control.						
a. Stream Diversions	3	30,000	square meter	\$0.78	\$23,400	
<b>Subtotal "B"</b>	<b>372</b>				<b>\$2,901,600</b>	

**Table 1 - Nkamouna Project  
Reclamation Cost Model  
Reclamation Cost Estimate Summary**

Item	Hectares	Quantity	Unit	Cost/Unit	Total	Comments
<b>C. Detoxification, Water Treatment &amp; Disposal of Wastes</b>						
1. Process Ponds/Sludge (0.25 Deep)						
a. Process Water		2,175	tonne	\$166.45	\$362,029	
b. PLS Pond		725	tonne	\$166.45	\$120,676	
c. Sx Raffinate Pond		725	tonne	\$166.45	\$120,676	
2. Surplus Water Disposal		6,128,790	gallon	\$0.0084	\$51,482	
3. Monitoring		3	year	\$18,000	\$54,000	
4. Hazardous Materials and Chemicals / Other Reagents <sup>1</sup>					\$32,743	5% of Items C.1 & C.2
<b>Subtotal "C"</b>					<b>\$741,606</b>	
<b>D. Structure, Equipment, and Facility Removal</b>						
1. Small Buildings and Structures:						
a. Man Camp - 32 1 story buildings		32	each	\$2,725	\$87,200	
b. Process Area - 22 1 story buildings		22	each	\$2,725	\$59,950	
2. Large Buildings and Structures:						
a. Service / Repair Shops (20000 m <sup>2</sup> x 4.5 m)		90,000	cubic meter	\$0.33	\$29,700	Cubic meter of intact building volume.
b. CCD Thickeners (400 m x 220 m x 6 m)		528,000	cubic meter	\$0.33	\$174,240	
c. Mill & Primary Thickener (350 m x 80 m x 6 m)		168,000	cubic meter	\$0.33	\$55,440	
d. Warehouse (220 m x 110 m x 4.5 m)		108,900	cubic meter	\$0.33	\$35,937	
e. Flash Dryer/Co-Ni recovery (80 m x 350 m x 6 m)		168,000	cubic meter	\$0.33	\$55,440	
<b>Subtotal "D"</b>					<b>\$497,907</b>	
<b>E. Direct Reclamation Costs</b>						
1. Total of A, B, C, & D					\$9,964,433	
2. Mobilization/Demobilization Amount					\$448,399	4.5% of Item E.1
<b>Subtotal "E"</b>					<b>\$10,412,832</b>	

**Table 1 - Nkamouna Project  
Reclamation Cost Model  
Reclamation Cost Estimate Summary**

Item	Hectares	Quantity	Unit	Cost/Unit	Total	Comments
<b>F. Administrative Costs</b>						
1. Engineering Design and Construction (ED&C) Plan <sup>2</sup>					\$624,770	6% of Direct Costs, Item E.
2. Contingency <sup>3</sup>					\$833,027	8% of Direct Costs, Item E.
3. Insurance <sup>4</sup>					\$156,192	On site liability 1.5% of Item E.
4. Bond <sup>5</sup>					\$312,385	Performance 1.5% and Payment 1.5% of Item E.
5. Contractor Profit <sup>6</sup>					\$1,041,283	10% of Direct Costs, Item E.
6. Contract Administration <sup>7</sup>					\$833,027	8% of Direct Costs, Item E.
<b>Subtotal "F"</b>					<b>\$3,800,684</b>	
<b>G. Grand Total (E and F)</b>					<b>\$14,213,516</b>	

**Footnotes**

- Handling of hazardous materials and chemicals/other reagents includes the cost of decontaminating, neutralizing, disposing, treating, and/or isolating all hazardous materials/chemicals/reagents used, produced, or stored on the site.
- Engineering design and construction (ED&C) plans are often necessary to provide details on the reclamation needed to contract for the required work. To estimate the cost to develop an ED&C plan use 4-8% of the O&M cost (Line E). Calculate the ED&C cost as a percentage of the O&M cost as follows: up to and including \$1 million, use 8%; over \$1 million to \$25 million, use 6%, and over \$25 million, use 4%. Inclusion of a line item for the development of an ED&C plan may not be necessary for small operations, such as notice-level exploration. With small, uncomplicated reclamation efforts construction may be able to proceed with out developing an ED&C plan.
- A contingency cost is included in the cost estimation to cover variables in estimated reclamation costs. Calculate the contingency cost as a percentage of the operational project costs as follows: up to and including \$500,000, use 10%; over \$500,000 to \$5 million, use 6%; and greater than \$5 million, use 4%. As with the ED&C cost, inclusion of a contingency cost may not be necessary for small operations, such as notice-level exploration.
- Insurance premiums are calculated at 1.5% of the total manpower costs. Enter the premium amount on this line if insurance items listed in #1 above are not included in the itemized unit costs.
- Federal construction contracts exceeding \$100,000 require both a performance and a payment bond (Miller Act, 40 USC 270 et seq.). Calculate the total performance bond and the payment bond premium at 3% of the O&M cost (Line E). Each bond premium is figured at 1.5% of the O&M cost.
- For Federal construction contracts, use 10% of estimated O&M cost (Line E) for Contractor profit.
- To estimate the contract administration cost, use 6 to 10% of the operational and maintenance (O&M) cost (Line E). Calculate the contract administration cost as a percentage of the O&M cost as follows: up to and including \$1 million, use 10%; over \$1 million to \$25 million, use 8%; and greater than \$25 million use 6%.

**Figure**

