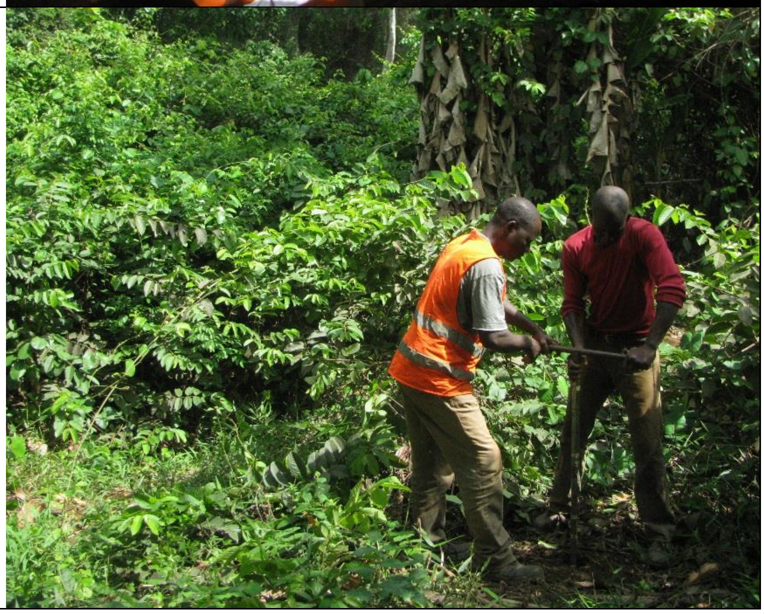
Yaoure Gold Project, Côte d'Ivoire

Environmental and Social Impact Assessment
Soil Management and Monitoring Plan



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Earth Science Solutions (Pty) Ltd (Original)
2D Consulting Afrique, Cote d'Ivoire (Update)

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DISCLAIMER

Summary of Management Requirements

The soils, land capability and land use are considered important aspects of any environmental and social management system (ESMS) when considering a new development. Mining requires that these important resources are considered throughout the project life cycle.

During the pre-construction and construction phase the following actions will be initiated:

- Stripping will occur where soils are to be disturbed by activities that are described in the design report, and where a clearly defined end rehabilitation use for the stripped soil has been identified;
- All in-situ vegetation is to be stripped along with the utilisable soil and stored as part of the utilisable soil stockpile, taking cognisance of any biodiversity requirements. This will preserve the vegetative seed pool and assist in natural regeneration of a vegetative cover to the soil stockpiles;
- Soils will be handled in dry weather conditions wherever possible to cause as little compaction as possible, and soil should be stripped to the utilisable depth where available and stockpiled separately from the lower "B" horizon and all soft overburden/softs (decomposed rock);
- Stockpiling areas will be identified in close proximity to the source of the soil and to the area of end use so as to limit handling and haulage distances, and to promote reuse of soils in the correct areas;
- The soil utilisation plan is intimately linked to the mine development plan, and it should be understood that if this plan of construction changes, these requirements will have to change as well.

During the operational phase it is required that:

- Rapid growth of vegetation on the soil stockpiles is encouraged/promoted (e.g. by means of seeding and use of soil additives/fertilisation if necessary) so as to protect the soils and combat erosion by water and wind;
- Stockpiles will be established with storm water diversion berms to prevent run off and reduce erosion;
- Soil stockpile heights to be restricted to <2m for areas where soils are to be retained for less than 3 years (reduce compaction and damage to the seed pool), while the long term (>3 years) storage of soils or where 2m not possible, stockpiles should be benched to a maximum height of 6m. For storage periods greater than 3 years, vegetative cover is essential, and should be encouraged using fertilisation and induced seeding with water if necessary.

Where possible slopes will be stabilised at a slope of 1 in 2, to promote vegetation growth and reduce erosion.

- Equipment movement on the soil stockpiles and/or rehabilitated ground will be limited to avoid topsoil compaction and damage to the seedbank.

The decommissioning and closure phase will see:

- The removal of all infrastructure other than that agreed with the government authorities to be left in place;
- The demolishing of all concrete slabs/plinths and the ripping of any hard/compacted surfaces;
- The backfilling of all voids and deep foundations and the reconstruction of the required barrier layer (compaction of ferricrete and clay rich materials) wherever feasible and possible;
- Topdressing of the disturbed and backfilled areas with the stored "utilisable" soil ready for re-vegetation;
- Fertilisation and stabilisation of the backfilled materials and final cover materials (soil and vegetation) if/where necessary;
- The landscaping of the replaced soils to be free draining.

Information supplied in the project description (ESIA – 2015) documents the areas that will be disturbed by the different activities for the development being planned. These figures (Refer to Table 0-1) are used to calculate the soil volumes that need to be stored assuming a 500mm stripping depth, and compares this to the volumes considered necessary for rehabilitation assuming a 200mm cover depth.

Table 0-1: Footprints of Project Infrastructure Elements (rounded)

Infrastructure element	Area (ha)	Soil stripping (ha)	Comments
Camp	9	9	
Plant & Admin Office Area	43.5	43.5	
Waste Dump	147	147	
Recycling and Waste Disposal	0.5	0.5	
TSF Pond	125	125	
TSF Embankment/s	72	72	
Water Storage Dam	9	9	
Pit	50		No soil is stripped from pit area because it is already disturbed by previous activities
ROM Pad & Stockpile	27		No soil stripping (former HL area)
Haul Roads	25	25	Assuming 25 m width
Other Site Roads	5	5	Assuming 8m width
Perimeter Fence	5	5	
New Workshop (MSA)	10	10	
Water Line Corridor – Plant to TSF	3.5	3.5	
Gendarme Accommodation	0.5	0.5	
HV Powerline Corridor	6.5	6.5	
Magazine Area	2	2	
Total footprint	**540.5**	**463.5**	

- Stockpiled: 463.5 ha x 0.5 m = 2.32 million m^3

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Figure 1-1: Potential End Land Use Objectives for Yaoure Gold Mine **Error! Bookmark not defined.**

GLOSSARY

Alluvium: Refers to detrital deposits resulting from the operation of modern streams and rivers.

Base status: A qualitative expression of base saturation. See base saturation percentage.

Buffer capacity: The ability of soil to resist an induced change in pH.

Calcareous: Containing calcium carbonate (calcrete).

Catena: A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage.

Clast: An individual constituent, grain or fragment of a sediment or sedimentary rock produced by the physical disintegration of a larger rock mass.

Cohesion: The molecular force of attraction between similar substances. The capacity of sticking together. The cohesion of soil is that part of its shear strength which does not depend upon inter-particle friction. Attraction within a soil structural unit or through the whole soil in apedal soils.

Concretion: A nodule made up of concentric accretions.

Crumb: A soft, porous more or less rounded ped from one to five millimetres in diameter. See structure, soil.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Denitrification: The biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertilizer: An organic or inorganic material, natural or synthetic which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand: (1) A soil separate consisting of particles 0.25-0,1mm in diameter. (2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0.25-0,05mm in diameter) more than 60% of the sand fraction.

Fine textured soils: Soils with a texture of sandy clay, silty clay or clay.

Hardpan: A massive material enriched with and strongly cemented by sesquioxides, chiefly iron oxides (known as ferricrete, diagnostic hard plinthite, ironpan, ngubane, ouklip, laterite hardpan), silica (silcrete, dorbank) or lime (diagnostic hardpan carbonate-horizon, calcrete). Ortstein hardpans are cemented by iron oxides and organic matter.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, mapable at 1:250,000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Mottling: A mottled or variegated pattern of colours is common in many soil horizons. It may be the result of various processes *inter alia* hydromorphy, illuviation, biological activity, and rock weathering in freely drained conditions (i.e. saprolite). It is described by noting (i) the colour of the matrix and colour or colours of the principal mottles, and (ii) the pattern of the mottling. The latter is given in terms of abundance (few, common 2 to 20% of the exposed surface, or many), size (fine, medium 5 to 15mm in diameter along the greatest dimension, or coarse), contrast (faint, distinct or prominent), form (circular, elongated-vesicular, or streaky) and the nature of the boundaries of the mottles (sharp, clear or diffuse); of these, abundance, size and contrast are the most important.

Nodule: Bodies of various shapes, sizes and colour that have been hardened to a greater or lesser extent by chemical compounds such as lime, sesquioxides, animal excreta and silica. These may be described in terms of kind (durinodes, gypsum, insect casts, ortstein, iron, manganese, lime, lime-silica, plinthite, salts), abundance (few, less than 20% by volume percentage; common, 20 – 50%; many, more than 50%), hardness (soft, hard meaning barely crushable between thumb and forefinger, indurated) and size (threadlike, fine, medium 2 – 5mm in diameter, coarse).

Overburden: A material which overlies another material difference in a specified respect, but mainly referred to in this document as materials overlying weathered rock

Ped: Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedocutanic, diagnostic B-horizon: The concept embraces B-horizons that have become enriched in clay, presumably by illuviation (an important pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky structure. In the case of a red pedocutanic B-horizon, the transition to the overlying A-horizon is clear or abrupt.

Pedology: The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Slickensides: In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickensides. They occur in clayey materials with a high smectite content.

Sodic soil: Soil with a low soluble salt content and a high exchangeable sodium percentage (usually EST > 15).

Swelling clay: Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand subseparates.

Vertic, diagnostic A-horizon: A-horizons that have both, a high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

1.0 SOIL MANAGEMENT PLAN

1.1 General

In accordance with the IFC PS, 2012, and the concept of sustainability, it is incumbent on any developer to not only assess and understand the possible impacts that a development might cause, but to also propose and table management measures that will aid in minimising and where possible mitigate the effects of any actions.

The management of the natural resources (soils, land capability and land use) follows a phase by phase approach using the same philosophy that was used in the impact assessment process. This involved the assessment of the construction phase, the operational phase and the decommissioning/closure phases as separate entities. This philosophy is in keeping with the need for different actions and activities through the Environmental and Social Management System (ESMS) process, a plan that is designed as a working plan and utilisation guide for soil and land use management.

The results tabled are based on the site-specific soil characterisation and classification in conjunction with the geomorphology (topography, altitude, attitude, climate and ground roughness) of the sites that will be impacted or affected.

The plan specifies how the stripping and handling of the soils will be carried out throughout the life of the development along with considerations for how the soils will be utilised for rehabilitation at closure.

It has been assumed that all infrastructure will be removed (except where the authorities agree otherwise) and that the areas that were affected will be returned to as close as possible their pre-construction state, and the end land use is assumed to be natural grasslands.

The concept of stripping and storage of all "utilisable" soil is required as part of any sustainable development.

The following soil utilisation guidelines are considered as guiding principles for the proposed mining and its associated support activities:

- Over areas of deep excavation (Open Pit Mining or Deep excavations/foundations where the majority or all of the soil profile is to be impacted) strip all usable soil from the profile to a depth of 500mm and stockpile as berms of 2m or less and/or low, terraced dumps of less than 6.0m;
- Alluvial soils are to be stockpiled separately from the colluvial (shallower) and in-situ derived materials, which in turn are to be stored separately from any ferricrete material, while the soft overburden is stored as a separate unit, as a defined dump of less than 6.0m in height in close proximity to the final end use;
- Stockpile hydromorphic (wet) soils separately from the dry materials, and the "ferricrete" separately from all other materials;

- Protect all soils stockpiles from contamination and erosion by rock cladding or vegetation cover and ensure adequate drainage of surface runoff. Natural regeneration is acceptable if adequate cover is achieved;
- Over areas planned for less invasive structures (Offices, Workshops etc.) and any material stockpile or storage, strip the top 500mm of usable soil over all affected areas including terraces and strip remaining usable soil and ferricrete (if present in profile) where founding conditions require further soil removal;
- At rehabilitation replace the soft overburden followed by the ferricrete (where present), compact initial layer followed by emplacement of the soil cover to appropriate soil depths (100mm to 300mm), and cover areas to achieve an appropriate topographic aspect and attitude with a free draining landscape as close as possible the pre-mining/construction land capability rating;
- At closure/rehabilitation, remove all large boulders and gravel from the rehabilitated landscape and place at the base/bottom of the open pit or rehabilitation profile so that they do not interfere with the tillage and cultivation of the final surface. Remove foundations to a maximum depth of 1m;
- Replace soil to appropriate soil depths over disturbed areas and in appropriate topographic position to achieve pre-development land capability and land form where possible;
- Over areas of TSF, WRD and all heavy vehicle haulage roads and major access routes, strip usable soil to a depth of 750mm where possible and at least 500mm wherever possible. Stockpile hydromorphic soils separately from the dry and friable materials;
- Over areas to be utilised for general access roads (light delivery vehicles), laydown pads and any conveyencing servitudes (above ground pipelines and power line servitudes) strip the top 150mm of usable soil over all affected areas and stockpile in longitudinal stockpile or berms upslope of the facilities. Protect from erosion and contamination.

1.2 Construction Phase

The construction methods and final end land use proposed in terms of the project guidelines and description require that sufficient utilisable soils is stripped and retained, for use in the rehabilitation process. Failure to remove and store the utilisable materials up front will result in the permanent loss of the growth medium.

Making provision for the retention/storage of utilisable material for the decommissioning and/or during rehabilitation will not only save significant costs at closure, but will ensure that additional impacts (borrow pits etc.) to the environment do not occur.

The depths of in-situ utilisable materials vary between <100mm and greater than 1,200mm.

Due to the shallow soil depths on the more rocky areas and ferricrete pavements it is important that sufficient materials are stripped and removed from the areas where the soils are deeper, so that the shallow areas can be adequately covered and rehabilitated (200mm) during rehabilitation and at closure.

The activities associated with the processing and open cast mining (pitting, haulage of waste rock and ore) and the associated infrastructure that is to be constructed (heavy industry and machinery) will require that Perseus strips sufficient soil from all footprint areas and stores this resource for future use. These stockpiles will need to be protected from erosion and compaction. Utilise natural regeneration of the vegetation by removing the vegetative cover along with the soils, and/or clad with waste rock.

The soils of low sensitivity are sufficiently similar in physical and chemical attributes that they can be stored as one soil group.

The sensitive and highly sensitive materials (wetland areas) should not be impacted unless absolutely necessary, and then only if the necessary authorisations having been considered).

Protection of the in-situ and stockpiled materials will require that a system of stormwater controls are emplaced (hydrological assessment will deal with this in more detail), while all dirty water is controlled and channeled to retention ponds or pollution control dams and clean water is diverted back into the environment. Any and all vehicle maintenance must be confined to as small a footprint as possible and retained within bunded areas. Spills of oil, lubricants and other hazardous materials will be cleaned up immediately to prevent further spread of contamination into soils and groundwater.

Table 1-1: Construction Phase - Soil Utilisation Plan describes the proposed utilisation of the soils during the construction phase.

Table 1-1: Construction Phase - Soil Utilisation Plan

Step	Factors to Consider	Comments
Delineation of areas to be stripped		Stripping will only occur where soils are to be disturbed by activities that are described in the design report, and where a clearly defined end rehabilitation use for the stripped soil has been identified. All footprints will be clearly demarcated and movement of vehicles and stripping of soil will be confined to these areas.
Reference to biodiversity recommendations/action plan		All vegetation is to be stripped and stored as part of the utilisable soil. However, the requirements for moving and preserving fauna and flora according to the Biodiversity Management Plan should be consulted.
Stripping and Handling of soils	Handling	Soils will be handled in dry weather conditions wherever possible to cause as little compaction as possible. Utilisable soil (topsoil and upper portion of subsoil B2/1) must be handled and stockpiled separately from the lower "B" horizon and all soft overburden/softs (decomposed rock).
	Stripping	The "utilisable" soil will be stripped to a depth of 500mm or until hard rock is encountered. These soils will be stockpiled together with any vegetation cover present (only large bushes and trees to be removed prior to stripping). The total stripped depth should be 500mm, where possible.
Delineation of Stockpiling areas	Location	Stockpiling areas will be identified in close proximity to the source of the soil and to the area of end use to limit handling and haulage distances, and to promote reuse of soils in the correct areas.
	Designation of Areas	Soil stockpiles will be demarcated, and clearly marked to identify both the soil type and the intended area of rehabilitation.

1.3 Operational Phase

The operational phase will see a significant change in the development footprint, with an increase in the size of the open cast mining and the related growth of the WRD and TSF requirements.

Some of the temporary infrastructure might become redundant and concurrent rehabilitation of these sites/features might be possible.

Maintenance and care of the soil and land resources will be the one of the management activities and objective required during the operational phase, with concurrent rehabilitation wherever possible. Management of material loss/erosion, compaction and contamination are issues of importance and consideration during this phase.

Table 1-2 details recommendations for the care and maintenance of the resource during the operational phase.

Working with or on the different soil materials (all of which occur within the areas that are to be disturbed) will require better than average management and careful planning if rehabilitation is to be successful during the operation and at closure.

Stockpiling and the protection of the soils stripped during the construction phase, and the separation of the "hardpan ferricrete/laterite" from the more friable soils is important if the success of sustainable rehabilitation is to be achieved. The ferricrete forms a natural barrier to soil water loss down the soil profile and is integral to the wetland development and the overall ecological balance and biodiversity.

Table 1-2: Operational Phase - Soil Utilisation Plan

Step	Factors to Consider	Comments
Stockpile management	Vegetation establishment and erosion control	Rapid growth of vegetation on the soil stockpiles will be promoted (e.g. by means of seeding and use of soil additives/fertilisation if necessary) to protect the soils and combat erosion by water and wind.
	Storm Water Control	Stockpiles will be established with storm water diversion berms and channels to prevent run off and reduce erosion.
	Stockpile Height and Slope Stability	Soil stockpile heights will be restricted where possible to <2m for areas where soils are to be retained for less than 3 years to avoid compaction and damage to the soil seed pool. Where stockpiles higher than 2m cannot be avoided or where long term (>3 years) storage is necessary, these stockpiles should be benched to a maximum height of 15m. Each bench should ideally be 1.5m high and 2m wide. For storage periods greater than 3 years, vegetative cover is essential, and should be encouraged using fertilization and induced seeding with water if necessary. The stockpile side slopes should be stabilized at a slope of 1 in 2. This will promote vegetation growth and reduce run-off related erosion.
	Waste	No waste material will be placed on the soil stockpiles.
	Vehicles	Equipment movement on the soil stockpiles and/or rehabilitated ground will be limited to avoid topsoil compaction and subsequent damage to the soils and seedbank.
	Concurrent rehabilitation	Concurrent rehabilitation will be exercised where possible. Topsoil will be sourced from the areas closest to the rehabilitation areas and soil will be taken from the closest point to avoid movement across the stockpile

As such these materials need to be available to be replaced within the profile at rehabilitation if and where possible. This will require that the materials are stockpiled separately but close to the area of end use.

1.4 Decommissioning and Closure

The decommissioning and closure phase will see:

- The removal of all infrastructure other than that agreed by the authorities to be left in place;
- The demolishing of all concrete slabs/plinths and the ripping of any hard/compacted surfaces;
- The backfilling of voids and deep foundations and the reconstruction of the required barrier layer (compaction of ferricrete and clay rich materials) wherever feasible and possible;
- Topdressing of the disturbed and backfilled areas with the stored "utilisable" soil ready for re-vegetation;
- Fertilisation (if required) and stabilisation of the backfilled materials and final cover materials (soil and vegetation);
- The landscaping of the replaced soils to be free draining.

Compared to the construction and operation phase, there will be a relative positive impact on the soil and land capability environments as the area of disturbance is reduced, and the soils are returned to a state that can support low intensity wildlife grazing or sustainable conservation in line with the end land use. End land use will as far as possible meet pre-mining land use.

Table 1-3: Decommissioning and Closure Phase - Soil Conservation Plan is a summary of the management and mitigation actions that will be implemented.

Table 1-3: Decommissioning and Closure Phase - Soil Conservation Plan

Step	Factors to Consider	Comments
Rehabilitation of Disturbed land & Restoration of Soil Utilisation	Placement of Soils	Stockpiled soil will be used to rehabilitate disturbed sites. Either as on-going disturbed areas become available for rehabilitation and/or at closure. The utilisable soil removed during the construction phase or while opening up of open cast workings will be redistributed in a manner that achieves an approximate uniform stable thickness consistent with the approved post mining land use (Low intensity grazing or wilderness), and will attain a free draining surface profile. A minimum layer of 200mm of soil will be replaced (limit for low intensity grazing land capability).
	Fertilisation	Representative sampling of the stockpiled soils will be analysed before replacement to determine the nutrient status of the utilisable materials. As a minimum the following elements will be tested for: EC, CEC, pH, Ca, Mg, K, Na, P, Zn, Clay% and Organic Carbon. Based on the outcome of the analysis, fertilisers will be applied if necessary.

	Erosion Control	Erosion control measures will be implemented to ensure that the soil is not washed away and that erosion gulley's do not develop prior to vegetation establishment
Pollution of Soils	In-situ Remediation	If soil is polluted, the first management priority is to treat the pollution by means of in situ bioremediation. The acceptability of this option must be verified by an appropriate soils expert and by the appropriate agency, on a case by case basis, before it is implemented.

1.5 Monitoring and Maintenance

Nutrient requirements reported are based on the monitoring and sampling of the soils at the time of the baseline survey. These values will alter during the storage stage and will need to be re-evaluated before being used during rehabilitation. Ongoing evaluation of the nutrient status of the growth medium will be needed on an annual basis throughout the life of the project and into the rehabilitation phase.

During the rehabilitation exercise preliminary soil quality monitoring will need to be carried out to accurately determine the fertiliser requirements needed.

Additional soil sampling should also be carried out annually after rehabilitation is completed until the nutrient levels, specifically magnesium, phosphorus and potassium, are at the required levels for sustainable growth. Once the desired nutritional status has been achieved, the interval between sampling is to be increased to bi-annual until the vegetative cover is sustainable. An annual environmental audit will to be undertaken by Perseus as well as having an independent audit every second year. If growth problems develop, ad hoc sampling should be carried out to determine the problem.

Monitoring should be carried out at the same time of the year and at least six weeks after the last application of fertiliser.

Soils should be sampled and analysed for the following parameters:

pH (H_2O)

Electrical conductivity

Cation exchange capacity

Magnesium mg/kg;

Zinc mg/kg;

Organic matter content (C %)

Phosphorus (Bray I)

Calcium mg/kg

Sodium mg/kg;

Potassium mg/kg

Clay

In addition, the following maintenance is required as part of the rehabilitation process:

- The area must be fenced, and all animals kept off the area until the vegetation is self-sustaining;
- Newly seeded/planted areas must be protected against compaction and erosion (Vetiver hedges etc.);
- Traffic on rehabilitated areas should be limited while the vegetation is establishing itself;
- Replace unhealthy or dead plant material;
- Fertilise grassed areas soon after germination (if required), and
- Repair any damage caused by erosion.

1.6 Roles and Responsibilities

Management of the soils, land use and land capability for the Life of Mine (LoM) will be the responsibility of the Safety Health Environment and Community (SHEC) Manager with the support of the Mine Manager.

The design engineer will need to liaise with the SHEC Manager on all aspects of construction, operation and decommissioning to optimise on a successful and sustainable “End Land Use”.

The costs of soil management and the implementation of the Soil Management Plan will need to be considered as part of the operational cost as these actions and responsibilities will be required through the LoM and into the closure operation.

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