Merian Project
Final ESIA Report
Volume IV
Environmental and Social Management and Monitoring Plan

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ERM

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS:

Acronym	Definition
AAQ	Ambient Air Quality
ABA	Acid Base Accounting
ABS	General Bureau of Statistics
AERMIC	AMS/EPA Regulatory Model Improvement Committee
AERMOD	AERMIC Model
AIDS	Acquired immunodeficiency virus
ANFO	Ammonium Nitrate/Fuel Oil
ANSI	American National Standards Institute
ANZECC	New Zealand Environment and Conservation Council
ARD	Acid Rock Drainage
Area of Influence	Environmental Study Area and a Social Study Area
ARI	acute respiratory infections
ART	Antiretroviral Therapy
ARV	Anti-retroviral
As	Arsenic
ASM	Artisanal and Small-Scale Mining
ATM	Ministry of Labor, Technological and Environment
AWA	Alcoa World Alumina LLC
BAPP	Biological Acid Production Potential
BFA	Bench Face Angle
BMP	Best Management Practices
BOD	Biological Oxygen Demand
BOPH	Bureau of Public Health
BPL	below the poverty line

Acronym	Definition
BSC	Biodiversity Steering Committee
BSS	Behavioral Surveillance Survey
CBO	Community Based Organizations
CC	Climate Change
CCD	Counter Current Decantation
CCME	Canadian Council Of Ministers of the Environment
CDD	Current Decantation
CDMP	Caribbean Disaster Management Program
CEC	Cation Exchange Capacity
CELOS	Center for Agricultural Research in Suriname
CFR	Code Of Federal Regulations
CH4	Methane
CI	Community Investment
CIA	Cumulative Impacts Assessment
CIP	Carbon-In-Pulp
CITES	Convention on International Trade in Endangered Species
CO	Carbon Monoxide
CO2	Carbon Dioxide
COD	Chemical Oxygen Demand
CN	Cyanide
Cr	Total Chromium
CR	Community Relations
CSNR	Central Suriname Nature Reserve
Cyanide Code	Code for the Manufacture, Transport and Use of Cyanide in the Production of Gold
dB	Decibels

Acronym	Definition
dBA	A-Weighted Decibels
DBK	Soil Survey Department Of Suriname
dBL	Linear-Weighted Decibels
DD	Data Deficient
DUI	Driving Under the Influence
EA	Environmental Assessment
EBRD	European Bank for Reconstruction and Development
EBS	Energie Berdrijven Suriname
EDC	Environmental Design Criteria
EHS	Environmental, Health and Safety
EMP	Environmental Management Plans
EN	Endangered
EP	The Equator Principles
EP	Evaluation Point
EPFI	Equator Principles Financial Institution
ERM	Environmental Resources Management
ERP	Emergency Response Plan
ESIA	Environmental and Social Impact Assessment
ESC	Erosion and Sediment Control Plan
ESMMP	Environmental and Social Management and Monitoring Plan
ESR	Environmental and Social Responsibility
ETP	Endogenous Thrombin Potential
FGD	Focus Group Discussions
FHWA	Federal Highway Administration
GDP	Gross Domestic Product

Acronym	Definition
GFR	General Fertility Rates
Gg	Gigagrams
Gj	Gigajoule
GHG	Greenhouse gases
GII	The Gender Inequality Index
GIS	Geographic Information System
GISPLAN	Geografisch-Planologisch Adviesbureau
GNI	Gross National Income
GoS	Government of Suriname
GPS	Global Positioning System
GRDC	Global Runoff Data Center
H&S	Health & Safety
ha	hectares
HCS	Highway Capacity Software
HCT	Humidity Cell Test
HDI	Human Development Index
HDR	Human Development Report
HFO	Heavy Fuel Oil
HIV	Human immunodeficiency virus
HR	Human Resources
HRS	Human Resources Services
HRD	Human Resources Development
HSLP	Health, Safety and Loss Prevention
HWTA	Hazardous Waste Transfer Area
ICMM	International Council of Mining & Metals
ICMC	International Cyanide Management Code

Acronym	Definition
IFC	International Finance Corporation
IHDI	Inequality Adjusted HDI
ILO	International Labor Organization
In/s	Inches per second
IPPF	International Planned Parenthood Federation
ISO	International Organization for Standardization
IUCN	International Union for the Conservation of Nature
IPCC	International Panel on Climate Change
IRA	Inter Ramp Slope Angles
ISEC	International Society for Ecology and Culture
IT	Information Technology
IZ	Industrial Zone
JMP	Joint Monitoring Program
JV	Joint Venture
KII	Key Informant Interviews
km	kilometers
KPI	Key Performance Indicator
LAeq	A-weighted steady equivalent sound level
LBB	Suriname Forest Service
LBGO	Lower Vocational Education School
LOM	Life of Mine
LVV	Ministry of Agriculture, Animal Husbandry and Fisheries
masl	meters above sea level

Acronym	Definition
MDGs	Millennium Development Goals
ML	metal leaching
MM	Bureau of Public Health, Medical Mission
mm/s	millimeters per second
MMI	Modified Mercalli Intensity
MNH	Ministry of Natural Resources
MNH GMD	Geological Mining Service
MOH	Ministry of Health
Moz	million ounces
MRD	Ministry of Regional Development
MSD	Malaria Service Delivery
MSDS	Material Safety Data Sheets
MTI	Ministry of Trade and Industry
MW	Megawatts
MWE	Megawatts Electricity
MWT	Megawatt Thermal
N2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAF	Non-Acid Forming
NAG	Net Acid Generation Test
NAP	National AIDS Program
NAWQA	National Water Quality Assessment
NCD	Nature Conservation Division
NCD	Non-Communicable Disease
NEAP	National Environmental Action Plan
Newmont	Newmont Overseas Exploration Limited

Acronym	Definition
NGO	Non-Governmental Organization
Ni	Nickel
NIMOS	the National Institute of Environment and Development in Suriname
NL	Not listed
NL	Netherlands
NMR - National Council for the Environment	Nationale Milieuraad
NMS	Newmont Metallurgical Services
NO2	Nitrogen Dioxide
NPI	Australian National Pollutant Inventory
NTFP	Non Timber Forest Products
NZCS	National Zoological Collection of Suriname
OAS	Organization of States
OGS	Ordening Goud Sector
OP	Operating Procedure
OSHAS	Occupational Health and Safety Advisory Services
oz	ounces
PAF	Potentially Acid Forming
PAG	Potentially Acid Generating
PAG	Peroxide Acid Generation
PAHO	Pan American Health Organization
PAPs	Project Affected Peoples
PCS	Petroleum Contaminated Soils
PFCs	hydro-fluorocarbons
PK	Porknocking
PM	Particulate Matter
PMF	Probable Maximum Flood

Acronym	Definition
POI	Points of Interest
ppbv	parts per billion by volume
PPE	Personal Protective Equipment
PPP	Purchasing Power Parity
PPV	Peak Particle Velocity
PVC	Polyvinyl Chloride
QA/ QC	Quality Assurance/ Quality Check
REEEP	Renewable Energy and Energy Efficiency Partnership
RGD	Bureau of Public Health, Regional Health Service
ROM	Run-of-Mine
SAG	Semi-Autogenous Grind
SBB	Foundation for Forest Management and Production Control
SBC	Suriname Business Coalition
SCBA	Self-contained Breathing Apparatus
SCF	Suriname Conservation Foundation
SES	Stakeholder Engagement Strategy
SEP	Stakeholder Engagement Plan
SF6	sulfur hexafluoride
SIA	Security Industry Authority
SMP	Social Management Plans
SO2	Sulfur Dioxide
SOC	Species of Concern
SOP	Standard Operating Procedures

Acronym	Definition
SPCC	Spill Prevention and Countermeasures Plan
SPLP	Synthetic Precipitation Leaching Procedure
SPS	National Planning Office of Suriname
STINASU	Foundation for Nature Conservation in Suriname
SRH	Sexual and Reproductive Health
SRK	SRK Consulting
SRD	Surinamese Dollar
SRU	Seismic Research Unit
SSA	Social Study Area
SSSA	Soil Science Society of America
STI	Sexually Transmitted Infections
STP	Sewage Treatment Plant
Surgold or the Company	Suriname Gold Company
SW	Surface Water
SWM	Surinamese Water Company
SWMP	Solid Waste Management Plan
TANA	To Assist Needy Animals
TB	Tuberculosis
TCLP	Characteristic leaching Procedure
TDS	Total Dissolved Solids
the Project	Merian Gold Project
TNM	Traffic Noise Model
TNM	Noise Technical Manual
ToR	Terms of Reference
TRV	Toxicity Reference Values
TSF	Tailings Storage Facility

Acronym	Definition
TSP	Total suspended particulate matter
TSS	Total Suspended Solids
TWS	Treated Water Storage
TWSR	Treated Water Storage Reservoir
UNESCO	United Nations Educational, Scientific and Cultural Organization
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USGS`	United States Geological Survey
UN	United Nations
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on
UNICEF	United Nations Children's Fund
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UV	Ultraviolet
VAC	Vacuum
VSB	Suriname Trade and Industry Association
VU	Vulnerable
WAD	Weak Acid Dissociable
WDI	World Development Indicators
WHIMIS	Workplace Hazardous Materials Information System
WHO	World Health Organization
WRD	Waste Rock Disposal
WRI	World Resource Institute
WSS	Water Supply and Sanitation

Acronym	Definition
WWF	World Wildlife Fund
XRD	X-ray Diffraction
XRF	X-ray Fluorescence
Zn	Zinc
mg/m^3	micrograms per cubic meter

1.0 *ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN*

The following document presents a framework Environmental and Social Management and Monitoring Plan (ESMMP) for the Merian Gold Project. The framework ESMMP includes the Project commitments and mitigation measures that have been identified in the Project Description and Impact Assessment chapters of the Merian Gold Project Environmental and Social Impact Assessment. The framework ESMMP elaborates on these mitigation measures to include specific management sub-plans designed to avoid, minimize or reduce negative impacts and enhance positive impacts associated with the Merian Project.

It should be noted that an ESMMP is an evolving document, which will be refined and altered throughout the life of the project. In particular, further revisions may be required during the ESIA approval process and as a result of specific conditions requested by the *National Instituut voor Milieu en Ontwikkeling in Suriname* (NIMOS - the National Institute for Environment and Development in Suriname). The requirements and suggestions included within this ESMMP should not be considered the finalised approach to mitigation measures and Surgold may adapt the approach as required in the spirit of the mitigation measure.

Surgold will use the framework ESMMP to develop a comprehensive "operational" Environmental and Social Management and Monitoring Plan (ESMMP) in a format deemed appropriate by Surgold as the Project moves into Construction and Operations. It will be used by Surgold and the relevant contractors to minimize Project impacts.

Descriptions of the main elements of the ESMMP are summarized below.

- ***Chapter 1: Environmental and Social Management and Monitoring Plan -*** a description of the goals and objectives and scope of the ESMMP.
- ***Chapter 2: Summary of Legal Requirements and Obligations*** – a summary of all relevant legal requirements, obligations and impacts identified from the ESIA.
- ***Chapter 3: Surgold's Approach to Environmental and Social Management and Monitoring –*** Surgold's ESR, H&S Policy and references to any other relevant policies and guidance including roles and responsibilities, etc.
- ***Chapter 4: Mechanisms for Feedback and Adjustment*** - details of the mechanisms through which problems and successes of the ESMMP may be recognized and appropriate adjustments made.

- *Chapter 5: Schedule* - detailing the phasing and coordination of mitigation and monitoring in conjunction with overall project implementation plans.
- *Chapter 6 - 14: ESMMP Sub-Plans* - a series of ESMMP sub-plans to manage specific environmental risks.

Figure 1-1 provides an overview of how the ESMMP is likely to develop from this present outline to implementation in the field. It is assumed that NIMOS will review this framework ESMMP and will not be required to review the finalized detailed ESMMP for implementation.

1. Framework ESMMP – Presented in this report and summarizes the main mitigation commitments from the ESIA to date.

Approval / Consent

2. Finalize 'operational' ESMMP – following completion of the approval and design process. To include further details specific to the Project regarding monitoring requirements, operating procedures and roles and responsibilities for Surgold and all relevant contractors.

Inclusion of ESMMP in tender documents for contractors

3. Adoption by Contractors - alignment of the ESMMP with the Contractor's own Environment, Health and Safety (EHS) procedures including development of sub-plans and a detailed audit and review programme.

4. Implementation – monitoring, audit and review with feedback from lessons learned as the Project progresses to aid continuous improvement.

Figure 1-1 ESMMP Development Process

1.1 PURPOSE OF THE ESMMP

According to industry good practice, the ESIA process and subsequent ESMMPs should be part of an overall Environmental and Social Management and Monitoring system that includes:

- Policies;
- Identification of risks and impacts (ESIA);
- Management Plans (ESMMP);
- Organizational capacity and competency;
- Emergency preparedness and response;
- Stakeholder engagement; and

- Monitoring and review.

The ESIA identifies the key environmental, social and health issues, impacts, and risks and opportunities associated with the Project. An ESMMP identifies the actions required to manage these commitments and serves as a mechanism for implementing the mitigation, monitoring and other commitments identified in the ESIA to avoid or reduce potential impacts. The ESMMP also outlines the roles, responsibilities and record keeping that will be implemented to ensure the mitigation measures are effective. Finally, the ESMMP provides a tool for the auditing of the Project's performance compared against its commitments, and communicates the management strategy and Project obligations to stakeholders.

The framework-level sub plans presented herein include suggested key performance indicators (KPIs) and monitoring programs. The KPIs are the means by which the success of mitigation measures will be verified, evaluated and reported. Additional KPIs may be developed as the Project progresses.

1.2 *SCOPE OF THE ESMMP*

This ESMMP addresses both Pre-Production and Operations phases of the Project and identifies the need for the management plans to be re-tailored for Closure phase activities. The Post-Closure phase is the phase after which Surgold no longer provides active management of the Site; therefore the ESMMP is not extended to cover this phase. The ESMMP also addresses activities within the Transportation Corridor and at the Mine Site.

1.3 *ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PROCESS*

The process for implementing an environmental and social management and monitoring plan follows the Plan, Do, Check, Act philosophy described below, and outlined in Figure 1-2, and discussed in this section.

Plan, Do, Check, Act

Plan:
· Define policies and objectives for environmental and social performance;
· Identify environmental and social impacts and risks of the operations;
· Develop mitigations and operational controls to address impacts and risks; and
· Develop a management plan to achieve these objectives.

Do:
· Implement management plan; and
· Implement mitigation and operational controls.

Check:
· Monitor performance against policies and objectives; and
· Check that mitigation and operational controls are effective.

Act:
· Make corrections to plans, mitigation, or controls in response to performance monitoring or out of control events.

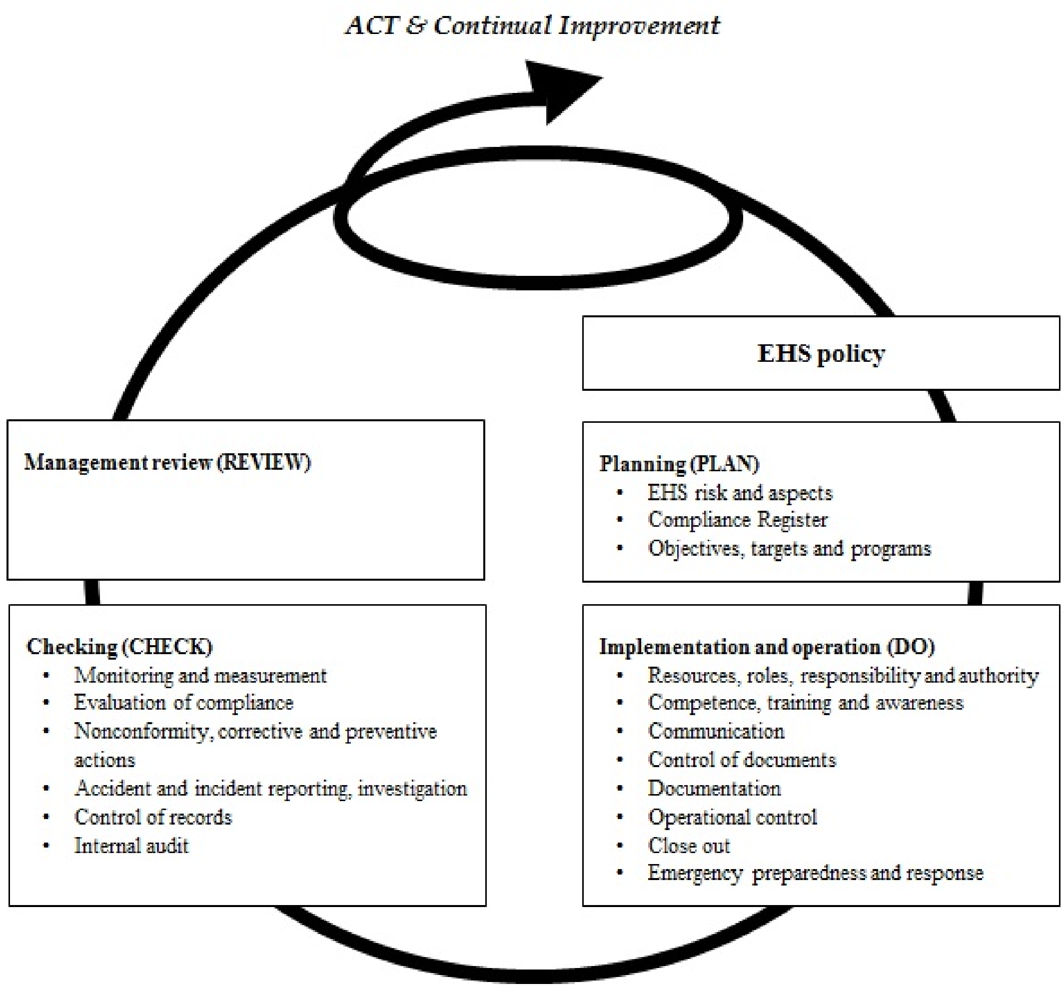


Figure 1-2 Environmental and Social Management and Monitoring Process

2.0 *SUMMARY OF LEGAL REQUIREMENTS AND OBLIGATIONS*

As presented in Chapter 2 of the ESIA, Surgold is committed to meeting all relevant Surinamese legal requirements and corporate commitments as well as following international good management practices.

2.1 *LEGAL REQUIREMENTS*

Suriname does not currently have an approved environmental policy and there is no legislation dealing specifically with environmental management. However environmental legislation is currently being developed and draft guidelines for environmental assessment have been issued by NIMOS. The proposed Merian Gold Project will comply with the draft environmental guidelines and other relevant existing legislation, including government policy documents. Surgold is committed to complying with the draft and relevant promulgated regulations as of September 2012. A summary of relevant legislation is provided in Chapter 2 of the ESIA.

2.2 *COMMITMENTS*

Surgold has committed to complying with Newmont's internal environmental and social standards, adapting best practices from international standards, including the International Financial Corporation's general and sector-specific guidelines and the International Cyanide Management Code. Furthermore, the Impact Assessment includes a number of mitigation measures that contribute to reducing and controlling potential impacts. Each sub-plan provided in this document outlines the obligations and commitments specific to each topic. A summary of the Project's commitments made in the ESIA and this ESMMP is provided at Appendix IV-A.

3.0 *SURGOLD'S APPROACH TO ENVIRONMENTAL AND SOCIAL MANAGEMENT*

Surgold is committed to providing resources essential to the implementation and control of the ESMMP and is in the process of developing a comprehensive Environmental and Social Management and Monitoring System. The following Chapter summarizes elements of the system that have been and are continuing to be developed.

3.1 *SURGOLD ESR-POLICIES*

Surgold has committed to adherence to Newmont Mining Corporation's Environmental and Social Responsibility (ESR) Standards and site-specific operating procedures. In addition to this, Surgold is in the process of developing a series of Standard Operating Procedures (SOPs) and policies specific to the Merian site (as guided by Newmont ESR Policy and Standards).

These policies and procedures will provide the overall direction to the subsequent management of social and environmental issues relevant to the Project and a preliminary outline of content is provided in Table 3-1.

Table 3.1 ***Newmont Mining Corporation Policies, Standards and Operating Procedures***

Standard or Operating Procedure	Corporate or Site Level	Relevant Contents
Environmental Policy	Corporate	Newmont's environmental policy, establishes the requirements to: · Operate facilities in compliance with applicable laws and regulations; · Adopt and adhere to standards that are protective of both human health and the environment at facilities; and · Develop, during the design phase, and implement during operations and closure, a closure and reclamation plan that provides for long-term environmental stability and suitable post-mining beneficial land uses.

Standard or Operating Procedure	Corporate or Site Level	Relevant Contents
Social Policy	Corporate	Newmont's social policy establishes the commitments to: · Develop and use systems to identify and manage risks, and provide accurate information to support effective decision making; · Train our people and provide the resources to meet our social responsibility objectives and targets; · Respect the Universal Declaration of Human Rights in our business operations; · Respect the social, economic and cultural rights of Indigenous people; · Adopt policies, standards and operating practices that ensure ongoing improvement; · Wherever appropriate and feasible, set operating standards which exceed the requirements of the local law; · Assess our performance against our policies and standards; · Demand leadership in social responsibility from all our people; · Seek to share our success by partnering with stakeholders in appropriate community development programs; · Consult stakeholders in matters that affect them; and · Strive to communicate our performance in an accurate, transparent and timely manner. It should be noted that Surgold do not intent to develop a Chance Finds Policy due to the context of the Project and the absence of likely cultural heritage items.
Health and Safety Policy	Corporate	Establishes the following commitments: · Newmont will identify and proactively control health and safety hazards and risks with the potential for loss to people, equipment, process and the work environment; · Newmont will adhere to its Newmont Safety Principles, which includes the demonstration of safety leadership in all our people; · Newmont's Health, Safety, and Loss Prevention (HSLP) management system will identify, assess and appropriately control HSLP risks; · Newmont will establish measurable objectives that drive the continuous improvements necessary to pursue an injury- and illness-free, healthy work environment; · Newmont will comply with statutory and other applicable requirements; · Newmont will positively reinforce safe behavior in pursuit of superior HSLP performance; · Newmont will be reviewed by internal and external resources to ensure that the HSLP organizational goals and objectives are being achieved; and · Newmont will consult employees and stakeholders on concerns, aspirations and values for HSLP during development of projects, operations and closure of all operations.

Standard or Operating Procedure	Corporate or Site Level	Relevant Contents
Carbon Management Policy	Corporate	Newmont's carbon management policy is a key component of the Environmental and Social Responsibility. It encompasses transparent reporting of emissions, improving energy efficiency, switching to low-emission energy generation, offsetting emissions and collaborating with third parties and stakeholders to provide adaptive management support to communities that surround our mines. This establishes the commitment to: · Reliably measure, report, and verify global GHG emissions; · Develop and implement a GHG emissions reduction plan; · Integrate carbon consideration in capital decision making; · Remain flexible to various policy approaches designed to stabilize atmospheric Co2 concentrations; · Strive to incorporate energy efficiency, renewable and low-emissions energy sources; · Foster innovation, creativity, knowledge sharing, partnerships and intelligent risk-taking to reduce GHG emissions; · Aspire to invest in carbon offsetting projects; and · Adaptation.
Cyanide Management Policy	Corporate	Cyanide Code Certification of the Project within 36 months after mineral processing operations are commissioned.
Environmental Responsibility Standards	Corporate	One level down from policy, environmental responsibility standards define the detailed guidance to operations on environmental performance.
Social Responsibility Standards	Corporate	Defines the overarching guidance related to social performance and stewardship including social baseline and impact assessment, stakeholder mapping and engagement, expectation and commitment management, complaints and grievance management , local community investment, security and human rights, and cultural heritage.
Health and Safety Standards	Corporate	Defines specific guidance on relevant topics including risk and change management, training, competency and awareness, contractor selection and management, accident/incident reporting and investigation, emergency preparedness and response, internal and external audits and occupational health and hygiene. Health and safety and loss prevention management standards are reported to have been reviewed and updated so as to align with Occupational Health and Safety Advisory Services (OHSAS) 18001.
Assessing Sustainability Management Performance	Corporate	Newmont state that they participate in, or undertake internally, multiple programs to verify achievement with internal environmental standards and compliance with applicable laws, and standardized management systems are in place to identify, address and manage the environmental and social risks including ISO 14001 certification, capital approval processes that include planning and budgeting to address social and environmental issues through the full mine lifecycle, a three-year rolling audit process and a specific Social Responsibility audit process (internal).
Surgold Complaints and Grievances Management and Resolution Standard Operating Procedure	Site	A Project and Site specific Standard Operating Procedure (SOP) that defines the process that must be follows when written or verbal complaints/ grievances are received. This SOP was in progress when the ESIA was completed.

Standard or Operating Procedure	Corporate or Site Level	Relevant Contents
Surgold Labor Recruitment Strategy and Selection Procedure for National Positions Operating Procedure	Site	The Project and Site specific Standard Operating Procedure (SOP) sets out how to ensure, as far as possible, suitable staff are recruited and that the recruitment process is free from bias and discrimination. SOP will include commitments to follow best practices and methods that allow fairness during recruitment and selection to ensure continuous efficiencies for human capital. This SOP was in progress when the ESIA was completed. It is understood that this will include requirements for contractors to comply with all Newmont policies and for compliance with all Suriname laws and conventions.
Surgold HIV/AIDS Policy	Site	The Project and Site specific policy is designed to ensure a consistent and equitable approach to handling HIV/AIDS among Surgold employees and their families. This was in progress when the ESIA was completed however preliminary versions included specific comments on HIV/AIDS in the workplace, ensuring non-discrimination, non-screening of employees, confidentiality etc.
Surgold Expectation and Commitment Register Standard Operating Procedure	Site	This Project and Site specific SOP define the procedures that must be followed for written and verbal expectations received and commitments made. The procedure states that it seeks to ensure expectations and commitments are managed in a culturally sensitive, timely and consistent manner, and that corrective actions are implemented where appropriate to promote confidence and positive relationships between Surgold and local and regional stakeholders. This SOP was in progress when the ESIA was completed.
Guiana Shield; Developing a culture of safety eliminate this section	Site	This Project and Site specific planning document outlines how Surgold intends to establish a strong safety culture throughout the workforce, manages contractor issues and contractor H&S performance, induction and H&S training, incentivizing safety behavior, etc. This document was in draft version when the ESIA was complete.
Surgold Internal and External Communication and Reporting SOP	Site	This project and site specific SOP serves to implement the environmental and social responsibility communication plan. This document was in draft version when the ESIA was completed however it includes staffing, responsibility and update requirements.
Surgold Environmental and Social Management Plan	Site	This project and site specific management plan reports that it is applicable to all Surgold staff and contractors. This document was in draft version when the ESIA was completed however it includes the responsibilities, procedures, review and approval loop for an ESMP.

Source: *Beyond the Mine; the Journey towards Sustainability* and Surgold Policies (Draft)

In addition Appendix 2-A in Volume III of the ESIA provides a summary of the Newmont Environmental and Social Responsibility (ESR) Standards.

3.2 *SURGOLD ORGANIZATIONAL STRUCTURE*

The Surgold organizational structure dictates that the Environmental and Social Responsibility department manager reports directly to the Project Director during construction as do the Construction and Camp Administration Manager, Business Manager and Chief Geologist. The roles and responsibilities relative to ESR are summarized in Table 3-2

Table 3.2 Environmental and Social Management and Monitoring and Organizational Roles and Responsibilities

Position	Responsibilities
Surgold Project Team	
Project Director / Site Manager	· Oversee and coordinate all activities pertaining to the environmental and social responsibility aspects of the project (ESR) as well as Health, and Safety and Loss Prevention (HSLP), Security, and Human Resources Services (HRS).
ESR Manager	· Ensure effective communication with all stakeholders; · Manage the activities of the ESR Team; · Review and approve the selected environmental and social management and monitoring plans; · Ensure that environment and social regulatory requirements are met and that ESMMP requirements are properly implemented; · Ensure that the project operates in accordance with applicable regulatory and best practice environment, and social requirements and plans; · Undertake regular site visits or inspections to ensure compliance with the ESMMP and sub-plans, and verify that environmental and social impacts are mitigated. Environmental checklists will be completed during site visits and photographic record of progress on site from an environmental perspective will be kept; · Report on environmental and social issues at site meetings and report any incidents that may cause unacceptable damage to the environment or breaches the ESMMP conditions; · Lead the establishment of the participatory monitoring program and oversee its implementation; · Ensure lessons learned are used as continuous improvement opportunities through revisions to the ESMMP; · Ensure all ESR reporting requirements are met; · Maintain a master listing of applicable ESR documents and plans and making sure that this list is communicated to the appropriate parties; and · Review the environment, social and community health management elements of the Contractors' bids.
Environmental Supervisor	· Oversee daily execution of the EMPs ; · Supervise Environmental Coordinators; · Prepare and deliver reports to the ESR Manager regarding environmental monitoring and training; · Support the ESR manager as needed; and · Cooperate with the Community Relations Supervisor to deliver consistent and integrated environmental and social management and monitoring strategies.
Environment Coordinator	· Perform environmental monitoring and documentation as required in the EMPs; and · Support Environmental supervisor as needed.
Community Relations Supervisor	· Oversee daily execution of the Social Management Plans (SMPs); · Supervise the Community Liaison Officers; · Prepare and deliver reports to the ESR Manager regarding social monitoring and community engagement activities; · Support the ESR manager as needed; · Cooperate with the Environmental Supervisor to deliver consistent and integrated environmental and social management and monitoring strategies.

Position	Responsibilities
Community Liaison Officers (on-site)	· Provide regular information on the project at local level and liaise with directly affected communities; · Identify and liaise with local community; · Implement project Stakeholder Engagement Plan (SEP) and manage disputes/ grievances; · Keep detailed records of stakeholder communication and actions.
Construction Contractors	
HSLP Manager	· Ensure all contractors (if any) on site will be obliged to have a staff member assigned to HSLP and ESR responsibilities relevant to the contractors activities and responsibilities; · Develop detailed plans (i.e. the sub-plans of the ESMMP) for implementation of mitigation and management measures in the field; · Monitor and report on performance and cooperate with Surgold audits and reviews; · Inspect the site and surrounding areas on a daily basis with regard to compliance with the ESMMP and keep records of these inspections; and · Report any incidents of non-compliance with the ESMMP or sub-plans to Surgold and the ESR Team.

Table 3.3 Other Positions with Environmental and Social Management and Monitoring Roles and Responsibilities

Position	Responsibilities
Surgold Project Team	
Security Manager	· Develop operational policies and procedures for the deployment of Security in keeping with the Project's Security Policy and international best practices such as the Voluntary Principles for Security and Human Rights; · Develop methods for monitoring and otherwise confirming that security practices related to the Project follow the above; and · Provide direction to Security Personnel.
Human Resources Manager	· Develop policies and procedures that ensure Surgold's commitments with respect to labor, human resources and training and are met.
HSLP Manager	· Develop Health and Safety Plan and policies that meet international standards and applies best management practices; · Cooperate with the ESR Manager in the development of site Emergency Response & Preparedness Plan; · Oversee HSLP training; and · Liaise with ESR and Security Managers as necessary.
Site maintenance and Camp and Transportation Manager	· Actively work with ESR staff to ensure that site maintenance, personnel transportation and camp operations follow relevant ESR commitments.
Site Manager	· Ensure operations personnel are aware of their obligations under the ESMMPs and perform these as required. · Receive and review all ESR reporting; and · Facilitate efforts between ESR and operations staff to ensure ESR commitments are met.

Surgold assumes ultimate responsibility for the management and supervision of all project activities. Surgold has a dedicated Management and ESR staff, competent on the basis of appropriate education, training, and experience.

Surgold's approach to construction and operations is to complete most construction and operations functions with in-house staff rather than using a large number of contractors and sub-contractors. However, where contractors or sub-contractors are retained, all contracts will require that contractors and sub-contractors follow all of Surgold's policies and procedures. Supervision of contractor activities will be conducted by Surgold's technical team. This will be accomplished through management controls over strategic project aspects and interaction with contractor staff where project activities take place. The Surgold organization will be staffed at a level to allow for continuous effective supervision of contractor activities and work products.

3.3 *TRAINING AND AWARENESS RAISING*

Surgold will identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environment or social conditions or who have responsibilities with respect to ESR commitments. The Project recognizes that it is important that personnel at all levels and functions are aware of the Project's environmental and social policy; potential impacts of their activities; and roles and responsibilities in achieving conformance with the policy and procedures within the limits of their control. The Project will become ISO 14001 compliant, which also provides a means by which to ensure awareness across the organization of the Project' s environmental and social policies, commitments and responsibilities. The Project aims to achieve compliance with ISO 14001 within three years of the start of operations and will complete annual appraisals thereafter.

A formal training and a training refresher process will be developed and implemented to address ESR and HSLP policies and procedures. The on-site Human Resources Manager is responsible for coordinating training, maintaining personnel training records, and ensuring that these are monitored and reviewed on a regular basis. The Project Human Resources team have budgeted to coordinate training requirements and the delivery of this training will be the responsibility of respective teams.

The ESR Manager will work with the HR Manager to develop and implement a program that includes:

- Formal training needs analysis for all levels of personnel throughout the facility;
- Competency needs to meet regulatory and site requirements;

- Competency needs required to perform specific task functions.

The training program will incorporate:

- Site induction for all personnel, including employees, contractors, and visitors;
- Area or workplace specific orientation and inductions;
- Awareness training based on facility-specific needs. At a minimum, all personnel will be made aware of the following:
  - Surgold ESR, HSLP, HR and Security policies;
  - Risks and hazards associated with work activities; and
  - Requirements within ESR Standards and relevant facility procedures;
- Technical training;
- Competency training appropriate to task performance and potential impacts of tasks performed;
- Refreshing training specific to meet the required skills or maintenance of minimum competency levels for all personnel; and
- Manager and Supervisor training ensuring required skills to perform their duties.

Personnel responsible for performing site inspections will receive training by drawing on external resources as necessary. Training will be undertaken prior to the beginning of large-scale field activities and should be conducted as quickly as is feasible. Upon completion of training and once deemed competent by management, these staff will be ready to train other people.

Similarly the project will provide ESR and health and safety training to any contractors' personnel that will be working on-site to assure that environmental, social and health and safety practices meet Surgold requirements. All contractors and sub-contractors will be required to comply with all relevant Surgold policies, procedures and standards. Through a contractor control system Surgold will coordinate with subcontractors, through a tender and contracting process, to assure that workers have sufficient training (or planned training) to achieve required competency levels.

3.4 *COMMUNICATION*

Surgold will maintain a formal procedure for communications with NIMOS and other environmental authorities under the responsibility of the Site Manager. This will be coordinated with the ESR Manager. Community Liaison Officers (CLOs) will be responsible for communication with local stakeholders.

The Site Manager, through the ESR Manager, is responsible for communications with the public and local stakeholders. At the time of writing the Project is in the process of developing a Stakeholder Engagement Strategy / Plan (SES) for the duration of operations.

This SES/ Stakeholder Engagement Plan will set the objectives and methods for stakeholder engagement and will maintain a system of written registration of stakeholder interactions to effectively track communications so that commitments made can be tracked and implemented. This includes feedback (complaints and grievances) that is tracked through a formal feedback procedure which will be administered by the CLOs. Required content for the engagement plan for the operations period and grievance mechanism are described in greater in *Chapter 6 – Social Management Plan.*

Part of the communication efforts will include routine reporting to stakeholders regarding ESMMP monitoring results. This is discussed further in Section 4.6.1.

3.5 *DOCUMENTATION*

Surgold will control ESR documentation, including management plans; associated procedures; and checklists, forms and reports, through a formal procedure (Surgold plans to become ISO 14001 compliant). The document control procedure will describe the processes that the Project will employ for official communication of both hardcopy and electronic document deliverables. In addition, it will describe the requirement for electronic filing and posting and for assignment of a document tracking and control numbers (including revision codes). The documentation system will include a process to manage the revision of documents.

Documentation controls will be developed for:

- Policy statements and statements of commitments;
- Strategic, continuous improvement and action plans;
- Corporate management system and discipline specific standards;
- Governmental required documentation;
- Training documentation; and
- SOPs/ STPs.

The ESR Manager is responsible for maintaining a master listing of applicable ESR documents and plans and making sure that this list is communicated to the appropriate parties. The ESR Manager is responsible for providing notice to the affected parties of changes or revisions to documents, for issuing revised copies and for checking that the information is communicated within that party's organization appropriately.

Contractors will be required to develop a system for maintaining and controlling their own ESR documentation and describe these systems in their respective ESR plans that meet all the requirements of the this ESMMP. These will need to be reviewed, audited and signed off by the Surgold ESR Manager.

3.6 *EMERGENCY PREPAREDNESS AND RESPONSE*

Surgold will develop and overall Emergency Response and Preparedness Plan that will include procedures to identify the potential for and response to environmental accidents and health and safety emergency situations (*e.g.* fire, oil spillage, traffic accidents etc.) and for preventing and mitigating potentially adverse environmental and social impacts that may be associated with them.

Emergency preparedness and response will be reviewed by Surgold after the occurrence of any accident or emergency situations to ensure that lessons learnt are used in the continuous improvement process. Emergency exercises will be undertaken on a regular basis to confirm adequacy of response strategies. Investigations of accidents or incidents will follow formal documented procedures.

4.0 MECHANISMS FOR FEEDBACK AND ADJUSTMENT

Feedback and adjustment is an essential part of a successful ESMMP. Feedback systems include inspections, monitoring and audits to confirm proper implementation of the ESMMP as well as effectiveness of mitigation. Corrective actions include response to out-of-control situations, non-compliances, and non-conformances. Actions also include those intended to improve performance.

4.1 INSPECTION

ESR inspections will be conducted by representatives of the ESR team as specified in the ESMMPs to ensure that all personnel (employees or contractors) are fulfilling their obligations. The results of the inspections will be reported to the Site Manager on a weekly basis or as specified in the ESMMP, this is scheduled to begin in November 2012.

4.2 MONITORING

Monitoring will be conducted to ensure compliance with ESIA commitments and to evaluate the effectiveness of operational controls and other measures intended to mitigate potential impacts. Details regarding monitoring programs specific to different aspects of the Project are presented in in ESMMP Chapters 6 - 15. The monitoring programs describe what effect is to be measured and the frequency and will serve to confirm that the Project is meeting its obligations with respect to environmental management and work practices. Monitoring will be carried out by Surgold's ESR staff, specific monitoring input will also be conducted by process, mining and infrastructure personnel to ensure continuous compliance with legal obligations and commitments.

It should be noted that monitoring requirements are discussed only at a high level within the framework ESMMP (this document) and include key performance indicators for each specific sub-plan. At the time of writing Surgold are in the process of developing a separate 'stand-alone' operational Environmental and Social Monitoring Plan that will be submitted to NIMOS and the Government of Suriname within two months of receipt of approval for the ESIA as demonstrated by granting of the Right of Exploitation. This Monitoring Plan will provide in-depth detail of the environmental and social monitoring required including schedules, methodologies, sampling locations, key performance indicators etc.

As part of this on-going work Surgold are continuing to conduce a series of environmental and social studies these are detailed in Table 4-1

Table 4.1 On-Going Environmental and Social Studies

Resource	Study Type	Responsible Party	Description	Timing
Surface water	Stream gauging	Golder/Surgold	Continue and improve existing program of continuous stream gauging. Improvements are needed due to poor reliability of pressure transducers and dataloggers due to porknocking activities and natural variability in stream flows. More reliable data will support the Adaptive Water Management plan. Alternatives being evaluated include ultrasonic or radar systems that are above the water surface.	Program was started in 2010 and will continue through construction and operations. As noted, modifications are being evaluated to improve reliability of data collection due to the site-specific conditions (e.g. porknocking).
Surface water	Spot flow measurements	Surgold	Stream flow measurements completed twice a month to assure accuracy of rating curves and to support Adaptive Water Management Plan	Started in 2003 and continues into future; associated with stream gauging to support rating curves.
Surface water	Quality	Surgold	Sampling of water quality at several locations (ambient monitoring) above and below planned mine facilities. Objectives are to allow for monitoring of operational controls and to assure compliance with project environmental compliance. Results of monitoring are integral to the Adaptive Water Management Plan.	Currently quarterly, but will become more frequent during operations. Frequency will depend on location and objectives, which will be defined (and updated) in the Operational Monitoring Plan.
Surface water	Quality	Surgold	Sampling of operational releases (effluents) from sewage water treatment plants, sediment ponds, and the treated water storage reservoir. Operational monitoring will include ore chemistry, tailings water quality, and TSF reclaim pond water quality. Results of monitoring are integral to the Adaptive Water Management Plan.	Will start with construction and continue through operations. Frequency will depend on location and objectives, which will be defined (and updated) in the Operational Monitoring Plan.
Surface water	Quality	Surgold	Sampling of water produced by the potable treatment plants for the mine facilities. Objective is to assure that water provided is protective of human health.	Will start with construction and continue through operations. Frequency will depend on location and objectives, which will be defined (and updated) in the Operational Monitoring Plan.
Surface water	Quality	Surgold	Flocculent testing using soil from the Merian site to determine the dosage rates and application methods to effectively control the fine portion of sediments in order to meet project environmental criteria.	Will be used to support final design of the sediment ponds and flocculation systems.
Surface water	Quality	Surgold	Monitoring sediment pond performance to assure that project environmental criteria are met. This monitoring is integral to the Adaptive Water Management plan.	Will start with construction and continue through operations. Frequency will depend on location

Resource	Study Type	Responsible Party	Description	Timing
				and objectives, which will be defined (and updated) in the project monitoring plan.
Groundwater	Quantity	Surgold	Monitoring of depth to groundwater to assess changes in groundwater due to operations.	Monthly during construction to expand baseline database, and then continue into operations to monitor conditions and compare to predicted changes.
Groundwater	Quality	Surgold	Sampling of water quality at several locations above and below planned mine facilities, including TSF seepage collection wells and trenches. Locations, parameters and frequency to be defined in Operational Monitoring Plan.	Currently quarterly, but will become more frequent during operations. Frequency will depend on location and objectives, which will be defined (and updated) in the Operational Monitoring Plan.
Sediment	Quality	Surgold	Analysis of metal levels in sediment to monitor operational changes relative to the baseline conditions. This will include several indicator metals, including mercury due to the past porknocking activities.	Annually. Parameters and locations likely to continue as established under baseline, but will be defined in the Operational Monitoring Plan.
Climate		Surgold	Continue monitoring of climate conditions at the current Exploration Camp and future Plant Site. Results will be incorporated into the water management plans under the Adaptive Water Management plan.	Planned additional climate station to be installed during construction and operated continuously.
Air quality	Ambient monitoring	Surgold/ Consultant	Continuous monitoring of ambient air quality at three locations around the project; NOx, SO2, PM10, PM2.5, TSP to assure compliance with project environmental controls.	Equipment to be installed in Q2 of 2013 and operated continuously.
Air quality	Emission testing	Surgold/ Consultant	Continuous emission monitoring of Power Plant for SO2, NOx, and PM; annual stack testing for NOx, SO2, and metals to assure compliance with project environmental controls.	Equipment to be installed during construction and monitoring to be continuous during operations.
Noise	Ambient monitoring	Surgold	Monitoring of noise levels at project perimeter to assure that project meets defined environmental controls.	Monitoring to start during construction and continue during operations.
Biology	Fisheries	ERM/Local experts	Additional fish surveys in the Commewijne basin to better define existing fish communities and confirm sufficiency of the mitigation plans in the ESIA.	Work was completed in November 2012. ASM activities continue to negatively impact fisheries. Work confirmed that the mitigation measures in the ESIA are

Resource	Study Type	Responsible Party	Description	Timing
				protective.
Biology	Species of conservation	Surgold/ Consultant	Pre-timbering surveys for flora and fauna species of concern; development of nursery for flora and re-location of Anomaloglossus surinamensis and Atelopus hoogmoedi nassaui	Primarily during construction, though plant nursery will be operational throughout operations to support concurrent reclamation and final closure.

4.3 *PARTICIPATORY MONITORING*

Participatory monitoring of environmental and social performance and adherence to the ESMMP was identified through stakeholder engagement by local Pamaka stakeholders as a measure that stakeholders would like to see developed by Surgold. The following provides an outline for a participatory monitoring program to be developed by Surgold in consultation with stakeholders. The development of the program will generally follow recommendations and resources published by the World Bank.

The World Bank articulates the following core principles of participatory monitoring and evaluation[1]:

- Primary stakeholders are active participants – not just sources of information;
- Building capacity of local people to analyze, reflect and take action;
- Joint learning of stakeholders at various levels; and
- Catalyzes commitment to taking corrective actions.

Participatory monitoring will require the establishment of a stakeholder participatory monitoring group that will collectively identify what will be monitored, how, by whom and how monitoring and indicators will be reported. The involvement of stakeholders in the identification of topics to be monitored, measurements, scales to be used and the collection of data is crucial.

Activities in which members will engage may include but would not be limited to:

- Identification of elements of concern for monitoring;
- Development of a monitoring program(s);
- Field work, data and sample collection;
- Reviewing results or analyses from a laboratory or other professional;
- Reporting data to the community; and
- Evaluating results and recommending changes to processes or systems.

Depending on the stakeholders' interest, participatory monitoring maybe conducted as part of the Project's planned:

- Air quality monitoring;
- Water quality monitoring;

[1] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSOCIALDEVELOPMENT/EXTPCENG/0,,contentMDK:20509352~menuPK:410312~pagePK:148956~piPK:216618~theSitePK:410306,00.html

- Biological monitoring;
- Social impact monitoring; and
- Other monitoring programs as identified through consultation.

Where Surgold and an established participatory monitoring group establish an agreement and monitoring program it may prove necessary for Surgold to assist the monitoring group to access monitoring and testing laboratories for independent analysis. This should be discussed and agreed with stakeholders. In addition Surgold and the participatory monitoring group may see a need for the involvement of environmental NGOs to help build their capacity and understanding of monitoring.

At the time of writing Surgold continue to engage local stakeholders regarding their involvement in the environmental and social management and monitoring process.

4.4 *AUDITING*

Audits will be carried out by Newmont to ensure compliance with ESIA requirements as well as their own Environmental and Social Standards and Health and Safety standards and policies. The frequency of joint audits with HSLP will be risk based and will vary with the stage of the Project and will depend on the results of previous audits. Audits to be conducted will also cover the contractor self-reported monitoring and inspection activities. The audit shall be performed by qualified staff and the results shall be communicated to the manager and related executive management.

The audit will include a review of compliance with the requirements of the ESMMP and include, at minimum, the following:

- Completeness of ESR documentation, including planning documents and inspection records;
- Conformance with monitoring requirements;
- Efficacy of activities to address any non-conformance with monitoring requirements; and
- Training activities and record keeping.

Newmont typically conduct audits if legal and internal compliance every three years starting from one year after production has begun.

4.5 *CORRECTIVE ACTION*

Identifying potential impacts, hazards and risks is an important part of the environmental and social management and monitoring approach. Equally important is the investigation and root cause analysis of accidents and “near misses” so that valuable lessons and information can be used to prevent similar or more serious occurrences in the future.

Surgold will implement a formal non-compliance and corrective action tracking procedure for investigating cause and identifying corrective actions in response to accidents or environmental or social non-compliances. This will ensure coordinated action between Surgold and their contractors. The ESR Manager will be responsible for keeping records of corrective actions and for overseeing the modification of environmental or social protection procedures and/or training programs to avoid repetition of non-conformances and non-compliances.

Where corrective actions are deemed necessary, specific plans (with designated responsibility and timing) will be developed to achieve continuous improvement in performance. Surgold will also develop Key Performance Indicators (KPIs), aimed at driving continuous improvements in performance.

4.6 *REPORTING*

Throughout the life of the Project, Surgold will keep relevant authorities informed of the project performance with respect to Environment and Social matters by way of written status reports and face-to-face meetings. In addition to regular reporting, official notification shall be made for any of the following:

- Significant modifications of Project design; or
- Significant changes in the implementation of the Project.

The Health and Safety Plan will also include its own reporting requirements and commitments.

Surgold will provide appropriate documentation of ESR related activities, including internal inspection records, training records, and reports to relevant authorities as required.

Contractors will also be required to provide ESR and HSLP performance reporting as relevant based on the contractor's responsibilities. Reporting will be required to Surgold on a regular basis.

Regular reporting will be completed by the ESR department to the Surgold Site Manager.

An annual (or as specified by Surgold Operational ESR Plans) Environmental and Social Management and Monitoring report will be compiled that reports the results of the years monitoring, audits, reviews and changes to specific ESMMP sub plans.

4.6.1 Reporting to the community or local stakeholders

Surgold will establish through consultation with the community the preferred mechanism to deliver regular reporting to stakeholder groups regarding results of environmental and social monitoring.

4.7 *CHANGE MANAGEMENT*

In order for an ESMMP to be effective it must follow the process as described in Figure 1-2, which calls for regular changes and improvements to the management plan. Surgold will develop an ESMMP change management process that outlines how changes to the ESMMP will be identified, approved, and implemented. The process will include steps and roles similar to the following:

- Methodical way in which improvements or need for change are identified. Such methods have already been identified throughout this ESMMP such as: review of monitoring program results and KPIs as identified in the supporting sub-plans; Internal and external audits/3rd party reviews and should also include periodic review of legal obligations and commitments international best practices

- Appointment of a person responsible for change monument in each team: Each major change to the ESMMP will be assigned a the relevant team's change manager who will be responsible for developing a plan to implement the change including but not limited to research, testing, approval, communication and documentation.

- Change implementation and documentation: as per the approved change management plan.

5.0 *SCHEDULE*

Framework management plans are provided in this document. These will be further developed in more detail by Surgold between the time of writing and commencement of Pre-Production activities as on-site activities dictate.

- August 2012 – May 2013: Development of final ESMMPs relevant to Pre-Production Activities;
- 2 months prior to start-up of process plant – review and update of relevant Management Plans; and
- 3 months prior to Operations – review and update of relevant Management Plans.

6.0 *SOCIAL MANAGEMENT PLAN*

6.1 *INTRODUCTION*

This chapter presents a Social and Health Management Plan (SMP) for the Merian Project. The SMP includes the Project commitments and mitigation measures that have been identified in the project description and impact assessment chapters of the ESIA and other best practice measures designed to avoid, minimize or reduce negative impacts and enhance positive impacts.

6.1.1 Purpose of the SMP

The ESIA process identifies the key environmental, social and health issues, impacts and risks associated with the Project. A SMP identifies the necessary actions required to manage the identified social and health impacts and serves as a mechanism for implementing the commitments and mitigation identified in the ESIA to avoid or reduce the potential for impacts. In addition the SMP outlines the monitoring or record keeping that will be implemented to ensure the effectiveness of the mitigation measures implemented. The SMP also provides details of the process for auditing the implementation and communicates the management strategy and the Project commitments and obligations to stakeholders.

It should be noted that the health component of the SMP includes certain occupational issues where worker health and community health intersect.

The objectives of an SMP, as provided in World Bank guidance (World Bank, 1999:2), are to:

- Identify the set of responses to potentially adverse impacts;
- Determine requirements for ensuring that those responses are made effectively and in a timely manner; and
- Describe the means for meeting those requirements.

6.1.2 Scope of the SMP

Construction and operation of the Merian Project and the transportation corridor road may pose direct, indirect and induced impacts to the local population living, working and/or travelling within the vicinity of the affected areas. The SMP is relevant to all Project activities throughout the life of the project including pre-production and operations.

6.2 SUMMARY OF LEGAL REQUIREMENTS

Surgold will comply with all legal requirements of Suriname including the constitution of 1987, reformed in 1992. This includes providing a working environment that fulfills requirements related to equal opportunities to employment, safe working conditions, safe labor conditions, prohibition on forced labor, and freedom to form trade unions amongst other requirements.

Specifically in relation to child labor the minimum age for employment in Suriname is 14 years. Children under 18 years are prohibited from night work, which is defined as work between the hours of 7:00 p.m. and 6:00 a.m., and hazardous work, which is defined as work that endangers life, health, and decency, or as determined by the Minister of Labor. Employers are required to maintain a Register of Young Persons that includes each employee's name, address, date of birth, and the occupational starting and ending dates.[1]

In addition Suriname has signed and ratified several international conventions to which Surgold will comply. These include:

- ILO Convention 29 on forced labor;
- ILO Convention 87 on freedom of association and protection of the right to organize convention;
- ILO Convention 98 on the right to organize and collective bargaining;
- ILO Convention 105 on the abolition of forced labor convention;
- ILO Convention 182 on the worst forms of child labor;
- ILO Convention 62 on the safety provisions for building;
- ILO Convention 95 on the protection of wages; and
- ILO Convention 151 on collective bargaining.

6.3 COMMITMENTS

The Project has made the following commitments during the ESIA process:

- Adherence to the Voluntary Principles on Human Rights and Security;
- Adherence to Workers' Accommodations Processes and Standards Guidance Note published by the IFC and EBRD; and
- Adherence to Newmont Mining Corporation's Environmental and Social Responsibility Standards and operating procedures.

A list of Surgold ESR policies and procedures is included in Section 3.1. As some of these site specific policies and procedures were in draft format on completion of the ESMMP specific required content and additions are included in Table 6-1.

[1] Clive Pegus, A Review of Child Labour Laws of Suriname – A Guide to Legislative Reform, ILO Subregional Office for the Caribbean, June 2005, 25. See also U.S. Department of State, "Country Reports – 2007: Suriname," section 6d.

Table 6.1 Surgold Policies, Strategies and Documents

Surgold Documents, Strategies and Policies	Additional Required Content
Labor Recruitment Strategy and Selection Procedure for National Positions Operating Procedure	Surgold will develop, implement and review / monitor a Recruitment Policy that: · Establishes the criteria by which someone can be classified as from the Pamaka Area or from Suriname; · Specifically establishes a preferential hierarchy for employment of people first from the Pamaka Area, then from Suriname and finally from elsewhere in the World; · Specifies a commitment to advertise all positions within the Pamaka Area (where relevant to local skills), in Suriname (where relevant to national skills). · Sets the criteria by which a department must demonstrate they have sought to identify primarily Pamaka and secondarily Surinamese candidates prior to employing non-Pamaka Surinamese or foreign nationals for jobs that may reasonably be staffed from the local area or in Suriname; · Dictates the transparent hiring techniques to be advocated including; engagement and information dissemination in the Pamaka area that is required prior to hiring; the advertisement locations, methods, frequency, notice and language; and the specifics around how and when candidates can apply; · Specifies that workers should receive clear understandable information regarding their rights under national labor and employment laws including their rights related to hours of work, wages, overtime, compensation, and benefits upon beginning the working relationship and when any material changes occur; · Specifies that no unskilled or temporary hiring should occur in an informal or ad hoc manner that has not involved liaison with or review of a Pamaka Human Resources Database and Surgold; and · In alignment with the laws of Suriname specifies that workers are allowed to form unions.
Procurement Policy	Develop and Implement a Procurement Policy that: · Specifically establishes a preferential hierarchy for qualified suppliers and service providers, where available (and relevant to local capabilities) to be procured first from the Pamaka Area, then from Suriname (where relevant to national capabilities) and finally from elsewhere in the world; · Requires all contractors and service providers to comply with Surgold ESR, labor and health and safety standards; · Establishes a requirement to assess the risk or safety issues, child or forced labor within the supply chain and remedy where appropriate; · Specifies a commitment to advertise all required procurement of goods and services within first the Pamaka Area (where relevant to local capabilities), then Suriname (where relevant to national capabilities)and finally from elsewhere in the World; and · Dictates the transparent techniques for procurement of goods and services including; engagement and information dissemination in the Pamaka area that is required prior to procurement of goods and services; the advertisement locations, methods, frequency, notice and language; and the specifics around how and when candidates can apply.
Worker Code of Conduct	Develop a Worker Code of Conduct that: · Establishes zero tolerance controls on illegal narcotic substances and alcohol in camp policy (none brought onto camp, only sold and consumed on designated days in designated places); · Establishes criteria for behavior at work (non-discrimination, non-violence etc.); · Establishes closed camp policy with controls on visitors and unauthorized departures from camp; and · Establishes the required behavior and standards when engaging stakeholders and upon chance finds; · Establishes limits on visits to Pamaka area for those not on official Surgold business.
(Integrated) Social Closure Plan	Develop a Social component to the Closure Program that: · Establishes the manner in which Surgold will manage the potential impacts during closure and post-closure including

Surgold Documents, Strategies and Policies	Additional Required Content
	retrenchment of employees; · Identifies any potential alternatives to retrenchment; · Contains commitments to provide all workers with suitable notice of dismissal and severance payments mandated by law and collective agreements in a timely manner including social benefits and pension payments where relevant; · Contains provision to engage and coordinate with Suralco and the GoS where possible, regarding potential new opportunities and employment requirements at other projects such as the Nassau Plateau Operations during the Merian closure / post-closure process; · Establishes the participatory processes and engagement with stakeholders during closure planning; · Establishes the review and update process for the closure plan; · Establishes objectives, targets and monitoring requirements; · Establishes draft closure costs; and · Establishes potential community uses of infrastructure after decommissioning and relinquishment.
(Pamaka) Human Resources Database	· Records the names, contact details, education and skills of interested candidates; · Records the eligibility and requirements to be considered of Pamaka ethnic status; and · Establishes the update schedule and process.
Stakeholder Engagement Strategy	Develop and implement a Stakeholder Engagement Strategy that sets out the short, medium and longer term objectives and methods for stakeholder engagement throughout the LoM and that: · Establishes a requirement for ongoing update of a stakeholder map and database as the basis of engagement activities; · Establishes the process and form for recording all engagement activities including engagement undertake by surgold employees outside of the esr department; · Establishes the medium to long term engagement objectives, standards, methods and program for the merian project; · Establishes the schedule for review and update of the ses and stakeholder mapping; · Explicitly states the engagement objectives, standards, methods and program for asm related stakeholders. · Explicitly states the schedule and topics to engage asm related stakeholders on including surgold land use and area of expansion or exploration, surgold reclamation schedule and processes, surgold relinquishment of areas of the exploration concession, surgold safety and security measures, · Explicitly states the schedule and topics to engage different stakeholder groups on potentially including surgold current and planned work, the mining lifecycle, the monitoring and esmmp implementation process, the mineral agreement, community investment planning and progress, areas of forest clearing, local procurement, expectations and commitments registers, training and capacity development, and employment and feedback mechanism; · Establishes the schedule and frequency of meetings with key stakeholder groups such as the traditional authority, wider community members, potential community investment partners, government regulators, community based organizations etc.; · Establishes differentiated measures for the participation of disadvantaged or vulnerable stakeholders; · Establishes the details and methods for further culturally appropriate engagement surrounding the feedback mechanism; and · Establishes the details and methods for engagement with representative community groups.
HIV/AIDS Policy	Develops a HIV AIDS Policy that: · Provides a clear statement about non-discrimination, in particular non-discrimination based on HIV and on gender; · Establishes procedures for addressing HIV/AIDS issues in the workplace , including no mandatory HIV screening of workers or job applicants, ensuring strict confidentiality related to HIV testing and HIV status of worker, ensuring no dismissal of workers due to HIV, providing for prevention and protection of workers living with HIV against

Surgold Documents, Strategies and Policies	Additional Required Content
	harassment, providing education and awareness raising services to workers, providing psycho social support and counseling for workers and their families living with HIV; and · Establishes the condition for engagement with the Ministry of Health (MOH) National AIDS Program (NAP) where possible.
Community Investment Policy and Strategy	Develop and implement a Policy/plan that sets out the conditions in which Surgold will provide Community Investment and that:: · Establishes the requirement for a participatory needs assessment conducted by qualified person(s); (ideally and independent expert) as a fundamental part of community investment planning; · Establishes the targeted percentage breakdown of community investment funds for each geography; · Establishes the preference and methods for producing post-closure duplication of funds as a critical component of succession planning; · Establishes the timeframe and process, stakeholder participation, and accountability, transparency and monitoring of community investment spending. · Establishes a program of community capacity development prior to large scale community investment; and · Establishes the preference for sustainable community investment in project not reliant on Surgold for on-going upkeep.
Community Feedback Mechanism	Establish a community feedback mechanism that: · Is an understandable and transparent process; · Is scaled appropriately to risks and impacts · Is culturally appropriate and readily accessible to all segments of the population; · Has no cost implications and is without retribution; and has no impediment to judicial or administrative remedies · Outlines the objectives, methods and engagement schedule surrounding a community feedback mechanism; · Establishes the practicalities for management and monitoring of feedback including roles and responsibilities; and · Establishes the conditions for dissemination of information and popularizing the community feedback mechanism.
Worker Feedback Mechanism	Establish a Worker Feedback mechanism that: · Establishes the objectives, methods and engagement schedule surrounding a worker feedback mechanism; · Establishes the requirement for the process to be confidential, transparent, timely, without retribution, or impede access to other judicial or administrative remedies or substitute for feedback mechanisms provided through collective agreements; and · Provides details of workers access to a psychologist to address any psycho-social issues and mental stress in a confidential manner.
ASM Policy and Strategy	Establish an ASM Policy and Strategy that: · Establishes the principles of where ASM presents a H&S risk to Surgold staff because of Surgold activities; · Establishes the security measures that will be put in place to protect Surgold assets from ASM activity; · Establishes a program to investigate possibilities to build capacity to allow procurement of non-mining services from ASM miners / ex-miners such as road construction, clearing etc. · Establishes a desire to continue to engage miners regarding mining outside of high risk areas controlled by Surgold, in partnership with the OGS; and · Establishes efforts to partner with GoS (e.g. OGS) or other organizations to provide income generation opportunities for those people who are reliant on ASM livelihoods.

6.4 MONITORING AND KEY PERFORMANCE INDICATORS

Key Performance Indicators (KPIs) are discusses in greater detail in Table 6-2, these include:

- Employees hired who have previously received training)provided by Surgold);
- Feedback on training given delivered by Surgold to Pamaka stakeholders;
- Ethnicity and home location of people hired;
- Training achievements and needs of Surgold staff;
- Increases in attendance at higher education courses promoted by Surgold;
- Availability of PPE;
- Use of PPE by workforce;
- Availability of in date rapid malaria diagnostic tests on site;
- Anecdotal evidence of changes to agricultural production;
- Local price of typical basket of goods;
- Anecdotal evidence of increased sustainability in ASM practices;
- Cultural appropriateness of Surgold teams with whom stakeholders have interacted; and
- Documenting chance finds.

Monitoring of these KPIs (and those detailed in Table 6-2), and of the commitments and mitigation measures described in Table 6-2 and Appendix IV-A will be included within a specific stand-alone operational Environmental and Social Monitoring Plan. Greater detail of social monitoring plans will be described in that Monitoring Plan.

6.5 MANAGEMENT PLAN STRUCTURE

This SMP serves as a sub-plan of the overall Environmental Management Plan (EMP). It serves to provide greater detail for implementing the commitments and mitigation identified within the social and health impact assessment. The SMP also contains the monitoring and reporting requirements so that the SMP aligns with the 'plan, do, check, act' process to environmental and social management and monitoring. Table 6-2 provides a summary of the key management and mitigation measures, their implementation and monitoring requirement.

Specific framework mitigation and management measures related to ASM Management included in Table 6-3, Cultural Heritage Management and Influx Management are included in Table 6-4.

Table 6.2 *Social and Health Management Summary Table*

Project Impact (positive and negative)	Applicable Phases Pre-Production (PP), Operations (O), Closure (C), Post – Closure (PC)	ESIA Management / Mitigation / Enhancement Measures	Monitoring activities	Timing and frequency of monitoring (routine, how often, continuous or in emergency situations only)	Key Performance Indicators	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible person for ensuring commitment implementation	Reporting Requirements (internal / external)	Related plans	Estimated Cost of Monitoring
Increased employment and income generating opportunities	PP, O, C	Develop and Implement a Recruitment Policy stipulating preference for qualified local applicants and transparent hiring techniques.	Check presence of policy. Review adherence and updating of policy for recruitment activities.	Review and update policy on yearly basis until post-closure.	Presence and updated versions of policy. Number/percentage of employees hired from the Pamaka area. Positive feedback from candidates and Pamaka stakeholders gathered regarding hiring processes.	All Surgold locations	N/A	Surgold Human Resources Supervisor	Record and report presence of updated policies, strategies and plans.	N/A	Time spent by Human Resources staff member to review presence, updating and adherence to documentation. This may include on average up to one day per six months.
Increased employment and income generating opportunities	PP, O, C	Develop and Implement a Procurement Policy stipulating preference for local procurement of goods and services.	Check presence of policy. Review adherence to policy for procurement activities.	Review and update policy on yearly monthly basis until post-closure	Presence and updated versions of policy. Number / percentage spend of goods and services procured from within Pamaka area or Suriname.	All Surgold locations	N/A	Surgold Human Resources Supervisor	Record and report presence of updated policies, strategies and plans.	N/A	
Increased employment and income generating opportunities	PP, O, C	Develop and update a Human Resources database to record local interest, skills and education.	Check presence of database. Review update and use of database for hiring of new employees.	Review presence and use of database on annual basis until post-closure.	Presence and updated versions of database. Numbers of employees who were hired after registering on database.	All Surgold locations	N/A	Surgold Human Resources Supervisor; Surgold ESR Supervisor	Record and report numbers of employees hired from local area. Record and report numbers of people registered on database.	N/A	
Stakeholder engagement will help to manage / mitigate / enhance the effect of all impacts	PP, O, C	Develop and implement a Stakeholder Engagement Strategy that sets out the short, medium and longer term objectives and methods for stakeholder engagement throughout the LoM.	Check presence of Stakeholder Engagement Strategy. Review update and use of strategy to define engagement activities.	Review presence and use of strategy on a six month basis until post-closure.	Presence and updated versions of Stakeholder Engagement Strategy. Records of engagement activities saved in central database; regular engagement with key stakeholders conducted. High level of involvement in engagement activities by stakeholders.	All Surgold locations	N/A	Surgold ESR Supervisor; Surgold Community Relations Manager	Record and report presence of updated policies, strategies and plans.	N/A	Time spent by ESR staff member to review presence, updating and adherence to documentation. This may include on average up to two days per six months.

Project Impact (positive and negative)	Applicable Phases Pre-Production (PP), Operations (O), Closure (C), Post – Closure (PC)	ESIA Management / Mitigation / Enhancement Measures	Monitoring activities	Timing and frequency of monitoring (routine, how often, continuous or in emergency situations only)	Key Performance Indicators	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible person for ensuring commitment implementation	Reporting Requirements (internal / external)	Related plans	Estimated Cost of Monitoring
Benefits from Community Investment	PP, O, C	Develop and implement a Community Investment Policy that sets out the conditions in which Surgold will provide Community Investment.	Check presence of policy. Review adherence to policy for Community Investment activities.	Review and update policy on a six month basis until post-closure.	Presence and updated versions of policy. Records of investment spending and partnership with other organizations. Positive feedback from beneficiaries of level and design of investment spending.	All Surgold locations	N/A	Surgold ESR Supervisor; Surgold Head of Social Investment	Record and report presence of updated policies, strategies and plans, level of Community Investment and partnership.	N/A	
Benefits from Community Investment	PP, O, C	Develop and implement a Community Investment Strategy that sets out the short, medium and longer term objectives and methods for providing Community Investment.	Check presence of Community Investment Strategy. Review update and use of strategy to define investment activities.	Review presence and use of strategy on a six month basis until post-closure.	Presence and updated versions of Community Investment Strategy. Records of investment spending and partnership with other organizations. Positive feedback from beneficiaries of level and design of investment spending.	All Surgold locations	N/A	Surgold ESR Supervisor; Surgold Head of Social Investment	Record and report presence of updated policies, strategies and plans, level of Community Investment and partnership.	N/A	
Increased employment and income generating opportunities	PP, O, C	Revise the existing closure plan to integrate social aspects of closure including retrenchment of employees.	Check presence of integrated social closure plan. Review process of updating plan.	Review presence and on-going update of Closure plan on annual basis until post-closure.	Presence and updated versions of Closure Plan.	All Surgold locations	N/A	Surgold ESR Supervisor	Record and report presence of updated policies, strategies and plans.	N/A	
Increased employment and income generation opportunities within the Pamaka area	PP, C	Develop and provide (with partners where applicable) where possible pre-emptive skills training to people in the Pamaka area prior to up-scaling in hiring.	Record of number of employees hired who previously received training. Maintain record of feedback on training received from attendees, and review training given based on that feedback Maintain records and auditing of financing provided to partner organizations. Develop targets for hiring of people who self-identify as from Pamaka Area and Suriname.	On-going monitoring of hiring and training given for duration of training and for six months after implementation.	Number of employees hired from the Pamaka area. Number of employees hired who have previously received Surgold supported training.	Throughout the Pamaka Area	N/A	Head of ESR, Head of Social Investment, Head of Human Resources	Record and report numbers of people who received training courses directly provided or supported by Surgold. Record and report financial commitments made to providing training. Record and report approximate Surgold man-hours spent on training.	N/A	Time spent by CLO to establish and maintain systems to record outcomes of training provided. This may include on average up to one day per month for one CLO during the pre-production and early construction period. Time spent by Head of Social Investment to monitor and audit the financing provided to partner organizations. This may include on average up to five days per month.

Project Impact (positive and negative)	Applicable Phases Pre-Production (PP), Operations (O), Closure (C), Post – Closure (PC)	ESIA Management / Mitigation / Enhancement Measures	Monitoring activities	Timing and frequency of monitoring (routine, how often, continuous or in emergency situations only)	Key Performance Indicators	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible person for ensuring commitment implementation	Reporting Requirements (internal / external)	Related plans	Estimated Cost of Monitoring
	PP, O, C	Award certification of training and competency in new skills gained through formal Surgold or 'on the job' training in formal certificates.	Record training achievements and needs of Surgold staff through annual appraisals.	On-going monitoring of training given.	Percentage of employees who receive certification of training received.	For all training provided or supported by Surgold.	N/A	Head of ESR, Head of Social Investment, Head of Human Resources	Record and report numbers of people who received certification of training received.	N/A	
	PP, O, C	Develop and provide (with partners where applicable) Financial Management Training to employees and their partners from within the Pamaka area.	Target 100% of training provided to interested employees within six months of hiring. Maintain record of feedback on training received and review training given based on that feedback Maintenance and auditing of financing provided to partner organizations.	On-going monitoring of training given for duration of training and for six months after implementation.	Percentage of employees who receive Financial Management Training.	Available for all employees, particularly those hired from within the Pamaka area and their partners.	N/A	Head of ESR, Head of Social Investment, Head of Human Resources	Record and report numbers of people who received training courses directly provided or supported by Surgold.	N/A	Time spent by Human Resources staff to establish and maintain systems to record formal and 'on the job training' delivered and issues certificate. This may include on average two days per month.
	PP, O, C, PC	Promote training programs (with partners where applicable) focused on the skills required for large scale mining operations (with partners where applicable) in place at higher education organization.	Record increases in attendance at relevant courses at higher education organizations. Maintain records and auditing of financing provided to partner organizations.	On-going monitoring of training given until post-closure or cessation of training programs (and therefore for six months after implementation).	Percentage increase in students who graduate from courses that provide the skills required for large scale mining operations.	Paramaribo	N/A	Head of ESR, Head of Social Investment, Head of Human Resources	Record and report numbers of people who benefitted from Surgold support for mining skills training at higher education institutes.	N/A	Time spent by Head of Social Investment to liaise with higher education organization and record the changes in enrolment. This may include on average up to two days per month.

Project Impact (positive and negative)	Applicable Phases Pre-Production (PP), Operations (O), Closure (C), Post – Closure (PC)	ESIA Management / Mitigation / Enhancement Measures	Monitoring activities	Timing and frequency of monitoring (routine, how often, continuous or in emergency situations only)	Key Performance Indicators	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible person for ensuring commitment implementation	Reporting Requirements (internal / external)	Related plans	Estimated Cost of Monitoring
Transmission of infectious and communicable diseases	PP, O, C	Implement a malaria control and prevention program including supporting the MoH's National Malaria Program.	Update and check induction process to consider malaria. Check availability of personal protection equipment including bed and window nets, anti-insect spray, chemoprophylaxis etc. Check medical staff have access to valid on-site rapid malaria diagnostic tests. Check existence of trained medical staff as Malaria Service Delivery point of contact.	Review the malaria program on a 6 monthly basis until post-closure.	Numbers of malaria cases detected amongst Project workforce. Number of MoH visits to Merian Area (where the MoH has agreed to assist in the management of communicable diseases). Percentage of non-immune personnel who receive chemoprophylaxis Numbers of rapid malaria diagnostic tests. Available on site Numbers of medical staff to receive MoH / malaria training Percentage of employees who received induction training involving malaria awareness training.	Merian Camp and Surgold Offices	N/A	Surgold HSLP Supervisor	Signed MOU between Ministry of Health's Malaria Program and Surgold Numbers of cases of malaria amongst project workforce.	N/A	Time spent by HSLP office to review malaria control and prevention mechanisms. This may include on average of one day per six months.
Transmission of infectious and communicable diseases	PP, O, C	Implement a Worker Health Screening and Monitoring Program.	Update and check induction process to consider basic hygiene training. Assess application of medical screening for all employees, including TB screening.	Review procedures on a 6 monthly basis until post-closure.	Percentage of employees subjected to health screening.	Merian Camp and Surgold Offices	N/A	Surgold HSLP Supervisor	Numbers of reportable health incidents amongst project workforce. Infectious and Communicable Disease Monitoring & Evaluation reporting to the MOH as required	N/A	Time spent by HSLP office to review health screening and monitoring. This may include on average of one day per six months.
Transmission of infectious and communicable diseases	PP, O, C	Develop and implement a HIV in the Workplace Policy that provides a clear statement of non-discrimination and establishes procedures.	Check presence of policy. Review adherence and updating of policy.	Review and update policy on a six month basis until post-closure.	Presence and updated versions of policy Numbers of worker grievances related to HIV treatment in workplace.	All Surgold locations	Newmont's global HIV/AIDS policy which reflects the principles of the International Labor Organization (ILO) and the World of Work Code of Practice,	Surgold Human Resources Supervisor; Surgold HSLP Supervisor	Record and report presence of updated policies, strategies and plans.	N/A	Time spent by Human Resources and HSLP staff member to review presence, updating and adherence to documentation. This may include on average up to two day per six months.
Transmission of infectious and communicable diseases	PP, O, C	Develop and implement appropriate emergency communication plan / system with relevant health agencies	Check presence of plan / system. Review adherence and updating of plan / system.	Review and update plan / system on a six month basis until post-closure	Presence and updated versions of plan / system.	All Surgold locations	N/A	Surgold HSLP Supervisor	Record and report presence of updated plan / system	N/A	

Project Impact (positive and negative)	Applicable Phases Pre-Production (PP), Operations (O), Closure (C), Post – Closure (PC)	ESIA Management / Mitigation / Enhancement Measures	Monitoring activities	Timing and frequency of monitoring (routine, how often, continuous or in emergency situations only)	Key Performance Indicators	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible person for ensuring commitment implementation	Reporting Requirements (internal / external)	Related plans	Estimated Cost of Monitoring
Exposure of workforce to insufficient occupation Health And Safety or labor and accommodation standards	PP, O, C	Audit subcontractors for adherence to H&S or Labor and Accommodation standards	Check presence of auditing program and qualified auditors. Spot check one set of audit results during every monitoring period (six months)	Review and update auditing program on six monthly basis until post-closure	Presence and updated auditing program.	All Surgold locations	N/A	Surgold HSLP Supervisor	Record and report presence of updated plan / system and results of those audits.	N/A	
Exposure of workforce to insufficient occupation Health And Safety or labor and accommodation standards	PP, O, C	Engagement with workforce surrounding H&S and labor and accommodation terms and conditions in contracts	Spot check contracts for application of correct wording during every monitoring period (six months). Hold informal conversation with new employees to gather anecdotal evidence of whether human resources department explained in simple terms employment rights.	Review contracts and level of engagement on six monthly basis until post-closure	Presence of correctly worded contract. Number of grievances from workforce regarding H&S, labor and accommodation standards.	All Surgold locations	N/A	Surgold HSLP Supervisor; Surgold Human Resources Supervisor	Record and report presence of correct policy and wording in contracts.	N/A	Time spent by HSLP staff member to review contracts and engage workforce. This may include on average up to one day per six months.
Stakeholder engagement will help to manage / mitigate / enhance the effect of all impacts	PP, O, C	Develop and implement a culturally appropriate community feedback mechanism for the LoM in adherence to the best practice model included within the Stakeholder Engagement Plan	Check presence of community feedback mechanism documentation. Engage range of stakeholders regarding their knowledge and ability to use community feedback mechanism. Check presence of disseminated material and supporting systems (posters, email address, telephone number) regarding feedback mechanism.	Review and update community feedback mechanism and documentation. On six monthly basis until post-closure	Number of items of feedback received and recorded.	All Surgold locations	N/A	Surgold ESR Supervisor	Record and report presence of community feedback mechanism. Report numbers of grievances received.	N/A	Time spent by ESR staff member to review grievance documentation and engage stakeholders. This may include on average up to two days per six months.
Exposure of workforce to insufficient occupation Health And Safety or labor and accommodation standards	PP, O, C	Develop and implement a culturally appropriate worker feedback mechanism	Check presence of worker feedback mechanism documentation. Engage range of employees regarding their knowledge and ability to use feedback mechanism.	Review and update worker feedback mechanism and documentation. On six monthly basis until post-closure	Number of items of worker feedback received and recorded.	All Surgold locations	N/A	Surgold Human Resources Supervisor	Record and report presence of worker feedback mechanism. Report numbers of worker grievances received.	N/A	Time spent by Human Resources staff member to review grievance documentation and engage workers. This may include on average up to one day per six months.

Project Impact (positive and negative)	Applicable Phases Pre-Production (PP), Operations (O), Closure (C), Post – Closure (PC)	ESIA Management / Mitigation / Enhancement Measures	Monitoring activities	Timing and frequency of monitoring (routine, how often, continuous or in emergency situations only)	Key Performance Indicators	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible person for ensuring commitment implementation	Reporting Requirements (internal / external)	Related plans	Estimated Cost of Monitoring
Increased burden of chronic diseases	PP, O, C	Promote healthy behavior amongst workforce	Check provision of healthy food options, fatigue and stress management program Check access to worker provision for access to a psychologist to address any issues in a confidential manner. Check provision of exercise and recreational activities.	Review on six-monthly basis.	Number of grievances from workforce regarding H&S	All Surgold locations	N/A	Surgold Human Resources Supervisor	Record and report promotion of health behaviors	N/A	Time spent by Human Resources staff member may include on average up to half a day per six months
Exposure of stakeholders to environmental health hazards	PP, O, C	As part of Emergency Response Plan include adequate communication systems with health facilities and other stakeholders	See Emergency Response Plan	See Emergency Response Plan	See Emergency Response Plan	See Emergency Response Plan	See Emergency Response Plan	See Emergency Response Plan	See Emergency Response Plan	Emergency Response Plan	Emergency Response Plan

Table 6.3 *ASM Management Summary Table*

Project Impact	Applicable Phases Pre-Production (PP), Operations (O), Closure (C), Post – Closure (PC)	ESIA Management / Mitigation	Monitoring activities	Timing and frequency of monitoring (routine, how often, continuous or in emergency situations only)	Key Performance Indicators	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible person for ensuring commitment implementation	Reporting Requirements (internal / external)	Related plans	Estimated Cost of Monitoring
Reduction in standard of living due to reduced productivity of income generating opportunities related to ASM	PP, O, C, PC	Develop and provide (with partners where applicable) a program of livelihood improvement, such as micro-finance measures to improve access to markets, improved seeds or other inputs etc.	Monitor anecdotal evidence of changes to agricultural production. Monitor local food prices of a typical 'basket of goods' produced locally and imported to the Pamaka area. Maintain record of feedback on investment and training received and review processes based on that feedback Maintain records and auditing of financing provided to partner organizations.	On-going monitoring throughout and for six months after implementation.	Volumes of food grown locally. Access to markets and income from agriculture. Changes to costs of certain typical imported foods.	10 Pamaka villages.	N/A	Head of ESR, Head of Social Investment,	Record and report numbers of beneficiaries for provision of community investment Report and record level of investment in partner organizations.	N/A	Time spent by CLO monitoring food prices and agricultural production. This may include on average one day per month. Time spent by Head of Social Investment to monitor and audit the financing provided to partner organizations. This may include on average up to five days per month.

Project Impact	Applicable Phases Pre-Production (PP), Operations (O), Closure (C), Post – Closure (PC)	ESIA Management / Mitigation	Monitoring activities	Timing and frequency of monitoring (routine, how often, continuous or in emergency situations only)	Key Performance Indicators	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible person for ensuring commitment implementation	Reporting Requirements (internal / external)	Related plans	Estimated Cost of Monitoring
	PP, O, C, PC	Work with partner organizations (such as the OGS) to improve the sustainability of ASM in the Pamaka Area through the provision of training and promotion of best practices.	Monitor anecdotal evidence of changes in ASM practices such as retort use, improved waste management and sewerage, and dam breach on cessation of mining. The collection of this type of data may occur through engagement with partner organizations such as the GoS, OGS or other independent professionals.	On-going monitoring throughout partner organizations involvement in area (until post-closure) or until cessation of involvement (and therefore for six months after implementation).	Adaptation of best practices. Numbers of ASM miners in receipt of training and equipment. Monitor level of ASM in and around project area. Monitor anecdotal evidence of increases in sustainable practices e.g. retort use, dam breach at mine cessation etc. Maintenance and auditing of financing provided to partner organizations.	10 Pamaka villages. ASM camps.	N/A	Head of ESR, Head of Social Investment	Report and record investment and support provided to OGS and partner organizations. Record and report OGS activities and level of ASM within protected areas	N/A	Time spent by ESR staff liaising with OGS and other organizations. This may include on average five days per month for Community Relations Manager. Time spent my qualified independent contracted specialist to undertake monitoring activities. This may include on average 2 days per month.
Reduction in standard of living and reduced productivity of income generating opportunities related to ASM	PP, O, C, PC	Work with partner organization to engage Pamaka people and support a Pamaka ASM Commission.	Monitor progress of supporting organizations in access to small scale concession.	On-going monitoring until concession awarded or post-closure period.	Progress in achievement of small scale mining application.	Paramaribo	N/A	Surgold Head of ESR, Surgold Head of Social Investment	Report and record investment and support provided to Pamaka ASM Commission and any partner organizations.	N/A	Time spent by ESR staff liaising with Pamaka ASM Commission. This may include on average five days per month for Community Relations Manager.
Reduction in standard of living and reduced productivity of income generating opportunities related to ASM	PP, O, C	Develop and implement an ASM Policy that sets out the conditions which structure Surgold's engagement and interaction with local ASM workers.	Check presence of policy. Review adherence and updating of policy for ASM engagement and interaction activities. Continued engagement with relevant stakeholders to understand their views on the way in which Surgold relates to ASM miners.	Review and update policy on a six month basis until post-closure.	Presence and updated versions of policy. Number of ASM miners working in industrial area.	All Surgold locations	N/A	Surgold Head of ESR	Record and report presence of updated policies, strategies and plans.	N/A	Time spent by ESR staff member to review presence, updating and adherence to documentation. This may include on average up to two days per six months.
Reduction in standard of living and reduced productivity of income generating opportunities related to ASM	PP, O, C	Develop and Implement an ASM Strategy that sets out the short, medium and longer term objectives and methods for engaging and interacting with ASM miners.	Check presence of ASM Strategy. Review update and use of strategy to define ASM engagement and interaction activities. Continued engagement with relevant stakeholders to understand their views on the way in which Surgold relates to ASM miners.	Review presence and use of strategy on a six month basis until post-closure.	Presence and updated versions of ASM Strategy. Number of ASM miners working in industrial area	All Surgold locations	N/A	Surgold Head of ESR	Record and report presence of updated policies, strategies and plans.	N/A	

Table 6.4 *Cultural Heritage Management Summary Table*

Project Impact	Applicable Phases Pre-Production (PP), Operations (O), Closure (C), Post – Closure (PC)	ESIA Management / Mitigation	Monitoring activities	Timing and frequency of monitoring (routine, how often, continuous or in emergency situations only)	Key Performance Indicators	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible person for ensuring commitment implementation	Reporting Requirements (internal / external)	Related plans	Estimated Cost of Monitoring
Loss of cultural identity, decreased social cohesion and erosion of traditional management and leadership systems	PP, O, C	Implement cultural awareness training as part of the induction process for all employees including archaeological chance finds, local customs tradition, religious beliefs and responsible community relations.	Check presence and review / update of cultural awareness training in induction process. Engage local Pamaka stakeholders regarding cultural appropriateness of Surgold teams with whom they have interacted.	Review and update training on six monthly basis until post-closure	Numbers of community grievances received relating to culture and heritage. Percentage of employees who have received cultural awareness training	All Surgold locations	N/A	Surgold Head of ESR; Surgold Head of Human Resources	Record and report presence and updating of cultural appropriateness training.	N/A	Time spent by Human Resources and ESR staff members to review presence, updating and adherence to documentation. This may include on average up to three days per six months.
Loss of cultural identity, decreased social cohesion and erosion of traditional management and leadership systems	PP, O, C	Implement a Worker code of Conduct Policy	Check presence and review / update of Worker Code of Conduct Policy Engage local Pamaka stakeholders regarding cultural appropriateness of Surgold teams.	Review and update policy on six monthly basis until post-closure	Number of disciplinary / dismissals of Surgold workforce for code of conduct violations. Numbers of grievances received relating to culture and heritage	Review and update policy on six monthly basis until post-closure	N/A	Surgold Head of ESR; Surgold Head of Human Resources	Record and report presence of updated policy	N/A	
Loss of cultural identity, decreased social cohesion and erosion of traditional management and leadership systems	PP, O, C	Promote Pamaka culture through participation (where invited) in Pamaka festivals	Review level of participation by Surgold in Pamaka festivals. Engage local Pamaka stakeholders regarding Surgold participation in Pamaka festivals.	Review and update participation on six monthly basis until post-closure	Number of festivals attended by Surgold staff. Level of investment in goods and services for Pamaka festivals.	Review and update policy on six monthly basis until post-closure	N/A	Surgold Head of ESR, Surgold Head of Social Investment	Record and report participation in festivals. Report level of investment to support festivals.	N/A	Time spent by ESR staff to review involvement in festivals. This may include on average up to one day per six months.
Loss of cultural identity, decreased social cohesion and erosion of traditional management and leadership systems	PP, O, C	Allow Pamaka workers leave requests (where within their terms of contract) to participate / celebrate community festivals, ceremonies and important socio-cultural events (funerals, ceremonies etc.).	Review holiday request process for Pamaka workers to ensure they have the ability to request leave. Engage Pamaka workforce on the suitability of the leave request system. Review results of workforce feedback mechanism for complaints regarding leave requests.	Review and update on six monthly basis until post-closure	Number of festivals attended by Surgold staff. Feedback from workforce. Number of relevant grievances received.	All Surgold locations	N/A	Surgold Head of ESR, Surgold	Record and report participation in festivals.	N/A	

6.6 *CHANGE MANAGEMENT*

Some gaps and uncertainties in information regarding the project description and the environmental and social baseline inevitably remain at the time of completing the ESIA report. The project will therefore require a clear and transparent Change Management procedure to address these gaps and uncertainties as they are resolved.

Specific to the SMP this will be managed through a process of monitoring and review. The SMP will be based on adaptive management as a way to integrate lessons learned during its implementation and thus respond adequately and manage change. This Plan, like all of the EMP sub-plans, is a living document designed to be updated as the process develops and used as a basis for Operating Procedures (OP). This plan will be reviewed and updated on a yearly basis and/or when major changes in the project take place.

In addition to this review of the management plan further change management measures included are related to monitoring against the mitigation measures included. The objective of this monitoring program is to:

- Verify the implementation of the specific actions of the plan by fulfillment of the specific goals in time; and
- Continuously evaluate the effectiveness of the plan's strategies and adjust them as necessary.

Further change management processes of the SIA mitigation that would be recommended include:

- Continuous review and update of stakeholder mapping (every 3-6 months);
- Continuous review and update of social baseline and mitigation measures (every 1-5 years);
- Corporate assurance and review against Newmont standards;
- Community participation in monitoring; and
- Implementation of a feedback mechanism to monitor stakeholder feedback on project performance.

These processes are included within the monitoring, mitigation and management measures proposed or will be included within the policies and strategies discussed in Chapter 3.

6.7 *IMPLEMENTATION*

This section discusses the resources essential to the implementation and control of the SMP. Relevant resources discussed include the appropriate human resources and specialized skills, however does not include required equipment and transportation (four-wheel drive vehicles, boats, petrol etc.)

6.7.1 *Responsible Parties*

This section describes the staffing roles and responsibilities required to implement the management plan. Staff and management responsibilities required to implement the SMP are listed in Table 6-5. These are typically limited to the Environmental and Social Responsibility Team (ESR) but also include the Human Resources (HR) Team and the Health, Safety and Loss Prevention (HSLP) Team.

Table 6.5 ***Social and Health Management and Organizational Roles and Responsibilities***

Position	Responsibilities
Surgold Project Team	
Site Manager	· Oversees the implementation of the agreed upon parts of the SMP and makes resources available to do so · Ensure the implementation of Corrective Actions · Manage the activities of the ESR team, HR, medical and HSLP Team
ESR Manager	· Oversee and coordinate all activities pertaining to the SMP and social aspects of the project · Ensure effective communication with all stakeholders · Review and approve the SMP. · Ensure that the project operates in accordance with applicable regulatory and best practice health, safety and social requirements and plans. · Undertake regular site visits to ensure compliance with the SMP and sub-plans, and verify that impacts are mitigated. · Give report-back on social issues at site meetings and report any incidents that may cause unacceptable damage or breaches to the SMP. · Ensure lessons learned are converted into continuous improvement through revisions to the SMP. · Review the social and community health management elements of the Contractors' bids. · Manage and monitor the performance of the ESR Team
Head of Social Investment / Social Responsibility Specialist	· Develop, review and update Community Investment policies, systems and documentation · Implement the relevant mitigation and management measures outlined in the SMP related to Community Investment · Carry out monitoring program and ensure compliance with the component of the SMP and sub-plans related to Community Investment. · Manage the performance of the Community Relations Team in relation to the SMP and Community Investment implementation and monitoring · Report monitoring findings as stipulated in the SMP
Community Relations Supervisor	· Implement the relevant mitigation and management measures outlined in the SMP · Carry out monitoring program and ensure compliance with the component of the SMP and sub-plans. · Manage the performance of the Community Relations Team in relation to the SMP implementation and monitoring · Liaise with other teams as necessary relating to the SMP · Report monitoring findings as stipulated in the SMP
Community Relations Officer(s)	· Assist Community Relations Supervisor to implement mitigation and management measures · Assist Community Relations Supervisor to monitor and report on the SMP · Provide regular information on the project at local level and liaise with directly affected communities. · Implement project SEP and manage disputes / grievances. · Keep detailed records of stakeholder communication and actions. · Report to Community Relations Supervisor.
ASM Relations Officer	· Assist Community Relations Supervisor to implement mitigation and management measures related to ASM · Assist Community Relations Supervisor to monitor and report on the SMP regarding issues related to ASM · Provide regular information on the project to local ASM miners · Keep detailed records of stakeholder communication and actions. · Report to Community Relations Supervisor.

Position	Responsibilities
Project Archaeologist (on-call contractor)	· Implement the relevant mitigation and management measures outlined in the SMP related to a chance finds program · Carry out monitoring program and ensure compliance with the component of the SMP and sub-plans related to cultural heritage chance finds procedures. · Liaise with other teams as necessary relating to the SMP · Audit subcontractors for adherence to chance finds procedures · Report monitoring findings as stipulated in the SMP · Provide technical oversight to chance finds program
HSLP Supervisor	· Implement the relevant mitigation and management measures outlined in the SMP · Carry out monitoring program and ensure compliance with the component of the SMP and sub-plans related to H&S. · Manage the performance of the HSLP Team in relation to the SMP implementation and monitoring · Liaise with other teams as necessary relating to the SMP · Audit subcontractors for adherence to H&S and labor and accommodation standards · Report monitoring findings as stipulated in the SMP
HSLP Officer, Project Medic & Project Nurse(s)	· Assist the HSLP Supervisor in establishing all HSLP policies, schemes and associated documentation · Assist HSLP Supervisor in monitoring and reporting implementation of the SMP and sub-plans related to HSLP. · Report to HSLP Supervisor.
HR Supervisor	· Implement the relevant mitigation and management measures outlined in the SMP · Develop, review and update HR policies, systems and documentation · Develop review and update worker training and induction processes · Establish contracting templates and engage employees regarding their rights · Carry out monitoring program and ensure compliance with the component of the SMP and sub-plans related to HR. · Liaise with other teams as necessary relating to the SMP · Manage the performance of the HR Team in relation to the SMP implementation and monitoring · Report monitoring findings as stipulated in the SMP
HR Officer	· Assist the HR Supervisor in establishing all HR policies, schemes and associated documentation · Assist the HR Supervisor in implementing the relevant mitigation and management measures outlined in the SMP · Assist HR Supervisor in monitoring and reporting implementation of the SMP and sub-plans related to HR. · Report to HR Supervisor.
Subcontractors	
EHS Manager(s)	· Develop detailed plans / implement Surgold plans for implementation of mitigation and management measures in the field. · Monitor and report on performance and cooperate with Surgold audits and reviews. · Inspect the site and surrounding areas on a daily basis with regard to compliance with the ESMMP and keep records of these inspections. · Report any incidents of non-compliance with the ESMMP or sub-plans to the EHS Team.

6.7.2 *Training and certification*

This section describes the training and capacity development required to implement the management plan. The following training sessions will be necessary for Project Staff:

- Malaria Prevention Training. The Project medical staff may receive training from MOH on their roles and responsibilities for Malaria Service Delivery (MSD) and will include training on the use of rapid diagnostic tests.
- HIV in the Workplace. The project medical staff will receive training on non-discrimination and the correct procedures for addressing HIV in the workplace.
- Worker Health & Safety Training. The Project medical staff will receive training from the MOH on their roles and responsibilities in monitoring TB and other infectious diseases and procedures for reporting.
- Onsite health workers and supervisors will be trained in recognizing the signs and symptoms of mental distress (e.g., disruption in sleep cycles) that could jeopardize the safety of the workers, co-workers and families.
- Health workers hired for the onsite medical facility at the Mine Site will have the qualifications and capabilities to provide primary health care and trauma care, in addition to occupational health care (e.g., worker health screenings).
- Stakeholder Engagement Training. The Community Relations Team will receive specific stakeholder engagement training that covers the processes, mind-set, value, requirements and methods for successful engagement.
- Grievance and Feedback Management Training. The ESR and Community Relations team will receive specific training on feedback mechanisms. This includes how to establish and operate a successful mechanism.
- Human Rights Training. The Security Team will receive regular training on the protection of Human Rights.

7.0 *AIR QUALITY MANAGEMENT PLAN*

The following Air Quality Management and Monitoring Plan (Plan) presents a system for controlling air emissions at the Merian Gold Project Mine Site and includes control measures and monitoring for both fugitive dust and combustion emissions. Targeted pollutants of interest include total suspended particulate matter (TSP), particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO). The Plan is based on the fugitive dust and combustion emission control measures recommended in the ESIA. Industry good practice requires quantification of GHG emissions for projects/operations that produce > 25,000 tonnes of carbon dioxide equivalent (CO_2e) emissions per annum, so Surgold would quantify direct and indirect GHG emissions annually per industry good practice.

Surgold intent to finalise the pollutants included within air quality monitoring as part of the on-going development of an operational ESMMP. This will be will in compliance with the IFC guidelines including monitoring for PM, NO_x and SO2. This plan provides recommendations based on industry good practice of additional pollutants (eg. TSP PM_{10} etc).

The scope of this Plan applies to Pre-Production, Operations and Closure activities. It is anticipated that the Plan will require periodic revisions and updates as the Project progresses through different Mine life stages as well as during implementation as results are reviewed and improvements identified.

7.1 *PURPOSE AND OBJECTIVES*

The purpose of the Air Quality Management and Monitoring Plan is to establish and document control measures and monitoring to minimize and control fugitive dust and combustion emissions as recommended in the ESIA. The Plan defines the following:

- Procedures that Surgold personnel would follow to control emissions;
- Fugitive dust and combustion emission trigger levels requiring corrective actions;
- Steps that would be followed to bring emissions within appropriate ranges i.e., below published air quality standards and guidelines;

- Steps that Surgold would take to demonstrate that corrective procedures are followed and to verify the facility is controlling avoidable air emissions; and
- Identifies a few non-mandatory measures to minimize noise and vibration levels.

The primary objective of the ambient air monitoring program is to characterize the existing air quality and to monitor for any changes in air quality in the vicinity of the Project. To meet these objectives, the Plan:

- Identifies all major fugitive dust and combustion emission sources listed in the ESIA;
- Identifies the general control measures and practices to control and minimize air emissions;
- Identifies visible emissions observation and corrective action requirements;
- Establishes an air quality monitoring program at the Project site;
- Identifies air emissions control record keeping requirements; and
- Describes air emission control training elements.

7.2 *SUMMARY OF LEGAL REQUIREMENTS AND COMMITMENTS*

7.2.1 Legal Requirements

Suriname's laws regarding air quality management and monitoring are limited. There are no technical standards or specific legislation concerning air quality management and monitoring in Suriname.

7.2.2 Commitments

The Merian Project has committed to the Project's Environmental Design Criteria, which follows applicable IFC guidelines and recognized industry best practice.

7.2.3 Key Performance Indicators

The following Key Performance Indicators (KPIs) are recommended to be measured and used to evaluate the Project's performance with respect to its stated objectives and commitments:

- TSP concentrations from Project activities averaged over 24-hour periods[1];
- PM_{10} concentrations from Project activities averaged over annual and 24 hour periods;
- $PM_{2.5}$ concentrations from Project activities averaged over annual and 24-hour periods;
- NO_2 concentrations from Project activities averaged over annual and 1-hour periods;
- SO_2 concentrations from Project activities averaged over 24-hour, 1-hour, and 10 minute periods;
- CO concentrations from Project activities averaged over 8-hour and 1-hour periods[2];
- Metals concentrations (Pb, Se, As, Hg, and Ni) will be obtained from the TSP samples (TSP samples will be analyzed in a lab to determine metal concentrations);
- Total annual cleared area including type of area i.e. secondary vegetation, mature forest and types of trees cleared;
- Total area of newly established vegetation due to reclamation;
- Annual volume of heavy fuel oil (HFO) purchased/used by the reciprocating generators at the Plant Site;
- Annual volume of diesel purchased/used by the mine fleet and construction power generators;
- Annual fuel (thousand liters) consumed by mine fleet, delivery trucks (supplies, reagents), power plant, carbon kiln, etc. (diesel, HFO, gasoline, waste oil, aviation fuel);
- Quantity (tonnes) of ANFO and emulsion explosives blasted annually
- Quantify amount of lime (tonnes) used annually;

[1] TSP is not among the pollutants regulated under the World Health Organization (WHO) Ambient Air Quality Guidelines or the United States Environmental Protection Agency (US EPA) National Ambient Air Quality Standards. For the purpose of this Air Quality Management and Monitoring Plan, TSP concentrations will be measured in order to determine metal concentrations attributed to the Project. Measurement of this KPI can be discontinued after a few years if metal concentrations from Project activities are generally found to be negligible.

[2] CO concentrations from air dispersion modelling in the ESIA were determined to be minimal. For the purpose of this Air Quality Management and Monitoring Plan, CO concentrations will be measured in order to validate the results of the air dispersion modelling. Measurement of this KPI can be discontinued after a few years if CO concentrations from Project activities are confirmed to be minimal.

- Quantity of refrigerants (kg) used annually (e.g., R-22, R-134a, R-410A, CFCs, HCFCs, etc.);
- Annual direct energy consumption in million GJ; and
- Annual electricity consumption in million GJ.

Monitoring of these KPIs and of the commitments and mitigation measures described in Appendix IV-A will be included within a specific stand-alone operational Environmental and Social Monitoring Plan.

7.3 *MANAGEMENT PLAN COMPONENTS*

The following Air Quality Management and Monitoring Plan sets out to:

- State principals of air quality management at the Merian Gold Project;
- Identify potential fugitive and combustion emission sources associated with the Project;
- Describe measures for managing air quality at the Project site; and
- Describe the air quality monitoring program, including monitoring location, equipment, and estimated costs.

7.3.1 *Principals of Air Quality Management at Merian Gold Project*

The Merian Gold Project has committed to the following:

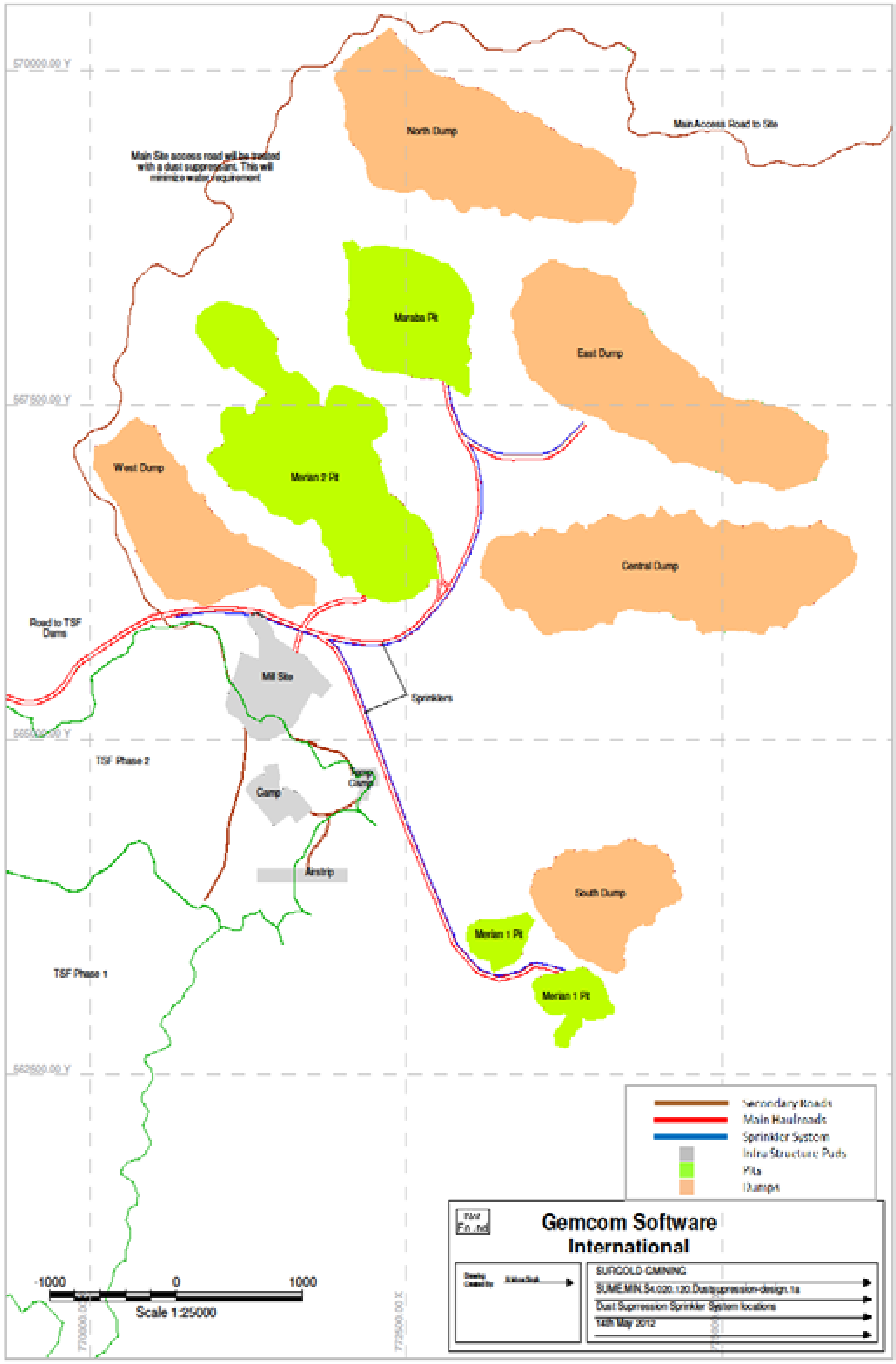
- Dust suppression as needed, i.e., watering disturbed areas. A Level 1 watering program is assumed as a base case. This assumes 2 $L/m^2/hr$ watering (equivalent to 50 percent dust control on unpaved roads). Surgold will follow the dust suppression strategy described in the Dust Suppression Operational Strategy memorandum dated 12 May 2012 (GMining 2012)[1]. As indicated in the memorandum, sprinkler systems will be installed on all main haul roads from the mill to every pit. The remaining main haul roads, ramps, secondary roads and WRDs will be watered with water trucks (e.g., Cat 785 with a Tow Haul water system). During the highest production years, approximately 13.5 km of main haul roads will have to be watered with 8.3 km done by sprinklers and the remaining 5.2 km done with water trucks (see Figure 7-1). During peak periods, one main water truck (151,400 liter/day capacity) delivering 20 loads per day is expected to cover the daily water requirements (3.12

[1] GMining 2012. *Dust Suppression Operational Strategy*, memorandum to ESIA Team, dated 12 May 2012.

million liters/day) needed for the total unpaved road surface area (130,000 m^2) (see Table 7-1);

- Reclaim or stabilize disturbed areas (excluding Tailings Storage Facility) as they become available;
- Use of low sulfur fuel[1] for the new HFO power plant;
- Use of HFO power plant compliant with International Finance Corporations (IFC) air quality performance standards for thermal power plants – i.e., high energy efficiency reciprocating engines (> Tier 2 engines); and
- Use of new mine equipment (drills, excavators, dump trucks, dozers, etc.) with high efficiency non-road diesel engines (> or equal to Tier 2 engines).

[1] Preliminary data indicates that fuel available may be <1% sulfur. Surgold will use fuel less than 3% sulfur as per IFC guidelines.



Source: GMining 2012.

Figure 7-1 Sprinkler Location Overview

Table 7.1 Truck Requirement Calculations

Parameters	Values	Units
Dust control requirements	2	litres per m2 per hour
Haulroad width to be watered	25	m
1 litres	0.264	gallons
Tow Haul Water Truck capacity	151,400	liters
Pumps to fill water trucks	3400	gal/min
Time to fill TowHaul watertruck	11.8	min
Flow rate for spraying roads	6000	Liters/min
Time to dispense water	25.2	min
operating eff. Factor	80%	
Working hrs per day	24	hrs
Truck availability	85%	
Use of availability	93%	
Utilization	83%	
Net Operating hrs	15.7	hrs
Cycle time trucks	46.2	min
Number of loads delivered per day	20	water lds/day
Water delivery capacity per day	3,028,000	liters by main water truck
Road surface to be covered by trucks	130,000	m2
Time road watering is required	12	hrs
Water requirement per day	3,120,000	liters
Number trucks required	1	

Source: GMining 2012.

7.4 *IDENTIFICATION OF AIR EMISSION SOURCES*

The emissions associated with Pre-production, Operations, and Closure phases will occur concurrently throughout the Project life. The major fugitive dust and combustion emission sources associated with the Project are described below[1].

[1] Emissions from sources such as the carbon regeneration kiln at the process plant, emergency diesel generators (<200 hours of operations per year), employee commute vehicles, and contractor vehicles are expected to be much smaller in comparison to emissions from the power generators, non-road diesel powered mine equipment, and fugitive dust activities from surface disturbance at the Mine Site and hence, not included in this Plan. Since the emission factors used in quantifying the Projects'

7.4.1 Unpaved Roads

Unpaved road fugitive dust sources covered by the Plan include:

- Mine Haul Roads: This source involves dump trucks hauling material on unpaved access roads within the Mine Site. The materials being hauled include waste from the mine pits to WRDs near the pits and mined ore (soft and hard ores) from the pits to the crusher/Feeder stockpile area near the Plant Site;
- Other Project Roads: This source involves non-mining transport within the project area on unpaved roads (e.g., North Access Road within the Project gate and other ancillary roads); and
- The North Access road from the Moengo Road to the Mine's gate will be a public road and will be maintained by Surgold in the same fashion as the Moengo road between the North Access Road and Moengo.

7.4.2 Stockpiles

Stockpile fugitive dust sources covered by the Plan include:

- Wind erosion from WRDs;
- Wind erosion from any exposed or dry tailings in the Tailings Storage Facility (most of the TSF will be submerged); and
- Wind erosion from stockpiles at the crushing area (negligible due to the high moisture content of the saprolite).

7.4.3 Material Transfer Points

Material transfer fugitive dust sources covered by the Plan include:

- Dump trucks unloading overburden onto stockpiles at waste disposal areas;
- Excavators loading ore into dump trucks;
- Dump trucks unloading ore onto stockpiles at crushing area; and
- Material handling, transferring, and conveying activities at the process plant area.

combustion emissions are conservative, these emissions would likely offset the other minor emissions not quantified (carbon regeneration kiln, etc.).

7.4.4 *Power Generation*

Power generation combustion emission sources covered by the Plan include:

- Fuel combustion associated with operating diesel-fuelled construction generators (3.33 megawatt- (mwe)) to power the worker camps and other facilities at the Mine Site during the Pre-Production Phase; and
- Fuel combustion associated with operating onsite HFO power plant (52.5 mwe) to power the processing equipment, worker camps, and other facilities at the Mine Site during the Operations Phase.

7.4.5 *Non-road Diesel Engines*

Non-road diesel engine combustion emission sources covered by the Plan include:

- Fuel combustion associated with operating non-road diesel engines (trucks, excavators, dozers, loaders, etc.) At the mine pits and along the access roads and transport corridor.

7.5 *RECOMMENDED AIR EMISSION CONTROL MEASURES*

The following fugitive dust and combustion emission control measures have been recommended for the Project.

- Implement an ambient air quality monitoring program at the Mine Site during Pre-Production and Production phases. ERM recommends this includes monitoring of TSP, PM_{10}, $PM_{2.5}$, NO_2, SO_2, and CO and annual stack testing (USEPA manual testing; not CEMs) for the following pollutants PM_{10} and $PM_{2.5}$ (USEPA methods 1 to 5), SO_2 (USEPA method 6c), NOx (USEPA method 7e), CO (USEPA Method 10) and CO_2 (USEPA Method 3);
- Increase watering of disturbed surfaces such as mine roads (main haul roads, secondary roads, and ramps), stockpile area, and material transfer points during dry, low humidity, and windy conditions. Watering of unpaved road surfaces can be increased from base case Level 1 (2 $L/m^2/hr$ or 50 percent dust control) to Level 2 (>2$L/m^2/hr$ or 75 percent dust control);
- If needed, add more sprayer/misters at the crusher area (primary and pebble crushers) for additional dust control during crushing activities;

- Perform daily visible fugitive dust checks on all active mine haul roads, stockpiles, and material transfer points;
- Implement a concurrent rehabilitation program that minimizes the amount of land that will be disturbed at one time;
- Ensure that all construction equipment and mine fleet are maintained in accordance with manufacturer's specifications;
- Rotate spigoting of tailings to maintain moisture content and/or irrigate tailings surface to minimize dust generation;
- Quantify the Project GHG emissions on an annual basis;
- Avoid open-burning of waste on-site; and
- If required, adjust or fine-tune the fuel-to-air ratio for the HFO reciprocating engines during start-up to control NO_2 emissions.

7.6 *NOISE AND VIBRATION*

Based on the lack of projected adverse impacts on noise and vibration as described in the ESIA, a noise and vibration management plan is not required. The following control/management measures can be implemented to further reduce the minimal noise and vibration levels expected at the Mine Site:

- Ensure regular maintenance of all mine equipment and haul trucks in accordance with manufacturer's specifications;
- Install sound suppressive devices such as silencers and mufflers on mine equipment and haul trucks as necessary;
- Ensure that blasting occurs the same time each day to reduce the startle factor; and
- Where possible, avoid blasting during unfavorable atmospheric conditions, such as low level inversions.

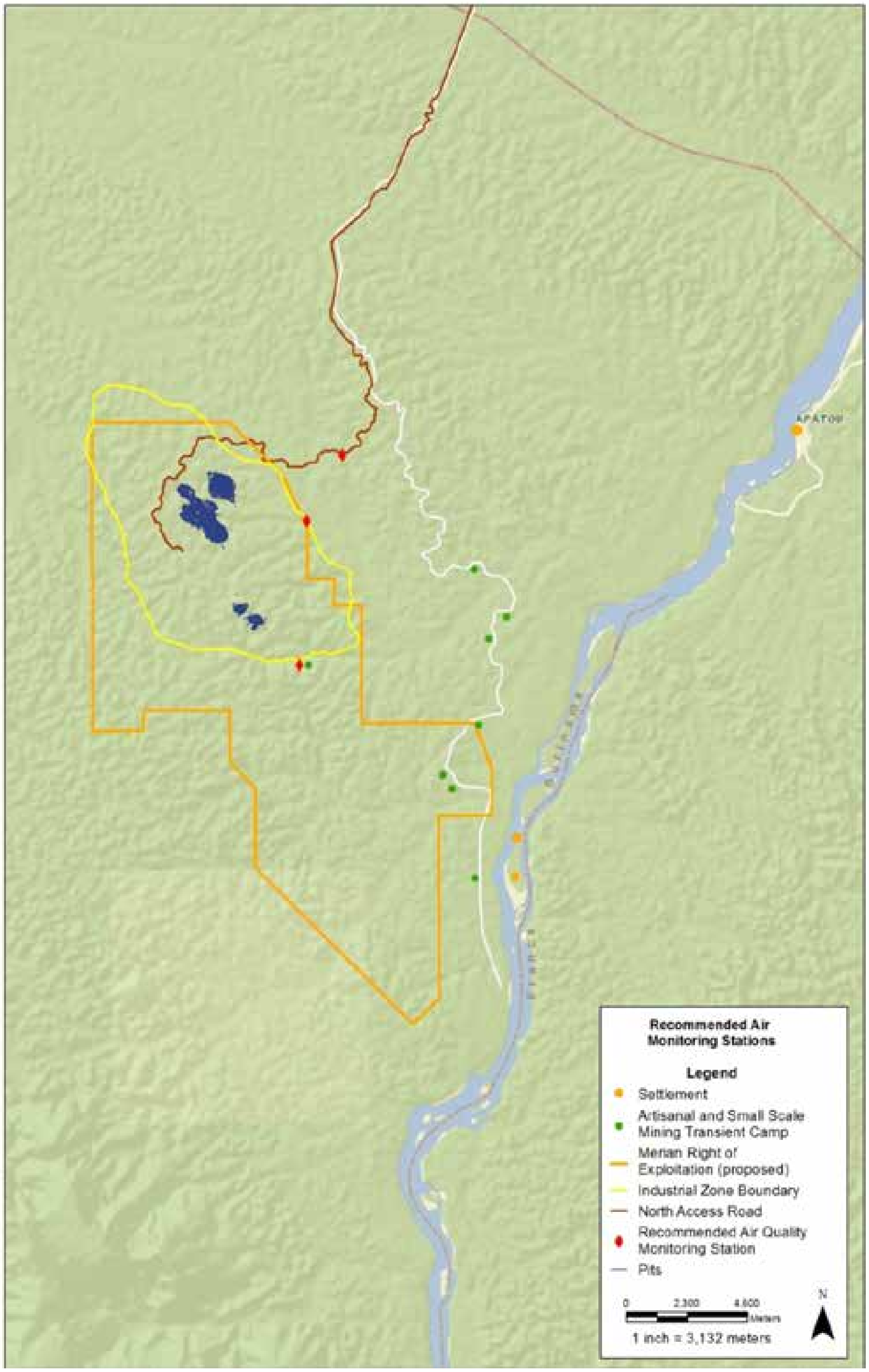
Based on on-going monitoring and adaptive control Surgold will engage stakeholders surrounding potential noise concerns through ongoing stakeholder engagement. If required noise monitoring should be conducted at project parameter (preferably at same locations as the ambient air monitoring locations) during project construction and operation twice a year during the dry season. The monitoring would be conducted in accordance with the IFC General EHS Guidelines for noise. Vibration monitoring is not anticipated to be required.

7.7 *AIR QUALITY MONITORING PROGRAM*

Surgold will implement an ambient air monitoring program at the Mine and Plant sites and along the Transport Corridor to collect air quality data to establish representative background concentrations during the pre-production and production phases of the Merian Gold Project. The information in this section will be expanded and included within a stand-alone operational Environmental and Social Monitoring Plan as described in Section 4.2.

7.7.1 *Monitoring Location*

The general approach for monitoring is to install and operate one primary air monitoring station downwind of the plant and mine sites on the southeastern edge of the Industrial Zone boundary. This station will be supplemented with two additional air monitoring stations to measure fugitive dust impacts associated with transport, including one at the eastern edge of the Industrial Zone boundary and one along the North Access Road (see Figure 7-2).



Source: ERM

Figure 7-2 Recommended Air Quality Monitoring Stations

These locations are tentatively selected and may change depending on wind conditions, mining activities, and ease of access and required security for the monitoring equipment and portable generators at the sites. During the initial week of equipment installation and on-site training, the Air Monitoring Specialist will select the specific equipment locations at each monitoring site following U.S. Environmental Protection Agency (USEPA) siting guidelines. The recommended equipment for each site is summarized below.

Primary Site

The primary site will be equipped for continuous monitoring of criteria pollutants (recommended to be PM10, PM2.5, NO2, SO2, and CO) using US EPA Reference or Equivalent Methods (analyzers, calibration systems, and data logging equipment). The equipment will be installed in a temperature controlled shelter and 110 VAC or 220 VAC line power will be required. In addition, a volumetric flow controlled filter-based sampler will be located adjacent to the shelter for collecting samples of TSP on 47-mm Teflon media. Each sample will undergo subsequent laboratory analysis of TSP and target metals such as arsenic (As), chromium (Cr), and nickel (Ni). TSP samples will be collected from midnight to midnight (24 hours) every sixth day in accordance with the US EPA sampling schedule. Meteorological data (hourly averages) during the monitoring program will be obtained from the collocated weather station. These data will be used to create wind rose data summarizing wind patterns during the sampling period, as well as to assess diurnal variation.

All continuous monitoring data from the primary site will be stored in a central data acquisition system (DAS) and accessed via laptop computer a minimum of once per week for review and archiving. In addition, bi-weekly quality assurance calibrations will be completed to ensure monitors are operating within US EPA quality assurance guidelines.

Transport Monitoring Sites

The other two recommended monitoring sites will supplement the measured air quality data from the Primary Site and will measure fugitive dust impacts at transport sites on the eastern edge of the Industrial Zone boundary (ancillary road) and along the North Access Road. It is anticipated that these sites will likely not have line power available. Therefore, sampling for TSP and PM10 will only occur every sixth day using a US EPA approved portable solar-powered volumetric flow controlled filter-based sampler. Samples will be collected on 47-mm Teflon media and will be stored after the completion of each sample event. On a quarterly basis samples will be transported to a US-based laboratory for analysis of TSP and PM10. Like the primary site, meteorological data will also be obtained from the onsite weather station.

7.7.2 *Estimated Costs*

Estimated cost of equipment, procurement, installation and operations for the first year are summarized by task as follows:

- Equipment cost = $170,400 (excludes cost of generator for power);
- Monitoring protocol = $5,000;
- Equipment procurement, testing, and system integration = $20,000;
- Shipping, installation in Suriname, and training = $35,000;
- First year operation, quarterly audits, and reports = $60,000;
- Total cost for first year = $290,400;
- Total cost for subsequent years (routine operation and maintenance costs only) = $60,000; and
- Annual stack testing = approximately $60,000.

It should be noted that these are only preliminary estimated costs.

7.8 *CHANGE MANAGEMENT*

All data from the monitoring activities will be recorded including instrument calibration data, sampling data, sampling locations, sampler ID, filter number, sampling time, sampling duration at each location, adequate fuel supply verification, time the generator was turned on, time generator was turned off, fuel level remaining after sampling, general weather observations, and any notes regarding the site equipment. Monitoring records will be completed daily and the records will be turned in for inspection, filing, and quality assurance at the site office at the end of each day.

Reporting requirements for the Air Quality Management and Monitoring Plan will include:

- Daily and weekly inspections of monitoring equipment and Primary and Transport sites;
- Monthly report submitted to the Site Manager; and

- Annual input to the Annual Environmental and Social Management and Monitoring Report (ESMMP).

During daily inspections, small-scale infractions or improvements will be identified, and actions taken to improve or change practices will be documented.

The monthly report to the Site Manager will be used to identify more systematic problems, solutions that require budget allocation beyond the Environmental and Social Responsibility (ESR) discretionary spending budget, or legal or contractual input.

The Plan will be reviewed on an annual basis and updated to reflect improvements or changes identified throughout the year. The KPI's will be compared against past performance and analyzed for trends to determine if there are areas that can be improved, fuel use reduced, etc.

The monthly and annual air quality data summary report would contain the following:

- A listing of all valid hourly meteorological data obtained from the onsite weather station and wind rose analysis for the monitoring period;
- A summary of measured pollutant concentrations (annual, 24-hour, 1-hour, etc.) for comparison to the World Health Organization (WHO) Ambient Air Quality Guidelines[1];
- A discussion of the measured exceedances of the WHO Ambient Air Quality Guidelines, if any;
- A determination of the percentage of data recovered; and
- Associated quality assurance/quality control results, including audit and calibration data and blank sample results.

The results of the monitoring samples will be reviewed immediately upon receipt to determine if site conditions are in compliance with the applicable air quality goals for the project. If the results show that pollutant levels exceed the WHO Ambient Air Quality Guidelines, then appropriate measures would be taken to determine the cause of the exceedance. Procedures for pre-production and operation activities will be reviewed to see what modifications or control measures would be made to ensure that these levels would not continue to be exceeded (see Section 7.5). The changes will be documented to show that

[1] WHO Ambient Air Quality Guidelines taken from International Finance Corporations' (IFC) Environmental, Health, and Safety (EHS) Guidelines dated 30 April 2007.

corrective actions have been implemented and subsequent data will be reviewed to confirm that corrective actions have resulted in reduced pollutant levels.

7.9 IMPLEMENTATION

7.9.1 Responsible Parties and Roles and Responsibilities

To ensure that all work conducted will be carried out in accordance with this air monitoring program, the responsible parties as well as their roles and responsibilities are described in Table 7-2.

Table 7.2 Responsible Parties and Roles and Responsibilities

Responsible Parties	Roles and Responsibilities
Site Manager	· Review monthly reports to identify systematic problems and solutions that may require additional budget; and · Ensure operational personnel have management systems in place to support ESR commitments (i.e. maintenance of machinery, water truck operation etc.).
ESR Manager	· Develop and provide training to appropriate ESR staff regarding duties regarding air quality management and monitoring; · Review daily and weekly inspection reports and monthly reports; · Deliver monthly reports to Site Manager; · Oversee ESMMP annual reporting; and · Liaise with contractors regarding air quality management issues.
Environmental Supervisor	· Schedule daily inspections of monitoring equipment; · Resolve issues identified in daily and weekly inspections of monitoring equipment; · Schedule training sessions on operation and maintenance of monitoring equipment for relevant staff; · Schedule training sessions on sample handling procedures for relevant staff; · Schedule dust observation and visibility training from time-to-time to all staff; and · Prepare monthly report.
Environmental Coordinator	· Perform daily and weekly inspections of monitoring equipment to ensure they are working properly; · Perform daily inspection of weather station; · Check fuel levels of diesel generators (for locations that require generators) and refuel as necessary; · Collect and download monitored data into a laptop for further processing such as determining 24-hour averages; and · Complete inspection sheet

7.9.2 *Training*

Training will be provided to the ESR staff by the ESR Manager (or in some cases, a qualified contractor/ other member of staff) regarding the duties involved in implementing the Air Quality Management and Monitoring Plan. The training will include:

- Operation, calibration, and maintenance of the monitoring equipment;
- Sample handling procedures;
- Forms and record keeping;
- Reporting;
- Corrective actions;
- Work orders;
- Dust observations and visibility training;
- Weather observation; and
- Location of information.

Surgold will provide training in the areas listed above to new employees as their job function demands. Refresher training will be provided to existing employees on an annual basis.

7.9.3 *Schedule*

Table 7-3 provides a schedule for activities associated with this Plan.

Table 7.3 Schedule for the Air Quality Management and Monitoring Plan

Time	Activity
September – May 2013	· Develop a Monitoring Protocol that includes specifics regarding number and locations of monitoring sites, ease of access to sites/security, power availability at the sites, monitoring methodology, etc.; · Equipment procurement, testing, and system integration; · Develop detailed budget for first year of implementation of the Plan; and · Identify responsible parties for the Plan (Environmental Field Worker, Environmental Supervisor, etc.)
Pre-Production	· Implement Plan; · Shipping of equipment, installation in Suriname, and training; and · First year operation, quarterly audits, report.
Operations	· Implement Plan; and · Review and update on an annual basis or when there is a change in process.

Closure	· Reassess air emission sources and revise Plan; and · Implement, revise and update on an annual basis.

8.0 BIOLOGICAL IMPACT MANAGEMENT PLAN

The following Biological Management and Monitoring Plan presents a system for controlling impacts on terrestrial and aquatic biological resources at the Merian Gold Project Mine Site, downstream of the Mine Site, and along the Transportation Corridor. The Plan is based on the biological mitigation measures recommended in the ESIA. This Plan applies to Pre-Production, Operations and Closure activities. It is anticipated that the Plan will require periodic revisions and updates as the Project progresses through different mine-life stages as well as during implementation as results are reviewed and improvements identified.

8.1 *PURPOSE AND OBJECTIVES*

The purpose of the Biological Management and Monitoring Plan is to establish and document the successful implementation of measures to control impacts and maximize benefits to terrestrial and aquatic biological resources as recommended in the ESIA. The Plan defines the following:

- Methods to measure actual observed impacts against impacts predicted in the ESIA;
- Impacts that require management;
- Measures Surgold will implement to manage these impacts; and
- Procedures for confirming successful implementation of these measures.

The primary objective of the Plan is twofold: to reduce the magnitude of significant[1] Project-related negative impacts on biological resources, and to maximize positive effects of the Project on biological resources. To meet these objectives, the Plan:

- Identifies the major biological impacts listed in the ESIA;
- Identifies management measures that can be implemented to control and minimize negative impacts, and maximize the benefits of positive effects;
- Identifies Key Performance Indicators that can be used to evaluate the efficacy of the management measures;
- Identifies Success Criteria that, when met, will signify that restoration activities are complete; and

[1] "Significant" negative impacts are those impacts that were rated Minor or higher in the ESIA.

- Describes a biological monitoring program that can be implemented at the Project site to assess progress toward achieving the Success Criteria.

8.2 *SUMMARY OF LEGAL REQUIREMENTS AND COMMITMENTS*

8.2.1 Legal Requirements

Suriname's laws regarding biological management and monitoring are limited. There are no technical standards or specific legislation concerning biological management and monitoring in Suriname.

8.2.2 Commitments

The Merian Project has committed to the Project's Environmental Design Criteria, which specify IFC guidelines as well as recognized industry best practices and the International Cyanide Management Code (ICMI).).

8.2.3 Key Performance Indicators

The following Key Performance Indicators (KPIs) will be measured and used to evaluate the Project's performance with respect to its stated objectives and commitments[1]:

- Survivorship and vigor of vegetative species of concern (*Oenocarpus sp. aff. O. bacaba Mart.*, *Virola surinamensis*, and *Vouacapoua americana*) salvaged from impacted areas and raised as part of the Project's nursery program;
- Successful relocation of *Anomaloglossus surinamensis* and *Atelopus hoogmoedi nassaui* from areas that will be impacted by the Project to unimpacted areas within the Project Area;
- Net change in vegetative or faunal species richness at selected monitoring sites throughout the Project Area;
- Net change in major vegetation community types in the Project area;
- Survivorship of aquatic species of concern in the Marowijne and Commewijne River watersheds; and
- Net change in species composition of aquatic biological communities downstream of the Project area in the Marowijne and Commewijne River watersheds.

[1] Key Performance Indicators related to cyanide concentrations in water management ponds are included in the Cyanide Management Plan. These KPIs are relevant to the protection of wildlife from exposure to cyanide.

Monitoring of these KPIs and of the commitments and mitigation measures described in Appendix IV-A will be included within the specific stand-alone Environmental and Social Monitoring Plan. High level monitoring requirements are also discussed in Section 8.6.

8.3 *MANAGEMENT PLAN COMPONENTS*

The Biological Management and Monitoring Plan:

- Identifies the significant potential impacts on biological resources associated with the Project;
- Describes measures for managing biological resources at the Project site; and
- Describes the biological monitoring program, including monitoring location, equipment, staff needs, and estimated costs.

8.4 *IDENTIFICATION OF SOURCES OF IMPACTS ON BIOLOGICAL RESOURCES*

The significant sources of impacts on biological resources associated with the Project are described in the following sections.

8.4.1 Timber harvesting and clearing

Sources related to removal of vegetation covered by the Plan include:

- Loss of vegetation in roads, skid lines and areas cleared during timber harvesting;
- Clearing remaining vegetation to construct Project infrastructure
- Desiccation and increased risk of blowdown along roads and timber harvest areas;
- Increased fire risk along roads and near accumulated slash/logging debris;
- Changes in vegetation structure and species assemblage (increased ground cover and lianas); and
- Reduced geneflow across roads and logged areas.

8.4.2 Loss of wildlife habitat

Sources related to habitat loss covered by the Plan include:

- Loss of vegetation in roads, skid lines and areas cleared during timber harvesting;
- Clearing remaining vegetation to construct Project infrastructure;
- Desiccation and increased risk of blowdown along roads and timber harvest areas;

- Increased fire risk along roads and near accumulated slash/logging debris;
- Changes in vegetation structure and species assemblage (increased ground cover and lianas); and
- Reduced geneflow across roads and logged areas.

8.4.3 *Metabolic stress in vegetation*

Sources related to metabolic stress in vegetation covered in the Plan include:

- Deposition of dust onto leaves near Project infrastructure during Pre-Production; and
- Deposition of dust onto leaves from extractive activities at the Merian and Maraba pits, waste rock facilities, road network, processing facility (production only), and TSF (closure only).

8.4.4 *Wildlife injury and/or mortality*

Sources related to injury or mortality of wildlife covered by the Plan include:

- Lethal and sublethal injury due to crushing, collision, entanglement, etc. in roads, skid lines, and other areas where heavy machinery harvest commercial timber or construct Project facilities;
- Roadkill and vehicular injury; and
- Entrapment/drowning in pits and/or TSF.

8.4.5 *Sensory disturbance*

Sources related to sensory disturbance covered by the Plan include:

- Noise emissions from the pits, TSF impoundments, water treatment facilities, power plant, etc.;
- Interruption of circadian rhythms;
- Increased mortality in attractive areas with man-made hazards (i.e. parking lots, security gates, etc.);
- Interference with social vocalizations (in social species such as some birds and primates);
- Interference with mating activities (amphibians in particular);
- Increased exposure to predation/ mortality; and
- Implementation of the biological monitoring program.

8.4.6 *Increased turbidity and sedimentation*

Sources related to turbidity and sedimentation covered by the Plan include:

- Runoff from disturbed areas from timber harvesting and construction of the Project infrastructure.

8.4.7 *Hydrological and water quality changes to Merian Creek watershed*

Sources related to hydrological and water quality changes in Merian Creek watershed covered by the Plan include:

- Increased competition for habitat and likely displacement of some species due to changes in flows in receiving stream(s);
- Runoff and seepage from the waste rock facilities and discharge from mine pit de-watering;
- Operation of access road network (runoff of dust and eroded material from roadway); and
- Potential introduction of contaminants to surface water in the event of a spill or accident.

8.4.8 *Loss of aquatic habitat*

Sources related to loss of aquatic habitat covered in the Plan include:

- Installation of sediment basins in the western headwaters of Merian Creek and the eastern headwater of Tempati Creek; and
- Impoundment of A3 Creek for the construction of the TSF and TWSR.

8.4.9 *Hydrological and water quality changes to Las Dominicanas Creek*

Sources related to hydrological and water quality changes in Las Dominicanas Creek covered by the Plan include:

- Increased competition for habitat and likely displacement of some species due to changes in flows in receiving stream(s);
- Nutrient enrichment of A3 Creek watershed due to Pre-production phase discharges of effluent from the Pioneer Camp, Operations Camp and Process Plant sewage treatment plants;
- Potential changes in water quality in A3 Creek and Las Dominicanas Creek watershed downstream of confluence;

- Barriers to fish movement created by unnatural flow regimes in Las Dominicanas Creek and A3 Creek, due to transfer of flows between the North Fork and South Fork of A3 Creek and potential seepage from the TSF, as well as decreased water quality in the watershed;
- Altered water quality conditions in A3 Creek and Las Dominicanas Creek and due to discharge from TWSR;
- TSF seepage to A3 Creek, Tomulu Creek, and Las Domincanas Creek could impact overall water quality in potential spawning areas for fish species of concern in Lower Dominicanas Creek, especially during low-flow periods in September – November (i.e.; spawning season) if not properly managed; and
- Potential introduction of contaminants to surface water in the event of a spill or accident.

8.5 *RECOMMENDED MEASURES TO MANAGE IMPACTS ON BIOLOGICAL RESOURCES*

The following measures have been recommended for the Project to manage impacts on biological resources. Some measures address multiple sources of impacts and other measures included in other plans intended primarily to manage impacts on physical resources (air, water, etc.) are also included by reference.

The impacts associated with the Project will evolve as the Project is implemented over time, so certain measures should be implemented during specific phases of the Project. This section is therefore organized according to Project phase. Where specific measures should be implement over multiple phases, these measures are identified for each relevant phase.

8.5.1 Pre-production measures

Relevant mitigations measures during pre-production include:

- Minimize cleared width of roads and temporary work camp site;
- Avoid known areas of high vegetation diversity to the extent practicable;
- Survey road routes prior to construction to avoid mature special-status species to the extent practicable;

- Survey and transplant Species of Concern (SOC) seedlings to areas of similar habitat to the collection site which will not be impacted by the Project;
- Establish onsite plant nursery to maintain locally-derived stock for re-planting during restoration;
- Minimize potential fuel/ ignition sources (e.g.; brush piles, grubbed material stockpiles);
- Where possible remove lianas from forest edges as necessary to prevent 'secondary felling';
- Implement dust control measures as further described in the Air Quality Management Plan;
- Enforce speed limits on Project roads;
- Minimize night driving to avoid the possibility of wildlife collisions/ fatalities;
- Conduct a pre- timber harvest/construction survey and relocate listed herpetiles (*Anomaloglossus surinamensis* and *Atelopus hoogmoedi nassaui*) to areas with similar habitats to the collection site that will not be impacted by the Project;
- Concurrently with the pre- timber harvest/construction survey, conduct a small mammal pitfall trapping survey to relocate small mammals to areas with similar habitats to the collection site that will not be impacted by the Project;
- Locate sediment dams on all impacted streams downstream of project activities, and treat Project-site runoff to meet Project discharge criteria as described in the Water Management Plan. Apply BMPs during early construction prior to construction of sediment dams;
- Progressively reclaim Waste Rock Facilities;
- Implement Erosion and Sediment Control Plan (described in the Water Management Plan);
- Treat sewage to meet project sewage effluent discharge criteria;
- Monitor quality of sewage treatment plant effluent discharges to the A3 Creek watershed to confirm continued adherence to Project sewage effluent limits as described in the EDC;
- Monitor water quality in receiving environment in accordance with the Water Management Plan;

- Build fuel storage areas on bunded impermeable pads;
- Treat runoff from bunded areas with oil-water separators;
- Store reagents indoors;
- Store all fuel and reagents in double-hulled tanks.(Not required if on bunded impermeable pads);
- Exercise controls for inspecting equipment and refueling, handling of chemicals, in accordance with the Spill Prevention, Control and Countermeasures Plan (SPCC); and
- Prohibit hunting by Project staff and contractors, and enforce this prohibition through staff training programs and patrols if necessary.

8.5.2 *Operation measures*

Relevant mitigation measures during operations include:

- Enforce speed limits on Project roads;
- Minimize night driving to avoid the possibility of wildlife collisions/ fatalities;
- Implement dust control measures as further described in the Air Quality Management Plan;
- Conduct a pre- timber harvest/construction survey and relocate of listed herpetiles (*Anomaloglossus surinamensis* and *Atelopus hoogmoedi nassaui*);
- Support OGS' program to improve environmental sustainability of ASM activities;
- Build fuel storage areas on bunded impermeable pads;
- Treat runoff from bunded areas with oil-water separators;
- Store reagents indoors;
- Store all fuel and reagents in double-hulled tanks.(Not required if on bunded impermeable pad;
- Exercise controls for inspecting equipment and refueling, handling of chemicals, in accordance with the Spill Prevention, Control and Countermeasures Plan (SPCC);
- Rescue animals trapped in pits and/or TSF if possible (consistent with maintaining safety of staff);

- Discharge pit de-watering flows and WRD runoff to small Merian Creek tributaries impounded by sediment ponds located downstream of impacted areas;
- Treat sediment pond discharge to meet Project criteria for TSS;
- Develop tailored treatment and management systems if necessary to meet Project criteria for surface water quality in accordance with the Water Management Plan;
- Progressively reclaim/ reforest disturbed areas, preferably using propagules from onsite nursery program to the extent practicable;
- Establish sediment dams to attenuate peak flows from the drainage basins during frequent rainfall events;
- Remove or breach sediment dams during operations or closure, depending on phasing of Project to allow streams to return to more natural hydrologic conditions;
- Route water in the TSF pond through a treatment process to meet Project discharge criteria at relevant evaluation points as described in the Water Management Plan;
- Include a Cyanide Destruction circuit at the Process Plant to reduce cyanide concentrations in the tailings slurry discharged to the TSF;
- Match or approach existing peak flow conditions downstream of the sediment dams where feasible;
- Implement an Erosion and Sediment Control Plan;
- Improve channels to include erosion protection to maintain bank stability if monitoring indicates increased erosion;
- Add root clumps to creek channel to reduce velocities if monitoring indicates increased erosion;
- Implement the Water Management Plan to manage discharges from the Treated Water Storage Pond;
- Design dewatering plan for TSF to mimic existing baseflow conditions as feasible (i.e.; constant discharge rate during dry conditions rather than intermittent pumping);
- Collect and return affected seepage to the TSF for reuse in the Process Plant and/or treatment in the WTP;

- Optimize operation of the Water Treatment Plant and potential groundwater collection system to mitigate potential impacts as outlined in the Water Management Plan; and
- Prohibit hunting by Project staff and contractors, and enforce this prohibition through staff training programs and patrols if necessary.

8.5.3 *Closure measures*

Relevant mitigation measures during closure include:

- Enforce speed limits on Project roads;
- Minimize night driving to avoid the possibility of wildlife collisions/ fatalities;
- Implement dust control measures as further described in the Air Quality Management Plan;
- Remove fuel storage areas and pads;
- Remove runoff treatment devices and oil water separators;
- Remove fuel and reagent storage areas;
- Exercise controls for inspecting equipment and refueling, handling of chemicals, in accordance with the SPCC Plan;
- Continue rescuing animals trapped in pits and/or TSF if possible (consistent with maintaining safety of staff) until such time as the TSF is sufficiently stabilized to support wildlife traversing it;
- Breach sediment dams to allow natural flow patterns to resume;
- Restore impacted creeks to stabilize banks and return creeks improved conditions;
- Continue/finish progressive restoration of vegetation (re-forestation), using propagules from onsite nursery to the maximum extent practicable; and
- Prohibit hunting by Project staff and contractors, and enforce this prohibition through staff training programs and patrols if necessary.

8.6 *BIOLOGICAL MONITORING PROGRAM*

Surgold will implement a biological monitoring program at the Project site and along the Transport Corridor to measure actual impacts against the impacts predicted in the ESIA and to assess the effectiveness of the mitigation measures against the background concentrations during the pre-production and production phases of the Merian Gold Project. The detail provided within this plan is the high level explanation of biological monitoring activities, specific detail will be included as part of the separate Environmental and Social Monitoring Plan described in Section 4.2.

One of the challenges in designing the biological monitoring program is selecting biological monitoring sites that are representative of the range of flora and fauna that may be impacted by the Project. Another challenge is selecting sites that are distributed appropriately to represent the different types of impacts that will occur across the entire Project site. In addition to these considerations, the monitoring sites must be selected to allow comparison with data collected prior to the Project, and control sites (sites that will remain unaffected or minimally impacted by the Project but are ecologically representative of the sites that will be impacted) must also be included in order to distinguish between natural variability and Project-related effects. The monitoring program has therefore been designed to balance the following objectives:

- Accounting for the largest practicable proportion of biodiversity that currently occurs in the Project area;
- Locating sites that are proximal to areas that will be disturbed/impacted by the Project; and
- Including a mix of affected and non-affected (control) sites.

8.6.1 *Monitoring Locations*

The general approach for this monitoring plan is to conduct annual biological monitoring at a subset of the sampling stations established during the baseline site investigation for the ESIA to assess species richness at these sites for the life of the Project. Figures 8-1 and 8-2 show these locations.

These locations have been tentatively selected and may change depending on mining activities, ease of access, and further analysis of the biological baseline data. Additional sites will likely be required to track survivorship of transplanted seedlings and relocated herpetiles during the Operation phase and during the Closure phase to assess vegetative re-growth as reclaimed areas begin to revegetate. The basic rationale for selection of each site and data to be collected at each site is presented in Table 8-1. It should be noted that efforts must be made to ensure that monitoring points are accessible.

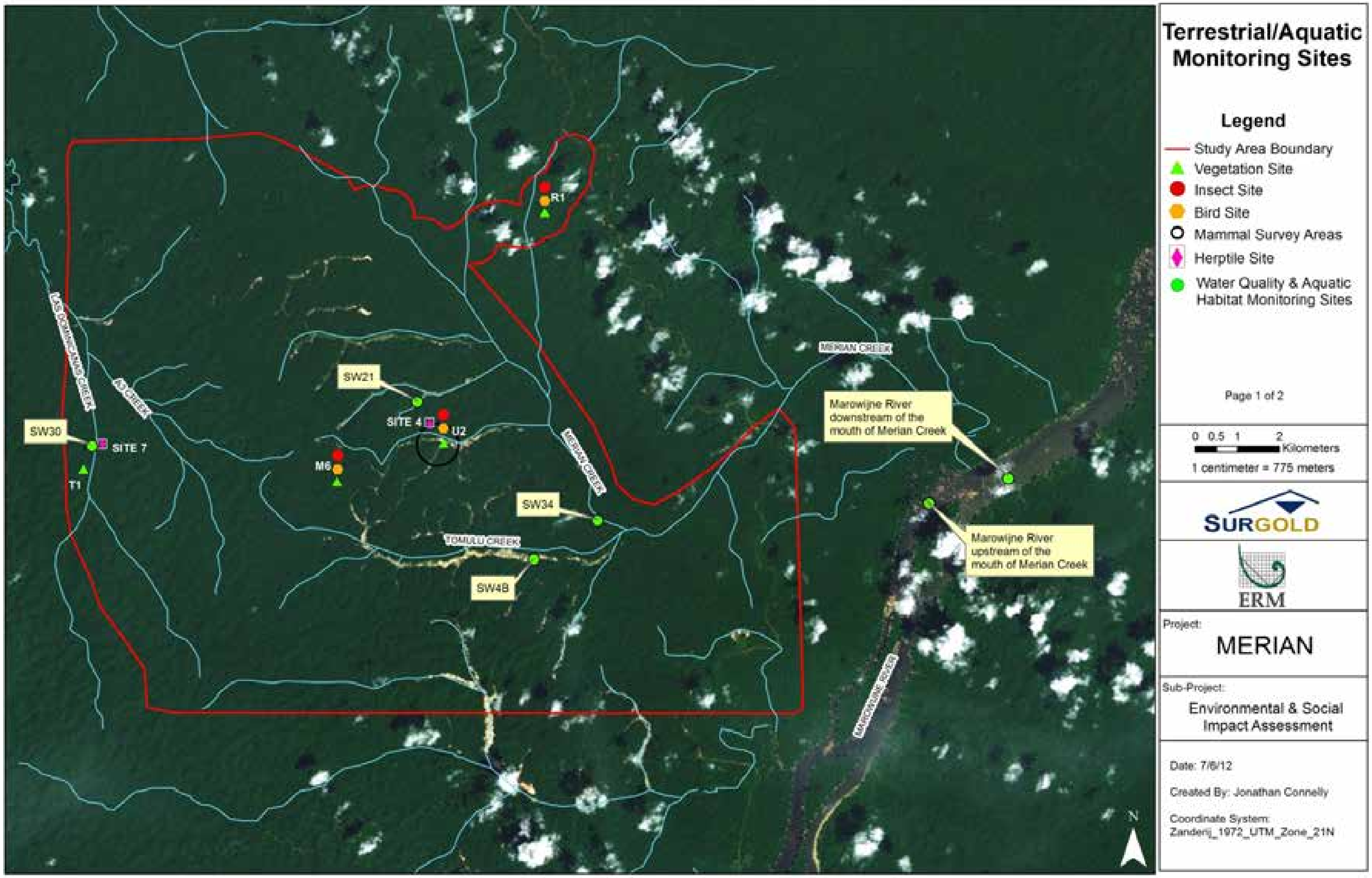


Figure 8-1 Recommended Terrestrial and Aquatic Biological Monitoring Sites

Figure 8-2 Recommended Downstream Aquatic Biological Monitoring Sites

Table 8.1 Recommended Biological Monitoring Stations

Site	Rationale for Selection	Data to be Collected
	Terrestrial Sites	
M6	Approximately equidistant between the North Waste Storage facility and the Merian 1 North Pit	Vegetation, Bird, and Mammal Species Richness
U2	Near TSF, camp, and mill site	Vegetation, Bird, and Mammal Species Richness
R1	Within transport corridor	Vegetation, Bird, and Mammal Species Richness
T1	Proximate to the TSF	Vegetation species richness
Site 7	Proximate to the TSF	Herpetile species richness
	Aquatic Sites	
SW21	Downstream of the North Waste Storage Facilities	Fish, Macroinvertebrates, Aquatic macrophytes, Physical Habitat
SW30	Reference site for other sites in Commewijne River watershed, has one aquatic species of concern	Fish, Macroinvertebrates, Aquatic macrophytes, Physical Habitat
SW34	Downstream of the Merian 1 pit and representative of aquatic communities in the lower reaches of tributaries to Tomulu Creek	Fish, Macroinvertebrates, Aquatic macrophytes, Physical Habitat
SW4B	Only site on main channel of Tomulu Creek	Fish, Macroinvertebrates, Aquatic macrophytes, Physical Habitat
Marowijne River upstream	Reference site for Marowijne River; has several aquatic species of concern	Fish, Macroinvertebrates, Aquatic macrophytes, Physical Habitat, Water Quality
Marowijne River downstream	Downstream of confluence of Tomulu Creek and the Marowijne River and therefore exposed to downstream effects on all activities on the Marowijne side of the Project area; has several species of concern	Fish, Macroinvertebrates, Aquatic macrophytes, Physical Habitat, Water Quality
Upper Commewijne River	Downstream of confluence of Las Dominicanas Creek and the Commewijne River and therefore exposed to downstream effects on all activities on the Commewijne side of the Project area	Fish, Macroinvertebrates, Aquatic macrophytes, Physical Habitat, Water Quality
Lower Mapane Creek	Reference site for downstream impacts on the Commewijne River	Fish, Macroinvertebrates, Aquatic macrophytes, Physical Habitat, Water Quality

In addition to active monitoring at the sites identified above, ERM recommends that Surgold continue the ongoing camera-trapping program at the Project site. This program represents the primary method of assessing the presence of large nocturnal mammals (i.e.; wild cats) at the Project site. ERM also recommends additional biomonitoring in A3 Creek for macroinvertebrates if discharges of hard water from the treatment plant results in elevated pH in the end-of-pipe discharge (as measured during the end-of-pipe monitoring referenced in Section 15.6).

8.6.2 *Reporting*

Reporting on the biological monitoring program results should occur bi-annually to account for seasonal changes in the presence and/or detectability of certain species.

8.6.3 *Estimated Costs*

The terrestrial estimated cost of the monitoring plan is summarized by terrestrial and aquatic components as follows:

- Equipment cost = $5,000 USD (nets, preservative, etc.) initially, assume complete replacement of equipment at least once during Project lifetime;
- Training = $5,000 (handling of SOCs, operation of the nursery-first year only);
- Field work = $50,000; and
- Annual reporting and data analysis = $15,000

Total annual cost = $71,000 first year, $66,000 annually thereafter.

It should be noted that these are only preliminary estimated costs at this time, and that the field work, reporting, and data analysis will be performed in part by contractors (at least during the first few years of the Project).

8.7 *IMPLEMENTATION*

8.7.1 *Responsible Parties and Roles and Responsibilities*

To ensure that all work conducted will be carried out in accordance with this biological monitoring program, the responsible parties as well as their roles and responsibilities are described in Table 8-2.

Table 8.2 Responsible Parties and Roles and Responsibilities

Responsible Parties	Roles and Responsibilities
Site Manager	· Review reports to identify systematic problems and solutions that may require additional budget; and · Ensure operational personnel have management systems in place to support ESR commitments.
Environmental Supervisor	· Schedule daily inspections of monitoring equipment (air monitors), erosion and sediment control facilities, etc.; · Resolve issues identified in daily inspections; · Schedule annual field work; · Direct daily activities of field workers;

	·	Manage nursery; and
	·	Work directly with OGS representative on ASM sustainability program.
Environmental Field Worker	·	Perform daily inspections of monitoring equipment to ensure they are working properly;
	·	Adherence to appropriate HSE protocols (speed limits, handling of hazardous materials, etc.);
	·	Collection of SOCs in the field; and
	·	Daily operation of the nursery.

8.7.2 Schedule

Table 8-3 provides a schedule for activities associated with the Plan.

Table 8.3 Schedule for the Biological Management and Monitoring Plan

Time	Activity
January to May 2013	· Refine/revise Monitoring Plan; · Establish nursery program; · Develop detailed budget for first year of implementation of the Plan; · Identify responsible parties for the Plan (Environmental Field Worker, Environmental Supervisor, etc.); and · Collect any supplemental field data necessary to support the monitoring program.
Pre-Production	· Implement Plan; · First year field work; · First annual report; · Begin salvage of SOC plants; · Transplant SOC herpetile and small terrestrial mammal species; · Establish mechanism with OGS for addressing sustainability of ASM; and · Enforce speed limits.
Operations	· Implement Plan; · Operate nursery; · Review and update on an annual basis or when there is a change in process; · Begin reclamation/revegetation of inactive areas; · Continue annual field work and reporting; and · Enforce speed limits.
Closure	· Continue reclamation/revegetation of inactive areas; · Continue annual field work and reporting; and · Enforce speed limits.

9.0 *TRAFFIC AND TRANSPORTATION SAFETY MANAGEMENT PLAN*

9.1 *INTRODUCTION*

9.1.1 *Purpose of the Management Plan*

The purpose of the Traffic and Transportation Safety Management Plan is to reduce Project related risks and potential impacts on transportation facilities and human health and safety along the Transportation Corridor. The impact assessments for the Transportation Corridor identified key transportation-related risks to the safety of the communities during construction and operations. This Plan presents the recommended strategies and measures to mitigate or eliminate potential negative safety risks/impacts for affected communities. While the impact assessments for the Project did not identify any key risks related to transportation facilities (such as traffic congestion or degradation of road facilities), this Plan nonetheless presents recommended strategies and actions to ensure that impacts to transportation facilities remain insignificant.

This Plan focuses on preventing impacts from occurring in the first place. Recommended measures are prioritized to minimize the potential risks and exposures. In instances where measures identified here are being implemented as part of the other Environmental and Social Management and Monitoring Plans for the Project, the corresponding management plan is referenced. In particular, management of transportation-related safety risks is directly related to the Spill Prevention and Countermeasures Plan (Chapter 11 of the ESMMP).

This Plan also describes the objectives, measures and responsibilities for the Surgold personnel who manage the Project.

9.1.2 *Scope of the Management Plan*

This Plan addresses construction, operation, and closure activities on the publicly accessible portion of the Transportation Corridor: the East-West Highway from Paramaribo to Moengo, and the Moengo-Langa Tabiki Road between Moengo and the entrance to the Mine Site. Because this Plan addresses impacts on the public, the privately-controlled portion of the mine access road is not evaluated. The North Access road from the Moengo Road to the mine gate will be a public road.

The communities along the Transportation Corridor where relevant safety risks and potential impacts have been identified include the following:

- The heavily populated east bank of the Suriname River, which consists of a nearly continuous linear community along the East-West Highway between the Suriname and Commewijne Rivers, and scattered settlements between the Commewijne and Moengo;

- The Moengo Area including Moengo and the surrounding area; and
- The small communities south of Moengo including the villages of Mora Kondre and Pelgrim Kondre.

9.1.3 *Assumptions*

The recommendations in this Plan presume that Project-related traffic volumes and vehicle types will be as estimated in Section 20 of the ESIA: approximately 16 round-trips per day during construction; 33 round-trips per day during operations; etc. Substantial changes to the Project Description could require revision of this Plan.

9.2 *SUMMARY OF LEGAL REQUIREMENTS AND COMMITMENTS*

9.2.1 *Legal Requirements*

Suriname laws and regulations that are applicable to this plan include the following:

- Occupational Safety Law G.B. 1947 no.142 as amended (Ministry of Labor) - Advance safety and hygiene in enterprises so as to reduce the chance of accidents and occupational diseases.

9.2.2 *Commitments*

Surgold will adopt the Environmental and Social Responsibility (ESR) Standards and Policies of Newmont Mining Corporation and adapt international best practices for the purpose of developing mitigation and management measures. These commitments include aspects as described below:

- Surgold ESR Standards (Security and Human Rights ESR Standard);
- International Standards:
    - Section 3.4 of IFC's Environmental, Health, and Safety (EHS) General Guidelines, which address traffic safety, emphasizing the "*adoption of safety measures that are protective of project workers and road users, including those who are most vulnerable to road traffic accidents*" (IFC 2007); and
    - Section 3.5 of the IFC Guidelines, which describe requirements related to identification of hazardous materials and the requirement to have mobile response resources in case of spills (IFC 2007);

- International Cyanide Management Code, Principles and Standards of Practice; and
- Other Surgold Environmental and Social Management and Monitoring Plan Commitments:
    - Worker Health & Safety Program: As discussed in section 3.3 of the CHS Plan, particularly as it relates to Contractor's Health and Safety Management, Driver Policy; and
    - Worker Wellness Program: As discussed in section 3.4 of the CHS Plan, particularly as it relates to Worker Fatigue and Stress Management Program.

9.3 *MONITORING AND REPORTING*

The monitoring of this Plan will be a component of the Environmental and Social Management and Monitoring Plan (ESMMP) monitoring program. It will be based on adaptive management as a way to integrate lessons learned during its implementation and thus respond adequately to the developing situation. This Plan, like all ESMMP modules, is not a final document, but a living document designed to be updated as the process develops. This plan will be reviewed and updated on a yearly basis and/or when major changes in the project take place. This section provides 'high level' description of the monitoring activities and programs however the specific details of traffic and transportation monitoring will be included within a stand-alone Environmental and Social Monitoring Plan as discussed in Section 4.2.

The objectives of the monitoring program are to:

- Verify the implementation of the specific actions of the Plan by fulfillment of the specific goals in time; and
- Continuously evaluate the effectiveness of the Plan's strategies and adjust them as necessary.

Monitoring of this Plan will continue throughout the life of the project, starting with the arrival of the first workers and continuing through the decommissioning phase and facility closing.

The Key Performance indicators for the plan are:

- Annual number of minor accidents involving Project vehicles along the Transportation Corridor (i.e. no injuries, minor property damage);

- Annual number of major accidents involving Project vehicles along the Transportation Corridor (i.e. personal injuries requiring medical attention, major property damage);
- Annual number of fatal accidents involving Project vehicles along the Transportation Corridor;
- Annual number of complaints or grievances lodged with the Project regarding Project vehicles; and
- Number of vehicle trips daily/monthly/annually, including truck trips.

Monitoring of these KPIs and of the commitments and mitigation measures are described in Table 9-1 and Appendix IV-A, and will be included within the specific stand-alone Environmental and Social Monitoring Plan as discussed in Section 4.2.

Table 9.1 Summary of Mitigation, Monitoring and Reporting Traffic and Transportation Safety Management Plan

Project Impact	Applicable phases[1]	ESIA mitigation recommendations	Monitoring Activity	Timing and frequency of monitoring	KPI(s)	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible party for ensuring commitment implementation	Reporting requirement	Related plans	Estimated Costs
Increase in accidents and injuries along the transportation corridor (Item 10 in Table 25-3)	PP, O, C	Community Awareness and Coordination on Public Safety	Community meetings and stakeholder interviews	Quarterly and incident-specific (if needed)	Number of accidents	Selected settlements along Transportation Corridor	IFC Guidelines, Surgold standards	TBD	Summary memos of community meetings and interviews	SMP	minimal
		Contractor's Health and Safety Management	Contracts and enforcement	Contract signature and as needed.	Full contractor compliance	Periodic reviews by HSLP of Contractors' HSE performance and documentation	Surgold standards	Contractors are responsible for implementation of HSE programs, ESR responsible for review and oversight	Annual reporting required by contractors regarding HSE implementation, Annual ESMMP reporting by ESR to Site Manager	SMP	
		Drivers and contractors will not stop for unplanned/ unauthorized breaks on the journey	Review of travel logs.	Periodic audits, as needed per incident.	Full employee and contractor compliance.	As above	Surgold standards	As above	As above	None	Minimal
		Drivers Policy and Trainings	Contractual requirement, periodic training.	Periodic audits, as needed per incident.	Full employee and contractor compliance.	As above	IFC Guidelines, Surgold standards	As above	As above	None.	Minimal

[1] PP – Pre-Production, O – Operations, C - Closure

Project Impact	Applicable phases[1]	ESIA mitigation recommendations	Monitoring Activity	Timing and frequency of monitoring	KPI(s)	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible party for ensuring commitment implementation	Reporting requirement	Related plans	Estimated Costs
		Required compliance with speed limits; monitoring of driving speeds.	Review of travel logs, in-vehicle data logs.	Contract signature and as needed.	Full employee and contractor compliance.	N/A	IFC Guidelines, Surgold standards	Contractors are responsible for regular review of travel logs; ESR will review these on a quarterly basis.	Quarterly reporting by HSLP to Site Manager, Annual ESMMP reporting	SMP,	Minimal
Increased Project-related traffic volume on the Transportation Corridor (compared to baseline conditions).	PP, O, C	Fuel will be delivered in caravans to reduce distribution of increased truck traffic.	Number of vehicles (including trucks) daily leaving and arriving at site will be logged at access gate. Caravans will be noted.	Daily	Number of truck trips daily, number of trucks in caravan	Main access gate		Security	None required	SMP	Minimal
		Incident and Accident reporting	All drivers will be required to report any incidents, altercations or accidents to the Contractor Manager immediately.	As necessary	Number of incidents, accidents	N/A		Contractor is responsible to ensure all drivers understand the requirements regarding reporting and incidents/accidents are reported immediately through proper channels. Contractor Manager will forward all reports to ESR Manager.	Designated Surgold Manager will track and report all incidents/accidents to the Site Manager as per the reporting requirements on a quarterly basis. Severe accidents will be reported to the Site Manager immediately.		

[1] PP – Pre-Production, O – Operations, C - Closure

9.4 CHANGE MANAGEMENT

As identified in Table 9-1, regular monitoring to confirm the implementation of preventative measures will be regularly conducted and reported quarterly. Trends and areas for improvement will be identified in quarterly reports and changes implemented following the Project's change management system as required.

Accidents and grievances will be reviewed or investigated upon occurring or receipt of notice. Changes identified that are necessary to protect worker or public health and safety will be implemented immediately after approval by the Site Manager.

9.5 IMPLEMENTATION

9.5.1 Responsible Parties and Roles and Responsibilities

The roles are responsibilities for the implementation of the management plan are presented in Table 9-2.

Table 9.2 Responsible Parties and Roles and Responsibilities

Responsible Parties	*Roles and Responsibilities*
Contractor	· Develop and deliver ESR and HSLP and Emergency Response training to drivers as required by Surgold; · Receipt and review of drivers logs weekly; · Ensure that all drivers are aware of reporting requirements and procedures; · Ensure all transportation equipment is in good running order and manufacturers maintenance recommendations and requirements are followed and documented; and · Meet the requirements included in the contract with Surgold.
Logistics Manager	· Develop training standards for drivers with ESR, and HSLP Manager; and · Include details of traffic volumes and KPIs as well as changes and improvements in ESMMP annual report.
Security manager	· Develop system for security staff to track number of vehicles (specifically trucks—including destination, contractor) on a daily basis; · Ensure security staff are collecting data; and · Participate in any accidents/incident investigations as necessary.

Responsible Parties	*Roles and Responsibilities*
HSLP Manager	· Lead any reviews or investigations into reported accidents/ incidents; · Develop standards for driver training in cooperation with Logistics Manager; · Review all contracts prior to signing and confirm these contain requirements to meet Surgold standards; · Receive all notifications of incidents/accidents and ensure proper response is being followed including reporting and review; · Prepare quarterly report of accidents/incidents and reviews of contractor practices; · Develop schedule for review of contractor practices and documentation; · Prepare quarterly reports; and · Develop system to collect truck traffic information from Security staff.
ESR Manager	· Support HSLP manager in development of training and management plans to ensure environmental concerns are addressed as well as HSLP.

9.5.2 Training

Driver training standards will be developed by the HSLP Manager and delivered by Contractors. Driver training will include commitments made in the worker health and safety Driver Policy and the Worker Wellness Program: as it relates to Worker Fatigue and Stress Management Program Training will address:

- Training will also include accident and incident response and reporting details. Details regarding training requirements will be included in detail in the final Traffic and Transportation Safety Management Plan.

9.5.3 Schedule

The schedule for development and implementation of this plan is presented in Table 9-3.

Table 9.3 Schedule

Time	**Activity**
August – May 2013	· Develop training standards, driver requirements, reporting forms and finalize Traffic and Transportation Safety Management Plan
Pre-Production	· Implement TTSMP · Update TTSP periodically based on quarterly reviews.
Operations	· Implement SWMP · Review and update on an annual basis or when there is a change in process.
Closure	· Implement, revise and update on an annual basis.

10.0 WASTE MANAGEMENT PLAN

The following Solid Waste Management Plan (SWMP) presents a system for controlling waste produced by the Merian Gold Project, which includes control and monitoring measures. The Plan is based on the waste management mitigation measures recommended in the ESIA.

The scope of this Management Plan includes activities and waste generated at the Mine Site and applies to Pre-Production, Operations and Closure activities. Post-Closure will not require waste management. This plan addresses domestic and hazardous waste but does not address the two major mining waste streams: tailings and waste rock. A separate Waste Rock Management Plan is included within this ESMMP which will also be supplemented with a TSF Operational Plan when design is further advanced.

Solid (non-hazardous) wastes generally include any garbage refuse. Examples of such waste include domestic trash and garbage; inert construction/demolition materials. Refuse such as metal scrap and empty containers (except those previously used to contain hazardous material which should, in principle, be managed as a hazardous waste); and residual waste from industrial operations (IFC General EHS Guidelines, 2007).

Hazardous waste shares the properties of a hazardous material (e.g.; ignitability, corrosivity, reactivity or toxicity), or other physical, chemical, or biological characteristics that may pose a potential risk to human health or the environment if improperly managed. Wastes may also be defined as 'hazardous' by local regulations or international conventions based on the origin of the waste and its inclusion on hazardous waste lists, or based on its characteristics (IFC General EHS Guidelines, 2007). For the purpose of this plan the Basel Convention definitions and hazardous waste lists will be used as a guideline for defining hazardous wastes.

The SWMP presented here is based on the Project Description provided in the ESIA. It is anticipated that the Plan will require periodic revisions and updates as the Project design advances and as the Project progresses through different mine life stages as well as during implementation as results are reviewed and improvements identified.

10.1 PURPOSE AND OBJECTIVES

The purpose of the SWMP is to characterize waste streams, establish and document control measures and waste generation monitoring, handling and disposal such that human health and the environment are protected. The Plan defines the following:

- Procedures that Surgold personnel will follow to manage and handle waste;
- Procedures that Surgold personnel will follow to characterize and quantify waste; and
- Procedures for confirming implementation of the SWMP.

10.2 SUMMARY OF LEGAL REQUIREMENTS AND COMMITMENTS

10.2.1 Legal Requirements

Suriname's laws regarding waste management are limited. There is no general or specific legislation concerning solid waste management and there are no technical standards on solid waste management.[1]

10.2.2 Commitments

The Project has committed to base its solid waste management plan on guidance provided by industry good practice such as the IFC's General IFC EHS Guidelines (2007). The Project's Environmental Design Criteria further describes the commitments and approach of Solid Waste Management.

Surgold is also committed to complying with its internal Environmental Standard on Waste Management and the Project Environmental Design Criteria.

10.2.3 Key Performance Indicators

The following Key Performance Indicators (KPIs) will be measured and used to evaluate the Project's performance with respect to its stated objectives and commitments:

- Annual volume of hazardous waste generated by the Project;
- Annual volumes of hazardous waste disposed of off –site but not recycled(i.e. no longer in temporary storage);
- Annual volumes of hazardous waste recycled off-site;
- Annual percent change of hazardous waste volume compared to previous year;
- Annual volume of non-hazardous waste generated;

[1] Regional Evaluation Municipal Solid Waste Management Services, Country Analytical Report Suriname Evaluation 2002.

- Annual volume of non-hazardous waste reused or recycled;
- Annual volume of non-hazardous waste disposed of on-site;
- Annual volume of non-hazardous waste disposed of off-site;
- Annual volume of contaminated soils generated and treated on-site;
- Annual percent change of volume of non-hazardous waste production compared to previous year; and
- Volume of hazardous waste transported across international boundaries.

Monitoring of these KPIs and of the commitments and mitigation measures described in Appendix IV-A will be included within the specific stand-alone Environmental and Social Monitoring Plan described in Section 4.2.

10.3 *MANAGEMENT PLAN COMPONENTS*

The Solid Waste Management Plan will:

- State principals of waste management at Merian Gold Project;
- Identify waste streams;
- Identify on-site infrastructure required for management of waste;
- Describes management measures, monitoring, reporting and documentation mechanisms for managing solid waste at Merian Gold Project; and
- Describe the mechanism to identify potential issues or opportunities for improvement.

10.3.1 Principals of Waste Management at Merian Gold Project

The Merian Project has committed to:

- Avoid or minimize generation of hazardous and non-hazardous wastes to the extent practicable;
- Recover and reuse waste materials where possible;
- Treat, destroy and or dispose of un-recoverable and un-reusable waste in an environmentally sound manner;
- Consider the use of less hazardous substitutes for hazardous materials where possible; and
- Observe the tenets of the Basal Convention on the Control of Trans boundary Movement of Hazardous Waste.

Non-hazardous solid waste generated at the Merian site will be collected and transferred to a central storage area on-site for temporary storage. The waste will then be transferred from the site to a facility appropriate for disposal. A reputable, licensed contractor will be hired to handle final disposal of recyclable and saleable waste.

Hazardous waste generated during the Pre-Production and Operation phases will be temporarily stored on-site in a facility with secondary containment and then disposed of by a licensed contractor. Oils and lubricants will be reused or otherwise returned to the supplier for recycling or sent to a reputable recycling facility through a trading company authorized to handle recyclable materials. Hydro-carbon impacted soil (as determined by visual or olfactory cues) will be treated on-site (i.e. biopile).

10.3.2 Waste Streams

Table 10-1 summarizes identified waste streams and disposal methods. A detailed Solid and Hazardous Waste Management Plan will be completed prior to the commencement of operations. This will include detailed characterization of all waste streams with recycling, handling and disposal policies for each; for those waste streams without detailed disposal processes outlined below further information will be included in this Solid and Hazardous Waste Management Plan.

Table 10.1 Summary of Waste Streams and Disposal Methods

Material/ Waste Stream	*Disposal*
Waste lubricants and filters and waste oils	Waste lubricants from service vehicles and mobile or stationary equipment including generators and pumps, will be collected and stored in bulk waste oil tanks. The tanks will be placed in the designated petroleum hydrocarbon waste area in the Hazardous Waste Transfer Area (HWTA). Waste will be backhauled to Paramaribo for recycling. Lubricant supplier will provide this service, including used and crushed filters. In other areas where access to bulk lube/ oil collection tanks are not available, such as the process plant, waste oil and lubricants will be collected in 45 gallon drums, or in 1000 L totes, and sealed using the original drum bungs or plastic sealing caps. These containers will be properly labeled and stored in an area with secondary containment. Filters will be collected and crushed to extract remaining oil. Crushed filters will be transported to Paramaribo for disposal by carriers qualified to handle and transport waste. Waste lubricants could potentially be blended with diesel fuel and burned in the regeneration kilns/ elution heaters – however this approach is still to be discussed with vendors.

Material/ Waste Stream	*Disposal*
Paints and Solvents	Waste paints and solvents will be collected, stored and likely transported to Paramaribo for proper disposal. If appropriate disposal is not available in Suriname, materials will be back-hauled to the USA for proper disposal.
Electronic and Electrical Equipment	Electronic and Electrical Equipment: Recycling options available in Suriname (Recomsur) will be used, though backhauling of waste may also be needed if in-country services are not able to meet international guidelines.
Waste lamps	Waste Lamps: Contracts will be tendered and developed to collect these from site and dispose in Paramaribo, or to be managed at site using appropriate equipment (e.g. Bulb Crusher) for collection of mercury.
Tires	Tires will be recapped if possible. If recapping is not possible reuse in retaining wall construction where possible and finally the tires will be landfilled on site if re-use is not possible
Broken Parts/ used air filters/ etc.	These will be backhauled for manufacturer rebuild/ core charge recovery where possible. Recyclable materials - backhaul to Paramaribo for steel recycling. Non-recyclable, non rebuildable waste such as paper/rubber air filters - landfill on site.
Condemned Vehicles	Vehicles will be stored on site for spare part cannibalization. Once fully cannibalized, these will be backhauled to Paramaribo for recycling of the steel.
Typical recyclable materials - glass, metal, paper, cardboard, etc.	Waste will be segregated, collected and recycled per current site practice - plastic bottles, paper, etc.
Typical non-recyclable waste - foam, food waste, plastic packaging material, used clothing and work equipment, etc.	Merian will provide awareness programs on the negative effects of feeding wildlife to all personnel on site. Dedicated steel bins for the collection of food waste and packaging will be provided where people eat including the kitchen, offices and common areas. Food waste and other non-recyclable domestic waste will be collected, stored in dumpsters and transported to the landfill on site.
Batteries	Dry cell general batteries will be collected in specific containers in offices and common rooms. These will be collected occasionally, stored at the HWTA and backhauled for recycling/ safe disposal in Paramaribo. Waste lead-acid batters and rechargeable batteries will be temporarily stored in metal containers at the HWTA and backhauled for safe disposal in Paramaribo. Facilities also exist in Trinidad.
Medical Waste	All medical waste will be stored in specific containers and labeled as “BioHazard.” These will be backhauled for incineration in Paramaribo using an identified approved medical waste incineration facility in Suriname.

Material/ Waste Stream	Disposal
Wood packaging material - pallets, crating, etc.	All waste wood products will be collected in a designated wood waste depot. Reuse wood packing material / crates will be identified where possible for preparation of backhaul materials. Consideration will be given to offering waste wood to local communities for recycling. Any material not consumed by local communities will be landfilled.
Unused raw concrete	Batch plant will have pre-cast formwork ready at all times for items such as curbs and light standards. Any unused partial loads will be used for pre-cast items so that the concrete is not wasted. Any wash residue or cleanup waste will be allowed to settle, harden, and will be landfilled. However, quantities are expected to be minimal in operations.
Reagent bags	Bags will be used for shipping Lime, Carbon, and certain other reagents, in large quantities. These bags will likely contain some reagent residue. Since washing and reuse would not be practical, and the bags are not designed for durability and reliable re-use, these bags will be landfilled in the TSF.
Waste from emergency supplies of sodium cyanide	Emergency supplies of sodium cyanide will be provided in crates and bags. As recommended within the Cyanide Code these will be rinsed and burned or otherwise correctly disposed of.
Scrap Steel	Scrap steel will be collected in a scrap steel depot, and backhauled to Paramaribo for recycling if facilities exist.
Sewage Sludge	Landfill on site, within the confines of the future TSF as for construction. Once the TSF dams are in place and collecting runoff, any effluent will be treated in the TSF effluent treatment process prior to discharge to the environment. Investigations will be undertaken for the potential to use sludge for reclamation after composting (with wood waste or other).
Hydrocarbon Contaminated Soil	Hydrocarbon contaminated soil will be disposed of in lined cell or biocells

In addition to the waste streams highlighted in Table 10-1 Surgold recognizes that some degree of mercury, primarily associated with past porknocking activities, may be present that will require management. The Environmental Liability Assessment prepared for Surgold by TetraTech (May 2011) indicated raised levels of mercury in isolated areas of soils and perhaps in fish tissues as a result of illegal artisanal mining activities. It was reported that mercury 'hotspots' were recorded where artisanally mined material was processed.

During mining activities Surgold anticipates that these mercury hotspots will be processed through the processing plant. This may result in the transportation of trace amounts of mercury through the production cycle and disposal as part of the tailings management process, though the limited surficial contamination will be a very small load relative to all of the ore processed. Because of the limited total mercury inputs, It is anticipated that the amounts of mercury considered will not be of concern. However, monitoring for mercury is considered as part of the EDC and adaptive management measures will be developed as part of the operational Environmental and Social Monitoring Plan discussed in Section 4.2.

10.3.2 Waste Infrastructure

On-site waste infrastructure will include:

- Sorting and Temporary Storage facility part of which will be dedicated to storage of hazardous waste;
- Lined cell and/ or Bio pile;
- Wood waste depot; and
- TSF.

Waste Transfer Facility

The Waste Transfer Facility will be located close to the Plant and will be designated, signed and identified on site plans. The Sorting and Temporary Storage Facility will have designated containers and/or areas identified for each of the waste streams identified above. Containers/areas will be clearly labeled and delineated. Containers will be appropriate to the waste streams to protect the environment and human health. Wastes will not be mixed.

Hazardous materials will be stored within a designated area of the Waste Transfer facility. The Hazardous Waste Transfer Area will be fenced, signed, lit. The area will be built on a concrete pad and designed with secondary containment to control hazardous liquids in the case of a spill. Hazardous wastes will be segregated and stored in containers compatible with the waste.

A hazardous waste register will be maintained by each contractor or ESR as applicable and will include:

- Name and identification of the materials composing the waste;
- Physical state of the waste;
- Quantity;
- Waste shipment tracking documentation including quantity, type, date dispatched, date transported, date received, record of the originator, transporter and receiver;
- Method and date of storing/repacking/treating or disposing at the HWTA; and
- Location of each hazardous waste at the facility.

On-Site Landfill for Non-Hazardous Waste

The Project plans for three small landfill sites that will be included within the footprint of the West, Central and East WRDs. The landfill wastes will not be mixed with the waste rock, but the landfill will be operated until it reaches capacity and then capped with saprolite and overlain by waste rock.

The landfills will comprise dug trenches approximately 3 meters wide by 3 meters deep in which domestic waste will be buried. The deposited waste will be covered with saprolite. The trenches will be approximately 100 meters long and spaced 5 meters center to center. The trenches will be located within the footprint of the future WRDs but will be covered with waste rock material at a later stage when the WRD reaches this location[1].

The West domestic landfill will only be in operation during the first two years after which it will be covered by waste rock from the pit. The Central domestic landfill will be used once the West domestic landfill is closed followed by the East domestic landfill. The East domestic landfill will be used for the life of the mine and will be relocated ahead of the area that will be covered with waste rock from the pits.

Landfill siting and design will follow requirements and commitments set forth in the Surgold Environmental Standard on Waste Management and the Project Environmental Design Criteria.

Bio Pile

A biopile is a modification of the landfarming method for treating petroleum contaminated soils. The physical process of aerating the soils allows volatile compounds to dissipate into the atmosphere. The method stimulates microbial activity within the soils through aeration and addition of nutrients and moisture. The biopile is a modification to adapt the landfarm to climates with heavy rainfall.

The biopile will have air actively moved through the pile using slotted or perforated piping. This allows the pile to be constructed to a greater thickness and thereby reduces the required area. For the relatively small volumes of contaminated soils expected for the Project, this will allow the pile to be placed under a roofed structure, so that rainfall is excluded and the moisture content can be managed to provide optimum microbial growth. The PCS will be placed on a concrete slab covered by roof and perforated plastic pipes will be installed within the pile. A concrete curb around the perimeter of the slab will provide

[1] GMining Services Memorandum, 16 April, 2012. Subject: Disposing of Domestic Waste

containment. The bio pile will be up to 1.5 m high and 6 m wide and about 15 m long.

In the event that the biopile is not performing as required an engineered, a lined cell will be developed to encapsulate the contaminated soils.

Waste Wood Depot

An area near the Waste Transfer Station will be identified as the waste-wood depot. This area will be signed and designed such that if community members are interested in salvaging waste wood safe, controlled access can be provided by the Project as necessary.

Lined Cells

Lined cells will be developed as encapsulated cells within the saprolite waste dumps. The cells will be developed to have a compacted saprolite base and a compacted saprolite cover to limit infiltration and leachate production.

10.3.3 Monitoring and Reporting

The mitigation, monitoring and reporting measures recommended in this ESMMP are included provided in Table 10-2. Estimated costs do not include capital costs such as cost associated with the purchase of appropriate containers as these are expected to develop as part of mine operation planning rather than the ESMMP.

Table 10.2 Waste Management Measures, Monitoring and Reporting

Project Impact	Applicable phases [1]	ESIA mitigation recommendations and/or ESMMP measures	Monitoring Activity or Management Measure	Timing and frequency of monitoring	Other indicator/ measurement Parameter	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible party for ensuring commitment implementation	Reporting requirements	Related plans	Estimated Costs (USD)
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Development of a Waste Management Plan	Review of the Waste Management Plan by Site Manager	Annual	SWMP	N/A	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	ESR Manager	Annual update of WMP where necessary	ESMP	Costs associated with time to prepare plan approx. $15 000
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Development of a hydrocarbon contaminated soils procedure including criteria to determine required treatment	Review of Hydrocarbon Contaminated Soils procedure by Site Manager	Annual	N/A	N/A		ESR Manager	Annual reporting	ESMMP and WMP	Approx. $5000 to establish plan. Testing and laboratory analysis
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Process and Product review and revisions of the WMP based on process plant and mine operating conditions to confirm all waste streams are addressed and waste minimization opportunities are identified	Review of proposed changes in process or introduction of new products by ESR to provide feedback regarding risks and opportunities for waste reduction and waste management	1 – 2 months prior to change in process or introduction of new product	Revisions to the SWMP as necessary	N/A	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	ESR Manager	Annual Update of WMP as needed. Updates summarized in annual ESMMP report	ESMMP	N/A (assumed to be within standard operating costs)

[1] PP – Pre-Production, O – Operations, C-Closure. PC- Post Closure

Project Impact	Applicable phases [1]	ESIA mitigation recommendations and/or ESMMP measures	Monitoring Activity or Management Measure	Timing and frequency of monitoring	Other indicator/ measurement Parameter	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible party for ensuring commitment implementation	Reporting requirements	Related plans	Estimated Costs (USD)
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Daily waste collection and disposal at Transfer station	Observations and inspections	Weekly/ daily/ opportunistically	No overflowing garbage bins, all waste stored in appropriate containers throughout camp	Waste collection sites throughout site		Trained personnel are responsible for collecting and disposing of waste and maintaining manifest of types and volumes of waste deposited at Transfer Facility. ESR staff responsible for confirming collection is sufficiently frequent	Brief summary of any observed issues and/or remediation included in monthly reports to GM	N/A	N/A (assumed to be within standard operating costs)
Potential negative impacts to air, water and soils from poor waste management	PP,O, C	Segregated wastes in Waste Transfer Facility	inspections of the WTS	Weekly	Designated areas are respected and volumes of waste do not exceed storage area provided	Temporary storage Waste Transfer Facility	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	Trained personnel is responsible for segregating waste and disposing at temporary storage facility ESR staff will complete weekly inspections	**Internal**: Monthly reports to the Project Site Manager including record or inspections and volume of waste generated, transported and disposed of. **External**: Included in an Annual ESMMP reporting document made available to stakeholders	N/A	N/A (assumed to be within standard operating costs)

Project Impact	Applicable phases [1]	ESIA mitigation recommendations and/or ESMMP measures	Monitoring Activity or Management Measure	Timing and frequency of monitoring	Other indicator/ measurement Parameter	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible party for ensuring commitment implementation	Reporting requirements	Related plans	Estimated Costs (USD)
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Documentation of transport of volumes, waste type and final destination	Inspection of documentation at point of departure	Any transport off-site	Documentation completed prior to departure from site, volume of waste transported off site	Main gate		Security will be responsible for confirming documentation is complete and collecting a copy of documentation. ESR staff will be responsible for collecting sheets from security and checking for completeness	**<u>Internal</u>:** Monthly report to the Project Site Manager. **<u>External</u>:** Included in an Annual ESMMP reporting document made available to stakeholders		N/A (assumed to be within standard operating costs)
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Signage of containers	Included in Inspection of Waste Transfer Facility	Weekly	Signs on the containers are clearly legible	Waste Transfer Site and local collection points	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	ESR staff	Inspection sheet	None	marginal
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Use of appropriate containers for waste (at collection sites and at Transfer Station)	Included in Inspection of Waste Transfer Facility	Weekly	N/A	Waste Transfer Site and local collection points	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	Trained personnel is responsible for waste delivery to transfer station, ESR staff is responsible for inspecting practices			N/A (assumed to be within standard operating costs)

Project Impact	Applicable phases [1]	ESIA mitigation recommendations and/or ESMMP measures	Monitoring Activity or Management Measure	Timing and frequency of monitoring	Other indicator/ measurement Parameter	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible party for ensuring commitment implementation	Reporting requirements	Related plans	Estimated Costs (USD)
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Hazardous waste register	Maintenance of an up-to-date hazardous waste register	Monthly submissions	Confirm the register is up to date and complete	Each contractor will provide register to ESR	IFC EHS General Guidelines	ESR staff is responsible for maintaining register ESR staff is responsible for confirming presence and completeness of monthly submissions	Monthly submission of register	N/A	N/A
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Training of ESR/Contractor staff responsible for SWMP	Documentation of training provided to employees	Once prior to an employee assuming new roles/responsi bilities	N/A number of ESR employees trained.	N/A	Surgold Standards	ESR staff and management staff and HR Manager	Annual WMP reporting the GM	ESMMP	5 000 (for external hazardous waste manageme nt training)
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Training of all staff regarding waste management	Inclusion of waste management details included in induction training	Once during employee induction	Number of employees trained in waste management	N/A	Surgold Standards, IFC General EHS guidelines	ESR Manager, HR Manager	HR Manager to maintain training records	ESMMP	N/A (assumed to be within standard operating costs)
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Review of third-party waste disposal practices	Review of third-party waste disposal sites, permits and license (if applicable)	Every two years	Practices generally protect human health and the environment	Third-party disposal operations used by Surgold	Surgold Environmental Standards	ESR Management	Included in annual ESMMP reporting		$15 000 - 20 000/

Project Impact	Applicable phases [1]	ESIA mitigation recommendations and/or ESMMP measures	Monitoring Activity or Management Measure	Timing and frequency of monitoring	Other indicator/ measurement Parameter	Monitoring Locations	Relevant regulations/ standards / thresholds	Responsible party for ensuring commitment implementation	Reporting requirements	Related plans	Estimated Costs (USD)
Potential negative impacts to air, water and soils from poor waste management	PP,O,C	Audit of third-party hazardous waste disposal facility	Audit of third party facilities used for the disposal of hazardous waste	Every two years	Practices meet international standards	Third-party hazardous waste disposal facilities used by Surgold	Surgold Environmental Standards	ESR Management	Include in annual ESMMP reporting		15 - 30 000/ audit
Potential negative impacts to air, water and soils from poor waste management	PP, O, C	Use of properly trained and certified (if necessary) transportation services or personnel for the transportation of any waste off-site	Training of internal staff as necessary or review of transportation provider contracts to confirm requirements to follow Surgold standards	As required	All waste containers designated for off-site shipment should be secured and labeled with contents and associated hazards, be properly loaded on transport vehicles and accompanied by manifest.	Security gate	IFC EHS Guidelines	ESR Management	Included in annual ESMMP reporting		N/A

10.4 *CHANGE MANAGEMENT*

As shown in Table 10-2, reporting requirements for the Solid Waste Management Plan will include:

- Weekly inspections;
- A monthly report to the Site Manager;
- Monthly submissions of hazardous waste register from ESR department; and
- Annual WMP report for input to the Annual ESMMP Report.

During weekly inspections, small-scale infractions or improvements will be identified, and actions taken to improve or change practices will be documented.

The monthly report to the Site Manager will be used to identify more systemic problems, solutions that require budget allocation beyond the ESR discretionary spending budget, or legal or contractual input.

The SWMP will be reviewed on an annual basis and updated to reflect improvements or changes identified throughout the year. Annually, within the WMP report the KPIs will be compared against past-performance and analyzed for trends to determine if there are areas the can be improved, waste volumes reduced etc. The annual report should include an analysis of the waste streams and management processes to:

- Establish priorities based on a risk analysis that takes into account the potential EHS risks during the waste cycle and the availability of infrastructure to manage the waste in an environmentally safe manner;
- Identify opportunities to substitute inputs with less hazardous or toxic materials or with those that generate less hazardous waste or less waste volume;
- Identify opportunities to return unused or waste materials; and
- Identify opportunities to improve reuse and recycling.

The SWMP will include a hazardous waste minimization plan to be implemented the following year as per Surgold Environmental Standards.

10.5 *IMPLEMENTATION*

10.5.1 Responsible Parties and Roles and Responsibilities

The roles are responsibilities for the implementation of the management plan are presented in Table 10-3.

Table 10.3 Responsible Parties and Roles and Responsibilities

Responsible Parties	Roles and Responsibilities
ESR Manager	· Confirm that training regarding Waste Management is included in induction training for all employees; · Develop and provide training to ESR staff regarding duties regarding waste management; · Review weekly inspection reports and monthly reports; · Deliver monthly reports to Site Manager; · Oversee WMP annual reporting; and · Liaise with contractors regarding waste management issues.
Environmental Supervisor	· Schedule weekly inspections; · Resolve issues identified in weekly inspections; · Coordinate with HR manager as necessary to schedule training sessions for relevant staff; · Schedule inspections of other waste collection points from time-to-time; · Prepare monthly report; and · Receipt of monthly submissions of hazardous waste register from contractors.
Environmental Field Worker	· Perform weekly inspections of Waste Transfer Station; · Collect documentation from security on a weekly basis (re: transportation of waste off-site); and · Perform inspections of waste collection points and complete inspection sheet.
HR Manager	· Document training requirements and training delivery; and · Provide annual totals regarding number of employees trained.
Site Manager	· Ensure operational personnel have management systems in place to support ESR commitments where necessary.

10.5.2 Training

Training will be provided to the ESR staff by the ESR manager regarding the duties involved in implementing the SWMP.

It is recommended that third-party hazardous waste management training be pursued and completed by ESR staff as they complete a final, more detailed SWMP.

The ESR staff will provide any necessary training to the security staff responsible for collecting paperwork from trucks, contractors and other project staff who have responsibilities relevant to waste management.

WHIMIS Third-party training will be provided for all of those handling chemical or hazardous waste and renewed as required; this is captured in more detail in the Spill Prevention, Control and Countermeasures Plan and the Cyanide Management Plan.

10.5.2 *Schedule*

The schedule is presented in Table 10-4.

Table 10.4 Schedule

Time	Activity
January – May 2013	· Identify hazardous waste management training for ESR staff; · Identify hazardous waste management facilities that will accept wastes and review practices; · Identify recycling options; · Finalize Solid Waste Management Plan including specifics regarding locations for waste collection points within project site, storage containers; and · Develop detailed budget for first year of implementation of the SWMP.
Pre-Production	· Implement SWMP; · Construction of hazardous waste transfer facility; and · Update SWMP as new products and waste streams are brought on-site (i.e. when process reagents are introduced on-site).
Operations	· Implement SWMP; and · Review and update on an annual basis or when there is a change in process.
Closure	· Reassess waste streams and revise SWMP; and · Implement, revise and update on an annual basis.

11.0 *SPILL PREVENTION AND CONTROL AND COUNTERMEASURES PLAN*

The following Spill Prevention, Control and Countermeasures Plan (SPCC) presents a system for reducing the potential for spills at the Merian Gold Project and for responding to such events as well as means to monitoring operations to confirm that preventative measures are in place and followed. The Plan is based on the mitigation measures recommended in the ESIA.

The scope of this Management Plan includes activities at the Mine Site and Transportation Corridor and applies to Pre-Production, Operations and Closure activities. This plan is based on the Project Description provided in the ESIA. It is anticipated that the Plan will require periodic revisions and updates as the Project design advances and as the Project progresses through different mine life stages as well as during implementation as results are reviewed and improvements identified.

This SPCC will become part of the Project's Emergency Response Plan and will be supplemented by a Cyanide Management Plan, a Hydrocarbons Management Plan and a Spill Response Plan. The Spill Response Plan will include specific details regarding the steps, roles and responsibilities in the event of a spill associated with the Project. A hazardous materials risk assessment will also be conducted and a Hazardous Materials Management Plan developed.

11.1 *PURPOSE AND OBJECTIVES*

The purpose of the SPCC is to document and assess the risk of spills occurring at the Merian Gold Project so as to institute procedures and actions to reduce the potential for those spills to occur. This plan provides:

- Practical information required to assess spill risks and develop effective countermeasure solutions and respond in a safe and effective manner to a spill; and
- General procedures that Surgold personnel will follow to prevent spill and respond to spills.

Given that the detailed design of the mine is underway and not complete at this time this management plan presents conceptual measures for spill prevention and control and outlines the framework for developing a more comprehensive plan to be completed prior to various stages of construction and operations. The final plan will require consultation with mine engineers and contractors and will be led by Surgold ESR department.

11.2 *SUMMARY OF LEGAL REQUIREMENTS AND COMMITMENTS*

11.2.1 Legal Requirements

Suriname's laws regarding spill prevention and emergency management are limited. Under the Penal Code, contamination of a waterway may be penalized.

11.2.2 Commitments

The Project has committed to base its SPCC on industry good practice and that provided in the IFC's EHS Guidelines as well as the International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the Production of Gold (1) .

Surgold is also committed to complying with its internal Health, Safety and Loss Prevention Environmental and Social Responsibility Integrated Management Standard on Emergency Response, Chemical Management Environmental Standard, and Hydrocarbon Management Environmental Standard.

11.2.3 Key Performance Indicators

The following Key Performance Indicators (KPIs) will be measured and used to evaluate the Project's performance with respect to its stated objectives and commitments:

- Monthly and annual volumes of materials transported and handled by the Project that could result in harm to human health or the environment in the event of an accident or spill;
- Monthly and annual number of small spills occurring at the Project;
- Monthly and annual number and volume of accidental small releases to the natural environment (including soils and water);
- Annual and monthly number of major spills occurring at the Project;
- Number of cyanide releases;
- Number of hydrocarbon releases;
- Number of chemical releases;
- Number of other releases;
- Number of employees trained in spill response (compared to number of employees working with or around contaminants);
- Number of employees trained in first aid (compared to number of site personnel);

(1) Surgold signed the International Cyanide Management Institute's Cyanide Management Code in 2005.

- Number of employees trained in the safe and environmentally sustainable handling of chemicals on-site (compared to number of employees working with or around contaminants); and
- Response time and methods used in drills compared to the SPCC and Spill Response Plan.

Monitoring of these KPIs and of the commitments and mitigation measures described in Appendix IV-A will be included within a specific stand-alone Environmental and Social Monitoring Plan as described in Section 4.2.

11.3 *MANAGEMENT PLAN COMPONENTS*

The SPCC Plan aims to:

- State principal of Spill Prevention, Control and Contingency for the Merian Gold Project;
- Identify preliminary inventory of materials stored on-site and analysis of spills;
- Identify on-site infrastructure required for prevention, control and response to spills;
- Describe management measures, monitoring, reporting and documentation mechanisms for prevention and control of spills; and
- Describe the mechanism to identify potential issues or opportunities for improvement.

11.3.1 Potential Spill Sources and Analysis

The SPCC will maintain an updated list of all potential chemicals transported, handled or stored as part of the Project. The SPCC will include approximate volumes, storage and transfer locations and risks associated with each chemical. Table 11-1 presents a preliminary list of chemicals that will be managed as part of the Project.

The SPCC will also include an up-to-date plan or map of the Project site and the locations of all managed chemical products.

Part of the process of developing the detailed SPCC will be to assess the risk of spills. Risk will be evaluated based on likelihood of a spill including handling and transfer methods, presence of secondary containment, phase of chemical product (solid/liquid) preventative measures designed and in-place and the potential impacts of a spill based on toxicity, the potential for a spill to reach water courses, potential volumes available for spills, potential of a spill to affect human health.

Chemicals with a risk-rating greater than low will be evaluated to identify measures to risk associated with the contaminant and these will be included in an the final SPCC.

Table 11.1 Summary of Potential Spill Sources and Analysis

Materials that once released have the potential to cause an adverse effect	*Estimated mass used per day (kg) (Operations)*	*Locations stored, handled or used*	*Chemical Properties*	*Equipment/resources required for safe handling and spill response*
Sodium Cyanide	12,000	Transportation Corridor, Process plant reagent storage area. Shipped dry in 20t stainless steel ISO tank containers.	Corrosive, poisonous solid (small briquettes). Acute potential human health effects. May be fatal if inhaled or swallowed. Very toxic. Slightly flammable, dangerous on contact with acids, acid fumes, water or stream. Potential to produce toxic and flammable vapors.	Gloves, synthetic apron, vapor and dust respirator, splash goggles, fume hood, emergency shower, eye wash station
Lime	55,000	Transportation Corridor, Process plant, ETP and reagent storage area. Shipped dry in 1t bulk bags.	Corrosive solid, very hazardous in the case of eye contact and hazardous in the case of skin contact or ingestion. Non-flammable.	Emergency shower, emergency eye wash station, emollient,
Flocculent	3,300	Transportation Corridor, Process plant, reagent storage area, ETP and sediment control ponds. Shipped dry in 1t bulk bags.	Final flocculent not yet selected	Final flocculent not yet selected
Caustic	3,000	Transportation Corridor, Process plant and reagent storage area	Corrosive, poisonous liquid may react violently with acids. Non-flammable, non-explosive.	Absorbent material (i.e. sand), water spray curtain to divert vapor drift, dilute acetic acid, sandbags or other means to prevent runoff reaching sewers, emergency shower and eyewash station

Materials that once released have the potential to cause an adverse effect	*Estimated mass used per day (kg) (Operations)*	*Locations stored, handled or used*	*Chemical Properties*	*Equipment/resources required for safe handling and spill response*
Nitric Acid	2,000	Transportation Corridor, Process plant and reagent storage area	Corrosive, poisonous liquid. Oxidizing material. Non-flammable, explosive in presence of reducing materials, or organic materials, of metals, of alkalis. Non explosive in presence of open flames, sparks or shocks.	Absorbent material (i.e. sand), water spray to control vapor, sandbags etc., emergency shower and eyewash station
Anti-scalent	300	Transportation Corridor, Process plant and reagent storage area	Final anti-scalent to be selected	Final anti-scalent to be selected
Silica	50	Transportation Corridor, Process plant (smelter) and reagent storage area	Non-hazardous solid	N/A
Borax	65	Transportation Corridor, Process plant (smelter) and reagent storage area	Solid, slightly hazardous in case of skin contact.	Emollient, emergency shower and eyewash station.
Sodium Nitrate	10	Transportation Corridor, Process plant (smelter) and reagent storage area	Solid, hazardous in case of ingestion, non-flammable, will react explosively with hydrocarbons, oxidizing material.	Eyewash station, emollient, water spray curtain, safety glasses, dust respirator
Soda Ash	1,200	Transportation Corridor, Process plant (smelter), ETP and reagent storage area	Solid, hazardous in the case of contact with skin. Nonflammable.	Dilute acetic acid,
SMBS	20,000	Transportation Corridor, Process plant - CN detox circuit and reagent storage area	Non-hazardous, solid, non-flammable.	Caustic soda and/or ammonium hydroxide solution,

Materials that once released have the potential to cause an adverse effect	*Estimated mass used per day (kg) (Operations)*	*Locations stored, handled or used*	*Chemical Properties*	*Equipment/resources required for safe handling and spill response*
Copper Sulphate	2,200	Transportation Corridor, Process plant - CN detox circuit and reagent storage area	Non-hazardous solid, nonflammable.	Splash goggles, full suit, self-contained breathing apparatus, local exhaust ventilation
Ammonium nitrate	48	Supplied in 1t bulk bags. Approximately 95% of the weight of total explosives.	White odorless solid, not flammable	Inert absorbent materials, respiratory protection, well-ventilated area for storage, filtering face mask, safety glasses, PVC gloves, long sleeves and pants.
PIBSA (polyisobutylene succinic anhydride) emulsifier	2	Supplied in 20t isotainers. Blended on site into emulsion	Thick amber liquid	To be confirmed based on exact emulsifier selected
Sodium nitrite	8	Transportation corridor, mine pits	Poisonous solid, non-flammable, strong oxidizer, risks of explosion in presence of static discharge, slightly explosive in presence of shocks. Incompatible with sodium cyanide.	Safety glass, full suit, boots, gloves. Store in controlled access area and away from heat or sources of ignition or combustible material. Waste disposal containers, water spray.
Hydrogen Peroxide	To be confirmed	Supplied in 1000l IBC totes. Transportation corridor, Process plant grinding / gravity area.	To be confirmed	To be confirmed

Materials that once released have the potential to cause an adverse effect	*Estimated mass used per day (kg) (Operations)*	*Locations stored, handled or used*	*Chemical Properties*	*Equipment/resources required for safe handling and spill response*
Acetic acid	To be confirmed	Transportation corridor, mine pits	Flammable, corrosive liquid. Flammable in presence of open flames and sparks of heat, slightly flammable to flammable in presence of oxidizing materials, of metals. Risk of explosion in presence of mechanical impact or static charge.	Splash goggles, synthetic apron, vapor respirator, boots, gloves, SCBA. Dry chemical powder, alcohol foam, water spray, exhaust ventilation
Ferric Sulphate	5,500	Transportation Corridor, ETP.	To be confirmed	To be confirmed
Hypochlorite	4,500	Details to be determined in detailed engineering. Required in effluent treatment plant.	To be determined in detailed engineering.	To be determined in detailed engineering.
Zinc nitrate	To be confirmed	Transportation corridor, mine pits	Flammable in the presence of reducing materials. Oxidizing material. Risk of explosion in presence of mechanical impact or static discharge.	Splash goggles, lab coat, dust respirator, process enclosures, local exhaust ventilation,
HFO	180,000	Transportation Corridor, Power plant and HFO storage tanks	Liquid hydrocarbon, non-flammable, harmful to environment if released to aquatic systems	To be confirmed
Diesel	170,000	Transportation Corridor, Diesel storage tanks, generators and fuelling stations	Liquid hydrocarbon, non-flammable, harmful to environment if released to aquatic systems	To be confirmed
Waste oils and lubricants	2,500	Truckshop Used Oil System, Transportation Corridor	Liquid hydrocarbons harmful to environment if released to aquatic systems	To be confirmed

Materials that once released have the potential to cause an adverse effect	*Estimated mass used per day (kg) (Operations)*	*Locations stored, handled or used*	*Chemical Properties*	*Equipment/resources required for safe handling and spill response*
Paints and solvents	10-100	Waste Transfer Facility Transportation Corridor,	To be confirmed	To be confirmed
Waste oils and lubricants	2,500	Truckshop Used Oil System, Transportation Corridor	Liquid hydrocarbons harmful to environment if released to aquatic systems	To be confirmed

11.3.2 SPCC Infrastructure

Current Project design includes the following infrastructure that contributes to spill prevention and countermeasures:

- Indoor reagent storage area within main Process Plant on an impermeable surface in a properly ventilated, or outdoor in containers, these areas will be sealed and access will be controlled;
- Two HFO storage tanks (approximately 2,500 m^3 capacity each) built on impermeable surface and constructed with secondary containment;
- Two Diesel storage tanks (approximately 50 m^3 capacity each) built on impermeable surface and constructed with secondary containment;
- Spill response kits located at the reagent storage area, the HFO and Diesel storage tanks, fuelling stations, and the waste transfer facility and any other identified necessary locations;
- Secondary containment provided at the biopile (discussed in the Project Description and the Solid Waste Management Plan);
- Chemical storage facilities (tanks and piping) will have systems to detect leaks and recover product (i.e. active leak detection systems where applicable. Short piping runs that cannot accommodate leak detection systems will be visually inspected for leaks regularly); and
- Chemical storage tanks will be equipped with engineered overfill/overpressure protection devices.

11.3.3 Spill Preventative Measures

The following measures will be followed to prevent spills:

- Training of operators regarding proper methods for transporting, transferring and handling substances that have the potential impact to human health or the environment;
- Institution of a preventative maintenance program including inspection schedules to confirm and maintain the mechanical integrity and operability of pressure tanks, piping systems, relief and vent values systems, containment infrastructure, shutdown systems, controls, pumps and associated process equipment;
- Implementation of Standard Operation Procedures for handling materials including refueling vehicles, refilling HFO and Diesel tanks, delivering reagents, and managing secondary containment areas;
- Provision of secondary containment, drip trays or other overflow and drop containment measures, for hazardous materials containers at connection points or other possible overflow points. Identification and

provision of all equipment necessary to handle, transfer or transport materials properly; Use of transfer equipment that is compatible with and suitable for the characteristics of the materials transferred and designed to ensure safe transfer;

- Use of dripless hose connections for vehicle tank and fixed connections with storage tanks;
- Installation of gauges on tanks to measure volume inside;
- Review of all potential pollutants characteristics prior to introduction to site and establishment of proper storage, handling and transportation procedures and spill risk analysis and an updated to the SPCC as required;
- MSDS sheets for all contaminants on-site will be attached to the SPCC. These will include human health effects of chemicals handled at the Merian Gold Project and will be included in the required chemical environmental and safety training for all employees handling or otherwise exposed to the contaminants. All appropriate personal protective equipment, handling and response procedures identified in the MSDS sheets or otherwise recommended by the suppliers/manufacturers will be incorporated into the SPCC and followed by the Merian Gold Project;
- The Project will retain qualified third-party to review chemical storage and distribution systems, including appropriate testing every five years;
- Bulk transfers of chemicals during delivery will be observed by Surgold personnel trained in preliminary hazard analysis (PHA) methods; and
- Standard Operating Procedures for chemical transportation, unloading, transfer, storage, handling, use and disposal shall be developed, kept current, effectively implemented by trained personnel.

11.3.4 Spill Control and Countermeasures

The following measures will be followed in the event of a spill. These will be further elaborated both in the fully developed Emergency Response Plan and in the final SPCC.

- Maintenance of updated emergency contact information at all spill response kits locations;
- Maintenance of current mapping of spill routes from potential spill locations;
- Documentation of availability of spill response equipment sufficient to handle a large spill;

- Documentation of availability of specific personal protective equipment and training needed to respond to different potential spills;
- Maintenance of spill response kits on all project fuel and lubrication vehicles;
- Maintenance of spill response guidelines at all spill response kit locations;
- Maintenance of an up-to-date plan of the Mine site showing the location of all contaminants, spill response kits and other response equipment;
- Maintenance of an updated table of all contaminants on-site and recommended spill response procedures;
- Development, implementation and regular training and testing of a facility-wide Spill Response Training Plan;
- First-aid training for all mine personnel; and
- All spills will be reported to ESR.

Spill Response Sub-Plan

A site-specific spill response sub-plan will be developed as part of the final SPCC which will be integrated with the Project's Emergency Response Plan and the site's overall management structure as necessary. The Spill Response Plan will address:

- Roles in the event of a spill including: spill coordinator i.e. the person on the ground at the spill site and responsible for the immediate actions taken to contain the spill, respond to immediate dangers, notify necessary responders and the rest of the Mine site and personnel;
- Internal and external notification procedures;
- Decision system for determining severity and risk and defining an appropriate response;
- Communication system to be followed during the spill, first response and clean-up and communication infrastructure required i.e. radios, telephone systems etc.;
- Facility evacuation routes and procedures;
- Post-event activities such as clean-up and disposal, incident investigation, employee re-entry and restoration of spill-response equipment; and
- Reporting requirements at the time of the spill and after the spill.

11.3.5 Transportation of hazardous materials or chemicals

The transportation of the substances identified in Table 11-1 presents the potential for spills due to traffic accidents or other accidents or incidents en-route to or from the Mine Site. Certain hazardous materials or chemicals will be transported via convoy (see Cyanide Management Plan). Other precautions that will be followed are:

- Route alternative evaluations (where possible)
- Contractors will use transportation vehicles and tanks suitable for the materials and transportation routes used and maintained in adequate condition to insure proper handling and safety of chemicals;
- Contracts involving chemical transportation will require compliance with applicable laws as well as Surgold standards and will require responsible management of chemicals including emergency response and spill cleanup;
- Supply chain audits;
- Truck drivers will be required to notify the site of their departure time and arrival time and maintain a log of travel;
- All vehicles will be equipped with spill response kits appropriate to the materials being transported. The contractor will be required to maintain these in good condition and working order;
- Drivers will be trained in spill and emergency response and will have a means of communicating with the site, their administrative offices and emergency personnel for the entire transportation route; and
- Up-to-date emergency contact information and MSDS sheets and manifests documenting the volume, phase and characteristics of the chemical being transported will be carried with each shipment.

11.3.6 EMP Measures, Monitoring and Reporting

The mitigation, monitoring and reporting measures recommended in this ESMMP are included provided in Table 11-2.

Table 11.2 Spill Prevention, Control and Countermeasures, Monitoring and Reporting

Project Impact	*Applicable phases* [1]	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
Potential negative impacts to air, water and soils from spills and accidents	PP, O, C	Development of a SPCC	Review of the SPCC by Site Manager	Annual	SPCC	N/A	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	HSLP & ESR Manager	Annual update of ESMMPs where necessary	ESMMP	$15 000
	PP, O, C	Review of the SPCC to confirm all potential chemicals are addressed	Review of the SPCC in the event of a change in process within the mining or support operations	1 – 2 months prior to change in process	SPCC	N/A	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	HSLP & ESR Manager	Annual update of ESMMPs where necessary		N/A
	PP, O, C	Maintenance of emergency contact information, location of contaminants and table of contaminants and appropriate response	inspections	Bi-weekly	Presence of up-to-date information at all workstations/ spill response kits	Workstations /spill response kit locations		HSLP staff	Bi-weekly inspection form		N/A (assumed to be within standard operating costs)
	PP,O, C	Maintenance of spill response equipment	inspections of equipment	Monthly	All equipment in good condition and functioning properly	All identified required locations	Surgold Environmental Standards, IFC EHS Guidelines	HSLP staff	**Monthly inspection form**	N/A	N/A (assumed to be within standard operating costs)

[1] PP – Pre-Production, O – Operations, C-Closure. PC- Post Closure

Project Impact	*Applicable phases* [1]	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
	PP, O, C	Implementation of inspection and preventative maintenance program	Submission of quarterly reports by contractors to ESR	Quarterly		N/A	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	Contractors will be responsible for developing, implementing and reporting on inspection and preventative maintenance program. ESR will be responsible for tracking reporting and confirming actions identified in reports have been addressed.	**Quarterly**	N/A	N/A (assumed to be within standard operating costs)
	PP, O, C	First Aid training (Note: will be offered, but not necessarily to all mine personnel	Training documentation	As required by first aid training (1 or 2 years)	Number of employees receiving first aid training	N/A	Surgold Environmental Standards,	HSLP staff	To be included in the ESMMP annual report	N/A	25000
	PP, O, C	Chemical environmental and safety training for personnel handling or working around contaminants	Training documentation	As required/rec ommended by chemical environment al and safety	Number of employees receiving training	N/A		HR staff (should track training in all personnel files)	to be included in annual ESMMP report	N/A	25000

Project Impact	*Applicable phases [1]*	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
	PP, O, C	Develop a Spill Response Plan	SRP reviewed by ESR Manager and Mine Site Manager	Required within the next 2 – 3 months (beginning of Pre-Production phase)	SRP	N/A	Surgold Environmental Standards,	HSLP staff	To be included in the detailed SPCC	N/A	
	PP, O, C	Spill Response Training	Training documentation	Annually for all staff	Number of employees trained in spill response	N/A	Surgold Environmental Standards,	Contractors will be responsible for implementing training. Training will be prepared by HSLP. ESR and HSLP will be responsible for confirming training has been implemented.	To be included in annual reporting	N/A	
	PP, O, C	Spill Response Drills	Implementation of regular spill response drills for relevant personnel	Twice annually	Time and adequacy of spill response	N/A		HSLP Management	Included in annual ESMMP reporting		Approximately USD$ 20,000 per year
	PP,O,C	Inspection of SPCC infrastructure		Every two years	Practices meet international standards	Third-party hazardous waste disposal facilities used by Surgold	Surgold Environmental Standards	ESR and HSLP Management	Include in annual ESMMP reporting		15 0000/ audit
		Trained Surgold personnel will oversee bulk transfer of chemicals	Oversight of bulk transfer	Every delivery	Number of deliveries observed by Surgold personnel	Bulk transfer site	Surgold standards	ESR Manager	Weekly submission of checklist to ESR manager		

Project Impact	*Applicable phases [1]*	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
		Surgold review of SPCC infrastructure	Review	Every 5 years		N/A	Surgold standards	ESR and HSLP Manager	Report will be provided by the third-party reviewer. ESR Manager will report to Site Manager regarding how issues identified were addressed quarterly until complete.		~25 000/3rd party review
		Surgold audit of transportation contractors	audit	Every 3 years		N/A	Surgold standards	HSLP manager	As above		
		Spill reporting	review of all spill reports	Monthly	Number of small spills, number of major spills	N/A	Surgold Environmental Standards, IFC EHS Guidelines	ESR Manager	Contractors, employees and managers are required to report all spills	ERP	N/A

11.4 CHANGE MANAGEMENT

As shown in Table 11-2, monitoring and reporting requirements for the SPCC will include:

- Bi-weekly inspections;
- Quarterly reporting by contractors regarding preventative maintenance programs;
- Spill reporting at the time of the incident and monthly spill reporting developed by ESR department;
- Bi-annual spill response drills; and
- Annual reporting on training.

During bi-weekly inspections any missing response equipment, PPE, or documentation will be replaced or improved as necessary.

Quarterly reporting will identify any upcoming required preventative maintenance required as well as what preventative maintenance performed over the quarter. ESR will track any outstanding maintenance and require the contractor to complete it in a timely fashion.

The spill response drills and spill reporting will provide information regarding required revisions to training, the spill response plan or other aspects of the SPCC. Each spill reported will be reviewed by ESR and actions identified where possible to improve the site's overall SPCC. Updates/revisions will be made on a bi-annual basis or sooner if the deficiency identified is considered urgent. On a bi-annual (twice annually) basis the KPIs will compared against past-performance and analyzed for trends to determine if there are areas the can be improved.

11.5 IMPLEMENTATION

11.5.1 Responsible Parties and Roles and Responsibilities

Table 11-3 outlines the roles and responsibilities related to implementing this management plan.

Table 11.3 Roles and Responsibilities

Responsible Parties	*Roles and Responsibilities*
ESR Manager	· Work with HSLP manager to ensure SPCC addresses environmental risks as well as Health and Safety. · Support HSLP manager as required in SPCC planning. · Distribution of the SPCC and Spill Response Plans to all parties with responsibilities in implementing the plan

Responsible Parties	*Roles and Responsibilities*
	· Review monthly spill report · Plan spill response drills with Site Manager and Contractors. · Develop Spill Response Training
ESR and HSLP Supervisors	· Schedule bi-weekly inspections · Resolve issues identified in bi-weekly inspections · Schedule chemical environmental and safety training sessions for relevant staff · Prepare monthly spill report · Support HSLP Manager in planning Spill Response drills
Environmental Field Worker	· Perform bi-weekly inspections
Contractors	· Deliver spill response training to employees · Ensure all relevant employees receiving chemical environmental and safety, first aid and spill response training · Develop, implement and report on preventative maintenance plan
Site Manager	· Review monthly and annual spill reporting. · Review spill response drill outcomes and work with ESR Manager to identify necessary improvements · Ensure operational personnel have management systems in place to support ESR commitments.

11.5.2 Training

Chemical environmental and safety, Spill Response and First Aid training will be delivered to all relevant employees Training will be provided within one month of their start-date. Chemical environmental and safety and First Aid training will be provided by certified instructors. Spill Response training will be provided by contractors and ESR staff as necessary. Key personnel will be identified to receive Preliminary Hazard Analysis training.

11.5.3 Schedule

The schedule for this plan is presented in Table 11-4.

Table 11.4 Schedule

Time	*Activity*
January – May 2013	· Complete contaminant list and spill risk assessment; · Develop Spill Response Plan ; · Identify and procure all necessary spill response equipment; · Finalize SPCC Plan ; · Develop detailed budget for first year of implementation of the SPCC; and · Develop initial training and reporting structure.
Pre-Production	· Implement SPCC; and · Review and update SPCC at periodic construction milestones such as when process reagents are brought on-site

Operations	·	Implement SPCC; and
	·	Review and update on an annual basis or when there is a change in process.
Closure	·	Reassess SPCC and revise accordingly; and
	·	Implement, revise and update on an annual basis.

12.0 WASTE ROCK MANAGEMENT PLAN

The following Waste Rock Management Plan (WRMP) presents a framework for the management of waste rock at the Merian Gold Project.

The scope of this Management Plan includes activities related to the handling and storage of waste rock during Operations at the Merian Project and is related only to potential environmental impacts and does not address geotechnical stability or design. During closure the Closure and Reclamation Plan will be the primary plan for describing activities regarding waste rock management on the site. This plan is based on the Project Description provided in the ESIA. It is anticipated that the Plan will require periodic revisions and updates as the Project design advances and as the Project progresses through different mine life stages as well as during implementation as results are reviewed and improvements identified.

The following document will require revision and finalization depending on input from mine engineers and contractors.

Waste rock is removed from above or within the ore during mining activities and at the Merian project can include saprolite, saprock and fresh rock. Waste rock typically includes granular, broken rock and some soils all ranging from fines to large boulders depending on the geologic material and the type of mining. Waste rock consists of low-grade mineralized or non-mineralized soil and rock material is designated as waste rock because it contains concentrations of the target ore too low to process.

12.1 PURPOSE AND OBJECTIVES

The purpose of the WRMP is to provide a system and guidelines for the disposal, management and monitoring of waste rock at the Merian Project so to protect human health and the environment. Potential risks to human health and the environment posed by waste rock are mainly related to geotechnical stability and its potential to impact safety. Risks to the environment are mainly the potential to impact water quality through acid generation (although recognized to be very low probability) or metals leaching. Much of the plan outlined below is identified to control seepage into the WRDs thereby limiting potential for impacts to water

The plan addresses:

- Waste rock characterization;
- Waste rock disposal facility concurrent/progressive reclamation; and

- Waste rock disposal facility monitoring.

Water quality monitoring is addressed in the Water Management Plan. Water quality monitoring results may indicate necessary changes to the Waste Rock Management Plan.

12.2 *SUMMARY OF LEGAL REQUIREMENTS AND COMMITMENTS*

12.2.1 Legal Requirements

Suriname's laws regarding waste rock management are limited. There are no general or specific legislation concerning waste rock management. However, generally, Suriname's mining decree requires all mining to be carried out in an efficient manner, applying modern, international techniques, expert use of advanced technology and with due regard for the protection of health and safety, community health and safety and the environment.

12.2.2 Commitments

The Project has committed to follow guidance regarding waste rock management provided in:

- Industry good practice;
- Surgold's internal Environmental Standard on Waste Rock Management; and
- Surgold's Project Design Criteria.

As per Surgold's Waste Rock Management Environmental Standard, Surgold commits to the following:

- All waste rock disposal facilities will be designed, constructed, closed and reclaimed to be geotechnically stable;
- Waste rock disposal facility design will be reviewed by a qualified engineer;
- Waste rock will be physically and geochemically characterized prior to design, and during operation, and closure and reclamation phases, including the entrainment of potential pollutants due to blasting (i.e. nitrates); and
- Acid rock drainage (ARD) potential will be determined using the agreed upon Newmont acid-base accounting methodology.

12.2.3 *Key Performance Indicators*

The following Key Performance Indicators (KPIs) will be measured and used to evaluate the Project's performance with respect to its stated objectives and commitments:

- Annual volume of waste rock delivered to each WRD;
- Annual volume and tonnage of potentially-acid generating waste rock;
- Annual number of geochemical characterization tests performed on waste rock;
- Annual number of hectares of newly constructed waste rock disposal areas;
- Annual number of hectares of waste rock disposal areas at which reclamation has begun;
- Number of geotechnical inspections performed annually for evidence of slope instability and excessive erosion;
- Number of waste rock slope failures large enough to require corrective action lasting more than one day or that release waste rock to surface water; and
- Estimates of volume of waste rock seepage water managed and treated as indicated by observations.

Monitoring of these KPIs and of the commitments and mitigation measures described in Appendix IV-A will be included within a specific stand-alone Environmental and Social Monitoring Plan detailed in Section 4.2.

12.3 ***MANAGEMENT PLAN COMPONENTS***

The Waste Rock Management Plan will:

- Describe plans for an on-site waste rock characterization program;
- Describe waste rock disposal plan;
- Describe monitoring, reporting and documentation mechanisms for managing waste rock management at the Merian Gold Project; and
- Describe the mechanism to identify potential issues or opportunities for improvement.

12.3.1 *Waste Rock Characterization Program*

The Merian site will generate three different kinds of waste rock: saprolite, saprock and fresh rock. Physical and geochemical testing and results are summarized in Appendix 19-3 of the ESIA. Generally, testing shows that waste rock acid generating potential across all three rock types is very low, with the lowest potential associated with saprolite and the highest (although still remaining low) in the ore-bearing fresh rock. Despite the low risk associated with site with respect to acid-generating materials, the Project recognizes that continued waste rock characterization will serve to provide confirmation of the site's low risk or identify any waste rock that requires more careful management with sufficient lead time to limit risks and impacts. While all indications indicate that the materials are Non-Acid-Generating (NAG), confirmatory testing during operations will be completed.

Routine characterization of the waste rock will include analysis of Acid Rock Drainage (ARD) potential, metals mobility and monitoring of quality of water seepage through WRD. Static testing and monitoring of run-off and leachate will be performed routinely.

A sampling program will be developed by the Chief Geologist prior to the generation of waste rock.

The objective of the program will be to identify any potential changes in waste-rock characteristics from the results of the characterization program and to identify any waste rock that will need specific handling measures to protect the environment or human health. The sampling program will prescribe:

- Sampling program objectives;
- Sample collection methodology;
- Frequency and volume of samples (i.e. number of samples/volume of waste rock and volume of sample required);
- Documentation of sample collection;
- Analysis methods that are applicable to site conditions and resources;
- Definition of results that indicate PAG material;
- Roles and responsibilities;
- Quality Assurance and Quality Control (QA/QC) measures including periodic third-party analysis if needed;
- Thresholds for the definition of PAG or other contaminant generating material and trigger values that indicate that PAG management practices are required; and

- Data management system and procedures.

A balance of PAG and NAG material will be developed in order to evaluate and design controls to isolate PAG material from the environment in the near and long-term through mine planning, if needed. The balance shall be updated annually to assess the adequacy of available material for reclamation/closure. Prior to the end of the first year of Pre-Production a methodology for the development of the PAG/non-PAG balance will be developed, reviewed and approved and incorporated into the Waste Rock Management Plan.

12.3.2 Waste Rock Disposal Plan

The following section presents Waste Rock Disposal facility plans as presented in the ESIA Project Description (Chapter 3). Locations of the Waste Rock Disposal (WRD) facilities are provided in Figure 12-1.

Waste Rock Disposal (WRD) facility locations were selected to minimize truck travel distances from pits to the WRDs. WRDs heights and slopes will be geotechnically stable. The phasing of the opening and closing of the WRDs is dependent on the sequencing of the pit development. Pit production will begin at Merian II and the first WRD to be established will be the nearby West WRD. The West WRD will open during Pre-Production to store saprolite stripped from Merian II prior to Production. The North WRD will open in the first year of Production. The remaining three WRD facilities will become active in Year 3.

Waste rock from Merian II will be stored in the West WRD for the first three years of Production, after which waste rock will be diverted to the Central WRD for the remaining mine life. The West WRD will consist primarily made of saprolite. The southern part of the West WRD will also store low grade ore stockpiles. The West WRD will also include grubbing waste material from the TSF (if required). The surrounding area will also host ore stockpiles for processing.

Early waste rock (Years 1 – 3) from the Maraba pit will be deposited at the smaller North WRD. The North WRD will also comprise mainly saprolite. Once that facility reaches capacity the waste rock from Maraba will be deposited at the East WRD. The East WRD will comprise a blend of saprolite, saprock and fresh rock. All waste rock from the Merian I pit will be deposited at the South WRD. The majority of the South WRD will be saprolite.

Figure 12-1 Merian Gold Project Mine Site Layout

Table 12.1 Yearly Dump Plan by Material Type for each Pit (million tonnes)

Material Type per Pit	PP[1]	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Total
MER II - SAP	18	37	37	0.3		21	28	40	13	0.02				194
MAR - SAP		0.1	34	42	5	0.01								81
MER I - SAP				0.04	8	2		1	3	35	14	4		67
MER II - Saprock		0.25	0.25	1				2	16	0.2				20
MAR - Saprock				9	11	0.5								20
MER I - Saprock											0.3	0.4		1
MER II - Rock	0.01	0.03	0.03	12	2	1	0.1	0.5	25	27	23	10	1	102
MAR - Rock			0.02	3	46	47	41	26	16	7	1	0.1	0	187
MER I - Rock				0	0.03			0	0.02	0.2	1.3	0.2		2
Total	18	37	71	67	72	72	69	70	73	69	40	15	1	674

SAP – Saprolite

PP – Pre-production year

1 Suitable waste saprolite generated during pre-production will be used for the construction of the tailings dam.

Table 12.2 Estimated WRD Facility Capacity

Dump	Elevation (m.a.g.s)	Volume (Mm^3)	Million Tonnes
West	640	52	94
Central	640	144	223
North	640	89	145
South	640	43	71
East	640	92	145
Total		420	678

Waste material will be deposited at all WRDs in 10 to 20 meter benches. The benches may vary in height in order to facilitate drainage toward the working crest while avoiding ponding of water on top of the WRD. The benches will be built to facilitate drainage toward the working crest of the WRD and avoid ponding at the top of the WRD. At the WRD crests the bench height will be 10 – 12 meters. Depending on operational requirements, the WRDs may be operated on several benches at different elevations. WRDs will be started at the higher ground elevations to avoid pooling of runoff or seepage at the toe of the facilities.

Example cross-sections of the WRD facilities are provided in Figure 12-2.

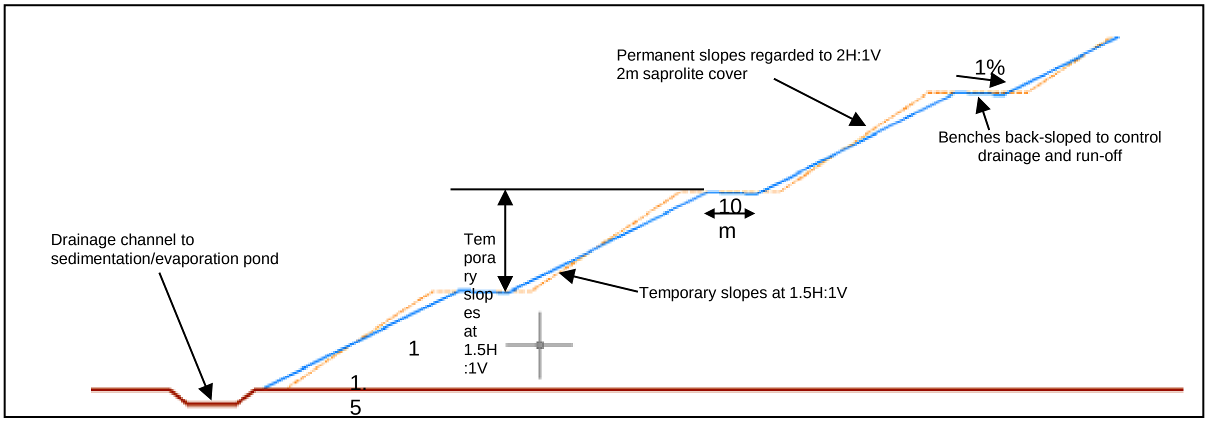


Figure 12-2 Example Cross-Sections of WRD

12.3.3 Waste Rock and Ore Tracking System

A waste rock and ore tracking system will be developed so that the Project has an accurate accounting of volumes of waste rock disposed of at each WRD and the characteristics of the waste rock within each WRD. Development of a tracking system will be the responsibility of the Mine Manager and will depend on mining techniques and the waste rock characterization program. It is recommended that daily logs of waste rock and ore movement be maintained and these provided to update a more sophisticated tracking system on a regular basis (i.e., monthly). Quarterly updates to drawings of the WRDs will be completed, unless timing is considered more appropriate by the Mine Manager. The drawings will indicate areas that are available for concurrent reclamation, areas that are active and areas already undergoing reclamation.

12.3.4 Concurrent reclamation

Concurrent reclamation activities shall be conducted as areas of the waste disposal facility become available. Once the WRD bench has reached its final area limit, interim bench slopes of 1.5 H: 1V will be re-graded to a slope of 2H: 1V with 5 meter benches sloped back to minimize erosion. The overall slope will be 2.5H: 1V. The slopes will be re-vegetated to limit erosive energy.

Growth media will be used to cover the WRD faces to facilitate re-vegetation. Growth media includes saprolite and grubbed or felled vegetation. Once the growth media is placed, the available WRD face will be re-vegetated through hydro-seeding or other methods. The focus will be to return the vegetation communities as quickly as possible to a native plant community. Reclamation of these areas shall be undertaken as areas become available.

A Concurrent Waste Rock Reclamation program will be developed based on goals and objectives of the detailed Closure and Reclamation Plan. The Concurrent Waste Rock program will be updated quarterly as WRD configurations change and are updated. The KPIs and objectives of the concurrent waste rock reclamation program will be based on those developed in the completed Closure and Reclamation Plan.

12.3.5 Monitoring and Reporting

The mitigation, monitoring and reporting measures recommended in this ESMMP are included provided in Table 12-3.

Table 12.3 Waste Rock Management Measures, Monitoring and Reporting

Project Impact	*Applicable phases* [1]	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
Potential negative impacts to surface and groundwater	PP, O	Development of a Waste Rock Management Plan	Review of the Waste Rock Management Plan by Site Manager	Annual	WRMP	N/A	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	Mine Manager and ESR Manager	Annual update of WRMP where necessary	Water Management Plan	N/A (assumed to be within standard operating costs)
Potential negative impacts to surface and groundwater	PP, O	Development of a Waste Rock Sampling Program including thresholds and triggers	Review of the WR Sampling Program by Head Geologist and Site Manager prior to production of waste rock	2 months prior to production of waste rock	Waste Rock Sampling Program	Pits and WRDs	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	Head Geologist,	Inclusion of Waste Rock Sampling Program in WRMP. Quarterly reporting of all testing results to Site Manager [2]		TBD depending on sampling program requirements
	PP, O	Development of methodology for PAG/NAG balance	Review by head Geologist and Site Manager	2 months prior to end of the first year of Pre-Production	PAG/NAG balance methodology	N/A	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	Head Geologist	Inclusion in WRMP. Annual report to Site Manager		N/A (assumed to be within standard operating costs)

[1] PP – Pre-Production, O – Operations, C-Closure. PC- Post Closure

[2] Identification of significant volumes of PAG material may require more frequent reporting. Thresholds and trigger values identified in the Waste Rock Sampling Program will indicate results that require more prompt reporting.

Project Impact	*Applicable phases* [1]	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
	PP,O, C	Geotechnical inspections	Geotechnical inspections and inspections of runoff and run on controls	Quarterly	Signs of significant instability, erosion, subsidence,	All WRDs	Surgold Environmental Standards	Mine engineering staff	Quarterly inspection sheet completed by ESR staff and provided to ESR Manager. Annual report to Site Manager	N/A	N/A (assumed to be within standard operating costs)
	PP,O,C	Heavy rain inspections (e.g., identified 24 hour event)	Inspections of WRDs after extended periods of heavy rain	As needed	Signs of ponding, accelerated erosion, seepage	All WRDs	Surgold Environmental Standards	ESR staff	Inspections documented and provided to the ESR Manager	N/A	N/A (assumed to be within standard operating costs)
	PP, O, C	Concurrent reclamation of areas as they become available	Identification of available areas based on updated drawings inspections of concurrent reclamation areas	Quarterly Review of WRD plans Monthly inspections	Disturbed areas recontoured to final landform and vegetation established within 2 years of becoming available.	Concurrent reclamation sites	Surgold standards, Project EDC	ESR Manager	Annual reporting to the Site Manager in the ESMMP annual report	Closure and Reclamat ion Plan	N/A (assumed to be within standard operating costs)
Potential negative impacts to surface and groundwater	PP, O	Development and Implementation of a Waste Rock and Ore Tracking System	Daily logs of material shipped to each WRDs, Monthly updates to volume tracking system	Logs recorded daily, Updates to system weekly	Volumes of PAG, volumes of NAG	WRDs	Surgold Environmental Standards	ESR and Site Managers, Truck operators are responsible for maintaining logs, Mine engineering staff responsible for maintaining up-to-date tracking system	Quarterly updates and Annual reporting in ESMMP report	N/A	N/A (assumed to be within standard operating costs)

Project Impact	*Applicable phases [1]*	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
	PP,O,C	Seepage and runoff water quality monitoring	Establishment of wells to monitor potential impacts to groundwater Monitoring of ponds receiving runoff	Per Water Management Plan	Per Water Management Plan	Per Water Management Plan	Per Water Management Plan	Per Water Management Plan	Per Water Management Plan	Per Water Management Plan	Per Water Management Plan

12.4 CHANGE MANAGEMENT

As shown in Table 12-2, reporting and monitoring requirements for the Solid Waste Rock Management Plan will include:

- Routine waste rock characterization and quarterly reporting;
- Inspections of WRDs after periods of heavy rain fall (e.g. defined 24 hour event);
- Quarterly inspections of WRDs for geotechnical stability and excessive erosion;
- Quarterly planning of concurrent reclamation;
- Monthly inspections of concurrent reclamation sites;
- Annual reporting of volumes of waste rock disposed at each WRD; and
- Annual reporting of PAG/NAG balance.

During waste rock characterization program and the quarterly reporting a review of the volumes of PAG will be completed to identify if specific measures for managing PAG are required of there is sufficient neutralizing material that no further measures are required. Annual reporting of the PAG/NAG balance should be reviewed and the Waste Rock Management Plan updated if the balance indicates that changes to the WRMP are required.

Results from testing for pollutants from blasting will be incorporated into water quality predictions and incorporated into the Water Management Plan.

Each geo-technical quarterly inspection will be reviewed by the mine engineering team to determine if immediate improvements or changes to the WRDs are required. Any actions or improvements will be documented within the inspection reports. These will be consolidated annual and reviewed for trends that indicate potential changes to overall processes.

Results of monthly inspections of concurrent reclamation areas will be reviewed to identify any immediate actions required to continue to improve the success of the reclamation activities. Actions will be documented within inspection reports. Annual reporting of concurrent reclamation will be included in the annual ESMMP report. Annual results from across the site will be reviewed to identify areas for improvement and changes incorporated into the Closure and Reclamation Plan.

12.5 IMPLEMENTATION

12.5.1 Responsible Parties and Roles and Responsibilities

The roles and responsibilities for the implementation of the management plan are presented in Table 12-4.

Table 12.4 Responsible Parties and Roles and Responsibilities

Responsible Parties	*Roles and Responsibilities*
Site Manager	· Ensure operational personnel have management systems in place to support ESR commitments.
Project Manager	· Oversee development of more detailed design of WRDs that follow Project EDC, Surgold Standards and internationals standards; · Oversee development of WRMP with input from engineers, Head Geologist, ESR Manager; · Review results from quarterly geo-technical inspections. Ensure improvements, remedial actions are identified and taken as needed based on inspections; · Ensure maintenance of up-to-date drawings of WRDs; and · Develop ore and waste rock tracking system.
Head Geologist	· Develop sampling program and associated costs; · Develop NAG/PAG balance methodology; and · Oversee implementation of the two programs listed above including QA/QC and data management.
ESR Manager	· Provide input to WRMP as necessary; and · Oversee development of concurrent reclamation program and integration with Closure and Reclamation Plan.
Mine Engineering Department?	· Complete quarterly inspections of WRDs; · Implement waste rock and ore tracking system, collect data from field crews/truck drivers and update tracking system; and · Produce quarterly updates and input to annual ESMMP report.
ESR Supervisor	· Schedule monthly inspections of concurrent reclamation sites; and · Review inspections or concurrent reclamation sites and identify any necessary improvements/changes as required.

12.5.2 *Training*

Training will be required for the following activities:

- Implementation of sampling program;
- Data management;
- Geotechnical inspections; and
- Concurrent reclamation inspections.

Training program will be developed by the managers responsible for ensuring the management plan is in place and being properly delivered. Training will be delivered by competent, qualified experts in their field and will include on-the-job training.

12.5.3 Schedule

The schedule is presented in Table 12-5.

Table 12.5 Schedule

Time	Activity
September - May 2013	· Develop detailed Waste Rock Management Plan including more detailed design of West WRD, concurrent reclamation plan, sampling program, NAG/PAG balance methodology.
Pre-Production	· Implement WRMP, continue to improve as implementation begins; · Implement sampling program when appropriate; · Develop data management system; · Train staff in sample collection; and · Train staff in waste rock tracking system.
Operations	· Implement WRMP and update and improve as necessary.
Closure	· Implement Closure and Reclamation Plan.

13.0 *CYANIDE MANAGEMENT PLAN*

The following Cyanide Management Plan (CMP) presents a framework for Merian Gold Project to develop a detailed CMP based on input from process engineers, mine engineers, water management experts and Project staff and management. This framework Plan is based on the International Cyanide Management Code for the Gold Mining Industry (Cyanide Code) and Surgold's Cyanide Management Standard.

The scope of the comprehensive Cyanide Management will address:

- Transportation from supplier to site;
- Onsite storage and handling;
- Solution conveyance, treatment and disposal processes;
- Environmental monitoring;
- Emergency preparedness and response;
- Risk communication; and
- Worker health and safety.

This plan addresses the above and identifies the integration with other Merian ESMMPs where necessary.

This plan is based on the Project Description provided in the ESIA. It is anticipated that the Plan will require periodic revisions and updates as the Project design advances and as the Project progresses through different mine life stages as well as during implementation as results are reviewed and improvements identified.

13.1 *PURPOSE AND OBJECTIVES*

The purpose of the Cyanide Management Plan is to set in place a framework to manage, monitor and minimize use of cyanide at the Merian Project. This framework plan provides:

- General procedures that Surgold personnel will follow during the receipt and transportation of cyanide;
- General procedures that Surgold personnel will follow for emergency preparedness, spill prevention and control, handling and storage procedures; and
- Training requirements planning and delivery.

13.2 *SUMMARY OF LEGAL REQUIREMENTS AND COMMITMENTS*

13.2.1 Legal Requirements

Suriname's laws do not specifically address the management of hazardous goods. An amendment to the Decree of the State placing restrictions on the importation and exportation of goods (Negative List), adopted under the Law on the Movement of Goods, was proposed in 2003 to add cyanides, sodium hydroxide, nitric acid, acetone and iridium to the Negative List, meaning that specific restrictions to the import and export of these chemicals would apply these can take the form of prohibitions, non-automatic licensing requirements, or certification requirements. Licenses are issued by the Ministry of Trade and Industry (MTI). Certificates may be issued by the MTI or other national government agency.

13.2.2 *Commitments*

The Project has committed to base its cyanide management procedures and processes on the Cyanide Code, Surgold's Cyanide Management Standard and international best practices. The Project has committed to becoming a signatory to the Cyanide Code.

The Project will be audited and certified as being in compliance with the Cyanide Code no less than every three years.

13.2.3 *Key Performance Indicators*

The following Key Performance Indicators (KPIs) are recommended to be measured and used to evaluate the Project's performance with respect to its stated objectives and commitments:

- Annual volume cyanide imported to Suriname for the Project;
- Annual number of near-misses regarding the transportation, handling, and storage of cyanide;
- Annual number of accidents and/or releases of cyanide to the environment (related to the Project);
- Average, maximum, minimum concentrations of cyanide(WAD and free) in tailings discharge to the TSF (measured routinely);
- Annual number of occurrences of cyanide concentrations greater than 0.5 mg/L CN_{WAD} in the discharge from the TWSR;

- Annual average, maximum and minimum concentration of cyanide in the tailings pond decant (reclaim) water (monitoring frequency to be determined in the Water Management Plan);
- Annual average, maximum and minimum concentration of cyanide (WAD and free) in any water discharges from the site to the environment from the TWSR (monitoring frequency to be determined in Water Management Plan); and
- Number of occurrences of cyanide concentrations greater than 0.1 mg/L WAD Cyanide or 0.005 mg/L CN_{free} in the receiving environment.

Monitoring of these KPIs and of the commitments and mitigation measures described in Appendix IV-A will be included within a specific stand-alone Environmental and Social Monitoring Plan as described in Section 4.2.

13.3 *MANAGEMENT PLAN COMPONENTS*

The components of the following Cyanide Management Plan:

- Procurement
- Transportation,
- Handling and storage,
- Operations,
- Health and Safety,
- Training, and
- Emergency Response.

13.3.1 Procurement and Delivery by Third-Party Supplier

Cyanide will be delivered to the Port of Houston by a third-party supplier (i.e. FAS Houston Port Facility or similar INCO Terms). Supplier selection will include a review of the supplier's practices and procedures to confirm that they operate in a safe and environmentally protective manner. Selection of a supplier certified by the International Council of Chemical Associations; Responsible Care Program and one that has adopted the Cyanide Code is recommended.

The supplier will be required to provide chain-of-custody documentation to show that the cyanide has been produced at a facility certified as compliant with the Cyanide Code should be provided annually.

A 3rd party ocean transport provider will provide ocean transport from the Port of Houston to a designated port in Suriname (yet to be decided).

Cyanide shipments will be regular with expected shipments every two to three weeks from the Port of Houston to Suriname.

Upon arrival in Suriname tanks/containers will be inspected by Surgold Logistics personnel to ensure no damage exists. In the event any container is found damaged, logistics personnel will notify the Procurement and Logistics Superintendent or his designate. The Procurement and Logistics Superintendent will advise Health and Safety Coordinator who will intern put in place the appropriate action to inspect and correct if required.

All ISO container movements will be handled by the use of a top loading container handling unit. This includes loading and unloading of trucks and vessels by:

- Crane with top loading spreader bar; and
- Fork lift with top loading container attachment

13.3.2 *Transportation*

Cyanide will be transported along the Transportation Corridor from the port to the Project site. Major transportation route options are limited due to the limited road network. Assessment of the transportation route should refer to the ICMI Cyanide Transportation Verification Protocol, Protocol 1.1.

Transportation will be via convoy on low-center of gravity trailers with container locks. Each trailer will have the capacity to carry two containers. The following precautions will be taken:

- Transport units will be escorted by a lead vehicle and a trailing vehicle to ensure safe passage while enroute;
- The lead and trailing vehicle will be equipped with appropriate warning signs and light bar;
- An emergency response vehicle will also be included in the convoy. The emergency response vehicle be equipped with spare tires for transport units, mechanical tools and the emergency response kit;
- A minimum of two persons trained in Emergency response will participate in the convoy (this may include drivers); and
- Where transport contractors are being used they will be Cyanide Code certified.

The cyanide will be transported dry in briquette form in stainless steel 20-foot Isotanks or isotainers, which are specially designed steel containers that provide maximum protection against possible loss of contents. Emergency supplies for the Project will be shipped in briquettes in 1 tonne bags inside a specially designed plywood box which provides additional protection to the product during transport and storage (emergency supply is approximated at 5% of the total volume of cyanide used by the Project).

The written contracts with the service suppliers will stipulate:

- Preparation and implementation of Transportation Safety Management Plan and an Emergency Response Plan that satisfy the requirements outlined in the ICMI Transportation Verification Protocol;
- Interim loading, storage and unloading practices during shipment to follow guidelines provided in Transportation Practice 2.1 of the ICMI Cyanide Transportation Verification Protocol; Maintain shipping records of the volume of cyanide in transit and a Material Data Safety Sheet (MSDS);
- Shipments by sea to be in compliance with the Dangerous Goods Code of the International Maritime Organization;
- Provision for reviews or audits as required by Merian Gold Project as deemed necessary by the Project;
- Provisions that require any sub-contractors to be bound by the same requirements as the contractor; and
- All relevant packaging and labeling to conform with the Recommendations for the Transport of Dangerous Goods (United Nations Economic and Social Council's Committee of Experts on Transport of Dangerous Goods).

Contractors Transportation Safety Plans will include:

- Provisions to ensure vehicles used in the transport of cyanide are only loaded to manufacturer specifications and procedures are in place to prevent overloading;
- Defensive driver training for drivers;
- Vehicle inspections prior to departure/shipment;
- Vehicles to be equipped with communication equipment that permits communication with transport company, Merian Project, cyanide supplier and emergency response for the entire transportation corridor;
- Transportation company to maintain communication in working order and document checks/inspections; and
- Other requirements as identified in the Transportation Verification Protocol.

The Contractors Emergency Response Plan will include all elements as identified in the Transportation Verification Protocol including but not limited to:

- Descriptions of response actions for anticipated emergencies;
- Roles of outside responders, medical facilities or communities;
- Roles of internal responders, duties and responsibilities;
- Appropriate emergency response training;
- Itemization of on-hand emergency response and health and safety equipment as identified in Surgold's checklist;
- Training plan including periodic refresher training;
- Procedures to inspect emergency response equipment;
- Procedures for remediation or recovery; and
- Provisions for periodically reviewing and evaluating the Plan.

On arrival on site tanks/containers will be inspected to ensure no damage exists. In event any container is found damaged, warehouse/surface personnel will notify the Procurement and Logistics Superintendent or his designate. The Procurement and Logistics Superintendent will advise the Health and Safety Coordinator who will, intern, put in place appropriate action to inspect and correct if required. All ISO container movements will be handled by the use of a top loading container handling unit. This includes loading and unloading of trucks and vessels.

13.3.3 Handling and Storage

Storage

Cyanide will be stored at a designated area with controlled access. The storage area will have primary and secondary containment provided.

The storage area will be:

- Controlled-access;
- labeled as a cyanide storage area and will have posted signs warning of the dangers associated with cyanide as well as who to notify in the case of an accident or emergency, how to reach the Project's medical clinic and first-aid locations in the immediate area;
- Equipped with a means of communicating with the mine and process manager on-duty, the medical clinic, the ESR and the HSLP manger on-duty;

- The cyanide storage containers will be sealed and protected from unrestricted access;
- Equipped with cyanide-specific first-aid and emergency response equipment including high-pH water, oxygen, resuscitator and appropriate PPE and an antidote for cyanide poisoning (this can only be administered by medical personnel) and instructions regarding the proper use of equipment;
- Spill prevention or containment measures will also be provided for process solution pipelines; and
- Standard containers with box cyanide will be stored with doors sealed and doors facing each other to limit access.

Storage areas will be inspected regularly as part of the CMP.

Handling

The Project will have a design review of the process plant and cyanide reagents system completed by an accredited ICMI auditor prior to completing the Project's detailed design of the process plant. The review would incorporate the process plant, secondary containment, cyanide reagent mixing system design, piping design and other features relevant to cyanide management.

The Project is currently proposing to use a bulk sparging system to introduce the cyanide to the distribution tanks. Bulk sparging reduces waste packaging, lowers the risks associated with road transportation, and allows for bulk delivery of dry product and reduces handling thereby protecting worker health and safety.

The Project will develop a written set of Standard Operating Procedures to be followed during the receipt of cyanide shipments. The procedures will include:

- Instructions for operating any and all valves/couplings;
- Requirements for Personal Protective Equipment (PPE);
- Measures to ensure that containers are neither ruptured nor punctured;
- Limits on stacking containers; and
- Contingency measures for responding to releases or spills of cyanide.

13.3.4 Operations

The Project will develop operations plans and procedures for the processing plant, mine, TSF and other mine works. Within these plans measures for the protection of the environment and human health specific to cyanide will be incorporated including:

- Maintenance of concentrations no greater than 50 mg/L WAD cyanide in the TSF pond;
- Maintenance of a safe freeboard in the TSF and Treated Water Storage Pond (details will be provided as part of the Water Management Plan as detailed design advances) or in any other ponds that contain more than 0.5 mg/L CN-WAD (as required by the Cyanide Code);
- Systematic identification of changes in processing or feedstock (i.e. percentage of fresh rock vs. saprolite) that could result in changes in volumes of cyanide required;
- Evaluation of control strategies for cyanide additions to optimize efficiency and reduce cyanide concentrations in tailings or recycled solutions;
- Evaluation of process solutions to determine appropriate pH for limiting the evolution of hydrogen cyanide gas and development of operating procedures and controls to reduce risk to workers;
- Review of processes to ensure that worker exposure to hydrogen cyanide gas and sodium and potassium cyanide is limited to 10 ppm as cyanide, not to be exceeded for any period of time. Additionally, workers should not be exposed to hydrogen cyanide gas and airborne sodium and potassium cyanide dust at concentrations exceeded 4.7 ppm as cyanide for a period of 8 consecutive hours or more;
- Procedures for maintaining, testing, calibrating cyanide monitoring equipment;
- Identification of piping containing cyanide by color code, signs, labels, tags, decals or other means to alert workers of their contents. The direction of cyanide flow in pipes should also be labeled, marked or otherwise designated, all in accordance with tanks ANSI1 / ASME2 standard A13.1. Tanks shall be identified with signs and labels in accordance with NFPA3 704 (all pipes and containers with solutions with concentrations greater than 0.5 mg/L CNWAD);
- No water discharges from the mine to the environment with concentrations greater than 0.5 mg/L WAD cyanide (as required by the Cyanide Code) nor discharges that result in concentrations greater than 0.022 mg/L (as per the Cyanide code) free cyanide within receiving water

[1] American National Standards Institute
[2] American Society of Mechanical Engineers
[3] National Fire Protection Association

body (water quality monitoring and reporting is described in the Water Management Plan) ;

- Regular groundwater monitoring around the TSF and groundwater capture and treatment as required (water quality monitoring and reporting is described in the Water Management Plan); and
- QA/QC programs to ensure facilities for the management of cyanide are constructed according to accepted engineering standards and specifications.

13.3.5 *Health, Safety and Loss Prevention*

The Project will develop a Health and Safety Plan that addresses the risks, hazards, preventative measures, mitigation, training and reporting for all jobs across the mine site including the mining operations, process plant, administrative functions etc. The HSP will incorporate specific risks associated with cyanide as specified in the guidance provided by the ICMI. Specifically the HSP will include:

- Initial identification of potential exposure scenarios and measures necessary to eliminate, reduce and control them and review of process changes and engineering controls that can be implemented to eliminate, reduce or control these scenarios;
- Development of standard operating procedures for the unloading, mixing, equipment decontamination, entry into confined spaces and plant operations that ensure worker exposure to cyanide is minimized;
- Identification, provision and training in the use of cyanide-specific PPE;
- SOPs for pre-work inspections, emergency response, communication, cyanide monitoring and documentation;
- Cyanide-specific training for all relevant workers including PPE, emergency response and cyanide first-aid;
- Requirement than any change in process be reviewed for potential impacts on worker health and safety;
- Provision for localized monitoring of ambient air quality in areas where exposure to hydrogen cyanide gas or other airborne cyanide contaminants exists. Cyanide-specific personal protective equipment must be required in any areas and for any activities where process and engineering or administrative controls are not practicable or effective in limiting worker exposures to a maximum of 10 parts per million or where personnel are exposed to more than 4.7 parts per million for a continuous 8-hour period;

- Warning signs should be placed where cyanide is used and should alert workers that cyanide is present, that smoking, open flames, eating and drinking are not allowed and that the necessary cyanide-specific personal protective equipment must be worn;
- Showers, low-pressure eye wash stations and dry powder or non-acidic sodium bicarbonate fire extinguishers should be located at strategic locations throughout the operation where cyanide is present. This equipment should be maintained, inspected, and tested on a regular basis, and records should be retained;
- Material Safety Data Sheets (MSDS), first aid procedures and any other informational materials on cyanide safety should be written in the language of the workforce and should be available in areas where cyanide is managed; and
- All exposure incidents should be investigated and evaluated to determine if the operation's programs and procedures to protect worker health and safety, and to respond to cyanide exposures are adequate or if changes are necessary.

13.3.6 Emergency Response

Similar to Health and Safety, the Project will develop an Emergency Response Plan that address the potential emergencies associated with the entire scope of Project activities, not limited to but including, those associated with cyanide as described in the guidance provided by the ICMI.

13.3.7 Stakeholder Engagement

The Project will develop an operational Stakeholder Engagement Plan (SEP) informed by the principles and processes mentioned in the ESMMP and ESIA SEP. This plan will provide direction regarding stakeholder engagement for all elements of the Project. The SEP will include aspects specific to cyanide management including:

- Opportunities to engage stakeholders and address their issues regarding cyanide; and
- Opportunities/ methods to provide information regarding the operation's practices and procedures related to cyanide transportation, storage, handling and monitoring including written descriptions in the appropriate languages as well as through presentations or other direct stakeholder engagement.

As described in the ICMI guidance, a specific communication plan will be developed as part of the SEP that outlines the communication required in the event of a release or exposure that involves:

- Incidents of cyanide exposure resulting in hospitalization or fatalities;

- Incidents where releases of the mine site required response or remediation;
- Incidents where a release on or off the mine site resulted in a significant adverse effect to health or the environment;
- Incidents where a release on or off the mine site required reporting under applicable regulations; and
- Releases that caused exceedances of applicable limits for cyanide.

13.3.8 Monitoring and Reporting

The mitigation, monitoring and reporting measures recommended in this management plan are included in Table 13-1. Monitoring of KPIs and of the commitments and mitigation measures described in Table 13-1 and Appendix IV-A will be included within a specific stand-alone Environmental and Social Monitoring Plan described in Section 4.2.

Table 13.1 Cyanide Management Measures, Monitoring and Reporting

Project Impact	*Applicable phases* [1]	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
Potential negative impacts to receiving aquatic environment and/ or human health due to unmanaged releases or exposure to cyanide	PP, O, C	Development of a Cyanide Management Plan	Review of the Cyanide Management Site Manager	Annual	CMP	N/A	Project EDC, Surgold Environmental Standards, IFC EHS Guidelines	Process Manager	Annual update of CMP where necessary		
		Review of contracts with third-party cyanide transportation service providers									
		Selection of a cyanide supplier	Review of supplier certification	Upon any new contract with supplier and confirmation of renewal of certification as required by certifying agency	Certification	N/A	Cyanide Code	Supply Chain Manager	Annual CMP reporting		

[1] PP – Pre-Production, O – Operations, C-Closure. PC- Post Closure

Project Impact	*Applicable phases* [1]	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
		Review of transportation routes including risk assessment, feasibility and stakeholder engagement		Every 3 – 5 years	N/A	N/A	Cyanide Code	Supply Chain Manager	Annual CMP reporting	SPCC	N/A
		Contractor Emergency Response Plan and Transportation Safety Plan	Review of required plans by Process, HSLP and ESR Managers	Upon establishment of any new contract, upon renewal of contracts	Plans provide for operations that will meet ICMI auditing standards			Contractors are responsible for developing plans, ESR, HSLP Managers responsible for review	Contractors will be required to report annually or as required by mine management	ERP, TTSP, SPCC	N/A (assumed to be within standard operating costs)
		Cyanide storage and handling SOPs	Review of SOPs by Surgold designated manager	Reviewed at regular intervals as prescribed in CMP							
		Maintenance of signage, first-aid and emergency response supplies at cyanide storage or handling areas	Inspection of cyanide storage and handling areas	Weekly	Present and in good working order	All identified cyanide storage or handling areas		Process and HSLP Managers			N/A (assumed to be within standard operating costs)
	PP, O, C	operating plans for the TSF, process plant and water treatment systems to address specific issues related to cyanide management	Review of operational plans by the HSLP and ESR Managers and external ICMI certified auditor	During development of operational plans and updates	Review of operational plans in comparison to the requirements of the ICMI	N/A	Cyanide Code	Process Manager is responsible for review and update, Site Manager is responsible for oversight	Operational plans provided to Site Manager for review as needed	ERP, HSLP	N/A (assumed to be within standard operating costs)

Project Impact	*Applicable phases* [1]	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
	PP, O, C	Development of health and safety procedures and provisions related to cyanide as part of overall HSP	Review of HSP to confirm cyanide-related risks are addressed	During development of HSP and upon regular updates/ reviews of the HSP	Review of HSP in comparison to guidance of the ICMI	N/A	Cyanide Code	General Manger			N/A (assumed to be within standard operating costs)
	PP,O,C	Development of cyanide-specific details within the Emergency Response Plan	Review of ERP to confirm cyanide-related risks are addressed	During development of ERP and upon regular updates/ reviews	Review of ERP in comparison to guidance of the ICMI	N/A	Cyanide code	General or designated Surgold Manager			N/A (assumed to be within standard operating costs)
	PP,O,C	Signatory to the ICMI and maintenance of up-to-date certification	External audits	Every 3 years?	Compliance with Cyanide Code requirements	N/A	Cyanide Code	Process and Site Manager	As required by the ICMI	ERP, SPCC, SEP, HSLPP	50 000 for gap analysis and 75 000 for audit
	PP,O,C	Internal audits	Internal audit and report	Annually	Compliance with Surgold's Cyanide Management Plan	N/A	Cyanide Code, Surgold Cyanide Management Standard	Site Manager	Internal: Annual audit report completed by designated Surgold Manager to the Site Manager External: results included in ESMMP annual report	ERP, SPCC, HSLPP	Considered part of normal operating procedures

Project Impact	*Applicable phases* [1]	*ESIA mitigation recommendations and/or ESMMP measures*	*Monitoring Activity or Management Measure*	*Timing and frequency of monitoring*	*KPI(s) or Parameter*	*Monitoring Locations*	*Relevant regulations/ standards / thresholds*	*Responsible party for ensuring commitment implementation*	*Reporting requirements*	*Related plans*	*Estimated Costs (USD)*
	PP,O,C	Stakeholder engagement specific to cyanide related issues	Inclusion of cyanide related topics/ issues in SEP	As needed	Compliance with Cyanide Code	N/A	Cyanide Code	ESR Manager		SEP	Incidental costs associated with SEP program such as translators, material production , venue rentals etc.

13.4 *MANAGEMENT OF CHANGE*

As shown in Table 13-1 reporting requirements for the Cyanide Management Plan will include:

- Incident reporting;
- Weekly inspections;
- Annual input to the Annual ESMMP Report; and
- Annual audit report.

During weekly inspections, small-scale infractions or improvements will be identified, and actions taken to improve or change practices will be documented.

All incidents will be investigated and findings used to update the cyanide management plan as recommended.

The annual audit and report to the Site Manager will be used to identify more systemic problems, solutions that require budget allocation beyond the ESR discretionary spending budget, or legal or contractual input.

13.5 *IMPLEMENTATION*

13.5.1 Responsible Parties and Roles and Responsibilities

The following present responsibilities that need to be fulfilled to implement the CMP. Surgold may assign the roles and responsibilities to parties other than those identified here. The final CMP should reflect these updates.

The roles are responsibilities for the implementation of the management plan are presented in Table 13-2.

Table 13.2 Responsible Parties and Roles and Responsibilities

Responsible Parties	*Roles and Responsibilities*
Supply Chain Manager	· Develop and oversee implementation of SOPs related to transportation of cyanide; · Input to the development of the final Cyanide Management Plan with respect to transportation safe practices; and · Work with ESR Manager to review transportation routes and conduct risk assessment and feasibility of routes.
Process Manager	· Ensure cyanide-specific requirements are incorporated into process SOPs; · Establish procedures for review and documentation of processes as identified in the ICMI guidance notes for Operations and identified in Section 13. 3.3.; and · Responsible for managing Surgold's compliance and

Responsible Parties	Roles and Responsibilities
	certification with ICMI.
ESR Manager	· Ensure ambient water surface and ground quality monitoring include analysis for cyanide and reviews results on a regular basis comparing to Project EDC.
HSLP Manager	· Responsible for development of final Cyanide Management Plan and overall implementation of plan; · Development of training programs for employees working around cyanide; and · Include cyanide-specific provisions and precautions in the Health and Safety Plan, Training programs and Emergency Response Plan
Site Manager	· Oversee the managers and the completion of their respective duties.
HR Manager	· Cooperate with ESRM and HSLP managers in development of training programs; and · Maintain up-to-date staff records regarding training and identify recertification or training refreshers as needed.

13.5.2 Training

The HSLP department will develop cyanide-specific training for all personnel who may encounter cyanide. Training will inform employees on cyanide's inherent hazards as well as how to manage cyanide in a safe and environmentally protective manner.

Training will include:

- Identification of all locations on-site where one can encounter cyanide;
- Information regarding health effects of cyanide;
- Symptoms of cyanide exposure; and
- Procedures to follow in the event of exposure.

Training requirements specific to cyanide will also be incorporated in the general HSP and ERP training programs as well as job-specific training as required. The training programs will be developed by the HSLP department and records maintained by the HR department. Training will be provided prior to employees working around cyanide.

Depending on their current knowledge and experience with working with cyanide, it is recommended the HSLP manager and staff consider third-party cyanide safety training for themselves prior to developing and implementing training programs and SOPs for the site.

13.5.3 Schedule

The following schedule is based on the assumption that cyanide will not be required on-site until two months before commissioning. The schedule if presented in Table 13-3.

Table 13.3 Schedule

Time	*Activity*
January – May 2013	· Finalize contracts with suppliers and transportation providers and review certification and procedures to confirm the compliance with ICMI requirements; · Continue to develop and finalize CMP; · Arrange for ICMI certified auditor of the process plant components and operational procedures etc.; and · Investigate potential 3rd party training for key personnel
Latter portion of Pre-Production	· Implement CMP; · Deliver initial training and revise/improve as necessary; and · Update CMP as issues or questions arise.
Operations	· Implement CMP; and · Review and update on an annual basis or when there is a change in process.
Closure	· Reassess CMP and revise to address issues specific to closure and decommissioning; and · Implement, revise and update on an annual basis.

14.0 *CLOSURE AND RECLAMATION PLAN*

As presented in Chapter 3 of the ESIA a Conceptual Closure and Reclamation (CC&R) Plan has been developed for the Project. The purpose of the plan is to provide an overview of closure plans for the site. The CCRP is included here (Appendix 15-A) again for the sake of completeness of the ESMMP and the Closure and Reclamation Plan of the Project will be developed and updated during operations in order to effectively plan for the closure phase.

The reclamation plan will be refined further when a comprehensive mine plan is in place and feedback has been received based on stakeholder engagement and social closure planning.

Operational reclamation plans that reflect actual landforms, soils and conditions will be designed on a site by site basis, with consultation with local communities. The final reclamation plan will be further defined when additional information on reclamation technologies, species suitability, and reclamation material, physical and chemical properties has been identified and field trials completed.

The CC&R Plan is a living document that will require updating, when appropriate, to include new reclamation technologies, strategies and tools become available. As the mine plan develops the CC&R Plan will be adapted to incorporate these changes. Adaptive Management will be applied to ensure closure and reclamation goals are met with the most economical and successful reclamation techniques available at the time.

15.0 *OVERVIEW OF WATER MANAGEMENT PLAN*

A separate, comprehensive Water Management Plan has been prepared for the Merian Gold Project and is provided as Appendix IV-B of this ESMMP. The Water Management Plan will serve as the governing document with regard to water management at the mining site. The section that follows has been developed to highlight, at a high level, the key components of the Water Management Plan.

15.1 *PURPOSE AND OBJECTIVES*

The purpose and objectives of the Water Management Plan are presented in Section 1.1 and 1.3 of the plan as provided in Appendix IV-B. The Water Management Plan presents the framework for water management at the Merian Project site. The plan identifies potential Project water-related impacts, identifies the environmental controls that will be put in-place to minimize these risks, provides an overview of a water-related monitoring program that will be implemented to evaluate performance and confirm compliance, and indicates adaptive mitigative actions that would be implemented should monitoring indicate deficiencies in performance or compliance.

15.2 *SUMMARY OF LEGAL REQUIREMENTS AND COMMITMENTS*

15.2.1 Legal Requirements

A detailed summary of the legal and institutional framework for Merian Project is provided in Chapter 2 of the ESIA. Suriname's laws regarding water management and water quality management are limited. There are no specific environmental guidelines or criteria for the quality of water discharge or ambient water quality in Suriname, nor are there specific requirements relative to monitoring and reporting.

As noted in Section 1.4 of the Water Management Plan (Appendix IV-B), water management for the Merian Gold project has been developed based on set of national, international and Project-specific regulations, guidelines and standards, including:

- Nationaal Instituut voor Milieu en Ontwikkeling in Suriname (NIMOS);
- International Finance Corporation (IFC), World Bank;
- Surgold environmental standards (Newmont 2006);
- Merian Project Environmental Design Criteria (EDC) (Surgold 2012); and
- International Cyanide Management Code (ICMI 2006-2012).

15.2.2 Commitments

The Merian Project has committed to the Project's Environmental Design Criteria (EDC), which follows applicable IFC guidelines and recognized industry good practice. The ambient water quality criteria and discharge standards have been developed in consideration of IFC EHS guidelines, the International Cyanide Management Code, and risk based values established by other sources such as the United States Environmental Protection Agency (USEPA) and the World Health Organization (WHO).

15.2.3 Key Performance Indicators

Section 4 of the Water Management Plan (Appendix IV-B) describes the Key Performance Indicator (KPI) monitoring, adaptive management and reporting that will be implemented to evaluate the Project's performance with respect to its stated objectives and commitments. Note that the list below represents a general listing of water-related monitoring to be performed in support of the Merian Project and more detailed information will be provided in an Environmental and Social Monitoring Plan to be submitted within two months after Project approval as indicated by granting of the Right of Exploitation.

Monitoring of KPIs to assess performance will include:

- Climate monitoring (rainfall, temperature, evaporation);
- Operational monitoring:
  - Ore geochemistry;
  - Tailings discharge quality;
  - TSF reclaim pond levels and quality, discharge quantity;
  - TWSR pond levels, discharge quantity and quality; and
  - Sedimentation Pond effluent quantity and quality;
- Water quantity and quality in the seepage collection system;
- Interim evaluation monitoring:
  - Groundwater levels and groundwater quality;
  - Surface water quantity and quality (e.g., sampling at interim evaluation points such as EP-A3, EP-A4, EP-B1, EP-B2, and EP-C1); and
  - WTP discharge quantity and quality (influent and effluent);
- Compliance monitoring:
  - Groundwater levels and groundwater quality at compliance locations; and

- Surface water quantity and quality (e.g., sampling at compliance points such as EP-A0, EP-B0, and EP-C0);

- Pre-production monitoring of sewage treatment plant (STP) discharges from the Pioneer Camp, Operations Camp and Process Plant STPs to A3 Creek (not specifically addressed in Water Management Plan in Appendix IV-B, but incorporated herein); and
- Monitoring potable water produced by Potable Water Treatment Plant to confirm compliance with EDC drinking water standards (not specifically addressed in Water Management Plan in Appendix IV-B, but incorporated herein).

15.3 *MANAGEMENT PLAN COMPONENTS*

The Water Management Plan provided in Appendix IV-B includes components similar to those included in the other management plans provided in the main body of this ESMMP. These components are listed below, along with the associated Water Management Plan section number in parentheses.

- States the purpose and objectives of the Water Management Plan (Section 1);
- Provides an overview of Merian Project water resource issues and risks (Sections 2.2 and 2.3);
- Describes erosion and sediment control management approach including planned controls, adaptive mitigation actions, and contingencies (Section 3.2.1, Table 1, and Erosion and Sediment Control Plan);
- Describes water management approach for plant site, WRDs and mine pits, and TSF, approach including planned controls, adaptive mitigation actions, and contingencies (Sections 3.2.2 through 3.2.4 and Table 1); and
- Describes water-related monitoring, adaptive management and reporting programs.

15.4 *IDENTIFICATION OF POTENTIAL SOURCES OF IMPACTS TO WATER RESOURCES*

The Water Management Plan (Appendix IV-B, Section 2.3 and 2.3) identifies the potential sources of Project related impacts local surface water and groundwater resources and identifies contaminants of potential concern. The Water Management Plan provides a summary discussion of the more detailed evaluation presented in ESIA Chapter 19. The Water Management Plan provides a high level listing of the potential water-related risks addressed by the Water Management Plan as follows:

- Surface erosion during site preparation, access road construction, and plant site construction during storm events;

- Surface erosion from WRDs, road fill slopes, plant area, camp area, and other disturbed areas on site with bare soil during storm events;
- Runoff and seepage containing residual nitrogen from blasting leaving the WRDs or being pumped out of the pits;
- Seepage from the TSF containing nitrogen, metals, or cyanide;
- Discharge of treated excess water from the TSF containing nitrogen species, metals, or cyanide;
- Stormwater runoff from the plant site containing nitrogen, metals, or cyanide;
- Stormwater runoff from the plant site containing nitrogen species, metals, cyanide, or petroleum; and
- Pre-production phase discharge of treated sanitary sewage to A3 creek (not specifically addressed in Water Management Plan in Appendix IV-B, but incorporated herein).

15.5 *PLANNED WATER MANAGEMENT CONTROLS, ADAPTIVE MITIGATION MEASURES AND CONTINGENCIES*

The Water Management Plan (Appendix IV-B, Section 3 and Table 1) identifies the controls built in to the design of the Merian Project to manage and minimize potential impacts to local surface waters and groundwater.

Planned controls include:

- Implementation of an Erosion and Sediment Control (ESC) plan that includes:
    - Use of ESC best management practices during construction of major Project earthworks;
    - Source controls, to address and minimize soil erosion at the source;
    - Intermediate controls, to reduce erosion and promote settling of solids along and within the runoff conveyance system;
    - Perimeter controls consisting of sediment ponds downgradient of Project disturbed areas to capture runoff, promote settling and manage low flow and peak flow discharges;
- Management of WRD runoff and seepage and mine pit dewatering discharges by implement best management practices and routing flows through sediment basins prior to discharge to local surface waters; and
- Management of potential impacts associated with TSF seepage and TSF excess water discharges by:
    - Treatment of Process Plant tailings via a CCD/detoxification circuit;

- Treatment of TSF pond water for copper and ammonia at the Water Treatment Plant, prior to discharge to the Treated Water Storage Reservoir;
- Controlled discharge of treated water (with elevated hardness) from the TWSR to local receiving waters during low flow (dry) periods to provide dilution and increase hardness-dependent metals water quality criteria;
- Installation a drainage collection system upgradient of main dam number 6 in the TSF to reduce piezometric head and reduce seepage rates and a seepage collection and return system downgradient of the TSF to capture a portion of the seepage and return it to the TSF pond; and
- Other measures as described in the Water Management Plan.

The Water Management Plan also provides a high level discussion of water monitoring programs and possible adaptive mitigative actions that would be implement should monitoring indicate water levels or COPC concentrations approaching or exceeding trigger levels.

15.6 *WATER MONITORING PROGRAM*

The Water Management Plan (Appendix IV-B; Section 4 and Table 1) provides a high level discuss of planned performance and compliance monitoring programs. The Water Management Plan monitoring program, an overview of which is provided above in Section 15.2.3, is preliminary. Surgold will provide a more comprehensive Environment and Social Monitoring Plan to NIMOS within two months of Project approval, as indicated by the granting of the Right of Exploitation.

The monitoring program will include climatic monitoring, evaluation of ore geochemistry, end-of-pipe discharge water quality monitoring, instream ambient surface water quality monitoring (at both compliance points and upstream interim locations), streamflow monitoring, surface water level monitoring (TSF pond and TWSR), and groundwater level/water quality monitoring.

15.7 *IMPLEMENTATION*

15.7.1 Responsible Parties and Roles and Responsibilities

The Water Management Plan does not currently identify the parties responsible for carrying out the water monitoring programs or their roles and responsibilities. The more comprehensive Environmental and Social Monitoring Plan (to be provided to NIMOS by Surgold within 2 months of Project approval) will include this information.

15.7.2 Training

The Water Management Plan does not currently provide specific information regarding training of staff to conduct water monitoring programs. The more comprehensive Environmental and Social Monitoring Plan (to be provided to NIMOS by Surgold within 2 months of Project approval) will include this information.

15.7.3 Schedule

The Water Management Plan does not currently provide specific information regarding a schedule for water monitoring programs. The more comprehensive Environmental and Social Monitoring Plan (to be provided to NIMOS by Surgold within 2 months of Project approval) will be implemented to coincide with construction and operational activities of the project.

Volume IV
Appendix IV-A

Table of Commitments

1 ANNEX IV-A – TABLE OF COMMITTMENTS

Table 1.1 Merian ESIA Table of Commitments

Type of Commitment	Description of Commitment	Reference of Commitment
Governance Commitments		
Surinamese Laws and Regulations	Surgold is committed to complying with the laws and regulations of Suriname at the time of project permitting. The legal framework for national environmental management are detailed in Table 2-3 of the ESIA which summarizes the legal framework for the management of mineral resources, land and land use, air quality and noise, water and maritime issues, natural ecosystems, cultural heritage, occupational health and safety and public health. In addition Surgold will comply with all requirements stated within the Mineral Agreement agreed with the Government of Suriname.	ESIA - Chapter 2 (2.1 and 2.2)
International Standards	The Project will be developed in a manner consistent with all relevant international agreements and treaties to which Suriname is signatory at the time of project permitting.	ESIA - Chapter 2 (2.1.1)
	The Project will use industry good practice as resources for social and environmental risk management. This will include the IFC ESH General Guidelines, the IFC EHS Guidelines for Mining, and the International Cyanide Management Institute's (ICMI) Cyanide Code, and adherence to the Voluntary Principles on Human Rights and Security, and the Workers' Accommodations Processes and Standards Guidance Note published by the IFC and EBRD	ESIA - Chapter 2 (2.4)
International Standards	The Project will be consistent with the International Council of Mining & Metals (ICMM) 10 principles included within the ICMM Sustainable Development Principles including: implement and maintain ethical business practices and sound systems of corporate governance, integrate sustainable development considerations within the corporate decision-making process, uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by activities, implement risk management strategies based on valid data and sound science, seek continual improvement of health and safety performance, seek continual improvement of environmental performance, contribute to conservation of biodiversity and integrated approaches to land use planning, and facilitate and encourage responsible product design, use, re-use, recycling and disposal of products. This compliance will be achieved by using the guidance available in various ICMM good practice guidance.	ESIA - Chapter 2 (2.4.5)
	Surgold will aim to achieve compliance with ISO 14001 within three years of the start of operations and will complete annual appraisals thereafter.	ESIA ESMMP (3.3)
Corporate Standards	Surgold's Cyanide Management Standard requires Cyanide Code Certification of the Project within 36 months after mineral processing operations are commissioned.	ESIA - Chapter 2

Type of Commitment	Description of Commitment	Reference of Commitment
Corporate Standards	Surgold will adopt the Environmental and Social Responsibility (ESR) and health and safety standards, and the environment, social and health and safety policies of Newmont Mining Corporation for the purpose of developing the Merian Project. A summary of Newmont's Environmental and Social policies and standards is provided in Appendix 2-A. Corporate policies address such aspects as Air Quality Management, Water Management, Waste Rock Management, Tailings Management, Mercury management, Cyanide Management, Chemical Management, Hydrocarbon Management, Closure and Reclamation Planning, Social Baseline Studies, Social Impact Assessment, Stakeholder Mapping, Stakeholder Engagement, Expectation and Commitment Management, Complaints - Grievance Management, Monitoring and Evaluation, Local Community Investment, Security and Human Rights, , Management of Cultural and Heritage sites. Surgold will develop a series of Standard Operating Procedures (SOPs) and policies specific to the Merian site (as guided by Newmont ESR Policy and, Standards). This includes Environmental and Social Responsibility Policy, Complaint and Grievances Management and Resolution, Environmental and Social Management Plan Development and Update, Expectation and Commitment Register, HIV/AIDS Policy, Labor Recruitment Strategy and Selection Procedures, Developing a culture of safety and Internal and External Communication and Reporting. Surgold will adopt the Newmont performance requirements for assessing sustainability management and verify achievement with internal environmental standards and compliance with applicable laws.	ESIA - Chapter 2 (2.3)
Environmental and Social Management	The framework ESMMP included within the ESIA will be developed into a comprehensive Environmental and Social Management and Monitoring Plan (ESMMP) in a format deemed appropriate by Surgold as the Project moves into construction and Operations. It will be used by Surgold and the relevant contractors to minimize Project impacts. This will include further details specific to the Project regarding monitoring requirements and roles and responsibilities for Surgold and all relevant contractors.	ESIA ESMMP (1.0)
	The ESMMP and all relevant ESIA commitments will be adopted and applicable to contractors; all contracts will require that subcontractors follow all of Surgold's policies and procedures.	
	Surgold will audit and review the performance of subcontractors against these commitments and against the ESMMP developing corrective action measures as required	
Environmental and Social Monitoring, Auditing, Feedback & Adjustment Environmental	Surgold will develop and submit to NIMOS a detailed monitoring plan within two months of receiving Project approval through the granting of the Right of Exploitation.	ESIA ESMMP (1.3)
	ESR inspections will be conducted by representatives of the ESR team and will be reported to the Site Manager on a weekly basis or as specified in the ESMMP.	ESIA ESMMP (4.1)
	Surgold will develop, in partnership with local Pamaka stakeholders, a participatory community monitoring system. Participatory monitoring will require the establishment of a stakeholder participatory monitoring group that will collectively identify what will be monitored, how, by whom and how monitoring and indicators will be reported.	ESIA ESMMP (4.3)

Type of Commitment	Description of Commitment	Reference of Commitment
and Social Monitoring, Auditing, Feedback and Adjustment	Newmont3 - year basis for compliance with the ESI A commitments and Environmental and Social Standards and Health and Safety standards and policies. Audits to be conducted will also cover the contractor self-reported monitoring and inspection activities. The audit shall be performed by qualified staff and the results shall be communicated to the manager and related executive management.	ESIA ESMMP (4.4)
	Surgold will implement a formal non-compliance and corrective action tracking procedure for investigating cause and identifying corrective actions in response to accidents or environmental or social non-compliances. Where corrective actions are deemed necessary, specific plans (with designated responsibility and timing) will be developed to achieve continuous improvement in performance. Surgold will also develop Key Performance Indicators (KPIs), aimed at driving continuous improvements in performance.	
	Surgold will develop an ESMMP change management process that outlines how changes to the ESMMP will be identified, approved, and implemented.	ESIA ESMMP (4.7)
	The Project will be audited and certified as being in compliance with the Cyanide Code no less than every three years.	Cyanide Management Plan - ESMMP, Chapter 13
Organizational Structure and Staffing	Surgold will appoint suitably trained, skilled and experienced staff to implement the ESMMP including personnel responsible for health and safety, human resources, logistics, security, and emergency response. These staff members will be competent on the basis of appropriate education, training, and experience. The Surgold organization will be staffed at a level to allow for continuous effective supervision of contractor activities and work products.	ESIA ESMMP (3.2)
Training and Awareness Raising	Surgold will identify, plan, monitor, and record training needs for personnel whose work may have a significant adverse impact upon the environment or social conditions or who have responsibilities with respect to ESR commitments. A formal training and a training refresher process will be developed and implemented to address ESR and Health, Safety and Loss Prevention (HSLP) policies and procedures.	ESIA ESMMP (3.3)
	ESR Training will be undertaken prior to the beginning of large scale field activities and should be conducted as quickly as is feasible. Surgold will provide ESR and health and safety training to all employees and contractors that will be working on-site to assure that environmental, social and health and safety practices meet Surgold requirements.	
ESR Documentation	Surgold will control ESR documentation, including management plans; associated procedures; and checklists, forms and reports, through a formal procedure. The document control procedure will describe the processes that the Project will employ for official communication of both hardcopy and electronic document deliverables. In addition, it will describe the requirement for electronic filing and posting and for assignment of document tracking and control numbers (including revision codes). The documentation system will include a process to manage the revision of documents.	ESIA ESMMP (3.5)
	Contractors will be required to meet the requirements of Surgold, either through directly adopting the Surgold plans or by developing an acceptable system for maintaining and controlling their own ESR documentation and describing these systems in their respective ESR plans. These plans shall meet all the requirements of this ESMMP and will be reviewed, audited and signed off by the Surgold ESR Manager.	

Type of Commitment	Description of Commitment	Reference of Commitment
Emergency Preparedness and Response	Surgold will develop an overall Emergency Response and Preparedness Plan that will include procedures to identify the potential for and response to environmental accidents and health and safety emergency situations (e.g. fire, oil spillage, traffic accidents etc.). The plan will take into account environmental and social impacts of potential emergencies.	ESIA ESMMP (3.6)
	Emergency exercises will be undertaken on a regular basis to confirm adequacy of response strategies. Investigations of accidents or incidents will follow formal documented procedures.	
	The Emergency Response Plan will include adequate communication systems with health facilities and other stakeholders	
	Emergency response plans will adhere to guidance provided by the ICMI where possible	Cyanide Management Plan - ESIA ESMMP, Chapter 13 (13.3.6)
Engagement, Communication, Reporting and Feedback	Throughout the life of the Project, Surgold will keep relevant authorities informed of the project performance with respect to Environment and Social matters by way of written status reports and face-to-face meetings as required. In addition to regular reporting, official notification shall be made for any of the following: significant modifications to the Project Design or significant implementation changes.	ESIA ESMMP (4.6)
	An annual Environmental and Social Management and Monitoring Plan report will be compiled that reports the results of the years monitoring, audits, reviews and changes to specific ESMMP sub plans.	
	Surgold will establish through consultation with stakeholders (including local Pamaka communities) the preferred mechanism to deliver regular reporting to stakeholder groups regarding results of environmental and social monitoring.	
	Contractors will also be required to provide ESR and HSLP performance reporting as relevant based on the contractor's responsibilities. Reporting will be required to Surgold on a regular basis.	
Air Quality and Greenhouse Gas Emissions		
Minimization of Disturbed Areas	Conduct concurrent reclamation to reduce the area of disturbance throughout the mine life.	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)
Fuel Selection	Use of a Heavy Fuel Oil (HFO) power plant compliant with IFC high efficiency (40-45%) and greenhouse guidance for HFO-fired thermal power plants (reciprocating engines).	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)
	Use of low sulfur fuel for the HFO power plant, as per the IFC guidelines.	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)
Energy Conservation	Implement relevant energy conservation measures at the process plant.	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)
Equipment Selection	Use of mine equipment (drills, excavators, dump trucks, dozers, etc.) with high efficiency non-road diesel engines (> Tier 2 engines).	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)

Type of Commitment	Description of Commitment	Reference of Commitment
Power Plant Design	The power plant will be designed such that emissions meet those recommended in the IFC EHS Guidelines for Thermal Power Plants (2008). Sulfur emissions (SOx) will be controlled through the use of low-sulfur fuel. Nitrogen oxide emissions (NOx) will be controlled through the tuning of the engines' fuel-air mix during start-up. Particulate matter (PM) controls are currently being designed based on laboratory analysis of the fuel that will be supplied to the Project. Additional control technology will be employed as needed to achieve IFC emission criteria.	ESIA Chapter 3, Section 3.4.1
Equipment Inspection	All contractors on site will be required to undertake regular inspection and maintenance of all vehicles and construction equipment in accordance with manufacturer's specifications (for air quality, safety, noise and vibration).	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)
Dust Suppression	Dust suppression of disturbed surfaces such as mine haul roads, stockpile area, and material transfer points during dry, low humidity, and windy conditions if required to meet ambient air quality limits.	
	Rotate spigoting of tailings to maintain moisture content and/or irrigate tailings surface to minimize dust generation	
	Implement corrective actions for reducing point source dust sources if monitoring demonstrates the need for additional controls.	ESIA ESMMP (7.5)
Dust Monitoring	Perform daily visible dust emission checks on all active mine haul roads, stockpiles, and material transfer points.	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)
Stabilization of Disturbed Areas	Reclaim, revegetate or stabilize disturbed areas as they become available.	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)
Waste Management	Implement a solid waste management plan to effectively manage waste and meet IFC guidelines.	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)
Air Quality Monitoring	During power plant operations indicative monitoring devices of SOx, NOx and PM will be installed to monitor stack emissions.	ESIA Chapter 3 Section 3.4.1
	Implement an air quality monitoring program at the mine site during pre-production, operation, closure phases to monitor PM, NOx, and SO2	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-4)
	Annual stack testing (USEPA manual testing; not CEMs) will be performed for the following pollutants PM (USEPA method 5), SO2 (USEPA method 6c), and NOx (USEPA method 7e), CO (USEPA Method 10).	ESIA ESMMP (7.5)
Flora Monitoring	Monitor vegetation restoration efforts	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)
GHG Reporting	Quantify and report direct and indirect GHG emissions as per IFC requirements.	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 1-6)

Type of Commitment	Description of Commitment	Reference of Commitment
Noise		
Plant Design	The primary gyratory crusher will be enclosed in a concrete building on three sides, with the forth side partially open for access (including a roof over the top for rain protection).	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 7-8
	The power plant will be fully enclosed, with steel/foam sandwich panel walls and roof for noise abatement, insulation, and protection for the equipment.	
Vehicle Movements	Truck deliveries will be limited to day-time hours during pre-production, closure and post closure phases.	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 7-8)
Ground Vibration		
Blasting Limitation	Blasting will be limited to day-time hours during production phase.	ESIA - Chapter 25, Table 25-1 (Physical Impacts Summary Table: 9-11)
Traffic and Transportation Safety		
Industry Good Practice – Driving	Require licensing of drivers	ESIA – Chapter 20, Section 20.2.2
	Adopt limits for trip duration and arranging driver rosters to avoid fatigue.	
	Avoid dangerous routes and times of day to reduce the risk of accidents	
	Require drivers to follow speed limits and implement speed monitoring	
	Require contractors and subcontractors to adhere to Surgold driving standards to contractors and subcontractors	
Traffic Management	Develop a Traffic Management Plan that: i) identifies the key traffic-related accident hotspots or high risk areas (e.g.; key road crossings with the transportation road) and proposed locally-relevant and effective protective measures; ii) ensures Project work sites and areas are clearly marked with appropriate signage and barricades (particularly if work activities extend through the evenings); iii) promotes a safety culture at work particularly among workers with limited prior H&S awareness to reduce risk of accidents and injuries associated with construction activities. iv) enforces local speed limits; monitoring driving speeds and implementing corrective / disciplinary measures for drivers who are recorded speeding. v) assures that contractors use transportation vehicles and tanks suitable for the materials and transportation routes used and maintained in adequate condition to ensure proper handling and safety of chemicals. vi) assures chemical transportation will require compliance with applicable laws as well as Surgold standards and will require responsible management of chemicals including emergency response and spill clean-up. vii) assures appropriate tracking of transport vehicles and personnel viii) considers and manages driver fatigue ix) has adequate driver training for both Surgold and contractors	ESIA – Chapter 23, Section 23.10.3 ESIA ESMMP Chapter 9 Table 9.5 ESIA ESMMP (11.3.5)(SPCC) ESIA ESMMP (11.3.5) (SPCC) ESIA ESMMP (11.3.5) (SPCC) ESIA ESMMP Chapter 9 Table 9.6 ESIAESMMP Chapter 9 Table 9.6

Type of Commitment	Description of Commitment	Reference of Commitment
	Adopt a policy where drivers and contractors will not stop for unplanned/unauthorized breaks on the journey	
	Include safety precautions in contracts with subcontractors, including substantial penalties for violation of traffic laws and safety procedures, especially speed limits and public road signage (e.g., stop signs)	
Community Awareness	Conduct community consultations along the Transportation Corridor prior to commencement of deliveries for operations to explain the transportation of materials, identify potential high risk areas and incorporate community concerns.	ESIA – Chapter 23, Section 23.10.3
	Before activities that increase Project traffic, inform communities regarding construction activities and present relevant safety signage and advice.	ESIA – Chapter 23, Section 23.10.3
	Engage with communities along the Transport Road corridor to raise awareness on road safety and accident prevention.	ESIA – Chapter 23, Section 23.10.3
	Identify local/regional/national first responders and discuss potential coordination needs to ensure first aid and emergency medical response is provided in the event of accidents.	ESIA – Chapter 23, Section 23.10.3
Community Awareness	Community Awareness and Coordination on Public Safety topics included as part of Project's engagement plans	ESIA ESMMP Chapter 9 Table 9.1
Fuel Delivery	As practicable, fuel will be delivered in caravans to reduce distribution of increased truck traffic.	ESIA – Chapter 25, Table 25-1 (Physical Impacts Summary Table: 9-11)
Spill Response	Drivers will be trained in spill and emergency response and will have a means of communicating with the site, their administrative offices and emergency personnel for the entire transportation route.	ESIA ESMMP (11.3.5) (SPCC)
Incident and Accident Reporting	All drivers will report any incidents, altercations or accidents to the Contractor Manager immediately	ESIA ESMMP Chapter 9 Table 9.6
Land Use and Disturbance		
Site Access Control	Controlled access will be consistent with the right of exploitation, and would not prevent permitted use of adjacent lands.	ESIA – Chapter 25, Table 25-1 (Physical Impacts Summary Table: 13-14)
Disturbed Areas	Restore disturbed areas within the Project area as part of mine closure	ESIA – Chapter 25, Table 25-1 (Physical Impacts Summary Table: 13-14)
	Support OGS in their programs to improve ASM practices	
	As possible, reconfigure abandoned ASM sites within controlled access area to return streams to a more natural hydrologic regime to enhance natural reclamation	
Landscape and Soils		
Contaminated Soils	Any contaminated soil will be stored in a compacted containment cell.	ESIA – Chapter 25, Table 25-1 (Physical Impacts Summary Table: 15-18)
Soil Compaction	Deep rip compacted areas that are no longer in use.	ESIA – Chapter 25, Table 25-1 (Physical Impacts Summary Table: 15-18)

Type of Commitment	Description of Commitment	Reference of Commitment
Sediment and Erosion Control	Develop and implement a Sediment and Erosion Control Plan with soil erosion, storm water runoff, and sedimentation control measures	ESIA – Chapter 25, Table 25-1 (Physical Impacts Summary Table: 15-18)
Surface and Ground Water Resources		
Spill Prevention and Control	Manage the transportation, handling and storage of fuels, reagents, and other chemicals in accordance with a Spill Prevention, Control and Countermeasures (SPCC) Plan (see more detailed discussion of SPCC Plan under "Spill Prevention, Control and Countermeasures" section below).	ESIA - Chapter 25, Table 25-1 Physical Impacts Summary Table: 19. ESIA ESMMP Chapter 11
Sanitary Sewage Management	Provide treatment for Pre-Production phase sanitary sewage prior to discharge to A3 Creek. Pioneer Camp, Operations Camp and Process Plant will each be equipped with a sewage treatment plant that will produce an effluent that adheres to Project EDC effluent discharge standards for sewage.	ESIA - Chapter 25, Table 25-1 Physical Impacts Summary Table: 20
Erosion and Sediment Control	Implement an Erosion and Sediment Control (ESC) Plan (a component of the Water Management Plan)to control soil erosion in Project disturbed areas, manage TSS concentrations in runoff discharges from Project disturbed areas to local surface waters, and control discharge flow rates to local streams. Erosion and sediment control to be achieved during initial construction of major earthworks and throughout the life of the Project using a combination of source controls, intermediate controls, perimeter controls and adaptive management.	ESIA - Chapter 25, Table 25-1 Physical Impacts Summary Table: 21, 22; ESIA ESMMP (Water Management Plan – Section 3.2.1); ESIA ESMMP (Water Management Plan – Erosion and Sediment Control Plan)
Erosion and Sediment Control	Implement ESC best management practices during construction of major earthworks, which may include: - Grading of haul roads and access to avoid creation of steep slopes - Construct roadway crossing of streams using ESC measures that provide stream bank stabilization, protect streambeds from damage, and minimize sediment loading from construction - Install roadway base and/or surfacing material on traffic bearing roadway surfaces and staging areas - Install storm-water conveyance channels parallel to roadways; channels should divert flow to a sediment pond; - Design cut and fill slopes to consider slope stability and minimize erosion - Use source controls for temporary soils and other material stockpiles to minimize erosion - Use source controls and intermediate controls when constructing dams for TSF, TWSR, and sediment ponds to minimize erosion and sediment laden runoff - Use source control measures (e.g., benching) in active WRD areas and vegetate WRD faces when inactive for an extended period of time. Route WRD runoff to sediment ponds via ditches or other conveyances. - Grade around perimeter of mine pits to divert surface runoff away from pits; route pit dewatering flows to sediment ponds via ditches or other conveyances	ESIA ESMMP (Water Management Plan – Section 3.2.1); ESIA ESMMP (Water Management Plan – Erosion and Sediment Control Plan -Chapter 2)

Type of Commitment	Description of Commitment	Reference of Commitment
Erosion and Sediment Control	Implement ESC source controls to address erosion at the source. Source controls include such measures as run-on diversion dikes and swales, grading, benching, and contouring of slopes, use of silt fencing, and slope stabilization/seeding.	ESIA ESMMP (Water Management Plan – Section 3.2.1); ESIA ESMMP (Water Management Plan – Erosion and Sediment Control Plan -Chapter 3)
Erosion and Sediment Control	Implement ESC intermediate controls to capture sediment and promote settling of coarser sediments. Intermediate controls may include such measures as check dams, sediment traps and designed conveyance channels.	ESIA ESMMP (Water Management Plan – Section 3.2.1); ESIA ESMMP (Water Management Plan – Erosion and Sediment Control Plan -Chapter 4)
Erosion and Sediment Control	Implement ESC perimeter controls by constructing sediment ponds down-gradient of Project disturbed areas. Sediment ponds will be installed prior to major disturbance and will remain in place throughout the life of the mine. Sediment ponds are designed handle the 100-year, 24-hour storm event and to control peak flow discharges so that receiving water bodies are not eroded. to below preconstruction rates, and release minimum flows during low flow (dry) conditions to support downstream water needs. Sediment ponds are designed capture runoff flows with elevated sediment loadings and allow for settling of solids (aided by the additional of flocculants, as necessary, to adhere to the Project EDC TSS discharge criteria. Sediment ponds will remain in place and continue to operate until disturbed areas have been reclaimed and TSS concentrations in site runoff have dropped to baseline levels.	ESIA ESMMP (Water Management Plan – Section 3.2.1); ESIA ESMMP (Water Management Plan – Erosion and Sediment Control Plan -Chapter 5)
Erosion and Sediment Control	Implement ESC-related adaptive management as described in the ESC Plan (and in accordance with the Water Management Plan), including inspection and maintenance of source, intermediate and perimeter controls, implementation of other ESC controls (as needed), and sediment pond discharge flow and water quality monitoring and reporting.	ESIA ESMMP (Water Management Plan – Section 3.2.1); ESIA ESMMP (Water Management Plan – Erosion and Sediment Control Plan -Chapter 6)
Management of WRD and Mine Pit Waters	Manage potential WRD- and mine pit-related impacts to surface waters and groundwater by implementing an adaptive Water Management Plan that includes: - Routing of pit dewatering flows to sediment ponds to promote settling of solids (aided by flocculants, if required); - Routing of runoff from WRD areas to sediment ponds to promote settling of solids; - Implementation of water quality monitoring at sediment pond discharge locations, downstream monitoring locations and compliance points to assure compliance;.	ESIA - Chapter 25, Table 25-1 Physical Impacts Summary Table: 25a; ESIA ESMMP (Water Management Plan – Section 3.2.3 and Section 4.0)

Type of Commitment	Description of Commitment	Reference of Commitment
Management of Process Plant and TSF Waters	Manage potential TSF-related impacts to surface waters and groundwater by implementing an adaptive Water Management Plan that includes: - Treat tailings from the Process Plant prior to discharge to the TSF by means of a CCD circuit and / or cyanide destruction units to meet Cyanide Code requirements; - Maintain TSF pond surface area large enough to promote natural degradation of cyanide - Treat excess water from TSF so EDC criteria are met at downstream compliance points; At end of mining WTP will continue to operate until TSF water can be discharged and meet EDC at compliance points - Installation of seepage collection and recovery systems to capture TSF seepage and return it to the TSF pond; At end of mining, continue to operate seepage collection system until monitoring indicates that seepage collection is no longer required to meet EDC criteria at compliance points;	ESIA - Chapter 25, Table 25-1 Physical Impacts Summary Table: 23, 24; ESIA ESMMP (Water Management Plan – Section 3.2.3 and Section 4.0)
Water-Related Monitoring	Implement monitoring, adaptive management and reporting programs as described generally in the Water Management Plan (Section 4.0) and the ESMMP (Section 15.2.3). Monitoring programs will be described in greater detail in a detailed monitoring plan, which will to be submitted to NIMOS within 2 months of granting of Right of Exploitation	ESIA ESMMP (15.2.3); ESIA ESMMP (Water Management Plan – Section 4.0)
Terrestrial Habitats		
Rehabilitation and Restoration	Update rehabilitation and restoration plans during operations in preparation for the closure phase.	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 1-8)
Vegetation and Habitat Management	Minimize cleared width of roads and temporary work camp site, while considering worker safety. Avoid known areas of high vegetation diversity (e.g.,; M6). Survey road routes prior to construction to avoid mature special-status species (e.g.; M6).	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 1-8)
Dust Management	Implement dust control program to minimize dust deposition on “edge” vegetation and respiratory impacts on wildlife	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 1-8)
Wildlife Management	Enforce speed limits on Project roads.	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 1-8)
Wildlife Management	Schedule shift changes and transportation schedules to minimize night driving.	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 1-8)
Rehabilitation and Restoration	Prior to clearing, collect and transplant Species of Concern (SOC) seedlings to areas of similar habitat that will not be impacted by the Project.	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 1-8)
Vegetation and Habitat Management	Create and implement vegetation removal plan to minimize disturbance	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 1-8)

Type of Commitment	Description of Commitment	Reference of Commitment
Wildlife Management	Conduct a pre- timber harvest/construction survey and relocate listed herpetiles (*Anomaloglossus surinamensis* and *Atelopus hoogmoedi Nassau*) to areas with similar habitats to the collection site that will not be impacted by the Project	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 1-8)
	During Operations and Closure, rescue animals trapped in pits and/or TSF if possible (consistent with maintaining staff safety).	
	Prohibit hunting by Project staff and contractors, and enforce this prohibition through staff training programs and patrols if necessary.	
Aquatic Habitat		
Sediment Dam Locations	Locate sediment dams on all impacted streams downstream of project activities, and manage Project-site runoff to meet Project EDC discharge criteria at compliance points. Apply BMPs during early construction prior to construction of sediment dams	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 9-18)
Aquatic Habitat Management	Treat sewage to meet Project EDC effluent discharge standards prior to discharge (see commitments under Surface Water Resources for further details).	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 9-18)
Water Quality Management	Remove or breach sediment dams during operations or closure, depending on phasing of Project to allow streams to return to more natural hydrologic conditions.	
	Implement ESC perimeter controls by constructing sediment ponds downgradient of Project disturbed areas in order to achieve Project EDC TSS discharge criteria released water should be released into Merian creek headwater tributaries(see commitments under Surface Water Resources for further details).	ESIA – Chapter 25, Table 25-2 Biological Impacts Summary Table: 9-18)
Waste Management		
Waste Hierarchy	Surgold will seek to comply with the preferred waste hierarchy where possible: • Avoid or minimize generation of hazardous and non-hazardous wastes; • Recover and reuse waste materials where possible; • Treat, destroy and or dispose of un-recoverable and un-reusable waste in an environmentally sound manner; • Consider the use of less hazardous substitutes for hazardous materials where possible; and • Observe the tenets of the Basal Convention on the Control of Trans boundary Movement of Hazardous Waste.	ESIA ESMMP (10.3.1)
Waste Management Plan	Surgold will develop and implement a detailed waste management plan that will include: • hydrocarbon contaminated soils procedure including criteria to determine required treatment • Process and Product review and revisions of the WMP based on process plant and mine operating conditions • Requirements for inspection and observation of waste disposal methods and documentation • The maintenance of a hazardous waste register	ESIA ESMMP Table 10-2

Type of Commitment	Description of Commitment	Reference of Commitment
Waste Management Training	Surgold will train all personnel on site regarding waste management during induction training, this will be recorded and documented	ESIA ESMMP Table 10-2
Waste Management	Hazardous solid waste generated at Merian will be collected and transferred to a central storage area on-site for temporary storage. The waste will then be transferred from the site to a facility appropriate for disposal. A reputable, qualified contractor will be hired to handle final disposal of recyclable and saleable waste.	ESIA ESMMP (10.3.1)
Waste Management	Hazardous waste generated during the Pre-Production and Operation phases will be temporarily stored on-site in a facility with secondary containment and then disposed of by a qualified contractor.	ESIA ESMMP Section 10.3.2, Table 10-1
	Oils and lubricants will be reused or otherwise returned to the supplier for recycling or sent to a reputable recycling facility through a trading company authorized to handle recyclable materials.	
	Hydro-carbon impacted soil (as determined by visual or olfactory cues) will be treated on-site (i.e. biopile or lined cell).	
	Waste lubricants from service vehicles and mobile or stationary equipment including generators and pumps, will be collected and stored in bulk waste oil tanks with specified controls (e.g. secondary containment). Waste will be backhauled to Paramaribo for recycling. Lubricant supplier will provide this service, including the management of used and crushed filters. Filters will be collected and crushed to extract remaining oil. Crushed filters will be transported to Paramaribo for disposal by carriers qualified to handle and transport waste. Waste lubricants could potentially be blended with diesel fuel and burned in the regeneration kilns / elution heaters – however this approach is still to be discussed with vendors.	ESIA ESMMP Section 10.3.2, Table 10-1
	Waste paints and solvents will be collected, stored and likely transported to Paramaribo for proper disposal. If appropriate disposal is not available in Suriname, materials will be back-hauled to the USA for proper disposal.	
	Electronic and Electrical Equipment: Recycling options available in Suriname (Recomsur) will be used, though backhauling of waste may also be needed if in-country services are not able to meet international guidelines.	
	Waste Lamps: Contracts will be tendered and developed to collect these from site and dispose in Paramaribo, or to be managed at site using appropriate equipment (e.g. Bulb Crusher) for collection of mercury.	
	Tires will be recapped if possible. If recapping is not possible reuse in retaining wall construction where possible and finally the tires will be landfilled on site if re-use is not possible	
	Broken Parts/ used air filters/ etc. will be backhauled for manufacturer rebuild/ core charge recovery where possible. Recyclable materials - backhaul to Paramaribo for steel recycling. Non-recyclable, non rebuildable waste such as paper/rubber air filters - landfill on site.	
	Redundant equipment will be salvaged on site as possible or recycled for materials in Paramaribo	
Waste Management	Recyclable Material will be segregated, collected and recycled per current site practice - plastic bottles, paper, steel etc.	

Type of Commitment	Description of Commitment	Reference of Commitment
	Merian will provide awareness programs on the negative effects of feeding wildlife to all personnel on site. Dedicated steel bins for the collection of food waste and packaging will be provided where people eat including the kitchen, offices and common areas. Food waste and other non-recyclable domestic waste will be collected, stored in dumpsters and transported to the landfill on site.	
	Dry cell general batteries will be collected in specific containers in offices and common rooms. These will be collected occasionally, stored at the HWTA and backhauled for recycling/ safe disposal in Paramaribo. Waste lead-acid batters and rechargeable batteries will be temporarily stored in metal containers at the HWTA and backhauled for safe disposal in Paramaribo. Facilities also exist in Trinidad.	
	All medical waste will be stored in specific containers and labeled as "BioHazard." These will be backhauled for incineration in Paramaribo using an identified approved medical waste incineration facility in Suriname.	
	All waste wood products will be collected in a designated wood waste depot. Reuse wood packing material / crates will be identified where possible for preparation of backhaul materials. Any material not consumed by local communities will be landfilled or burned.	ESIA ESMMP Section 10.3.2, Table 10-1
	Batch plant will have pre-cast form work ready at all times for items such as curbs and light standards. Any unused partial loads will be used for pre-cast items. Any wash residue or cleanup waste will be allowed to settle, harden, and will be landfilled.	
	Reagent bags will be used for shipping Lime, Carbon, and certain other reagents, in large quantities. These bags will likely contain some reagent residue. Since washing and reuse would not be practical, and the bags are not designed for durability and reliable re-use, these bags will be landfilled or burned.	
	Emergency supplies of sodium cyanide will be provided in crates and bags. As recommended within the Cyanide Code these will be rinsed and burned or otherwise correctly disposed of.	
	Sewage Sludge will be landfilled on site, within the confines of the future TSF as for construction. Once the TSF dams are in place and collecting runoff, any effluent will be treated in the TSF effluent treatment process prior to discharge to the environment. Investigations will be undertaken for the potential to use sludge for reclamation after composting (with wood waste or other).	
Waste Management	Waste Storage containers in the Waste Transfer Facility will be clearly labeled and delineated. Containers will be appropriate to the waste streams to protect the environment and human health. Wastes will not be mixed.	ESIA ESMMP (10.3.2)
	Hazardous materials will be stored within a designated area of the Waste Transfer facility. The Hazardous Waste Transfer Area will be fenced, signed, lit. The area will be built on a concrete pad and designed with secondary containment to control hazardous liquids in the case of a spill. Hazardous wastes will be segregated and stored in containers compatible with the waste.	ESIA ESMMP (10.3.2) (Waste Infrastructure)

Type of Commitment	Description of Commitment	Reference of Commitment
	A hazardous waste register will be maintained by each contractor or ESR as applicable and will include: • Name and identification of the materials composing the waste; • Physical state of the waste; • Quantity; • Waste shipment tracking documentation including quantity, type, date dispatched, date transported, date received, record of the originator, transporter and receiver; • Method and date of storing/repacking/treating or disposing at the HWTA; and • Location of each hazardous waste at the facility.	
	Landfill wastes will not be mixed with the waste rock, but the landfill will be operated until it reaches capacity and then capped with saprolite and overlain by waste rock. Landfills will be constructed within the footprint of future WRDs.	
	An area near the Waste Transfer Station will be identified as the waste-wood depot. This area will be signed and designed such that if community members are interested in salvaging waste wood safe, controlled access can be provided by the Project as necessary.	
		ESIA ESMMP (10.3.2) (Waste Infrastructure)
Review of third-party waste disposal practices	Surgold will review of third-party waste disposal sites, permits and license (if applicable)	ESIA ESMMP Table 10-2
	Audit of third-party hazardous waste disposal facility	
	Use of properly trained and certified (if necessary) transportation services or personnel for the transportation of any waste off-site including training of internal staff as necessary or review of transportation provider contracts to confirm requirements to follow Surgold standards	
Disturbed Areas	Progressively reclaim WRDs. Growth media will be used to cover the WRD faces to facilitate re-vegetation. Growth media includes saprolite and grubbed or felled vegetation. Once the growth media is placed, the available WRD face will be re-vegetated through hydro-seeding or other methods. The focus will be to return the vegetation communities as quickly as possible to a native plant community.	ESIA - Chapter 25, Table 25-2 Biological Impacts Summary Table: 9-18)
Bunded Runoff	Oil-water separators will treat runoff from bunded areas.	ESIA - Chapter 25, Table 25-2 Biological Impacts Summary Table: 9-18)
Reagent Storage	Reagent storage will be indoors.	ESIA - Chapter 25, Table 25-2 Biological Impacts Summary Table: 9-18)
Fuel and Reagent Storage	All fuel and reagents will be stored with secondary containment appropriate to the storage volumes	ESIA - Chapter 25, Table 25-2 Biological Impacts Summary Table: 9-18)

Type of Commitment	Description of Commitment	Reference of Commitment
Waste Monitoring	Surgold will measure and record the Project's performance related to: • Annual volume of hazardous waste generated by the Project; • Annual volumes of hazardous waste disposed of off –site but not recycled(i.e. no longer in temporary storage); • Annual volumes of hazardous waste recycled off-site; • Annual percent change of hazardous waste volume compared to previous year; • Annual volume of non-hazardous waste generated; • Annual volume of non-hazardous waste reused or recycled; • Annual volume of non-hazardous waste disposed of on-site; • Annual volume of non-hazardous waste disposed of off-site; • Annual volume of contaminated soils generated and treated on-site; • Annual percent change of volume of non-hazardous waste production compared to previous year; and • Volume of hazardous waste transported across international boundaries.	ESIA ESMMP (10.2.3)
Waste Reporting	Surgold will develop internal waste reports including: • Weekly inspections; • A monthly report to the Site Manager; • Monthly submissions of hazardous waste register from ESR department; and • Annual WMP report for input to the Annual ESMMP Report.	ESIA ESMMP (10.4)
Spill Prevention, Control and Countermeasures		
Emergency Response Planning	Surgold will Develop and implement an Operational Emergency Response Plan including components of the Cyanide Management Plan, a Hydrocarbons Management Plan and a Spill Prevention Control and Countermeasures (SPCC) Plan. This will be guided by industry good practice and the Project will comply with the IFC's EHS Guidelines as well as the International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the Production of Gold.	ESIA ESMMP Section 11
Hazardous Material Management	Surgold will conduct a hazardous materials risk assessment will also be conducted and a Hazardous Materials Management Plan developed	ESIA ESMMP Section 11

Type of Commitment	Description of Commitment	Reference of Commitment
Spill Response Plan	Surgold will develop, implement and review an operational SPCC Plan that: • documents and assessed the risk of spills occurring at the Merian gold project so as to institute procedures and actions to reduce the potential for those spills to occur; • states the principal of spill prevention, control and contingency • identifies a complete inventory of chemicals and hazardous materials stored on-site and analysis of spills • identifies on-site infrastructure required for prevention, control and response to spills • describes management measures, monitoring, reporting and documentation mechanisms for prevention and control of spills • describes the mechanism to identify potential issues or opportunities for improvement • maintains an updated list of all potential chemicals transported, handled or stored as part of the project. The SPCC Plan will include approximate volumes, storage and transfer locations and risks associated with each chemical • includes an up-to-date plan of the mine site showing the location of all contaminants, spill response kits and other response equipment • defines standard operation procedures for handling materials including refueling vehicles, refilling HFO and diesel tanks, delivering reagents, and managing secondary containment areas • defines standard operating procedures for chemical transportation, unloading, transfer, storage, handling, use and disposal shall be developed, kept current, effectively implemented by trained personnel • MSDS sheets for all contaminants on-site will be attached to the SPCC. These will include human health effects of chemicals handled at the Merian gold project and will be included in the required chemical environmental and safety training for all employees handling or otherwise exposed to the contaminants. All appropriate personal protective equipment, handling and response procedures identified in the MSDS sheets or otherwise recommended by the suppliers/manufacturers will be incorporated into the SPCC and followed by the Merian gold project.	ESIA ESMMP Chapter 11
Emergency Contact Information	Maintain and monitor all spill kits and ensure updated emergency contact information is available at all spill response locations;	ESIA ESMMP Chapter 11 Table 11-2
Spill Response Kits	Maintenance, monitoring and review of spill response kits on all project fuel and lubrication vehicles;	ESIA ESMMP Chapter 11 Table 11-2
	Maintenance of spill response guidelines at all spill response kit locations;	ESIA ESMMP Chapter 11
	Surgold will maintain availability of spill response equipment sufficient to handle a large spill;	
Preventative Maintenance Program	Institution of a preventative maintenance program including inspection schedules to confirm and maintain the mechanical integrity and operability of pressure tanks, piping systems, relief and vent values systems, containment infrastructure, shutdown systems, controls, pumps and associated process equipment.	ESIA ESMMP Chapter 11 Table 11-2

Type of Commitment	Description of Commitment	Reference of Commitment
First Aid Training	First aid training will be delivered to an appropriate number of staff	ESIA ESMMP Chapter 11 Table 11-2
Spill Response Training	Development, implementation and regular training and testing of a facility-wide spill response training plan;	ESIA ESMMP Chapter 11 Table 11-2
	Training of operators regarding proper methods for transporting, transferring and handling substances that have the potential impact to human health or the environment (including bulk transfers of chemicals).	
Bulk Chemical Handling Observation	Bulk transfers of chemicals during delivery will be observed by Surgold personnel trained in preliminary hazard analysis (PHA) methods.	ESIA ESMMP Chapter 11 Table 11-2
Spill Reporting	Surgold will develop SPCC reporting protocols as part of the SPCC Plan including: • Scheduled inspections; • Regular reporting by contractors regarding preventative maintenance programs; • Spill reporting at the time of the incident and monthly spill reporting developed by ESR department; • Bi-annual spill response drills; and • Annual reporting on training.	ESIA ESMMP Chapter 11 Section 11.4
Spill Prevention Infrastructure	Provision of secondary containment, drip trays or other overflow and drop containment measures, for hazardous materials containers at connection points or other possible overflow points. Identification and provision of all equipment necessary to handle, transfer or transport materials properly; use of transfer equipment that is compatible with and suitable for the characteristics of the materials transferred and designed to ensure safe transfer.	ESIA ESMMP Chapter 11
	Use of dripless hose connections for vehicle tank and fixed connections with storage tanks.	
	Installation of gauges on tanks to measure volume inside.	
Chemical Usage and Storage Review	Review of all potential pollutants characteristics prior to introduction to site and establishment of proper storage, handling and transportation procedures and spill risk analysis and an update to the SPCC as required. This will be reviewed as part of an appropriate audit schedule.	ESIA ESMMP Chapter 11
Personal Protective Equipment	Surgold will maintain and distribute specific personal protective equipment and training needed to respond to different potential spills;	ESIA ESMMP Chapter 11

Type of Commitment	Description of Commitment	Reference of Commitment
Spill Monitoring	Surgold will measure and record the Project's performance related to: • Monthly and annual volumes of materials transported and handled by the Project that could result in harm to human health or the environment in the event of an accident or spill; • Monthly and annual number of small spills occurring at the Project; • Monthly and annual number and volume of accidental small releases to the natural environment (including soils and water); • Annual and monthly number of major spills occurring at the Project; • Number of cyanide releases; • Number of hydrocarbon releases; • Number of chemical releases; • Number of other releases; • Number of employees trained in spill response (compared to number of employees working with or around contaminants); • Number of employees trained in first aid (compared to number of site personnel); • Number of employees trained in the safe and environmentally sustainable handling of chemicals on-site (compared to number of employees working with or around contaminants); and • Response time and methods used in drills compared to the SPCC and Spill Response Plan.	ESIA ESMMP (11.2.3)
Waste Rock Management		
Waste Rock Storage Design	Surgold will ensure all waste rock disposal facilities will be designed, constructed, closed and reclaimed to be geotechnically stable.	ESIA ESMMP Chapter 12
	Surgold will ensure that waste rock disposal facility design will be reviewed by a qualified engineer	
	Surgold will ensure that waste rock will be physically and geochemically characterized prior to design, and during operation, and closure and reclamation phases, including the entrainment of potential pollutants due to blasting	
Potential Acid Rock Determination	Surgold will ensure that all acid rock drainage (ARD) potential will be determined using the agreed upon Newmont acid-base accounting methodology	ESIA ESMMP Chapter 12
Waste Rock Management Plan	Surgold will develop implement and review a comprehensive Waste Rock Management Plan that: • Describes an on-site waste rock characterization program; • Describes a waste rock disposal plan; • Describes monitoring, reporting and documentation mechanisms for managing waste rock management at the Merian Gold Project; • Describes the mechanism to identify potential issues or opportunities for improvement; • Describes a waste rock sampling plan prior to generation of waste rock	ESIA ESMMP Chapter 12

Type of Commitment	Description of Commitment	Reference of Commitment
Waste Rock Monitoring	Surgold will measure and record the Project's performance related to: • Annual volume of waste rock delivered to each WRD; • Annual volume and tonnage of potentially-acid generating waste rock; • Annual number of geochemical characterization tests performed on waste rock; • Annual number of hectares of newly constructed waste rock disposal areas; • Annual number of hectares of waste rock disposal areas at which reclamation has begun; • Number of geotechnical inspections performed annually for evidence of slope instability and excessive erosion; • Number of waste rock slope failures large enough to require corrective action lasting more than one day or that release waste rock to surface water; and • Estimates of volume of waste rock seepage water managed and treated as indicated by observations.	ESIA ESMMP Chapter 12 Section 12.2.3
Waste Rock Tracking	A waste rock and ore tracking system will be developed so that the Project has an accurate accounting of volumes of waste rock disposed of at each WRD and the characteristics of the waste rock within each WRD.	ESIA ESMMP Chapter 12 Section 12.3.3
Concurrent WRD Reclamation	A Concurrent Waste Rock Reclamation program will be developed based on goals and objectives of the detailed Closure and Reclamation Plan. The Concurrent Waste Rock program will be updated quarterly as WRD configurations change and are updated. The KPIs and objectives of the concurrent waste rock reclamation program will be based on those developed in the completed Closure and Reclamation Plan.	ESIA ESMMP Chapter 12 Section 12.3.4
Potentially Acid Generating Rock Management	Development of relevant management measures for waste rock to confirm it is not acid generating	ESIA ESMMP Chapter 12
WRD Monitoring	Surgold will conduct geotechnical inspections and inspections of runoff and run on controls for signs of significant instability, erosion, subsidence, especially after heavy rain events	ESIA ESMMP Chapter 12, Table 12-3
Social and Community / Worker Health		

Type of Commitment	Description of Commitment	Reference of Commitment
Labor Recruitment Strategy and Selection Procedure for National Positions Operating Procedure	Surgold will develop, implement and review / monitor a Recruitment Policy that: • Establishes the criteria by which someone can be classified as from the Pamaka Area or from Suriname; • Specifically establishes a preferential hierarchy for employment of people first from the Pamaka Area, then from Suriname and finally from elsewhere in the World; • Specifies a commitment to advertise all positions within the Pamaka Area (where relevant to local skills), in Suriname (where relevant to national skills). • Sets the criteria by which a department must demonstrate they have sought to identify primarily Pamaka and secondarily Surinamese candidates prior to employing non-Pamaka Surinamese or foreign nationals for jobs that may reasonably be staffed from the local area or in Suriname; • Dictates the transparent hiring techniques to be advocated including; engagement and information dissemination in the Pamaka area that is required prior to hiring; the advertisement locations, methods, frequency, notice and language; and the specifics around how and when candidates can apply; • Specifies that workers should receive clear understandable information regarding their rights under national labor and employment laws including their rights related to hours of work, wages, overtime, compensation, and benefits upon beginning the working relationship and when any material changes occur; • Specifies that no unskilled or temporary hiring should occur in an informal or ad hoc manner that has not involved liaison with or review of a Pamaka Human Resources Database and Surgold; and • In alignment with the laws of Suriname specifies that workers are allowed to form unions.	ESIA ESMMP, Chapter 6 (Social Management Plan)
Procurement Policy	Develop and Implement a Procurement Policy that: • Specifically establishes a preferential hierarchy for qualified suppliers and service providers, where available (and relevant to local capabilities) to be procured first from the Pamaka Area, then from Suriname (where relevant to national capabilities) and finally from elsewhere in the world; • Requires all contractors and service providers to comply with Surgold ESR, labor and health and safety standards; • Establishes a requirement to assess the risk or safety issues, child or forced labor within the supply chain and remedy where appropriate; • Specifies a commitment to advertise all required procurement of goods and services within first the Pamaka Area (where relevant to local capabilities), then Suriname (where relevant to national capabilities)and finally from elsewhere in the World; and • Dictates the transparent techniques for procurement of goods and services including; engagement and information dissemination in the Pamaka area that is required prior to procurement of goods and services; the advertisement locations, methods, frequency, notice and language; and the specifics around how and when candidates can apply.	ESIA ESMMP, Chapter 6 (Social Management Plan)

Type of Commitment	Description of Commitment	Reference of Commitment
Worker Code of Conduct	Develop a Worker Code of Conduct that: • Establishes zero tolerance controls on illegal narcotic substances and alcohol in camp policy (none brought onto camp, only sold and consumed on designated days in designated places); • Establishes criteria for behavior at work (non-discrimination, non-violence etc.); • Establishes closed camp policy with controls on visitors and unauthorized departures from camp; and • Establishes the required behavior and standards when engaging stakeholders and upon chance finds; • Establishes limits on visits to Pamaka area for those not on official Surgold business.	ESIA ESMMP, Chapter 6 (Social Management Plan)
Closure Planning	Develop a Social component to the Closure Program that: • Establishes the manner in which Surgold will manage the potential impacts during closure and post-closure including retrenchment of employees; • Identifies any potential alternatives to retrenchment; • Contains commitments to provide all workers with suitable notice of dismissal and severance payments mandated by law and collective agreements in a timely manner including social benefits and pension payments where relevant; • Contains provision to engage and coordinate with Suralco and the GoS where possible, regarding potential new opportunities and employment requirements at other projects such as the Nassau Plateau Operations during the Merian closure / post-closure process; • Establishes the participatory processes and engagement with stakeholders during closure planning; • Establishes the review and update process for the closure plan; • Establishes objectives, targets and monitoring requirements; • Establishes draft closure costs; and • Establishes potential community uses of infrastructure after decommissioning and relinquishment.	ESIA ESMMP, Chapter 6 (Social Management Plan)
Pamaka Human Resources Database	Develop and update a Human Resources database to record local interest, skills and education that: • records the names, contact details, education and skills of interested candidates; • records the eligibility of Pamaka ethnic status; and • establishes the update schedule and process.	ESIA ESMMP, Chapter 6 (Social Management Plan)

Type of Commitment	Description of Commitment	Reference of Commitment
Stakeholder Engagement Strategy	Develop and implement a Stakeholder Engagement Strategy that sets out the short, medium and longer term objectives and methods for stakeholder engagement throughout the LoM and that: • establishes a requirement for ongoing update of a stakeholder map and database as the basis of engagement activities; • establishes the process and form for recording all engagement activities including engagement undertake by Surgold employees outside of the ESR department; • establishes the medium to long term engagement objectives, standards, methods and program for the Merian Project; • establishes the schedule for review and update of the SES and stakeholder mapping; • explicitly states the engagement objectives, standards, methods and program for ASM related stakeholders. • explicitly states the schedule and topics to engage ASM related stakeholders on including Surgold land use and area of expansion or exploration, Surgold reclamation schedule and processes, Surgold relinquishment of areas of the exploration concession, Surgold safety and security measures, • explicitly states the schedule and topics to engage different stakeholder groups on potentially including Surgold current and planned work, the mining lifecycle, the monitoring and ESMMP implementation process, the Mineral Agreement, Community Investment planning and progress, areas of forest clearing, local procurement, expectations and commitments registers, training and capacity development, and employment and feedback mechanism; • establishes the schedule and frequency of meetings with key stakeholder groups such as the traditional authority, wider community members, potential community investment partners, government regulators, Community Based Organizations etc.; • establishes differentiated measures for the participation of disadvantaged or vulnerable stakeholders; • establishes the details and methods for further culturally appropriate engagement surrounding the feedback mechanism; and • establishes the details and methods for engagement with representative community groups.	ESIA ESMMP, Chapter 6 (Social Management Plan)
HIV/AIDS Policy	Develops a HIV AIDS Policy that: • Provides a clear statement about non-discrimination, in particular non-discrimination based on HIV and on gender; • Establishes procedures for addressing HIV/AIDS issues in the workplace , including no mandatory HIV screening of workers or job applicants, ensuring strict confidentiality related to HIV testing and HIV status of worker, ensuring no dismissal of workers due to HIV, providing for prevention and protection of workers living with HIV against harassment, providing education and awareness raising services to workers, providing psycho social support and counseling for workers and their families living with HIV; and • Establishes the condition for engagement with the Ministry of Health (MOH) National AIDS Program (NAP) where possible.	ESIA ESMMP, Chapter 6 (Social Management Plan)

Type of Commitment	Description of Commitment	Reference of Commitment
Community Investment Planning	Develop and implement a Policy/plan that sets out the conditions in which Surgold will provide Community Investment and that:: • Establishes the requirement for a participatory needs assessment conducted by qualified person(s); (ideally and independent expert) as a fundamental part of community investment planning; • Establishes the targeted percentage breakdown of community investment funds for each geography; • Establishes the preference and methods for producing post-closure duplication of funds as a critical component of succession planning; • Establishes the timeframe and process, stakeholder participation, and accountability, transparency and monitoring of community investment spending. • Establishes a program of community capacity development prior to large scale community investment; and • Establishes the preference for sustainable community investment in project not reliant on Surgold for on-going upkeep.	
Community Feedback Mechanism	Establish a community feedback mechanism that: • is an understandable and transparent process; • is scaled appropriately to risks and impacts • is culturally appropriate and readily accessible to all segments of the population; • has no cost implications and is without retribution; and has no impediment to judicial or administrative remedies • outlines the objectives, methods and engagement schedule surrounding a community feedback mechanism; • establishes the practicalities for management and monitoring of feedback including roles and responsibilities; and • establishes the conditions for dissemination of information and popularizing the community feedback mechanism.	ESIA ESMMP, Chapter 6 (Social Management Plan)
Worker Feedback Mechanism	Establish a Worker Feedback mechanism that: • establishes the objectives, methods and engagement schedule surrounding a worker feedback mechanism; • establishes the requirement for the process to be confidential, transparent, timely, without retribution, or impede access to other judicial or administrative remedies or substitute for feedback mechanisms provided through collective agreements; and • provides details of workers access to a psychologist to address any psycho-social issues and mental stress in a confidential manner.	ESIA ESMMP, Chapter 6 (Social Management Plan)

Type of Commitment	Description of Commitment	Reference of Commitment
ASM Policy and Strategy	Establish an ASM Policy and Strategy that: • Establishes the principles of where ASM presents a H&S risk to Surgold staff because of Surgold activities; • Establishes the security measures that will be put in place to protect Surgold assets from ASM activity; • Establishes a program to investigate possibilities to build capacity to allow procurement of non-mining services from ASM miners / ex-miners such as road construction, clearing etc. • Establishes a desire to continue to engage miners regarding mining outside of high risk areas controlled by Surgold, in partnership with the OGS; and • Establishes efforts to partner with GoS (e.g. OGS)or other organizations to provide income generation opportunities for those people who are reliant on ASM livelihoods.	ESIA ESMMP, Chapter 6 (Social Management Plan)
Skills and Training	Develop and provide (with partners where applicable) where possible pre-emptive skills training to people in the Pamaka area prior to up-scaling in hiring.	ESIA ESMMP, Chapter 6 (Social Management Plan) Table 6-2
	Award certification of training and competency in new skills gained through formal Surgold or 'on the job' training in formal certificates.	
	Develop and provide (with partners where applicable) Financial Management Training to employees and their partners from within the Pamaka area	
Communicable Disease Control	Implement a malaria control and prevention program including supporting the MoH's National Malaria Program.	ESIA ESMMP, Chapter 6 (Social Management Plan) Table 6-2
	Implement a Worker Health Screening and Monitoring Program.	
	Develop and implement appropriate emergency communication plan / system with relevant health agencies	
Chronic Disease Control	Promote healthy behavior amongst workforce through provision of healthy food options, fatigue and stress management program, access to worker provision for access to a psychologist, exercise and recreational activities	ESIA ESMMP, Chapter 6 (Social Management Plan) Table 6-2
Worker Engagement	Engage with workforce surrounding H&S and labor and accommodation terms and conditions in contracts.	ESIA ESMMP, Chapter 6 (Social Management Plan) Table 6-2
Income Generating Opportunities	Develop and provide (with partners where applicable) a program of livelihood improvement, such as micro-finance measures to improve access to markets, improved seeds or other inputs etc.	ESIA ESMMP, Chapter 6 (Social Management Plan) Table 6-2
Artisanal Mining Management	Work with partner organizations (such as the OGS) to improve the sustainability of ASM in the Pamaka Area through the provision of training and promotion of best practices.	ESIA ESMMP, Chapter 6 (Social Management Plan) Table 6-2
	Work with partner organization to engage Pamaka people and if desired support a Pamaka ASM Commission to gain legal small scale concession.	
Cultural Awareness	Implement cultural awareness policy and training as part of the induction process for all employees including archaeological chance finds, local customs tradition, religious beliefs and responsible community relations.	ESIA ESMMP, Chapter 6 (Social Management Plan) Table 6-2

Type of Commitment	Description of Commitment	Reference of Commitment
Training and Capacity Development	Provide relevant training to workforce including: • Malaria Prevention Training. The Project medical staff may receive training from MOH on their roles and responsibilities for Malaria Service Delivery (MSD) and will include training on the use of rapid diagnostic tests. • HIV in the Workplace. The project medical staff will receive training on non-discrimination and the correct procedures for addressing HIV in the workplace. • Worker Health & Safety Training. The Project medical staff will receive training from the MOH on their roles and responsibilities in monitoring TB and other infectious diseases and procedures for reporting. • Onsite health workers and supervisors will be trained in recognizing the signs and symptoms of mental distress (e.g., disruption in sleep cycles) that could jeopardize the safety of the workers, co-workers and families. • Health workers hired for the onsite medical facility at the Mine Site will have the qualifications and capabilities to provide primary health care and trauma care, in addition to occupational health care (e.g., worker health screenings). • Stakeholder Engagement Training. The Community Relations Team will receive specific stakeholder engagement training that covers the processes, mind-set, value, requirements and methods for successful engagement. • Grievance and Feedback Management Training. The ESR and Community Relations team will receive specific training on feedback mechanisms. This includes how to establish and operate a successful mechanism. • Human Rights Training. The Security Team will receive regular training on the protection of Human Rights.	ESIA ESMMP, Chapter 6 (Social Management Plan)Section 6.7.2
Monitoring	Surgold will measure and record the Project's performance related to: • Employees hired who have previously received training (provided by Surgold) • Feedback on training delivered by Surgold to Pamaka stakeholders • Ethnicity and home location of people hired • Adherence to Surgold policy on PPE use by all workers • Availability of in date rapid malaria diagnostic tests on site. Other Social monitoring criteria as relevant In addition Surgold will record and monitor the delivery of community investment based on financing awarded to NGOs and CBOs as part of community investment initiatives.	ESIA ESMMP, Chapter 6 (Social Management Plan) Table 6-2
Cyanide Management		

Type of Commitment	Description of Commitment	Reference of Commitment
Cyanide Management Plan	Surgold will develop, implement and review a comprehensive Cyanide Management Plan based on the requirements of the ESIA, EMMP, Newmont Corporate Standards and the International Cyanide Management Code for the Gold Mining Industry (Cyanide Code). This plan will address: • Transportation from supplier to site, • Onsite storage and handling, • Solution conveyance, treatment and disposal processes, • Environmental monitoring, • Emergency preparedness and response • Risk communication and • Worker health and safety.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan)
Cyanide Management Reporting and Monitoring	Surgold will measure and record the Project's performance related to: • Incident reporting, inspections, and audits • Annual volume cyanide imported to Suriname for the Project; • Annual number of near-misses regarding the transportation, handling, and storage of cyanide; • Annual number of accidents and/or releases of cyanide to the environment (related to the Project); • Average, maximum, minimum concentrations of cyanide(WAD and free) in tailings discharge to the TSF (measured routinely); • Annual number of occurrences of cyanide concentrations greater project criteria in the discharge from the TWSR; • Annual average, maximum and minimum concentration of cyanide in the tailings pond decant (reclaim) water (monitoring frequency to be determined in the Water Management Plan); and • Annual average, maximum and minimum concentration of cyanide (WAD and free) in any water discharges from the site to the environment from the TWST (monitoring frequency to be determined in Water Management Plan).	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.2.3
Cyanide Supplier Selection and Chain of Custody	Supplier selection will include a review of the supplier's practices and procedures to confirm that they operate in a safe and environmentally protective manner. A supplier will be selected that is certified by the International Council of Chemical Associations; Responsible Care Program and one that has adopted the Cyanide Code.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.1
	The supplier will be required to provide chain-of-custody documentation to show that the cyanide has been produced at a facility certified as compliant with the Cyanide Code should be provided annually.	
	Upon arrival in Suriname tanks/containers will be inspected by Surgold Logistics personnel to ensure no damage exists. In the event any container is found damaged, logistics personnel will notify the Procurement and Logistics Superintendent or his designate. The Procurement and Logistics Superintendent will advise Health and Safety Coordinator who will intern put in place the appropriate action to inspect and correct if required.	

Type of Commitment	Description of Commitment	Reference of Commitment
Cyanide Service Providers	Written contracts with service suppliers will stipulate that: • Preparation and implementation of Transportation Safety Management Plan and an Emergency Response Plan that satisfy the requirements outlined in the ICMI Transportation Verification Protocol; • Interim loading, storage and unloading practices during shipment to follow guidelines provided in Transportation Practice 2.1 of the ICMI Cyanide Transportation Verification Protocol; Maintain shipping records of the volume of cyanide in transit and a Material Data Safety Sheet (MSDS); • Shipments by sea to be in compliance with the Dangerous Goods Code of the International Maritime Organization; • Provision for reviews or audits as required by Merian Gold Project as deemed necessary by the Project; • Provisions that require any sub-contractors to be bound by the same requirements as the contractor; and • All relevant packaging and labeling to conform with the Recommendations for the Transport of Dangerous Goods (United Nations Economic and Social Council's Committee of Experts on Transport of Dangerous Goods).	ESIA ESMMP, Chapter 13 (Cyanide Management Plan)
Cyanide Transportation to Site	Transportation will be via convoy on low-center of gravity trailers with container locks.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.2
	Transport units will be escorted by a lead vehicle and a trailing vehicle to ensure safe passage while en-route	
	During transport the lead and trailing vehicle will be equipped with appropriate warning signs and light bar	
	An emergency response vehicle will also be included in the convoy. The emergency response vehicle be equipped with spare tires for transport units, mechanical tools and the emergency response kit	
	A minimum of two persons trained in Emergency response will participate in the convoy	
	Where transport contractors are being used they will be Cyanide Code certified.	
	The cyanide will be transported dry in briquette form in stainless steel 20-foot Isotanks or isotainers, which are specially designed steel containers that provide maximum protection against possible loss of contents (or other appropriate format). Emergency supplies for the Project will be shipped in briquettes in 1 tonne bags inside a specially designed plywood boxes, which will be containerized in 20-foot sea containers to provide additional protection to the product during transport and in-transit storage (emergency supply is approximated at 5% of the total volume of cyanide used by the Project).	
Cyanide Transportation to Site	Contractors Transportation Safety Plans will include: • Provisions to ensure vehicles used in the transport of cyanide are only loaded to manufacturer specifications and procedures are in place to prevent overloading; • Defensive driver training for drivers; • Vehicle inspections prior to departure/shipment; • Vehicles to be equipped with communication equipment that permits communication with transport company, Merian Project, and emergency response for the entire transportation corridor; • Transportation company to maintain communication in working order and document checks/inspections; and • other requirements as identified in the Transportation Verification Protocol.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.2

Type of Commitment	Description of Commitment	Reference of Commitment
Cyanide Transportation to Site	The Contractors Emergency Response Plan will include all elements as identified in the Transportation Verification Protocol including but not limited to: • Descriptions of response actions for anticipated emergencies; • Roles of outside responders, medical facilities or communities; • Roles of internal responders, duties and responsibilities; • Appropriate emergency response training; • Itemization of on-hand emergency response and health and safety equipment as identified in Surgold's checklist; • Training plan including periodic refresher training; • Procedures to inspect emergency response equipment; • Procedures for remediation or recovery; • Provisions for periodically reviewing and evaluating the Plan	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.2
Cyanide Transportation to Site	On arrival on site tanks/containers will be inspected to ensure no damage exists. In event any container is found damaged, warehouse/surface personnel will notify the Procurement and Logistics Superintendent or his designate. The Procurement and Logistics Superintendent will advise the Health and Safety Coordinator who will, intern, put in place appropriate action to inspect and correct if required.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.2
Cyanide Storage	The cyanide storage area at the mine site will be: • Controlled-access, with appropriate labeling for emergency contacts and hazards; • Equipped with a means of communicating with key staff to respond to any incidents. • The cyanide storage containers will be sealed and protected from unrestricted access; and • Equipped with cyanide-specific first-aid and emergency response equipment including high-pH water, oxygen, resuscitator and appropriate PPE and an antidote for cyanide poisoning (this can only be administered by medical personnel) and instructions regarding the proper use of equipment. • Spill prevention or containment measures will be provided for process solution pipelines. • Standard containers with box cyanide will be stored with doors sealed and doors facing each other to limit access. • Storage areas will be regularly inspected as stipulated in the Cyanide Management Plan	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.3
Cyanide Handling	The Project will have a design review of the process plant and cyanide reagents system completed by an accredited ICMI auditor prior to completing the Project's detailed design of the process plant.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.4
	The Project will develop a written set of Standard Operating Procedures to be followed during the receipt of cyanide shipments. The procedures will include: • Instructions for operating any and all valves/couplings; • Requirements for Personal Protective Equipment (PPE); • Measures to ensure that containers are neither ruptured nor punctured; • Limits on stacking containers; and • Contingency measures for responding to releases or spills of cyanide.	

Type of Commitment	Description of Commitment	Reference of Commitment
Cyanide Handling during Operations	The Project will develop operations plans and procedures for the processing plant, mine, TSF and other mine works. Within these plans measures for the protection of the environment and human health specific to cyanide will be incorporated including: • Maintenance of concentrations no greater than 50 mg/L WAD cyanide in the TSF pond; • Maintenance of a safe freeboard in the TSF or in any other ponds that contain more than 0.5 mg/L CNWAD. • Evaluation of control strategies for cyanide additions to optimize efficiency and reduce cyanide concentrations in tailings or recycled solutions; • Evaluation of process solutions to determine appropriate pH for limiting the evolution of hydrogen cyanide gas and development of operating procedures and controls to reduce risk to workers; • Review of processes to ensure that worker exposure to hydrogen cyanide gas and sodium and potassium cyanide is limited to 10 ppm as cyanide, not to be exceeded for any period of time. Additionally, workers should not be exposed to hydrogen cyanide gas and airborne sodium and potassium cyanide dust at concentrations exceeded 4.7 ppm as cyanide for a period of 8 consecutive hours or more; • Procedures for maintaining, testing, calibrating cyanide monitoring equipment; • Identification of piping containing cyanide by color code, signs, labels, tags, decals or other means to alert workers of their contents. The direction of cyanide flow in pipes should also be labeled, marked or otherwise designated. • No water discharges from the mine to the environment with concentrations greater than 0.5 mg/L WAD cyanide nor discharges that result in concentrations greater than 0.022 mg/L free cyanide within receiving water body (water quality monitoring and reporting is captured in the Water Management Plan); • Regular groundwater monitoring around the TSF and groundwater capture and treatment as required (water quality monitoring and reporting is captured in the Water Management Plan); and • QA/QC programs to ensure facilities for the management of cyanide are constructed according to accepted engineering standards and specifications.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.4

Type of Commitment	Description of Commitment	Reference of Commitment
Cyanide Health Safety and Loss Prevention	The Health and Safety Plan for the site will include: • Initial identification of potential exposure scenarios and measures necessary to eliminate, reduce and control them and review of process changes and engineering controls that can be implemented to eliminate, reduce or control these scenarios; • Development of standard operating procedures for the unloading, mixing, equipment decontamination, entry into confined spaces and plant operations that ensure worker exposure to cyanide is minimized; • Identification, provision and training in the use of cyanide-specific PPE; • SOPs for pre-work inspections, emergency response, communication, cyanide monitoring and documentation; • Cyanide-specific training for all relevant workers including PPE, emergency response and cyanide first-aid; • Requirement than any change in process be reviewed for potential impacts on worker health and safety; • Provision for localized monitoring of ambient air quality in areas where exposure to hydrogen cyanide gas or other airborne cyanide contaminants exists. Cyanide-specific personal protective equipment must be required in any areas and for any activities where process and engineering or administrative controls are not practicable or effective in limiting worker exposures to a maximum of 10 parts per million or where personnel are exposed to more than 4.7 parts per million for a continuous 8-hour period; • Warning signs be placed where cyanide is used and should alert workers that cyanide is present, that smoking, open flames, eating and drinking are not allowed and that the necessary cyanide-specific personal protective equipment must be worn; • Showers, low-pressure eye wash stations and dry powder or non-acidic sodium bicarbonate fire extinguishers should be located at strategic locations throughout the operation where cyanide is present. This equipment should be maintained, inspected, and tested on a regular basis, and records should be retained; • Material Safety Data Sheets (MSDS), first aid procedures and any other informational materials on cyanide safety should be written in the language of the workforce and should be available in areas where cyanide is managed; • All exposure incidents should be investigated and evaluated to determine if the operation's programs and procedures to protect worker health and safety, and to respond to cyanide exposures are adequate or if changes are necessary.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.5
Cyanide Stakeholder Engagement	Surgold will ensure that stakeholder engagement activities seek to provide: • Appropriately scheduled (e.g. prior to operations) engagement with stakeholders to address their issues regarding cyanide; and • Opportunities/ methods to provide information regarding the operation's practices and procedures related to cyanide transportation, storage, handling and monitoring including written descriptions in the appropriate languages as well as through presentations or other direct stakeholder engagement.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.3.7

Type of Commitment	Description of Commitment	Reference of Commitment
	As described in the ICMI guidance, a specific communication plan will be developed as part of the Emergency Response Plan that outlines the communication required in the event of a release or exposure that involves: • Incidents of cyanide exposure resulting in hospitalization or fatalities; • Incidents where releases of the mine site required response or remediation; • Incidents where a release on or off the mine site resulted in a significant adverse effect to health or the environment; • Incidents where a release on or off the mine site required reporting under applicable regulations; and • Releases that caused exceedances of applicable limits for cyanide.	
Cyanide Specific Training	The HSLP department will develop cyanide-specific training for all personnel who may encounter cyanide. Training will inform employees on cyanide's inherent hazards as well as how to manage cyanide in a safe and environmentally protective manner. Training requirements specific to cyanide will also be incorporated in the general HSP and ERP training programs as well as job-specific training as required. The training programs will be developed by the HSLP department and records maintained by the HR department. Training will be provided prior to employees working around cyanide. Training will include: • Identification of all locations on-site where one can encounter cyanide, • Information regarding health effects of cyanide, • Symptoms of cyanide exposure and • Procedures to follow in the event of exposure.	ESIA ESMMP, Chapter 13 (Cyanide Management Plan) Section 13.5.2
Closure and Reclamation		
Closure and Reclamation Plan	Surgold will develop and implement a closure and reclamation plan developed to implement the commitments made within the ESIA, the ESMP and the Conceptual Closure and Reclamation Plan as well as the Newmont Environmental Standard for Closure and Reclamation Planning and IFC Environmental, Health and Safety Guidelines for Mining	ESMMP Chapter 14
Closure Stakeholder Engagement	As part of the community consultation program, local communities will be asked for input into the implementation of site closure. This may include input into specific end land uses, important plant species and target wildlife habitat types. In addition, Surgold will take steps to involve the local community in reclamation and closure activities which may include: • woody debris handling • seed collection • establishment of a propagation nursery • erosion control • other potential employment opportunities	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 1.4)
	Surgold will work with local communities to determine if any other social enhancements such as retention of specific Project facilities after closure may be incorporated into the plan to provide longer term benefit to local residents.	

Type of Commitment	Description of Commitment	Reference of Commitment
Timber Salvage and Vegetation Clearing	As possible, transferring live vegetative material from newly disturbed sites to areas ready for closure to enhance soil microbial communities and vegetation establishment on the reclaimed landscape	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 4.1)
Organic Material Salvage	Organic material, including the topsoil veneer, will be used for concurrent reclamation by supplementing the use of saprolite as a growth media for revegetation, where possible. Topsoil will not be stockpiled as it is not practical to salvage topsoil from tropical soil profiles.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 4.2)
Saprolite / Subsoil Salvage and Storage	Reclamation will utilize stockpiled saprolite. The project will complete a material balance to assure sufficient materials are available to complete closure activities.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 4.3)
Interim Vegetation and Stabilization of Reclamation Material Stockpile	During operations, the reclamation material stockpiles will be revegetated to prevent erosion. Mulch from the non-merchantable forest vegetation may be used for initial erosion control. It is expected that over time this mulch will decompose and become incorporated into the reclamation material.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 4.4)
Progressive Reclamation	Detailed progressive reclamation timelines and locations will be updated on an annual basis to reflect the most current mine plan and on site conditions. The operations and closure teams will work closely together to ensure that opportunities for progressive reclamation are identified and implemented, where feasible.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 4.5)
Reclamation Procedures	Reclamation and closure of the mine site will be based on the following general objectives: • Industry good practice reclamation goals and objectives will be considered during design and planning of construction and operations. • Progressive reclamation will be implemented where it is possible and timely. • The reclamation and closure design will ensure that long-term physical and chemical stability is provided. • The long-term aim of reclamation is to return the site to a forested habitat consistent with the surrounding forest. • Social input will be incorporated into reclamation planning.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 5)
	Salvaged subsoil/saprolite will be placed on closed facilities as a medium for plant growth. This material will be ameliorated and revegetated.	
Erosion Control, Soil Preparation and Re-Vegetation	Vegetation will be established immediately following placement of reclamation material as both an erosion control measure and to build up soil organic matter in the reclamation material. Surgold may choose to plant legume vegetation that will fix atmospherically derived nitrogen into the soil. The use of temporary erosion control measures such as downed trees, mats, netting, or silt fences will be implemented where necessary to control erosion prior to establishment of a protective vegetative cover.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 5.3)
Establishing Native Trees	Native tree species and legume plugs may also be planted at varying densities across reclamation areas to create diversity in species and structure on the reclaimed landscape.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 5.4)

Type of Commitment	Description of Commitment	Reference of Commitment
Biodiversity Establishment	Revegetation will allow for the establishment of a variety of locally adapted species. Where planting is required, a variety of locally common species typical to the surrounding ecosystem will be planted.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 5.6.1)
Wildlife Habitat Establishment	The CC&R Plan aims to establish wildlife habitats compatible with similar areas in the surrounding landscape. This habitat will be achieved through recontouring disturbances to blend with the surrounding environment, re-establishing functional hydrology and re-vegetating to locally common, tropical forest species.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 5.6.2)
Facility Specific Closure and Reclamation	Building and structures related to the Project will be decommissioned and removed from the Project area prior to reclamation. Consideration will be given to retaining certain facilities that may be of ongoing benefit to local residents. Furthermore, any remediation activities in contaminated areas will have been completed following appropriate guidelines and procedures in place at the time of decommissioning.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 5.7)
Mine Pit reclamation	At closure, water will slowly inundate the pits, creating pit lakes. Reclamation material will be placed around the perimeter of the pit to establish a rooting zone for terrestrial ecosystem above the water line and vegetated according to Section 5 of this Plan. Fencing and or berms with appropriate signage will be in place, until water level, water quality and pit edges have stabilized.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 5.7.1)
WRD Reclamation	At the time of closure, WRD will be reclaimed smoothing and recontouring the benches to mirror surrounding local hills. Slopes will then be stabilized and revegetated according to the final Closure Plan.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 5.7.2)
Processing Plant, Haul Roads, Air Strip, Camp Facilities, Communications Tower, Access Roads and Laydown Areas Reclamation	The residual soil is expected to be compacted following decommissioning. Bulldozers will deep rip this soil, to ameliorate compaction issues, and attempt to encourage water percolation through this layer. Contours and flat areas will be re-established to control drainage and encourage heterogeneous vegetation cover during forest succession. Revegetation will commence immediately following contouring to limit erosion, according to Section 5 of this Plan.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 5.7.3)
TSF Reclamation	At Closure, tailings chemistry is expected to be within acceptable guidelines for direct discharge to surface waters. A permanent spillway will be excavated in the TSF to allow for controlled discharge of ponded water. Hydrological engineering should aim to maintain some open water to aid in sedimentation control. Closure re-vegetation efforts will remain focused on permanently trafficable areas, with natural ingress of wetland species in flood prone areas.	

Type of Commitment	Description of Commitment	Reference of Commitment
Field Trials	During the Project life, field trials will be initiated and conducted in concurrent reclamation areas to test potential reclamation technologies and to adapt reclamation procedures to Project specific requirements. Optimizing reclamation material content, reclamation material placement thicknesses and revegetation species assemblages are among the trials expected to occur. Test / experiments in concurrent reclamation areas will be used to improve and seek better closure techniques during the life of the mine.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 6)
Long Term Monitoring	A long term reclamation monitoring program will be developed and implemented for the Project. The program will monitor: • Soil physical and chemical properties • Soil flora • Erosion • Vegetation establishment • Vegetation growth and cover • Vegetation health • Vegetation diversity • Comparability of reclaimed communities to natural analogues • Wildlife usage of reclaimed environments Monitoring results will be compared to baseline conditions and analogous undisturbed areas and to establish when monitoring can cease. Findings will also be used to adapt reclamation strategies and apply mitigations where necessary.	ESIA ESMMP (Conceptual Closure and Reclamation Plan Section 6.1.1)

Volume IV
Appendix IV-B

Water Management Plan

REPORT

ESIA WATER MANAGEMENT PLAN

Merian Gold Project, Suriname

Submitted To: Suriname Gold Company, LLC
Surinamstraat 54
Paramaribo, Suriname

Submitted By: Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052 USA

November 12, 2012 **Project No. 113-93245.850**

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Golder Associates

Table of Contents

List of Tables

List of Figures

1.0 INTRODUCTION

1.1 Purpose

The purpose of this water management plan is to explain the framework for water management at the Merian Gold Project (the Project). This water management plan lays out the overall water management strategy for the Project based on the preliminary mine plans and facility designs that are presented in the Environmental and Social Impact Assessment (ESIA) for the project. The intent is to produce a framework document that can be expanded and refined as the mine plan, construction sequences, and facility designs are finalized.

This document also describes the adaptive aspect of the water management plan, which is integral to the strategy. Adaptive water management acknowledges and identifies the many uncertainties associated with the predicting future performance of mine facilities and conforming to the Merian Project Environmental Design Criteria (EDC) (Surgold 2012). The plan identifies the major risks and uncertainties with respect to water management and lays out the associated controls, performance indicators, adaptive management actions and contingency measures available to mine managers to adjust management controls to fit measured conditions.

1.2 Scope

This management plan addresses all types of water, water bodies, and major water management facilities on site and is supported by more detailed technical documents that address specific components of the mine water management system described in this document, including:

- Site-wide Water Balance and Mass Mixing Model (Golder 2012a)
- Erosion and Sediment Control Plan (2012b)
- Seepage Collection Systems, Tailings Storage Facility (Golder 2012c)
- Conceptual Sizing for Nitrate and Ammonia Removal (Golder 2012d)
- Conceptual Closure and Reclamation Plan (Golder 2012e)

1.3 Objectives

The objectives of this water management plan are to:

- Account for and characterize all water on site.
- Explain how regulatory and other water management requirements will be fulfilled.
- Identify all sources of impacted water and associated mitigation methods.
- Provide a strategy for routing water and providing treatment where necessary.
- Lay out a plan for evaluating system performance.
- Identify adaptive management and contingent actions available to mitigate unexpected impacts.

1.4 Regulatory and Other Requirements

This section summarizes regulatory and other requirements for the Project pertaining to water management, including requirements from the International Finance Corporation (IFC) and Surgold's internal standards. Sources of regulatory and other water management requirements include the following:

- Nationaal Instituut voor Milieu en Ontwikkeling in Suriname (NIMOS)
- International Finance Corporation (IFC), World Bank
- Surgold environmental standards (Newmont 2006)
- Merian Project Environmental Design Criteria (EDC) (Surgold 2012)
- International Cyanide Management Code (ICMI 2006-2012)

2.0 BACKGROUND

2.1 Project Plan

The Project will be constructed in the northeastern part of Suriname near the border with French Guiana, approximately 60 kilometers (km) south of Moengo. The Project site is located in tropical rainforest with a mean annual rainfall of about 2.4 meters (m) (Golder 2012f). The driest periods occur from August through November and the wettest periods are between March and June.

The Project will be constructed in the Las Dominicanas Creek watershed (tributary to the larger Commewijne River watershed) and the Merian Creek watershed (tributary to the larger Marowijne River watershed). The topography is hilly with low gradient creeks in the valley bottoms. Surface soils are generally composed of a thick layer of saprolite underlain by a transition layer of saprock overlying more competent bedrock (referred to as fresh rock).

The resource will be developed using open-pit mining performed using a truck and shovel operation. Blasting will be required for mining of the fresh rock and some of the harder saprolitic ores. It is assumed that approximately 25% of the saprolitic ores will require blasting. Blasting will be carried out using a blend consisting of 70% emulsion and 30% ammonium nitrate fuel oil (ANFO).

Ore processing at the plant site will use cyanide. A tailings wash thickener followed by a cyanide destruction circuit using an air and sulfur dioxide process will be used to reduce cyanide concentrations prior to discharge to the tailings storage facility (TSF).

The TSF will be constructed in the Commewijne River watershed in two phases and will store up to 150 Million Tonnes (Mt) of tailings. The combined area of the two TSF phases is approximately 12.4 square kilometers (km^2).

Approximately 680 Mt of waste rock will be generated over the 14-year mine life. Waste rock will be stockpiled in Waste Rock Disposal Areas (WRDs). WRD locations are shown in Figure 1.

In summary, the Project site will include the following facilities:

- Three open pit mines (named Merian I, Merian II, and Maraba)
- Waste rock disposal areas (WRDs)
- Processing plant and maintenance shops
- 50 MW Heavy Fuel Oil (HFO) power plant
- TSF
- One minor borrow area
- Air strip
- Accommodation camp

- Fuel and chemical storage
- Potable water treatment plant
- Wastewater treatment plant
- Haul roads and other access roads
- Landfill and waste management facilities
- Water and sediment control facilities

2.2 Overview of Potential Site Water Issues

The contaminants of potential concern (COPC) associated with the Project have been identified as follows:

- Cyanide
- Total Suspended Solids (TSS)
- Nitrates
- Ammonia
- Metals

Cyanide will be used in the ore processing at the plant site. Cyanide will be imported into Suriname and transported to the Project site where it will be contained, handled, and destroyed.

Major earthworks will be required to construct pits, processing facilities, tailings storage facilities, and supporting infrastructure. Areas of land will be stripped progressively of vegetation in preparation for the construction of mine facilities and infrastructure. Stockpiles of local soils and other materials will be formed for reuse because of site works and the resulting embankments will present opportunities for soil erosion and dispersion by wind or water, especially during storm events.

Runoff from disturbed areas within the pit areas and from WRDs is expected to pick up sediment and result in elevated TSS in water downgradient. Runoff and seepage into pits where blasting is occurring could potentially pick up blasting residue and result in elevated concentrations of nitrogen species (nitrate, nitrite and ammonia) in water pumped out of the pits. Similarly, blasting residue in the waste rock could potentially be picked up by runoff and seepage from the WRDs and result in elevated nitrogen species concentrations in water downgradient from these facilities.

Geochemical modeling was conducted to evaluate TSF pond water quality during operations. Model results indicate that nitrogen and some metal/metalloid concentrations in the TSF may exceed the strictest project water quality standards (for additional information see Golder 2012g).

2.3 Potential Risks

Potential risks to be addressed by the water management plan have been identified as:

- Surface erosion during site preparation, access road construction, and plant site construction during storm events.
- Surface erosion from WRDs, road fill slopes, plant area, camp area, and other disturbed areas on site with bare soil during storm events.
- Runoff and seepage containing residual nitrogen from blasting leaving the WRDs or being pumped out of the pits.
- Seepage from the TSF containing nitrogen, metals, or cyanide.
- Discharge of treated excess water from the TSF containing nitrogen species, metals, or cyanide.
- Stormwater runoff from the plant site containing nitrogen species, metals, cyanide, or petroleum.

3.0 MANAGEMENT STRATEGY

The general approach incorporates the principles of adaptive management. The water management strategy includes the following elements:

- Flow and Storage Monitoring
- Water Quality Monitoring and Water Characterization Updates
- Water Balance Updates and Calibration
- Control Plan Updates
- Monitoring, Adaptive Management, and Reporting
- Contingency Plans

3.1 Mine Water Management System

The mine water management system will be comprised of the following components:

- Existing channel network
- Diversion channels and stormwater drainage ditches
- Plant site stormwater facilities
- Pit dewatering infrastructure (sumps, pumps, ditches, pipes)
- Excess TSF water conveyance infrastructure (pumps, ditches, pipes)
- TSF seepage collection and pump back system
- Sediment ponds
- Treated water storage reservoir (TWSR)
- Water treatment plant (WTP) and infrastructure

Figure 2 is a conceptual schematic diagram that shows the major components of the mine water system and illustrates where mine water will be routed prior to reaching the evaluation points. This schematic focuses on the routing of flows between components of the mine water system and does not show flows from undeveloped portions of the watersheds draining to the sedimentation facilities, all evaluation points, direct precipitation, deep percolation, evaporative losses, or losses to tailings voids.

3.1.1 Water Characterization

All water on site was accounted for and characterized to identify potential sources of contamination and plan for mitigation measures to be put in place prior to commencement of activities expected to generate potential water contamination. Waters of the Project site were characterized as falling into one of the following five categories:

- **Fresh –** Surface and ground water emanating from undisturbed areas within the Project area. This water has baseline water quality. Note that this includes surface water currently impacted by artisanal mining, which has been shown to contain elevated TSS and some metals.

- **Sediment Laden –** Surface runoff from disturbed areas other than WRDs and pits (i.e., roads, fill slopes, etc.) that have elevated TSS concentrations.
- **Mine Influenced –** Water generated from dewatering open pits and run-off from WRDs within the mine disturbance area. Including groundwater, pit sump water, open pit run off, WRD runoff and seepage. Mine influenced water could potentially have elevated TSS and nitrate concentrations. WRD seepage also has the potential to have higher than baseline metal/metalloid concentrations, although concentrations and volumes are not expected to be high enough to exceed water quality standards.
- **Process Impacted –** Water used in the process at the mill, including water in the tailings slurry, TSF decant pond, stored in tailings voids, and seepage from the TSF. Process impacted water could potentially have elevated nitrogen species, metals, and cyanide concentrations. Outside the process plant site area, cyanide destruction will have removed cyanide from process impacted flow streams due to operation of the tailings wash and cyanide destruct circuits.
- **Treated Effluent –** Process impacted water that has undergone treatment for metals and nitrogen species at the WTP or other treatment locations. The treatment goals are such that COPC concentrations at the compliance points will be at or below the EDC. Treated effluent will have elevated hardness concentrations because of the treatment process.

3.1.2 Flow Routing

The following guidelines were used to develop a conceptual flow routing plan for the Project site:

- Limit potential impacts due to cyanide process water management to one watershed by keeping all water that could potentially contain cyanide in the Commewijne River watershed
- Minimize surface drainage to pits by placing and grading overburden material to route surface drainage away from the pit walls
- Prevent uncontrolled discharge of all Project impacted water

Construction of the Project will alter surface drainage paths in several watersheds within the project area. Figure 1 provides a map showing the ultimate footprints of the planned mine facilities, the evaluation points identified for the ESIA and their existing watershed areas and flow diversion arrows representing the conceptual drainage plan. Sedimentation facility locations and maximum inundation areas shown in Figures 1 are preliminary; facility details will be determined during the final design process. The downstream evaluation points (i.e., EP-A0, EP-B-0, and EP-C0) are locations along stream channels where water quality will be measured to demonstrate that Project activities are meeting regulatory requirements.

The planned placement and grading of fill material will divert plant facility runoff to the Marowijne watershed and will divert surface runoff away from the Merian II and Maraba pits. These changes will result in increased surface drainage to Las Dominicanas watershed, while decreasing surface drainage to the Merian watershed.

The Merian I pits are located on a divide between Tomulu Creek and an unnamed tributary to Merian Creek. Pit dewatering flows will be routed to the unnamed tributary to Merian Creek (draining to

EP-B2) effectively decreasing the surface drainage area for Tomulu Creek by about half a square kilometer.

3.1.3 Site-Wide Water Balance Model

Development of a site-wide probabilistic water balance is considered a “Best Management Practice” in mine water management. A water balance was developed using a dynamic systems model to track water flows related to the Merian Gold Project. The site-wide water balance model (WBM) was developed in part to support the Project ESIA by providing estimates of hydrologic impacts associated with the proposed project activities. The project description, planned project disturbance sequence, and mine infrastructure and process design assumptions used for this version of the WBM are preliminary and subject to change during final design. The model structure was designed to allow changes to be incorporated with relative ease as new information becomes available. The water balance will be reassessed annually as new data from the monitoring network becomes available. Changes to the mine plan will be evaluated using the site-wide WBM throughout the life of the Project.

The site-wide water balance model was used to estimate flow rates within the mine water system and support the conceptual design of water treatment facilities and TSF storage requirements. More detail on the site-wide WBM is provided in the Merian Site-Wide Water Balance and Mass Balance Mixing Model (Golder 2012a).

3.2 Control Plans

Mitigation of flow streams containing COPCs will involve the following controls:

- Site-wide erosion and sediment control
- Plant site water control
- TSF water treatment
- TSF seepage collection
- Nitrate and Ammonia removal

During construction, erosion and sediment impacts are the primary risks. Risks associated with process and mine-impacted flow streams arise during operations and continue into closure. The following sections summarize the control plans for various components of the mine water management system. More detail about the control plans is provided in the documents referenced in this water management plan.

3.2.1 Site-wide Erosion and Sediment Control

The general approach to erosion and sediment control has three components:

- Source erosion control Best Management Practices (BMPs)

- Intermediate sediment control BMPs
- Perimeter sediment control facilities

Source controls involve implementation of erosion control BMPs that prevent or reduce the amount of erosion from surfaces disturbed by the Project. Intermediate controls are located at points throughout the conveyance network and are typically used to settle coarser sediments and reduce the total volume of sediment storage required at perimeter control structures. Perimeter controls include sedimentation ponds.

Sedimentation ponds will be put in place downstream of all major disturbance areas including all construction areas, borrow areas, WRDs and pit disturbance areas. The general location of sedimentation ponds is shown in Figure 1. Sedimentation Ponds 1, 2, 3, 4, 5a, 5b, 6a, 6b, and 7 will be longer-term perimeter facilities that will be constructed prior to major disturbances in their respective watersheds and will remain in place throughout the life of mine, continuing to function until the sediment yield from the contributing watershed area has returned to baseline levels following reclamation. Dam 6a will be constructed at the starter dam location for Phase 2 of the TSF. This impoundment will be a dual-purpose facility put in place prior to construction of the plant area to provide perimeter sediment control. During operations, Dam 6a will serve as a treated water storage reservoir, storing treated TSF water prior to release to A3 Creek while providing perimeter sediment control. When Phase 2 of the TSF is needed for tailings storage, the TWSR will be moved to the Dam 6b location in the basin north of the TSF Phase 2 area.

The Erosion and Sediment Control Plan (Golder 2012b), provides more detail regarding planned source control BMPs, intermediate control BMPs, and conceptual perimeter sediment control facility designs.

3.2.1.1 Construction Sequence

Erosion control BMPs and perimeter sedimentation ponds will be put in place prior to all major disturbances during the construction period. A separate undesignated (not shown on Figure 1) dam will be constructed upstream of the Phase 1 TSF main dam for water control which will limit sediment generation during construction. Sedimentation Pond 6a will be constructed prior to major earthworks associated with construction of the plant and camp.

3.2.1.2 Tailings Storage Facility Perimeter Sediment Control

The TSF dam system will include a perimeter road located beyond the downstream toes of the dams. This road will provide access as well as sediment control during and after construction by impeding runoff from the dam surfaces and controlled release of flows to locations downgradient. Culverts and small sediment control ponds will be constructed on the up-gradient side of the road to allow settlement of sediment.

3.2.1.3 Closure

All permanent perimeter sedimentation ponds will continue to operate until disturbed areas have been reclaimed and TSS concentrations in site runoff have dropped to baseline levels. Additional information about closure is provided in the Conceptual Closure and Reclamation Plan (Golder 2012e)

3.2.2 Plant Site Water Control

Because the plant site will contain processes involving cyanide, the plant site will be completed encircled by a perimeter dike that will direct all rainwater runoff water and major spills that overflow the walled process containment areas to a plant site pollution control pond. This plant site pollution control pond will be drained by pumps to the TSF or back into the process plant tankage as required. In the event that this plant site pollution control pond overflows, drainage will be routed to the TSF decant pond in the Commewijne River Basin. Cyanide will be managed on the plant site in accordance with the International Cyanide Management Code (ICMI 2006 – 2012). All process water containing cyanide will be retained on the plant site and sent through counter current decantation (CCD) and detox before being discharged to the TSF.

Additional pollution control ponds will be located to collect runoff and spillage from the truck shop and maintenance area, the power plant area, and the fuel storage area. These pollution control ponds will separate hydrocarbons from runoff water prior to being pumped to the TSF reclaim pond of the TSF.

3.2.3 Waste Rock Disposal Areas and Pit Water Control

The primary water quality concern associated with pit dewatering flows and WRD runoff is TSS. Runoff from the WRDs and pit dewatering flows will be routed to sedimentation facilities prior to discharge to receiving streams. Figure 1 shows the conceptual routing of flows that will be achieved using a combination of diversion ditches, toe drains, collection ditches and other conveyance features that will route impacted water to the sedimentation facilities.

Areas adjacent to pits will be graded to drain away from the pits. The inflows to the pits will include direct precipitation and groundwater seepage. All pits are expected to receive seepage from the WRDs. The Merian I and Merian II Pits are expected to receive a limited amount of seepage from the TSF. During mining pit, dewatering flows will be pumped to sedimentation facilities before being discharged to receiving streams.

Preliminary geochemical and hydrologic calculations predicted that nitrate and ammonia concentrations below the sediment dams would only exceed the project EDC during low flow periods when there is less dilution from rainfall and runoff in the watersheds. Nitrate/ammonia concentrations at the compliance points are unlikely to exceed the project EDC at any time. In the event that monitoring detects elevated nitrate/ammonia concentrations exceeding performance targets, management will refine the blasting practices to reduce the levels of blasting residuals in the WRDs. If exceedances continue, contingency actions will be implemented to intercept and route seepage from WRDs through treatment lagoons downstream from the Sedimentation Ponds. The details of the contingent nitrate and ammonia removal options considered are provided in the Conceptual Sizing for Nitrate and Ammonia Removal Memorandum (Golder 2012d). Conceptual sizing and siting of biological treatment lagoons for nitrogen removal was considered downstream from Sediment Dam 1. It was concluded that there is adequate space to construct contingent biological lagoons in the valley bottoms downstream from sediment dams, if monitoring determines that they are necessary.

Process impacted seepage (e.g., uncaptured groundwater seepage from the TSF) that reaches Merian I and II pits will also be treated downstream from the sedimentation facilities if monitoring determines that it is necessary.

3.2.3.1 Closure

After mining, when the dewatering pumps are turned off, pits will fill and eventually spill to the surface drainage network by gravity. Pit overflows will be managed as required to meet discharge criteria during closure. Nitrate, ammonia, and metals treatment of mine and process impacted water will continue into closure until concentrations of COPCs at the compliance points reach the EDC.

3.2.4 Tailing Storage Facility Water Control

At full capacity, deposited tailings will occupy the majority of the natural basin area draining to the TSF. The tributary areas upstream of the tailing surface are fragmented and distributed around the perimeter of the basin near the drainage divide. There are no obvious collection points or discharge points. For these reasons, no attempt was made to divert runoff from the basin areas upstream of the tailings. All runoff from the TSF basin will report to the TSF pond.

Flows into the TSF reclaim pond include direct precipitation on the tailings and pond surfaces, runoff from the plant site and other disturbed areas, runoff from the temporary ore stockpile, tailings slurry water from the plant, and run-on from the undisturbed TSF basin area. The TSF reclaim pond will serve as a source of process (reclaim) water for the plant. When the TSF is at full capacity seepage is expected to flow to Las Dominicanas Creek (EP-A0), Merian Creek (EP-B0), and Tomulu Creek (EP-C0) as shown in Figure 2.

3.2.4.1 TSF Reclaim Pond Operation

The ore processing plant (Plant or Mill) will process ore according the mine plan producing slurry that is discharged to the TSF at a nearly uniform rate. A free-water (reclaim) pond will form on the surface of the deposited tailings and water from the pond will be recycled to the mill. The mill will include a CCD circuit and cyanide (CN) destruction circuit that will limit the CN concentration in the slurry. Natural degradation of CN in the pond will further reduce CN levels (see Golder 2012g) for more details). The TSF reclaim pond water will also include nitrate and ammonia, from blasting residue and CN destruction, as well as copper and other metals. The concentrations of these compounds are reduced somewhat in the TSF pond by dilution, but the concentrations of several of these constituents are expected to be above the project EDC. The predicted pond water quality is described in Geochemistry Baseline and Source Water Quality Predictions (2012g).

The TSF operation includes disposal of tailings at spigot points around the perimeter of the basin, usually from dams, dikes, and berms at the head of tributary drainages. When the slurry is deposited, the solids fraction will form a beach and excess water in the slurry will flow to the reclaim pond. Reclaim pumps (likely barge mounted) will remove water from the reclaim pond, returning it to the mill, or pumping it to the WTP for discharge. The location and size of the reclaim pond will be controlled by changing the location of the spigotting and the location and pumping rate of the reclaim pumps.

As presently planned, there will be two barges, one for reclaim water being returned to the mill, and a second for pumping excess water to the WTP for discharge. Seepage captured by the seepage collection and upstream drainage system will be pumped back to the TSF pond.

The reclaim water barge will return water to the mill nearly continuously, throughout the life of mine. The surface of the TSF will allow storage of significant volumes of water. The minimum volume of reclaim water necessary in the pond for mill operation is 2 Million cubic meters (Mm^3), when the volume of the pond is less than 2 Mm^3 the pond is too shallow and tailings become entrained in the reclaim pumps.

During normal operations, water will be pumped from the TSF reclaim pond to the WTP when the volume of the reclaim pond is greater than the minimum target volume (2 Mm^3). The pumping rate from the TSF to the WTP will vary with pond volume. In addition to removing metals and ammonia, one of the functions of the WTP is to supply the hardness necessary to increase the copper criteria at EP-A0. More details regarding required TSF water storage volumes, WTP capacity, and discharge rates to the Las Dominicanas watershed are provided in Merian Site-Wide Water Balance and Mass Balance Mixing Model (Golder 2012a).

3.2.4.2 Water Treatment Plant Operation

The water management plan includes construction and operation of a water treatment plant for excess TSF waters. The WTP will be located on the ridge north of the Phase 1 TSF area and above the TWSR. Water will be pumped directly from the TSF reclaim pond to the WTP. After treatment, the effluent will be discharged by gravity to the TWSR, where it will be released in a controlled manner to A3 Creek, a tributary upstream of Las Dominicanas Creek and upstream of EP-A0.

The TSF pond water is expected to contain ammonia species and some metals at modest levels but potentially higher than in stream discharge requirements. The WTP processes will include breakpoint chlorination for ammonia removal and copper removal using iron and lime precipitation. More details on the conceptual water treatment processes planned for the TSF are provided in the Tailings Storage Facility Water Treatment Plant – Conceptual Feasibility Configuration (Golder 2012h).

3.2.4.3 Treated Water Storage Reservoir Operation

The TWSR has a live storage volume of 2 Mm^3 and a regulating valve/gate that allows stored water to be released as needed. The mean annual inflow volume from the WTP is approximately 7 Mm^3 and the natural tributary basin adds another approximately 6 million cubic meters per year of runoff volume, depending on the hydrologic conditions. Because the annual inflow volume to the TWSR is much greater than the available storage volume, most flow must be immediately released and, in general, the TWSR will be a flow-through system. The water quality in the TWSR is a combination of unimpacted surface water from the drainage basin, flows from the WTP (which are treated to meet surface water discharge criteria for some constituents), and impacted seepage from the TSF that is not captured by the collection system. Because the TWSR has high hardness (a result of lime addition during treatment), released TWSR water has two benefits: 1) direct dilution and 2) increased hardness that also increases the criteria for copper and some other metals.

Releases from the TWSR will be made to meet water quality requirements at EP-A0. The primary COPC for the WTP was identified as copper because it has the highest ratio of predicted concentration relative to ambient criteria. The principal source for copper at EP-A0 is quartz vein (QV) seepage from the TSF that is not captured by the collection system. During most of the year, the natural flows of the basin above EP-A0 will provide the dilution necessary to keep copper and other constituent concentrations below the project EDC. The most critical periods for copper are during the dry season in September and October when flow in the creeks is comprised primarily of baseflow and the WTP is operating at lower levels because the TSF reclaim pond volume has been drawn down to less than 4 Mm^3. During these periods, the constant loading from QV seepage has the potential to cause copper concentrations to exceed criteria. When the potential for this condition occurs, stored water in the TWSR will be released to raise the hardness and copper criteria at EP-A0 and to dilute the QV seepage producing copper concentrations lower than the project EDC. Water balance modeling (Golder 2012a) indicates that 2Mm^3 of live water storage in the TWSR will be adequate to provide the necessary dilution water to Las Dominicanas Creek during dry periods.

Water balance modeling demonstrated that providing a minimum year round release rate of 700 cubic meters per hour (m^3/hr) from the TWSR would achieve Project water quality objectives at EP-A0. Releases greater than 700 m^3/hr will occur most of the time when the TWSR pool is at target operating volume.

3.2.4.4 Tailings Storage Facility Seepage Management

Seepage from the TSF will be controlled by a seepage collection system consisting of the following components:

- A drainage system upstream of TSF Main Dam 6 to lower piezometric heads driving seepage through the quartz vein system, reducing the quantity of quartz vein seepage from the TSF.
- Seepage collection drains downstream of the TSF dams to capture shallow seepage through the alluvium and the shallower parts of the quartz vein system.
- Seepage collection wells located downstream of the TSF dams to capture seepage through deeper parts of the quartz vein systems and the fractured saprock and fractured bedrock layers.
- Surface seep control drains installed perpendicular to the larger dams to capture upward flowing seepage that is predicted to reach the ground surface close to the dam toes.

Seepage collection around the TSF perimeter will be implemented in three stages in coordination with the TSF dam construction (main dams, saddle dams, and berms) and tailings deposition sequence and in response to surface water and groundwater monitoring data from points downstream. The staging for the seepage collection system and more detail on its components are provided in the Seepage Collection Systems Tailing Storage Facility memorandum (Golder 2012c).

A monitoring system will also be installed in conjunction with the seepage collection. The sequence of implementation for the monitoring and seepage collection system is part of the adaptive water management plan (see Section 4.0) and will be as follows:

1. Install monitoring wells at compliance points, interim compliance locations and operational monitoring locations (described in Section 4)
2. Conduct field investigations to assess presence, location and extent of quartz veins. Design seepage collection systems at each dam to capture identified quartz vein seepage.
3. Install seepage collection drains and wells at main dams in year 0 (Stage 1).
4. Install seepage collection drains and wells at smaller saddle dams and higher ravines that may contain quartz veins in advance of tailings deposition that generates a driving head for seepage at these locations (Stage 2).
5. Install seepage collection drains and additional wells downstream of Stage 1 or 2 (as applicable) components if groundwater or surface water quality impacts are observed at monitoring locations downstream of the collection systems (Stage 3).

Additional information and detail is provided in the Seepage Collection Systems Tailing Storage Facility memorandum (Golder 2012c).

3.2.4.5 Closure

At the end of mining, the WTP will continue to operate until water quality in the TSF can be discharged and meet the EDC at the compliance points. At that time, pumping of reclaim pond water to the WTP will cease and the TSF will fill and begin to overflow at the closure spillway draining to EP-A3.

Post closure, the seepage collection system will continue to operate and deliver TSF seepage to the WTP for treatment until monitoring shows that seepage can be released without treatment and meet the EDC at compliance points.

4.0 MONITORING, ADAPTIVE MANAGEMENT AND REPORTING

The Project will implement a site-wide water monitoring and adaptive management program to meet operational needs and environmental requirements. The adaptive water management approach includes controls, monitoring, adaptive actions, and contingencies that will be used to protect human health and the environment in receiving waters. Monitoring data will be used to refine and calibrate the operational site-wide water balance model, establish and refine performance targets for water management controls, track performance of controls, and support adaptive water management.

Key Performance Indicators for water management will be monitored at points throughout the system and downstream from project activities to confirm that water management controls are functioning as intended. In the event that a Key Performance Indicator is found not to meet performance targets, control measures will be adapted until performance is improved to the target levels. If ongoing monitoring indicates that controls are not meeting performance targets after adaptive actions have been taken, contingent actions can be taken. More details regarding the planned controls, monitoring triggers, associated adaptive actions, and contingencies are provided in Section 5.0.

The performance of water management controls will be monitored at points throughout the system to verify that targets are being met. Monitoring to assess performance will include:

- Climate monitoring (rainfall, temperature, evaporation)
- Operational monitoring
  - Ore geochemistry
  - Tailings discharge quality (end of pipe)
  - TSF reclaim pond levels and quality, discharge quantity (various locations)
  - TWSR pond levels, discharge quantity and quality (end-of-pipe)
  - Sedimentation Pond effluent quantity and quality (end-of-pipe)
- Water quantity and quality in the seepage collection system
- Interim evaluation monitoring
  - Groundwater levels and groundwater quality
  - Surface water quantity and quality (e.g., sampling at interim evaluation points such as EP-A3, EP-A4, EP-B1, EP-B2, and EP-C1)
  - WTP discharge quantity and quality (influent and effluent)
- Compliance monitoring
  - Groundwater levels and groundwater quality at compliance locations
  - Surface water quantity and quality (e.g., sampling at compliance points such as EP-A0, EP-B0, and EP-C0)

The existing and proposed surface water and groundwater monitoring locations that will be used to assess the performance of water management controls are shown in Figure 3. At operational monitoring locations, end-of-pipe discharges, and interim evaluation locations, Key Performance Indicators will include COPCs for the given flow stream at that location. At compliance points, Key Performance Indicators will include all parameters listed in the EDC. Key Performance Indicators will be sampled at a frequency that varies with the location. Details of the sampling procedures are provided in the Sampling and Analysis Plan (Golder 2012i).

Reporting of water monitoring data and results or revisions of the water management plan will be submitted to NIMOS as required. If no legal requirements are applicable, the monitoring program will be developed to demonstrate that closure success criteria have been met. An appropriate timeframe for continued monitoring post closure will be based on the success of progressive reclamation and the results of monitoring during operations. With most long-term monitoring programs, required sampling intervals and locations can be reduced with time as the system reaches steady state.

5.0 CONTINGENCY PLAN

Because the actual performance of the mine water management system will not be known until actual mine operation begins, the monitoring and adaptive water management strategy developed for the Project provides a framework for identifying the major risks and associated controls, performance indicators, adaptive management actions, and contingency measures to mitigate water quality impacts associated with those risks. An overview of the adaptive water management plan for the major risks identified for the Project based on the preliminary design is provided in Table 1.

GOLDER ASSOCIATES INC.

Michael L. Brown, PE
Principal

MLB/km

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TABLE

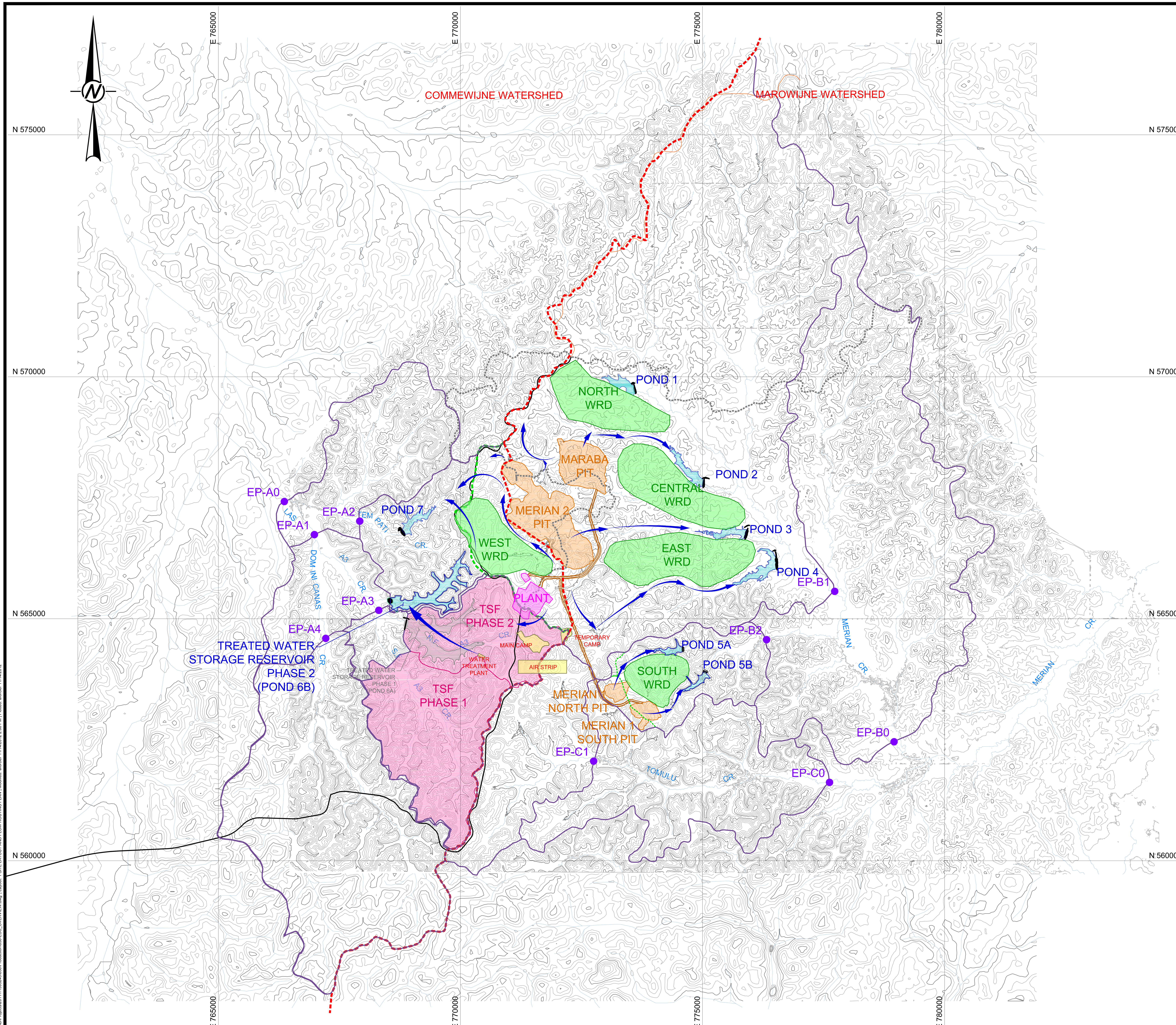
Table 1: Overview of Planned Controls, Monitoring Triggers, Adaptive Actions, and Contingency Plans for Water Management

Water Management Focus	Planned Controls	Monitoring Trigger	Adaptive Actions	Contingencies
Erosion and Sediment	Source erosion control BMPs Intermediate controls throughout the conveyance system Perimeter sediment ponds upstream from all major disturbances	TSS concentration at outlet of perimeter sediment pond above target level.	Implement additional source erosion control BMPs Add floc logs in conveyance channels	Adjust flocculent dosing in pond/Add flow curtains to pond
Mine Impacted Seepage and Runoff from Pits and WRDs	Runoff and seepage from all pits and WRDs routed to perimeter sediment ponds to reduce TSS	TSS or other COPC concentration at outlet of perimeter sediment pond above target level.	Implement additional erosion control BMPs in pits or WRDs Adjust blasting practices to reduce residual nitrogen loads in pits and WRDs	Add treatment for Nitrate /or Ammonia downstream from the perimeter sediment control ponds
Prevent Water Shortage	Provide adequate storage in TSF to supply required reclaim flows for production Pump freshwater makeup from wells near the plant site.	Water levels in the TSF decant pond drop below target	Adjust TSF decant pond operating procedures to store more water for dry season use.	Adjust TSF dam raise sequence to provide more water storage volume for dry season use.
TSF Source Water Quality	CCD/Detox Circuit to reduce CN concentrations in tailings slurry. Maintenance of a pond area large enough to encourage natural CN degradation.	COPC concentration in TSF reclaim pond higher than target	Increase target volume in TSF reclaim pond to: ▪ increase surface area and enhance CN degradation ▪ reduce impact of short-term spikes in tailings slurry COPC concentrations on overall TSF reclaim pond concentration Segregate WTP sludge from tailings in containment facility separate from TSF reclaim pond	Shut down processing plant if concentrations of COPC's in TSF reach trigger point and wait for freshwater dilution from precipitation and run-on
TSF Perimeter Controls	Containment and Seepage Collection System	COPC concentration at interim groundwater monitoring location approaches trigger point	Identify sources of COPCs, both quantity and quality, by localized sampling, trenching and drilling. Evaluate alternative means for collecting and/or controlling discharges. Extended Drains, Deeper Drains Drilling Wells to intercept additional QVs and penetrate fractured rock.	Grouting of quartz veins Increase grinding to produce finer tailings and lower permeability. Maintain dry beach for desiccation consolidation Expand TSF Area to reduce driving head for seepage
	Excess TSF Water Treatment Plant	COPC concentration in WTP effluent higher than target	Provide additional treatment for nitrate or ammonia Construct anaerobic biochemical reactor and wetland Add sludge recycle to the WTP process to reduce metals	Pump the TWSR discharge into the Merian watershed to increase the assimilative capacity of receiving streams Temporarily shut down WTP and store in TSF

Table 1 (Cont.)

Receiving Water Quality Downstream from TSF	TWSR for controlled release and blending of treated water to provide dilution of baseflows and increase hardness at EP-A0 raising hardness-dependent water quality limits Limestone lining to increase hardness and raise limits for dissolved constituents at EP-C1	Hardness at EP-A0 below target COPC concentration at interim surface water monitoring location approaches trigger point COPC concentration at compliance point approaches limit	Modify TWSR release strategy to achieve improved results Add hardness to TWSR effluent water Add additional hardness at EP-C1adding lime	Construct a freshwater reservoir at the head of the drainage to supply additional baseflow dilution water Pump groundwater with higher hardness into freshwater reservoir or directly to receiving waters Add hardness to freshwater reservoir Pipe WTP directly to EP-A0 to increase the effectiveness of the hardness.

FIGURES



LEGEND

	CONTOUR (25m INTERVAL)
	WATERSHED DIVIDE (MAROWIJNE-COMMEWIJNE)
	SURFACE WATER DIVIDE
	GROUNDWATER DIVIDE
	GROUNDWATER MODEL BOUNDARY
	RIGHT OF EXPLOITATION
	CREEK (APPROXIMATE)
	PLANT
	PIT
	WASTE DUMP
	TAILINGS STORAGE FACILITY (TSF)
	SEDIMENTATION POND
EP-A0	EVALUATION POINT
	FLOW DIVERSION

NOTES

WGS 84 DATUM - UTM ZONE 21N - GEOID EGM2008 - CONTOUR INTERVAL : 1m. CONTOURS FROM LIDAR SURVEY (MAY 2011)

CONTOUR LINES ARE NOT THEIR ACTUAL ELEVATIONS,THEY HAVE BEEN INCREASED 500m

0 1,600 3,200 4,800 m

SCALE

PROJECT

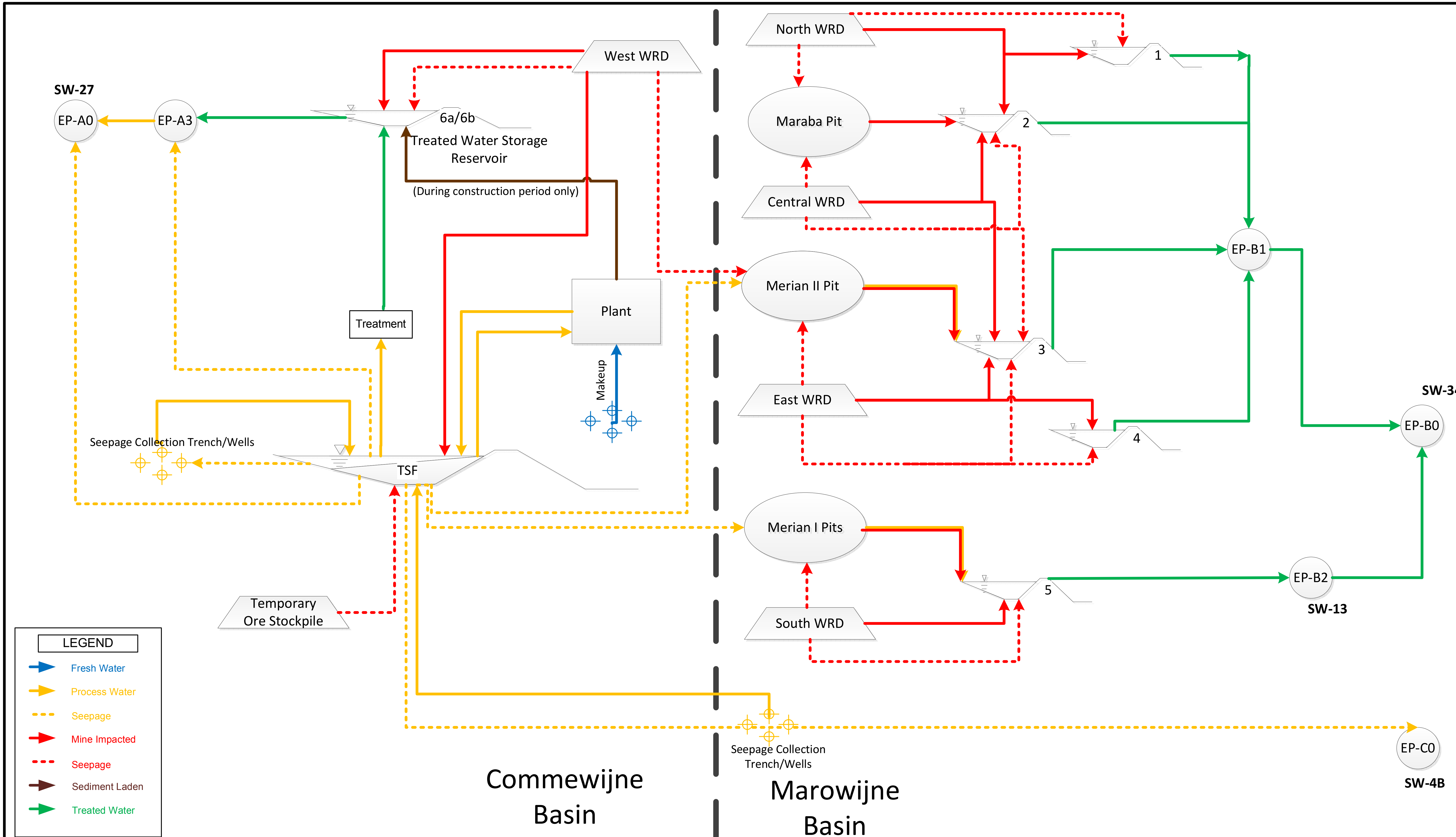
MERIAN GOLD PROJECT

TITLE

SITE LAYOUT AND FLOW ROUTING PLAN

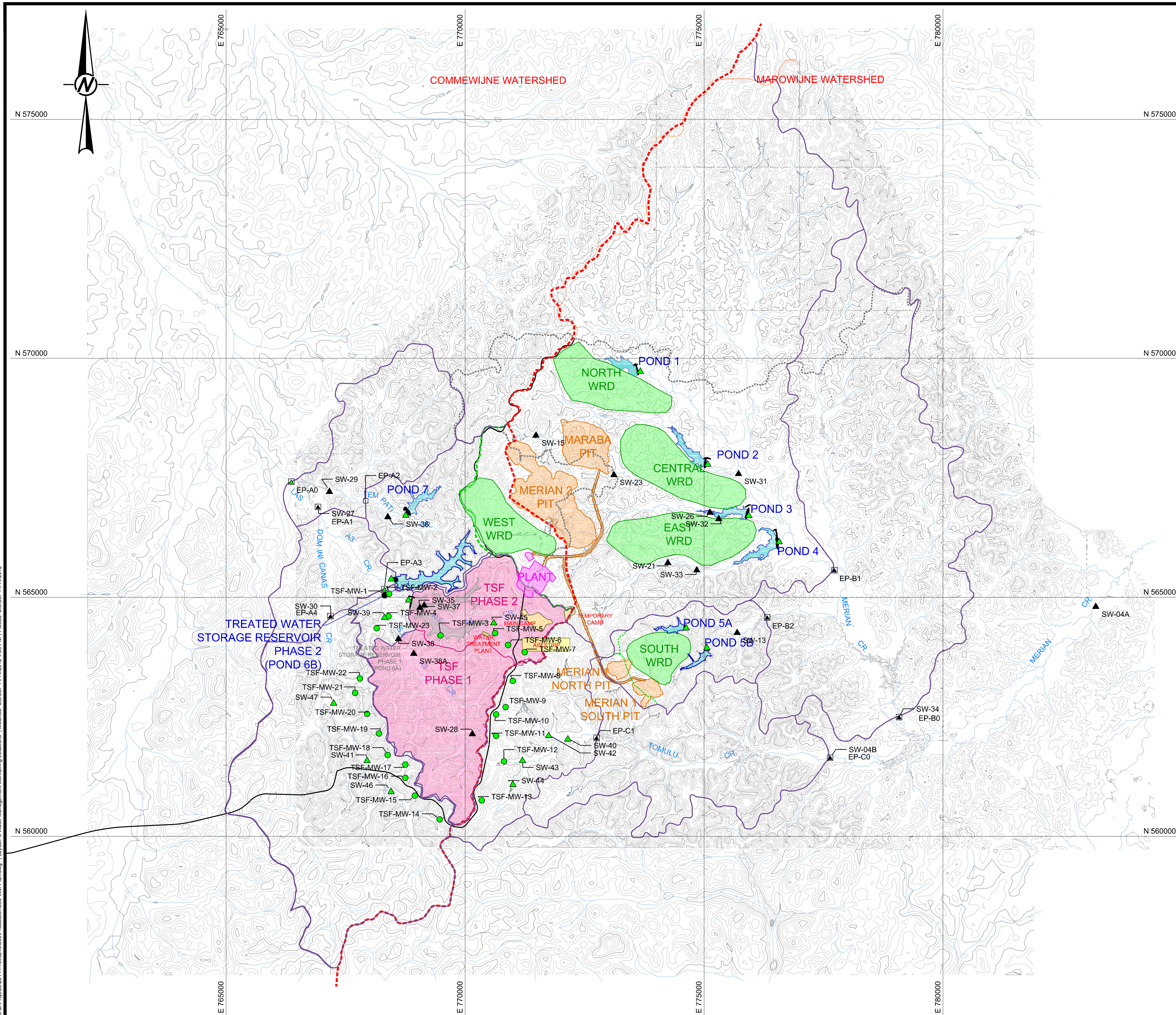
Golder Associates

PROJECT No.	113-93245	FILE No.	850-ESC_OVERVIEW
DESIGN		SCALE	AS SHOWN
CADD			
CHECK		FIGURE 1	
REVIEW			



Golder Associates | SURGOLD

PROJECT/REPORT Merian Gold Project – Water Management Plan	PROJECT NO 11393245.850
TITLE Conceptual Flow Diagram	FIGURE 2



LEGEND

- CONTOUR (25m INTERVAL)
- WATERSHED DIVIDE (MAROWJINE-COMMEWJINE)
- SURFACE WATER DIVIDE
- GROUNDWATER DIVIDE
- GROUNDWATER MODEL BOUNDARY
- RIGHT OF EXPLOITATION
- CREEK (APPROXIMATE)
- PLANT
- PIT
- WASTE DUMP
- TAILINGS STORAGE FACILITY (TSF)
- SEDIMENTATION POND

- TSF-MW-1 — EXISTING MONITORING WELL
- TSF-MW-23 — PROPOSED MONITORING WELL
- SW-36 — EXISTING SURFACE WATER MONITORING STATION
- SW-43 — PROPOSED SURFACE WATER MONITORING STATION
- EP-A3 — EVALUATION POINT AND EXISTING SURFACE WATER MONITORING STATION
- EP-A0 — EVALUATION POINT AND PROPOSED SURFACE WATER MONITORING STATION
- EP-A2 — EXISTING EVALUATION POINT

NOTES

WGS 84 DATUM - UTM ZONE 21N - GEOID EGM2008 - CONTOUR INTERVAL : 1m. CONTOURS FROM LIDAR SURVEY (MAY 2011)

CONTOUR LINES ARE NOT THEIR ACTUAL ELEVATIONS,THEY HAVE BEEN INCREASED 500m

0 1,600 3,200 4,800 m

SCALE

PROJECT

MERIAN GOLD PROJECT

TITLE

WATER MANAGEMENT MONITORING LOCATIONS

Golder Associates

PROJECT No.		113-93245	FILE No.	850-WM-Plan
DESIGN	JE	11-12-12	SCALE	AS SHOWN
CADD	ACF	11-12-12		
CHECK	JE	11-12-12	FIGURE 3	
REVIEW	MB	11-12-12		

REPORT

EROSION AND SEDIMENT CONTROL PLAN

Merian Gold Project, Suriname

Submitted To: Suriname Gold Company, LLC
Surinamstraat 54
Paramaribo, Suriname

Submitted By: Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052 USA

November 12, 2012 **Project No. 113-93245.854**

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Table of Contents

List of Tables (In text)

List of Figures

List of Appendix

1.0 INTRODUCTION

This Erosion and Sediment Control (ESC) Plan for the Merian Gold Project (Project) is one element of the project's Adaptive Water Management Plan. The ESC plan provides guidance for methods to address disturbances caused by mine construction and operational activities in order to reduce the potential for soil erosion and sediment-laden surface water leaving the site.

1.1 Erosion and Sediment Control Plan Scope

The ESC Plan addresses soil erosion, channel erosion, and removal of total suspended solids (TSS) within surface water flow. Given the tropical climate at the project site, dust control is not expected to be a frequent problem; therefore, this document focuses on erosion caused by surface water coming into contact with disturbed areas, and dust control is discussed only briefly in Section 2.1. The ESC Plan does not address the water quality of runoff or groundwater that might be impacted by geochemical processes, chemical spills, chemical handling, or the impacts of mine processes, which are addressed in other documents such as the Geochemical Baseline Report (Golder 2012a) and Chapter 19 of the Environmental and Social Impact Assessment (ESIA) (ERM in progress). Potential impacts from chemical handling and spills will be addressed in the mine's Spill Prevention and Control and Countermeasures Plan (SPCC).

During development and operation of the Merian Gold Project, major earthworks will be required to construct the mine facilities. These major earthworks will cause disturbance to the existing vegetative ground cover, which will increase the potential for erosion caused by surface water runoff. The goal of the ESC Plan is to reduce the amount of suspended sediments in the water leaving the mine site, in order to minimize the impacts on downstream waterways. The major earthworks include the construction and operation of the following mine facilities:

- Haul roads and other access roads
- Open pit mines
- Waste rock disposal areas (WRDs)
- A Tailings Storage Facility (TSF)
- Mine Operations Facilities: processing plant, maintenance shops, and power plant
- Water treatment plant (WTP)
- Treated water storage pond (TWSR) and sediment ponds
- Borrow and Stockpile areas
- Air strip
- Accommodation camps, potable water treatment facilities, and sanitary treatment facilities
- Landfill and waste management facilities

A map of the major project facilities, including surface water conveyance and control facilities, is shown on Figure 1.

1.2 Categories of Erosion Control Measures

The ESC Plan centers around three categories of ESC measures based on their location in preventing sediment-laden water from exiting the site:

- Source Controls: Actions implemented directly at the disturbed area, which are designed to prevent erosion processes and reduce the quantity of suspended sediments in water leaving the disturbed area. These actions are referred to as Best Management Practices (BMPs) adopted by the mining industry at many locations. Recommended source control measures are identified and described in Section 3.0.
- Intermediate Controls: Actions implemented downstream of disturbed areas in shallow concentrated flows and channel flows traversing the mine site, which are designed to reduce erosion caused by surface water flow and promote settlement of suspended sediments. These are also BMPs. Recommended intermediate control measures are identified and described in Section 4.0.
- Perimeter Controls: Ponds constructed at the downstream extents of the site where water is leaving the site. The perimeter control measures for this site are the sediment ponds described in Section 5.0.

1.3 Construction and ESC Implementation Sequence

The project construction must be planned with respect to the sequence of disturbances and implementation of associated ESC measures. The general construction sequence presented below will minimize erosion and sediment impacts caused by the construction of mine site facilities.

1. Construct access and/or haul roads and staging areas for the new facility, stabilizing the roadway base and surfacing materials as construction proceeds. Simultaneously, construct source and intermediate controls applicable to this activity. Limit clearing of vegetative cover to areas needed to install ESC BMPs.
2. Construct sediment ponds downstream of the planned disturbance, if not already constructed. Construct source controls associated with the construction of any sediment or tailings storage dams.
3. Working upstream from the sediment dams, construct the intermediate controls (such as check dams, sediment traps, and conveyance channels) up to areas of planned disturbance.
4. Construct diversions or barriers that direct clean run-on water around the planned disturbance or work areas.
5. Begin clearing and construction of planned mine site facility. Use adaptive controls to augment any BMPs that are not functioning as intended.
6. Stabilize disturbed areas as the work progresses using the source control BMPs such as seeding and mulching and slope contouring.
7. Regularly maintain all ESC measures, remove trapped sediments, and use adaptive controls as needed to reduce the amount of sediment-laden water from leaving the site.

8. When construction activities are complete, remove source controls that are no longer required. Retain intermediate and perimeter controls until closure or progressive closure renders them unnecessary.

The sequencing of construction and implementation of BMPs are critical to the prevention of erosion and sediment transport. Whenever possible downstream sediment dams should be in place prior to the initiation of construction; also, when possible, construction should be performed during the dry season, typically September and October.

Source and intermediate BMPs should be implemented prior to and/or during activities that disturb surface soils. The erosion control measures presented in this report do not act as stand-alone controls and are intended to create a comprehensive erosion and sediment control system from upstream of planned disturbances to the downstream extents of the Project. Additional erosion control systems may be installed in conjunction with the various phases of construction, as necessary to respond to changes in site conditions.

1.4 Selection Criteria

Section 2.0 of this report describes possible erosion source control measures that may be suitable at various locations across the project site. These controls were selected based on the following criteria:

- Effectiveness
- Implementation, maintenance and closure costs
- Temporary vs. permanent BMP
- Environmental compatibility
- Regulatory acceptability (as outlined by Surgold, ESIA, and local requirements)
- Availability
- Durability
- Longevity
- Ability to achieve vegetation establishment within project schedule
- Technical feasibility
- Risk/liability

The availability of products within the region is important to the selection of a surface erosion control method. Some erosion control materials may not be available locally. Native plant species and/or local agricultural products may provide more appropriate materials.

2.0 EROSION AND SEDIMENT CONTROL FOR MAJOR EARTHWORKS

This section describes erosion control measures that can be taken at various earthworks construction facilities. Erosion control should be implemented using the general construction sequence identified in Section 1.3 and the control methods identified in Sections 3.0, 4.0, and 5.0. A unique site-specific plan should be developed for each planned major earthwork prior to commencing construction, and the plan should be evaluated continuously throughout all stages of disturbance. Adaptive measures should be implemented if site conditions differ, or as needed to modify or augment erosion and sediment control measures to ensure these measures function properly.

2.1 Haul Roads and Access Roads

Haul roads and construction roadways should be graded to follow natural contours to the extent possible, avoiding the creation of steep slopes. This grading will minimize concentrated flows, reduce the velocity of runoff, and improve re-vegetation success. Long slope lengths, which are linked to erosion development, can be minimized by using benches, terraces, contour furrows, or diversion ditches.

Stream crossings should be designed to provide stream bank stabilization, protect streambeds from damage, and minimize sediment loading from construction traffic. Whenever possible, stream crossings should be located along a straight portion of the stream, to reduce the risk of bank erosion. If it is not possible to cross along a straight section, the banks of the stream should be stabilized using riprap, concrete, mats, biobags, sandbags, or a vegetative buffer, depending on the potential for erosion. Clearing of vegetation near or at road crossings should be avoided, whenever possible, which will also reduce bank erosion.

In order to maintain the roadways, prevent movement of soils due to construction and operation traffic, and reduce erosion, roadway base and/or surfacing material should be placed on all traffic bearing surfaces and staging areas. Conveyance channels constructed parallel to the roadway will reduce excessive erosion and rutting from construction traffic. These conveyance channels should divert water to a sediment pond before discharging into natural waters.

Although airborne dust is not expected to be a frequent problem, water can be applied to roadway surfaces for dust control, as needed.

2.2 Cut and Fill Slopes

Cut and fill slopes will be required to construct mine facilities. The angle of cut and fill slopes should be selected based on 1) the soil type, 2) slope stability, and 3) installation and maintenance requirements for erosion and sediment control. Slopes should have a maximum slope angle of 2H:1V (horizontal:vertical) if possible. Slopes that will require use of heavy equipment for installation or maintenance of vegetation should be limited to 3H:1V. Steeper slopes will require more robust erosion and sediment controls, such as slope contouring and erosion control mats.

2.3 Stockpiles

Temporary stockpiles of soils and other materials will be constructed as part of the site works. The resulting embankments will present a risk of soil erosion. Soil stockpiles should be constructed to reduce this risk by protecting them using any combination of the source control methods discussed in Section 3. Soil stockpiles should be stabilized as soon as practical. When vegetative stabilization is not practical, stockpiles may be protected using tarps or other methods.

2.4 Tailings Storage Facilities and Sediment Ponds

Several dams will be constructed around the perimeter of the mine site. Sediment control dams are discussed in detail in Section 5.0. Prior to construction of the TSFs, a temporary sediment dam (cofferdam) will be constructed upstream of the TSF starter dam (MD6) for water and sediment control during construction. Sediment Dam 6 will be constructed as a perimeter sediment control facility as well as the Treated Water Storage Reservoir that will store treated TSF water for controlled release during low flow periods. Source controls and intermediate controls will be implemented as necessary around the planned dam construction sites to minimize disturbed runoff associated with construction of the dams.

The TSF dam and dike system will include a perimeter road located beyond the downstream toes of the dams and dikes. This road will provide access as well as sediment control during and after construction by impeding runoff from the dam surfaces and providing controlled release of flows to locations downgradient. Culverts and small sediment traps will be constructed on the up-gradient side of the road to collect sediment.

2.5 Waste Rock Disposal Areas

The active faces of the WRDs will be continuously changing as material is added. Therefore, while the WRD is active, erosion control will be limited to benching. When a WRD face is inactive for an extended period, the slopes will be vegetated to provide erosion control.

Surface runoff and seepage from the WRDs will be routed to sedimentation facilities prior to discharge to receiving streams. Figure 1 shows the conceptual routing of flows that will be achieved using a combination of diversion ditches, toe drains, collection ditches, and other conveyance features that will route impacted water to the sedimentation facilities.

2.6 Mine Pits

The mine pits are expected to require continuous dewatering by pumping water out of the pits. The inflows to the pits include direct precipitation and groundwater seepage. Areas adjacent to pits will be filled and graded to divert water away from the pits.

During mining, the pit dewatering flows will be pumped to channels leading to a sediment pond before being discharged downstream. Sedimentation from dewatering activities at the Maraba, Merian I and Merian II pits will be routed to Sediment Ponds 2, 3, 5A, and 5B. Figure 1 shows the conceptual routing of flows that will route impacted water to the sediment ponds. To prevent localized erosion, an energy dissipater may be required at the outfall of the pump discharge.

3.0 SOURCE CONTROLS

Source controls address erosion before it begins, by protecting surficial soils from being detached and transported by movement of water or wind. Whenever possible erosion source controls should be used as the primary protection, with intermediate and perimeter sediment controls used as secondary protection. Typical details of the source control measures are shown in Appendix A.

3.1 Run-On Diversion

Diversion dikes and diversion swales (or diversion channels) are used to intercept, divert and convey surface runoff; diversion of water running onto work areas (run-on) prevents water from reaching erodible areas. Run-on diversions are typically constructed at the top of cut slopes or around the perimeter of disturbed areas. A diversion dike is a temporary ridge of compacted soil, stabilized with vegetation that channels water away from the disturbed area. Diversion swales or channels are drainage channels lined with grass, riprap, concrete or other materials that convey runoff around the construction perimeter to a less harmful discharge location. Run-on diversion should be constructed around all disturbed areas that have an upstream contributing watershed.

Diversion dikes and channels require less maintenance than linear sediment barriers such as silt fences or fiber rolls. These dikes and channels are also more economical, and when properly constructed provide more durable erosion control. Typically, temporary diversion dikes are appropriate for drainage basins up to 2 hectares, but can be modified to handle up to 4 hectares.

Design and Construction Considerations:

- Run-on diversion should be constructed and fully functional before ground disturbance begins.
- For slopes along diversion where traffic will cross, minimum slope should be 3H:1V, and the traffic area should be constructed of gravel in place of soil.
- Before excavation or placing fill, all trees, brush, stumps, and other objectionable materials should be removed from the path of diversion structure.
- Diversion structures should be constructed to adequately convey design flows based on evaluation of erosion potential, soil types, over-topping, flow backups and washout.
- Use in conjunction with other sediment control devices as necessary to prevent erosion in newly constructed diversion structures.
- Stabilize swales or channels as appropriate considering expected flow velocities.
- Compact placed fill to avoid settlement issues.
- Grade channel to maintain positive drainage to a stabilized outlet, adjusting field conditions as necessary. The channel should have no low points, or dips, where stormwater can collect.
- Channel outlet protection may be required.

- For diversion structures that will be used for more than 15 days, all exposed areas should be revegetated immediately after construction.

Maintenance:

- Inspect diversion structures at least once every 2 weeks, or before, during, and after rain events, for evidence of erosion or deterioration.
- Inspect earthen diversion dikes and swales after each major rainfall event to ensure continued effectiveness.
- Maintain dikes at their designed height. Decreases in height due to settlement or erosion should be repaired immediately.
- Inspect swales for washouts and replace lost channel lining as needed.
- Inspect linings, embankments, channel beds, and berms for accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed.
- Remove temporary diversion structures as soon as drainage area has been stabilized, or upon completion of construction.

3.2 Grading and Benching

Grading is used to direct overland flow (runoff) on work areas away from erodible disturbed areas and towards receiving streams. Grading practices should be integrated with construction. Grading minimizes the duration of exposure and the area of erodible soils. Grading and construction in areas with highly erodible soils, or areas adjacent to receiving waters, should be limited so erosion can be controlled effectively. Design considerations should take into account existing contours, drainage patterns, vegetation, slope length, slope angle, and erosion potential.

Site grading that fits the existing topography will minimize erosion potential. Whenever possible, natural drainage patterns should be maintained. Graded areas, especially sloped areas, should be constructed in a way that will facilitate revegetation. Cut and fill slopes, unless cut into competent rock, should be no steeper than 2H:1V.

Benching, or grading terraces, are ridge and channel systems that reduce erosion by shortening the slope length, decreasing runoff velocities, and collecting and redistributing runoff to stable outlets. Benching holds moisture and helps trap sediments, which decreases sediment-laden runoff. Benching is only effective if an adequate outlet is available. Benching is not suitable for rocky or sandy slopes, as benching in these areas may not properly redirect flow. Water permeating into the bench soils may cause sloughing and damage.

Design and Construction Considerations:

- Grading and benching are only effective if an adequate outlet is available such as a grassed waterway, vegetated area, or tile outlet. The outlet must convey water to a place where the outfall will not cause damage.

- Benching is not suitable for rocky or sandy slopes as these areas may not properly redirect flow. Excessive water permeating into the bench soil may cause sloughing.
- Graded and benched areas should be stabilized with appropriate BMP's, such as seeding and mulching, with the exception of waste rock piles.

Maintenance:

- Inspect benches regularly and after all major storm events.
- Inspect benches for erosion, washouts, and accumulation of debris and sediment. Repair as needed, and remove any debris and sediment.

3.3 Slope Contouring

Slope contouring measures, such as fiber rolls, may be used to reduce the velocity of water traveling down a slope by effectively reducing the slope length and the likelihood of gullies forming. The following slope contouring controls are not stand-alone practices, and must be used in conjunction with other erosion control methods, primarily revegetation.

3.3.1 Fiber Rolls (or Equivalent)

Fiber rolls are placed along the face of newly constructed, or recently disturbed, slopes to shorten slope lengths and reduce runoff velocities. Fiber rolls are small cylindrical barriers composed of biodegradable fibers, such as rice, straw, wood, coconut fibers or composted material, encased in photodegradable open weave netting. An equivalent approach suitable for the Project would be to use downed trees in a similar application.

Fiber rolls are an effective control for intercepting runoff, reducing flow velocity, relieving runoff as sheet flow, minimizing rill and gully development, and providing limited sediment retention for stockpiles and constructed slopes. Additionally, the soil and moisture trapped by the fiber rolls provide a favorable habitat for revegetation. Fiber rolls are adaptable to slope applications and contour installations. The rolls blend in with the landscape, do not obstruct revegetation efforts, and can be removed or left in place. Fiber rolls are most successful where flows do not exceed flood tolerances and are sufficient to keep the base of the roll wet during the growing season. In order for fiber rolls to be effective, they must be trenched, staked, and have sufficient diameter. Fiber rolls require relatively minimal maintenance, but removal of fiber rolls can be difficult when wet or saturated. Fiber rolls are not appropriate on slopes that are subject to creep, slumping, or landslides.

Design and Construction Considerations:

- Fiber rolls must be trenched, staked, and have sufficient diameter to be effective.
- Fiber rolls are not appropriate on slopes subject to creep, slumping, or landslides.
- Fiber rolls should be installed in a trench, along contour, and perpendicular to flow.

- Fiber roll spacing is dependent on slope, as shown in Appendix B.
- Begin building trenches and installing fiber rolls at the base of the slope and work uphill.

Maintenance:

- Fiber rolls should be inspected regularly for damage or signs of wear and tear, such as that done by equipment traffic, or for rilling below fiber rolls.
- Inspect fiber rolls immediately after a rainfall produces runoff, to ensure they remain thoroughly entrenched and in contact with the soil.
- Repair or replace split, torn, unraveled or slumping fiber rolls.
- Fiber rolls require relatively minimal maintenance, but removal of fiber rolls can be difficult when wet or saturated.
- Securely knot each end of fiber roll. Abut adjacent rolls tightly, end to end, without overlapping the ends.

Example of a Fiber Roll:

Equivalent approaches to fiber rolls also exist. At the Merian project, downed trees have been used during the mine exploration in a similar manner to intercept flow and reduce flow velocity. Like fiber rolls, the trapped soil and moisture provide a favorable habitat for revegetation. The downed trees also blend in with the landscape, do not obstruct revegetation efforts, and can be left in place. For downed trees to be effective, they must have sufficient diameter and size (weight) for the specific flow application. Site experience during the exploration phase showed that downed trees with diameters of approximately 200 mm to 500 mm were most effective and could be placed with local labor and light equipment. Downed trees are not appropriate on slopes that are subject to creep, slumping, or landslides.

3.3.2 *Soil Roughening*

Soil roughening is the creation of soil surface roughness by mechanical means, such as sheepsfoot rolling, track walking, scarifying, stair stepping, or imprinting. Soil roughening slows runoff, enhances infiltration, moderates soil temperature, traps moisture, and aids in seed germination and root penetration.

This measure is inexpensive and can be done with readily available equipment. Soil roughening provides moderate erosion protection while vegetation is being established. Because it is easy to implement, soil roughening is especially appropriate for soils that will continually be disturbed throughout the life of the Project.

Design and Construction Considerations:

- Soil roughening is best suited for slopes that are 3H:1V or greater.
- Soil roughening should be done after final grading of all construction, in patterns that are created parallel to slope contours (perpendicular to direction of runoff).
- Soil roughening is not appropriate for rocky soils.
- Avoid excessive compaction of soil surface, as it will inhibit vegetation growth and cause higher runoff speeds.
- Do not grade or scrape final roughened face.
- Roughened surfaces should be vegetated as soon as possible.
- Roughening could be washed away in heavy rainfall, and would require re-roughening of the surface and reseeding.

Maintenance:

- Inspect roughened slopes regularly, and after major storm events. Re-roughen as required.
- Routine inspections should indicate whether additional erosion control measures are required.
- Repair areas where erosion has occurred as soon as possible by filling, regarding, and reseeding.

3.4 Linear Barriers and Silt Fence

Linear barriers are temporary control measures that intercept sediment-laden runoff, preventing the runoff from exiting the source area. Examples of linear barriers may be silt fences, brush filters, compost berms or socks, or fiber rolls.

Silt fences are common temporary sediment barriers constructed of a synthetic filter fabric stretched across wooden or metal posts, designed to separate sediments from sheet flow runoff. Silt fences should be placed near the base of disturbed areas, where sediment-laden water can pond. Silt fences are intended to handle runoff from small areas, and should not be used for large slopes or in areas of concentrated flow.

Silt fences should not be used where concentrated sheet flow exists, the slope length above the silt fence exceeds 100 feet, or the size of the drainage area is greater than ¼ acre per 100 linear feet of fence

Design and Construction Considerations:

- Install silt fences prior to major soil disturbances.
- Silt fences should not be used where concentrated sheet flow exists, the slope length above the silt fence exceeds 30 meters, the slope steepness is greater than 1H:1V, or the size of the drainage area is greater than 0.1 hectare per 30 linear meters of fence.
- Silt fences are not designed to handle open channel flow, and should therefore not be placed across streams, channels or drainages
- Construct silt fences near the base of disturbed areas, where sediment-laden water can pond.
- Install silt fence along a line of uniform elevation, perpendicular to the direction of flow.
- Maximize detention of storm water by placing fences as far from the toe of slope as possible, without encroaching on sensitive areas, or outside of the clearing boundaries.
- Install the ends of the silt fence to point slightly up-slope to prevent sediment from flowing around the ends of the fence.
- During excavation, minimize ground disturbance around the trench as much as is feasible and smooth the surface following excavation to avoid concentrating flows.
- Ensure that the base of the fence is securely trenched into the slope.
- Concentrated flows uphill from silt fence must be intercepted and conveyed to settlement pond.

Maintenance:

- Inspect silt fences weekly and before, during, and after major storm events.
- Remove sediment when it reaches ⅓ of the exposed fence height.
- Inspect regularly for areas that have been eroded beneath the fence, or for sagging or collapse in the fence, causing runoff to flow over the top. Repair deficiencies immediately.
- Inspect regularly for signs of fence clogging, which causes the fence to act as a barrier to flow rather than a filter. Clean or replace clogged sections.
- Remove fences when land disturbing activities are sufficiently completed to allow permanent soil stabilization.

Example of a Silt Fence:

3.5 Stabilization

Preserving existing vegetation and promoting rapid revegetation of disturbed areas is the most efficient way to control erosion. Vegetation reduces erosion by shielding the soil surface from direct impact from water or wind, improving soil's water storage capacity, decreasing the runoff velocity, and trapping particulates in place with the root system. All disturbed areas will require stabilization, and should be seeded and mulched as soon as practical. Vegetative cover can be grass, trees, or shrubs.

3.5.1 Seeding

Seeding establishes a permanent, perennial vegetative cover on areas disturbed by construction activities. Seed mixtures should be based on rapid-growing native vegetation. The use of native, indigenous or naturally occurring grasses is recommended, as they will evolve in a manner that will not compete with or preclude the establishment of naturally-occurring woody vegetation. Native species will also reduce the amount of fertilizer, pesticides, and other additives required. Permanent seeding should be performed in any areas that will remain undisturbed for a year or more, and in restoration and rehabilitation areas.

Temporary seeding uses fast-growing grasses at locations where permanent plant growth is not necessary, such as disturbed areas that are likely to be redisturbed in the upcoming weeks. These areas could include soil stockpiles, sides of sediment basins, and temporary roadway embankments. Annual plants may be used for temporary seeding since they sprout rapidly and will not be required to survive for more than one growing season.

Seeding is an economical and adaptable method of source control. Its advantage is low cost. Perennial seeding has been shown to remove, on average, 90 percent of TSS from storm water runoff (USEPA 1993). Seeding must be used in conjunction with temporary stability measures, to maintain soil until vegetation is established. Additionally, the soils may require amendment to provide sufficient nutrients for seed germination and growth.

Design and Construction Considerations:

- Seeding must be used in conjunction with temporary stability measures, to maintain soil until vegetation is established.
- Proper erosion control practices upstream of treatment areas should be placed prior to seeding. Divert concentrated flows from seeded area.
- Temporary seeding can be performed on disturbed areas that are likely to be re-disturbed.
- Temporary seeding can use annual plants, which will sprout rapidly and will not be required to survive for more than one growing season.
- Permanent seeding should be performed in any areas that will remain undisturbed for one year or more, and in restoration and rehabilitation areas.
- Seed mixtures should be based on rapid-growing native vegetation. Grasses should emerge within 4 to 28 days after seeding.
- Seed mixtures should use native, indigenous or naturally occurring grasses if possible, as these plants will evolve in a manner that will not compete with, or preclude, the establishment of naturally-occurring woody vegetation. Native species will also reduce the amount of fertilizer, pesticides, and other additives required.
- Seeding alone will not provide erosion control until vegetation is established. Therefore, seeded areas must be covered by mulch to provide protection from weather. See Section 3.5.2, Mulching.
- Soils may require amendment to provide sufficient nutrients for seed germination and growth.
- Seedbeds should be firm, but not compacted. Topsoil should be loose, moist, and free of large clods and stones.

Maintenance:

- Inspect seeded areas to ensure grass is growing and reseed as necessary.
- If an area has insufficient cover, reevaluate the choice of seed and soil amendments.
- Seeded areas that become damaged due to runoff will require additional erosion control measures.

Example of Seeding:

3.5.2 Mulching

Seeding will not provide erosion control until vegetation is established. Therefore, seeded areas must initially be protected from weather. Mulches are temporary covers that provide immediate protection to the soil, seeds, and young plants by shielding soil from raindrop impact, increasing filtration, conserving moisture, preventing soil compaction or crusting, and decreasing runoff. Mulching can be placed using green materials (such as grass, shredded shrubs and trees), rice straw, woodchips, wood fibers, recycled paper, or gravel on the soil surface. Rice straw or chipped woody vegetation would be an acceptable, locally available material for mulching at the project site.

When applied to sloped areas, mulch should be anchored to minimize loss by wind or water. This can be accomplished by spraying over with a polysaccharide tackifying agent or the functional organic, non-toxic equivalent in order to bind the straw together and prevent displacement. Alternatively, the mulch may be held in place with biodegradable netting, although netting can be expensive.

Design and Construction Considerations:

- All mulch materials should be free of seeds.
- Adequate coverage must be maintained to prevent erosion, washout, and poor plant establishment.
- Slope face should be roughened prior to application of mulch.

Maintenance:

- Anchor mulches to resist wind and water erosion.
- Inspect mulched areas frequently to identify exposed areas, areas with inadequate coverage, or areas where mulch has loosened. Reseed these areas, if necessary, and replace mulch as soon as possible.
- Conduct inspections until the area is completely revegetated.

3.5.3 Hydromulching and Hydroseeding

Hydromulching is the application of a slurry of water, fiber mulch, and a tackifier to prevent soil erosion. Hydroseeding is hydromulching with the addition of seed to initiate plant growth while protecting from erosion. Placement of hydromulch requires agitating equipment and a truck mounted with a large tank and special pumping equipment. Hydromulching and seeding is often more expensive than regular seeding and mulching, and is often restricted to areas that have nearby access roads and a water supply. However, hydroseeding may be necessary in areas that are locally too steep for human access (i.e., steeper than 2H:1V); have shallow or irregular soil surfaces, with large clods, stumps or rock outcroppings.. Hydroseeding may provide the most dependable results on steep slopes with limited ability to adequately anchor mulch.

Bonded Fiber Matrix (BFM) is a type of hydromulching that uses of long fibers and two tackifiers, sprayed in a thick layer to form a porous, breathable mat. BFMs are mutually reinforced and relatively long lived (generally greater than 1 year). BFMs must have 100% coverage, and they require 1 to 2 days of rain-free weather to allow the tackifiers to dry completely. BFMs tend to be expensive, and are prone to failures due to imperfect contact with the underlying surface or incipient gullies.

Example of Hydromulching:

3.5.4 Soil Amendments

Disturbances during construction and mining activities are likely to diminish the nutrients necessary to revegetate the surface soils. Therefore, soil amendments may be required to ensure healthy soil. This could be done in the form of enriching topsoil, compost, fertilizers, or biofertilizers.

Topsoils can be enriched by mixing the top 6-inches of soil with on-site native vegetation, such as grasses or small shrubs that have been chipped. The organic material will provide the seed stock and nutrients required for revegetation. This mixture should be kept to a relatively low organic content (5-10 percent); if the organic content is too high, the nutrients required for the new vegetation will be used up during decomposition of the excess organic matter.

In the event that desirable, native species have a difficult time competing with weeds, biofertilizers and mycorrhizal fungi may be used to rebuild the soil that was damaged by earthwork. Biofertilizers contain living microorganisms, which increase microbial activity in the soil. Additionally, the biofertilizers cause high soil porosity, which will aid in water infiltration and promote vegetation growth. Biofertilizers are advantageous because they are non-chemical, and therefore do not pollute the water downstream.

Mycorrhizae are filamentous strands of fungi that penetrate plant roots and transfer nutrients from soil to vegetation. Mycorrhizal fungi have a strong relationship with native plant species; reintroducing them will promote cover of desirable plant species and reduce the invasion of non-native, invasive weeds.

4.0 INTERMEDIATE CONTROLS

Intermediate sediment control is a process of capturing soil particles after they have been detached and transported by the movement of water. Intermediate sediment controls are located at points throughout the conveyance network and are typically used to settle coarser sediments and reduce the total volume of sediment storage required at perimeter control structures. Intermediate sediment control BMPs include conveyance channels, check dams, and sediment traps. Typical details of the intermediate control measures are shown in Appendix B.

4.1 Conveyance Channels

Conveyance channels are designed to divert sediment-laden run-off to onsite sediment trapping devices, preventing sediments from entering undisturbed areas. Conveyance channels should be lined with rock riprap or vegetation to reduce the velocity of water and decrease the amount of sediment being transported through the channel. Due to the minimal availability of rock at the project site, grass-lined channels should be used whenever they can provide adequate energy dissipation.

Conveyance channels are effective in controlling the velocity and direction of stormwater run-off. However, when used alone, they do not have the capability to remove sediment and must be used with an appropriate sediment-trapping device. Sediment traps may be required at the inlet of grass-lined channels to prohibit severe sedimentation from disturbed areas. Energy dissipaters, such as rock riprap, stone, or concrete flow spreaders may be required at the outlet of the channel.

Design and Construction Considerations:

- Grass-lined channels will require vegetation to become established; rip-rap lined channels are immediately effective.
- Grass-lined channels will require high flows to be diverted or turf reinforcement mats (TRMs) will need to be used to provide erosion protection until vegetation is fully established.
- Lining the conveyance channel will increase the stability of the control and decrease the need for frequent repairs and maintenance.

Maintenance:

- Inspect channels at least once every two weeks or after major rain events (whichever is more frequent), for evidence of erosion or deterioration.
- Inspect grass-lined channels regularly, particularly while vegetation is being established.
- Inspect linings, slopes and channel beds for accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed. Perform spot vegetative repair as needed.

4.2 Check Dams

Check dams are temporary, relatively small structures placed across natural or man-made channels, across ditches along haul roads, and along channels near the base of disturbed slopes. Check dams are most effective when used with other sediment control measures. A check dam is intended to reduce the velocity of water flow during storm events and reduce sediment transport by allowing coarser grained sediments to settle out before water continues downstream to other controls. Check dams are constructed of materials such as rock, filter socks, logs and bags. Availability of rock will be limited during the majority of ground-disturbing construction at the project site. Therefore, check dams could be constructed using local products such as timber, brush, or other forest or agricultural products.

Check dams are appropriate for drainage areas up to about 4 hectares; however, multiple check dams spaced at appropriate intervals can be effective in handling larger areas. They can be used as a temporary measure in areas where it is impractical to implement other flow control practices, such as lining the channel with riprap or vegetation.

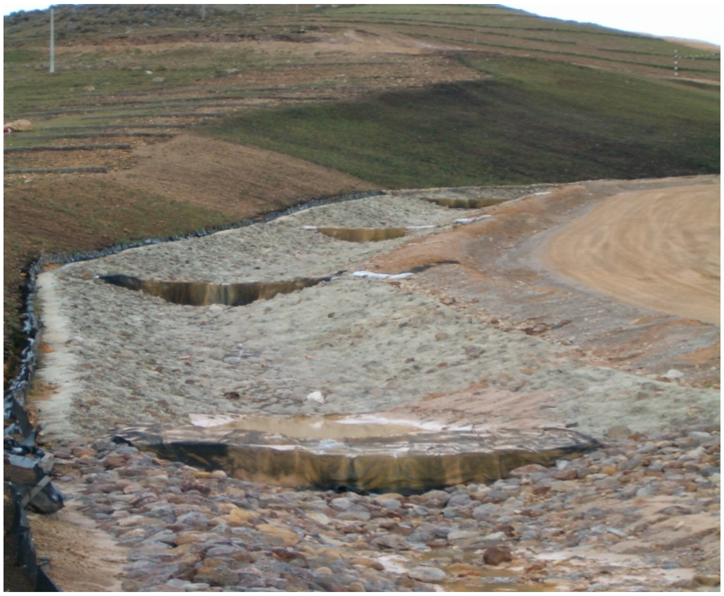
Design and Construction Considerations:

- Check dams should be installed perpendicular to flow.
- Check dam height should be limited to 1 meter, and the center of the dam should be at least 15 centimeters lower than the edges.
- Check dams should not be built in naturally flowing streams.

Maintenance:

- Inspect check dams before and after major storm events, or once weekly, whichever is more frequent.
- Check dams should be inspected regularly for structural integrity, buildup of sediment and debris, and erosion along the bottom of the check dam. Repairs to dams should be made as soon as possible.
- Perform repairs immediately if erosion or settlement causes the edges of the dam to fall to a height equal to, or below the height of the center of the dam.
- Remove sediment when it reaches ½ the original height of the dam, as measured at the center of the dam.
- Remove check dam upon completion of construction after the contributing area has been completely stabilized.
- Install permanent vegetation or other permanent erosion protection in the location where the dam was removed.

Example of a Check Dam:



4.3 Sediment Traps

Sediment traps are small temporary containment areas that collect runoff from drainage areas and allow for settling of suspended sediments. These excavated areas are a supplemental control and are intended to reduce some of the sediment in water that is to be conveyed to downstream controls such as the settlement ponds. A sediment trap provides settling of smaller particles than are removed by check dams, but does not remove the finest size particles.

Design and Construction Considerations:

- Sediment traps have limited ability to settle the finest sediments; the finest sediments will continue to the sediment ponds.
- Sediment traps must be used in conjunction with source controls.
- Sediment traps should be designed such that they are large enough to allow sediments to settle and have capacity to store collected sediment until it can be removed.
- Runoff must pass through sediment ponds before leaving the project site.
- Sediment traps should be limited to a drainage area of 2 hectares and typically have a useful life of around 18 to 24 months.
- Sediment traps need to be accessible for periodic maintenance and sediment removal.

Maintenance:

- Inspect sediment traps before and after major storm events, or once weekly, whichever is more frequent, for structural damage and excessive sediment and debris.
- Inspect sediment traps after every major storm event to ensure the trap is draining properly.
- Maintain the depth of the sediment trap spillway at a minimum of 0.5 meter below the low point of the trap embankment.
- Remove sediments when they reach 50% of sediment trap capacity or 30 centimeters depth, whichever is smaller.
- Sediment traps should remain in operation until after construction has ended and the drainage area is permanently stabilized.

5.0 PERIMETER CONTROLS (SEDIMENT PONDS)

5.1 Overview

Perimeter controls will consist of sediment ponds located downstream of all major disturbance areas including all construction areas, borrow areas, WRDs, and pits to reduce the amount of TSS leaving the mine site. Nine ponds are to be constructed: Ponds 1, 2, 3, 4, 5A, 5B, 6A, 6B, and 7. The locations of these ponds are shown in Figure 1.

The sediment ponds are long-term perimeter facilities that will be constructed prior to major disturbances in their respective watersheds and will remain in place throughout the life of mine, continuing to function until the sediment yield from the contributing watershed area has returned to baseline levels following reclamation.

Pond 6 is also known as the TWSR and provides sediment control for disturbed areas in the drainage basin and water storage for treated water from the water treatment plant (WTP) for the Phase 1 TSF. Pond 6 has two locations, designated as 6A and 6B. Initially, Pond 6A will be constructed as the TWSR and as a potential starter dam for the Phase 2 TSF, if required. Pond 6B is the location for the TWSR in the event the Phase 2 TSF is required and the TWSR needs to be relocated.

This section discusses the design and construction of the sediment dams as well as the function of the sediment ponds for erosion and sediment control. The sediment dams are significant structures requiring careful engineering design. Because this is the only document describing the sediment pond designs, a more detail design discussion is provided for these dams than is provided for other ESC Plan facilities.

5.2 Conceptual Dam Design

The sediment ponds are impounded by embankment dams approximately 7 meters high. The embankment will consist of compacted saprolite. The compacted saprolite fill will be covered with a layer of geotextile fabric, an additional 0.5+/- meter of laterite or rock, and erosion control netting to reduce the potential for erosion. For seepage control, the dams will contain a toe drain constructed of clean, well-graded sand and gravel. The dams will feature two spillways, the Principal Spillway (PSW) and Emergency Spillway (ESW). A typical, preliminary sediment pond dam design is shown in Appendix C.

The PSW will consist of a reinforced concrete intake structure and a 1-meter-diameter, high-density polyethylene (HDPE) pipe encased in reinforced concrete. The PSW Pipe will also feature three concrete cutoffs and a graded sand filter to reduce the potential for soil piping. The discharge point of the PSW will be submerged in a plunge pool to reduce erosion at the outfall.

The ESW will consist of an earth-cut, vegetated overflow spillway. Because the ESW soils are likely to be very erodible, the pond dimensions and hydraulics were selected so that the ESW will only operate for inflow floods greater than the 100-year storm event; smaller storms will be conveyed by the PSW.

5.3 Design Criteria

The sediment ponds were designed for two general criteria pertaining to the proportioning and sizing of the dams as listed below:

1. Sedimentation ponds must be designed to safely handle the 100-year, 24-hour storm event using the PSW. The ESW must be capable of passing the 500-year, 24-hour storm event while maintaining a minimum of 1 meter of freeboard between the water surface elevation and the dam crest.

2. For water exiting the sedimentation pond, the cumulative TSS curve must not exceed 50mg/l at least 95% of the time. For the remaining 5% of the time the TSS can be as high as baseline conditions, up to the 25-year storm event. Given the high percentage of fines in the grain size distribution for the saprolite, natural settling due to gravity is not expected to result in the necessary sediment removal described above, so a chemical flocculent will be required.

The design criteria are summarized in Table 5-1.

Table 5-1: Sediment Pond Design Criteria

Parameter	Criteria
Sediment Storage	Provide sufficient volume to accommodate sediment loads for several years before requiring cleanout.
Normal Pool Elevation / Retention Time	Provide sufficient storage above the sediment storage to allow enough retention time for sediments to drop out of suspension. Assumed to be equal to 4-m above the valley floor.
Flocculent Dosing Strategy	Satisfy TSS criteria limits up to the 25-year, 24-hour event (at least 95% of the time below 50 mg/l; baseline less than 5% of the time)
Principal Spillway Capacity / Emergency Spillway Crest Elevation	Provide sufficient storage and PSW discharge capacity to contain the 100-year, 24-hour storm event without activating the ESW.
Emergency Spillway Capacity	Provide sufficient storage and ESW discharge capacity to contain the 500-year, 24-hour storm event without overtopping the ESW
Dam Crest Elevation	One meter above the flood pool associated with the routed 500-year storm event.

Because expected suspended sediment settling rates with flocculation are not currently available, sediment storage and flocculent dosing remain to be determined. The preliminary design of the sediment ponds allows for normal water depths ranging up to 4 m. Based on experience with other sediment ponds of similar size, we expect that a flocculent is available that will provide more than the necessary TSS removal.

5.4 Hydrologic and Hydraulic Analyses

Hydrologic and hydraulic analyses for the sedimentation pond designs were performed using the SEDCAD 4 software (Civil Software Design, LLC 2010). The assumptions and results of these analyses are presented herein.

5.4.1 Precipitation

The design storm selected for the sediment ponds was the 24-hour event, with a National Resource Conservation Service (NRCS) Type III Distribution. The precipitation associated with the design storm recurrence intervals up the 100-year event were presented in the Climate Summary Report, dated May 16, 2012. The precipitation associated with the 500-year event was extrapolated using a logarithmic trend line. The precipitation amounts associated with the design storms are presented in Table 5-2.

Table 5-2: Design Storm Precipitation

Return Period (Years)	24-hour Precipitation (mm)
2	95
5	125
10	158
25	185
100	247
500 (extrapolated)	312

5.4.2 Hydrologic Model

Routing of the design storms through the sediment ponds was performed using the SCS Curve Number Method (formerly Soil Conservation Service, now National Resource Conservation Service [NRCS]) and the SEDCAD modeling program. Input parameters for the hydrologic model included precipitation and sub-basin characteristics. The curve numbers were assumed based on ground cover and soil types observed around the mine site. Based on engineering judgment, the curve number associated with jungle land cover was assumed to be 70, and the curve number associated with disturbed area such as WRDs was assumed to be 86. For the construction conditions, the watershed for each pond was divided into three subwatersheds by land cover: jungle area, disturbed area, and pond area. SEDCAD uses methods built-in to the software to compute time of concentration for subwatersheds, and uses Muskingum routing methods.

5.4.3 Hydraulics

The rating curve for the PSW was evaluated separately and imported as a user-defined spillway in SEDCAD. The PSW flow capacity was estimated by determining the hydraulic control under four different scenarios: weir flow at the intake structure weir crest, orifice flow at the intake structure top opening, orifice control at the intake structure transition, and pipe flow in the HDPE pipe. The ESW was assumed to behave as a broad-crested weir.

5.4.4 Proportioning

Reservoir routing was performed using the SEDCAD software. The crest elevation of the intake structure weir was set to be approximately 4 meters above the valley floor. The ESW was set to be equal to the routed 100-year flood pool level. For all dams, the routed 500-year pool level was less than one meter above the ESW crest; therefore, all the dam crest elevations for all the dams are 1 meter above the ESW crest. Overall sedimentation dam heights range from about 6 meters to 9 meters high. The TWSR is expected to be about 12 meters high due to the additional water storage requirements.

The configuration of the dams was established so that the ESW does not need to be armored. Because the ESW is only activated for storms that exceed the 100-year storm event, there is a low probability that the spillway will be activated during the life of the mine. If the spillway is activated, spillway flows could potentially cause erosion and damage, but are not expected to threaten the integrity of the dam embankment. The dams would require inspection after a greater than 100-year storm event and repair as needed.

5.4.5 Peak Flow Analysis and Low Flows

To verify that the proposed water management scheme does not adversely affect the downstream water conditions, a peak flow analysis was performed. This involved modeling each dam watershed under existing and proposed conditions. Because the dams are configured so that the ESW is not activated until the 100-year event, the dams will provide flood control due to the conveyance capacity of the PSW. The analyses indicate that the peak outflow for the dams for the 2-year through 100-year events is expected to be about 90% less than the peak flow expected under existing conditions. The results of the peak flow analysis are shown in Appendix D.

In summary, the sedimentation pond designs result in no increase in any downstream flows for storm events up through the 500-year event.

Under most normal operating conditions, outflow from the ponds will generally be approximately equal to inflow. The outlet works of the dams will be constructed such that the dams do not adversely affect downstream waterways or cause ecological impacts during low flow conditions. Although not shown on the drawings in Appendix C because of the preliminary nature of the design, the intake structures will be fitted with releases that will release either the minimum flow required to support the downstream water needs, or the minimum of inflow to the pond if that is less.

6.0 ADAPTIVE MANAGEMENT

The Merian Gold Project will implement an Adaptive Water Management Plan that addresses all water management issues including sediment and erosion. The water management plan, including the proposed monitoring plan and the adaptive aspects of the water management plan are presented in the Water Management Plan (Golder 2012b). This section briefly discusses the sediment and erosion aspects of the adaptive water management plan.

6.1 Inspection and Maintenance

In order to ensure effective and adequate erosion sediment control, the source, intermediate and perimeter controls must be inspected and maintained on a regular basis. Prior to commencement of construction activities, erosion and sediment controls should be inspected by an Erosion Control Inspector (ECI). The ECI should inspect control measures on a regular basis, during all phases of mine construction up to and including mine closure. The ECI will be responsible for monitoring the control measures and construction activities and adjusting, modifying, and installing additional controls to address evolving conditions. The ECI should maintain accurate records of inspection, maintenance, and corrective actions as they apply to sediment and erosion control activities.

Maintenance and operation of BMPs would benefit from formal employee training. Startup training for personnel working on site, relating to inspection and maintenance of BMPs, will increase awareness of the staff and aid in timely identification of maintenance needs.

Routine visual inspections of all BMPs should be performed daily. Construction site activities can easily damage BMPs, and routine inspection and maintenance will minimize work required. Any necessary repairs should be made immediately to minimize progressive failure of BMPs. A readily available inventory of BMP supplies should be maintained during all phases of construction

All erosion and sediment control practices should be checked prior to any major storm event to ensure that BMPs are cleaned out and operating properly. All BMPs should be inspected before periods of inactivity on the site, to prepare for large rainfall events that may occur during inactive period (such as a weekend or holiday). All erosion and sediment control practices should be checked for stability and operation following every major runoff-producing rainfall.

All newly seeded areas need to be inspected frequently to ensure vegetation is thriving. All seeded areas should be fertilized, and reseeded as necessary to create and maintain a dense vegetative cover. Areas where vegetative cover is inadequate should be reseeded as soon as such areas are identified. At seeded areas that are damaged due to concentrated runoff, additional source controls may be required. If mulching is properly applied and anchored, little additional maintenance should be required; however, mulched areas should be checked after high winds or significant rainstorms to assure adequate coverage is maintained.

Sediment ponds should be cleaned when the level of sediment reaches about one meter below the riser weir crest, or sooner. Sediment should be removed from sediment traps and inlet protection devices when approximately 50% of the storage capacity has been reached.

6.2 Additional Erosion and Sediment Control Measures

Numerous other methods and technologies of erosion and sediment control exist. The measures introduced as part of this document were selected as cost-effective, practical solutions for the Project. If any at time, a planned erosion and sediment control measure is not functioning as intended, additional methods of erosion and sediment control can be implemented such that the downstream water quality criteria for TSS (50 mg/L except during extreme events) is satisfied. Potential solutions are not limited to measures described in this document. Refer to Section 1.4 for selection criteria for proposed erosion and sediment control measures.

6.3 Data Collection

Reporting of water monitoring data and results or revisions of the water management plan will be submitted to the Nationaal Instituut voor Milieu en Ontwikkeling in Suriname (NIMOS) as required.

7.0 REFERENCES:

Civil Software Design LLC. 2010. Software: SEDCAD 4 for Windows Build 2010.12.5. Ames, Iowa.

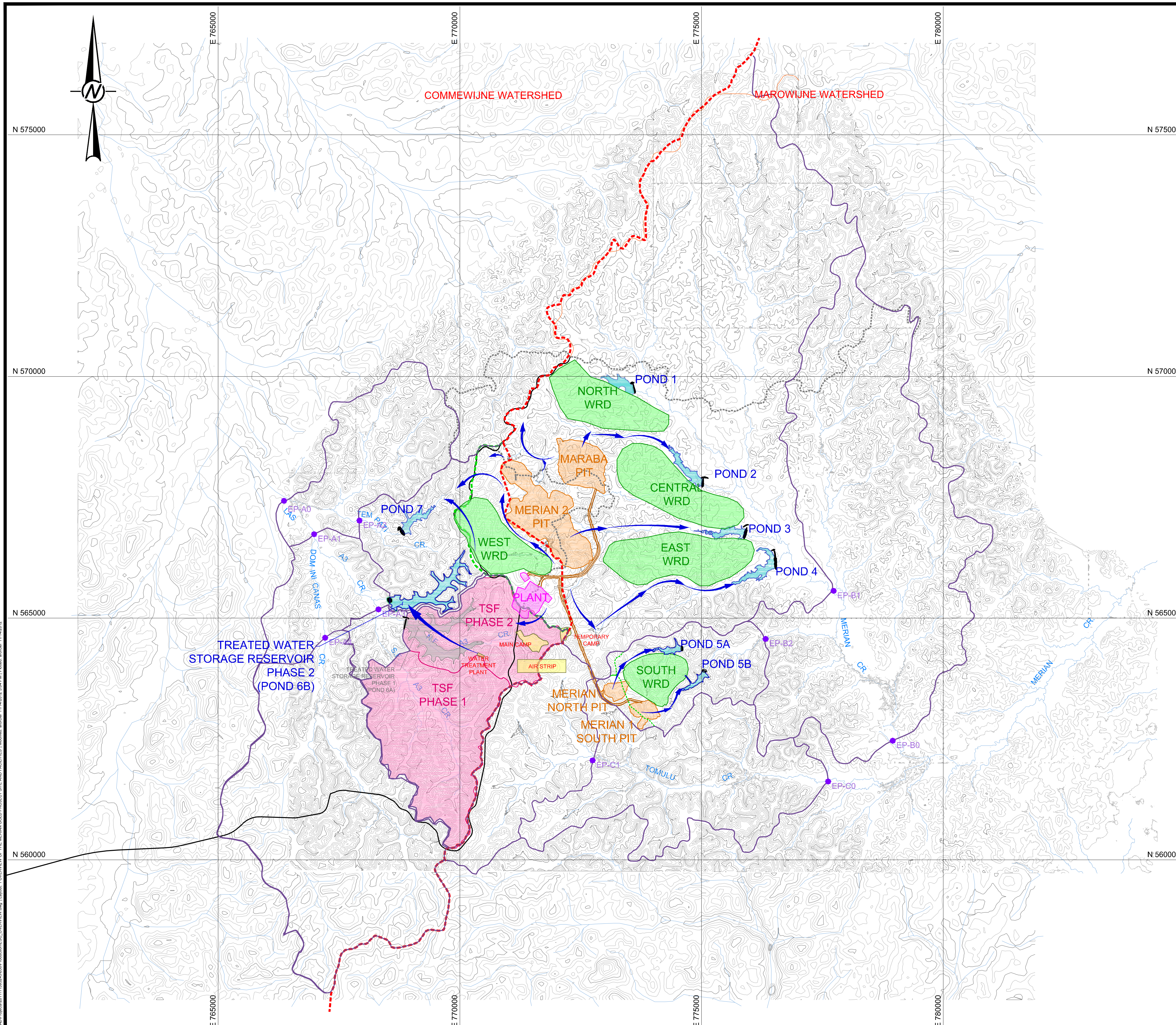
ERM. 2012 (In Progress). Chapter 19 of the Environmental and Social Impact Assessment (ESIA). November.

Golder. 2012a. Geochemistry Baseline and Source Water Quality Predictions (Rev. 5) Submitted to Suriname Gold Company LLC. November 13.

Golder. 2012b. ESIA Water Management Plan. Submitted to Suriname Gold Company LLC. November 12.

USEPA. 1993. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, EPA No. 840B92002 web.

FIGURE



LEGEND

- CONTOUR (25m INTERVAL)
- WATERSHED DIVIDE (MAROWIJNE-COMMEWIJNE)
- SURFACE WATER DIVIDE
- GROUNDWATER DIVIDE
- GROUNDWATER MODEL BOUNDARY
- RIGHT OF EXPLOITATION
- CREEK (APPROXIMATE)
- PLANT
- PIT
- WASTE DUMP
- TAILINGS STORAGE FACILITY (TSF)
- SEDIMENTATION POND
- EP-A0 EVALUATION POINT
- FLOW DIVERSION

NOTES

WGS 84 DATUM - UTM ZONE 21N - GEOID EGM2008 - CONTOUR INTERVAL : 1m. CONTOURS FROM LIDAR SURVEY (MAY 2011)

CONTOUR LINES ARE NOT THEIR ACTUAL ELEVATIONS,THEY HAVE BEEN INCREASED 500m

0 1,600 3,200 4,800 m

SCALE

PROJECT

MERIAN GOLD PROJECT

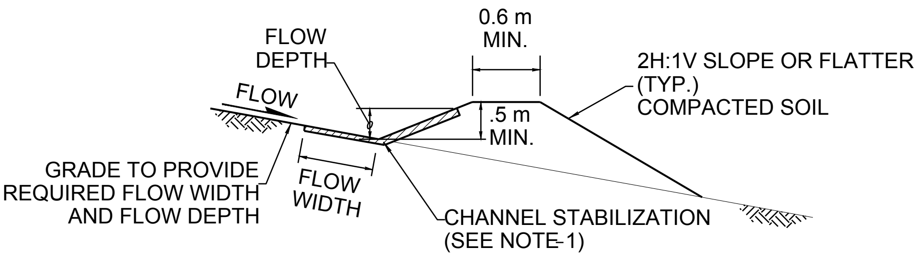
TITLE

OVERVIEW OF THE MERIAN GOLD PROJECT SITE AND FACILITIES

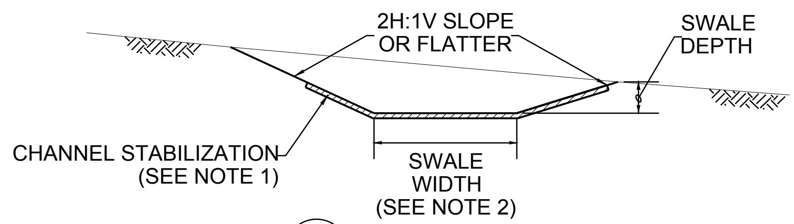
PROJECT No.	113-93245	FILE No.	ESC_OVERVIEW
DESIGN		SCALE	AS SHOWN
CADD			
CHECK		FIGURE 1	
REVIEW			

Golder Associates

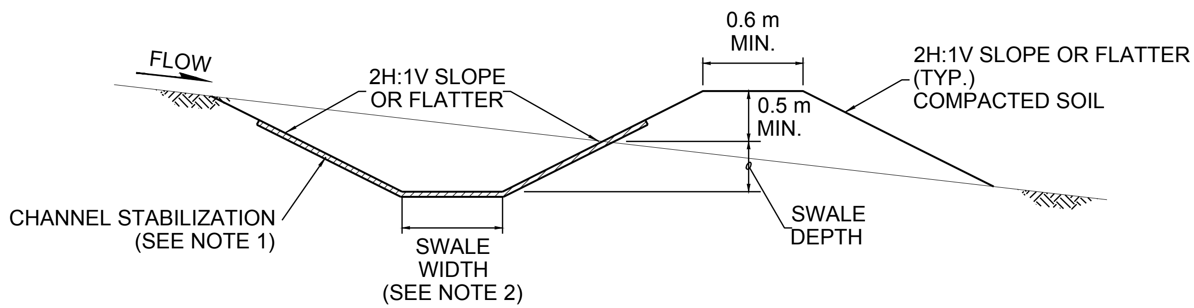
APPENDIX A
SOURCE CONTROL DETAILS



1 ---- DIVERSION DIKE DETAIL



2 ---- DIVERSION SWALE DETAIL



3 ---- PERIMETER DIKE/SWALE DETAIL

NOT FOR CONSTRUCTION

NOTES

1. STABILIZE CHANNEL BY LINING WITH GRASS, VEGETATION OR RIP RAP TO MITIGATE EROSION POTENTIAL WITHIN THE CHANNEL.
2. TYPICAL SWALE WIDTH IS 2 METERS.
3. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.

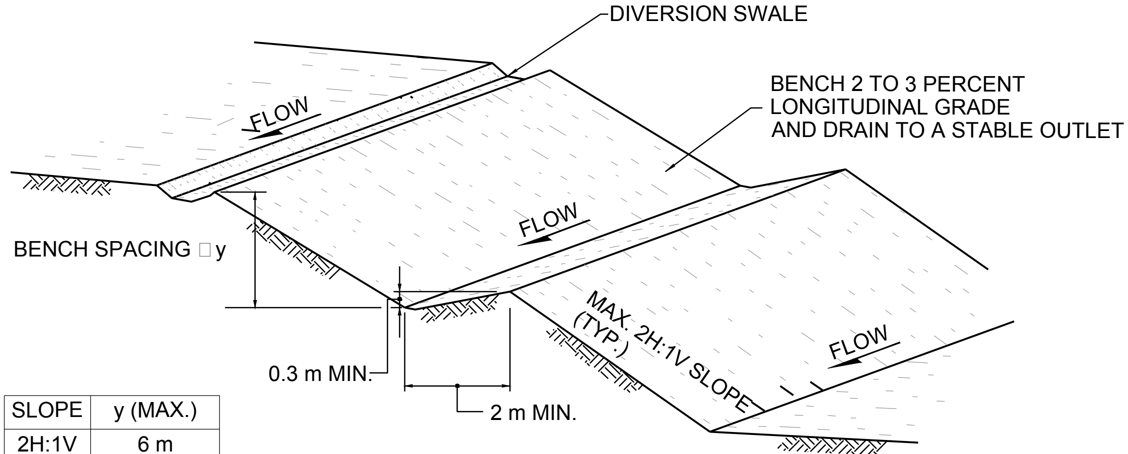
SOURCE: MARYLAND DEPARTMENT OF ENVIRONMENT, 2011 SOIL EROSION AND SEDIMENT CONTROL DETAILS

PROJECT
MERIAN GOLD PROJECT

TITLE
TYPICAL DIKE SWALE DETAILS

PROJECT No.		113-93245	FILE No. ESC-Details
DESIGN	BJV	NOV. 2012	SCALE NOT TO SCALE
CADD	BJV	NOV. 2012	**FIGURE A1**
CHECK	DL	NOV. 2012	
REVIEW	MLB	NOV. 2012	

Golder Associates



SLOPE	y (MAX.)
2H:1V	6 m
3H:1V	9 m
4H:1V	12 m

1 BENCHING DETAIL

NOT FOR CONSTRUCTION

NOTES

1. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.

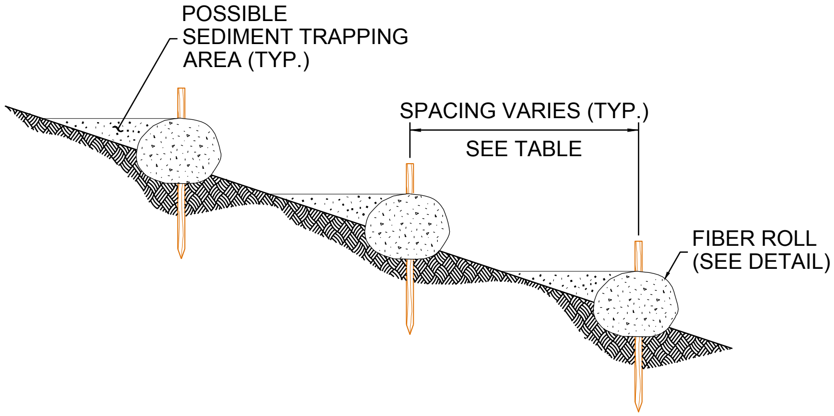
SOURCE: MARYLAND DEPARTMENT OF ENVIRONMENT, 2011 SOIL EROSION AND SEDIMENT CONTROL DETAILS

PROJECT
MERIAN GOLD PROJECT

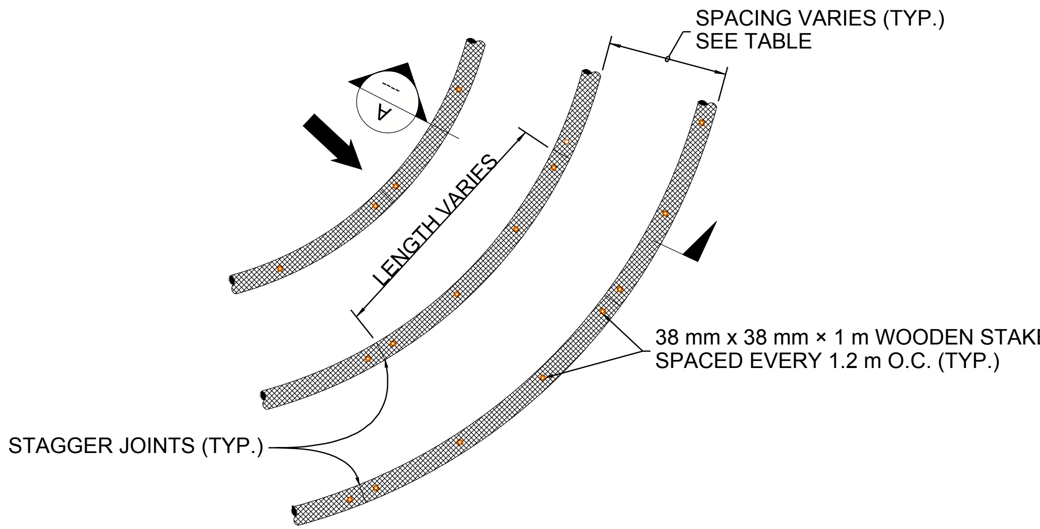
TITLE
TYPICAL BENCHING DETAILS

Golder Associates

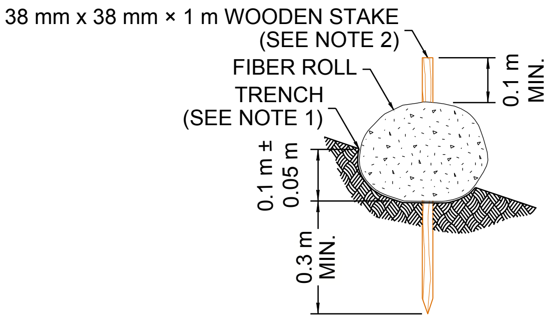
PROJECT No.		113-93245	FILE No.	ESC-Details
DESIGN	BJV	NOV. 2012	SCALE	NOT TO SCALE
CADD	BJV	NOV. 2012	**FIGURE A2**	
CHECK	DL	NOV. 2012		
REVIEW	MLB	NOV. 2012		



A FIBER ROLL SECTION VIEW



1 FIBER ROLL PLAN VIEW



2 FIBER ROLL DETAIL

FIBER ROLL SPACING	
SLOPE	MAX. SPACING
1H:1V	3 m
2H:1V	6 m
3H:1V	9 m
4H:1V	12 m

NOT FOR
CONSTRUCTION

NOTES

1. FIBER ROLLS SHOULD BE INSTALLED IN TRENCH, ALONG CONTOUR.
2. PILOT HOLES MAY BE DRIVEN THROUGH THE FIBER ROLLS AND INTO THE SOIL WHEN SOIL CONDITIONS REQUIRE.
3. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.

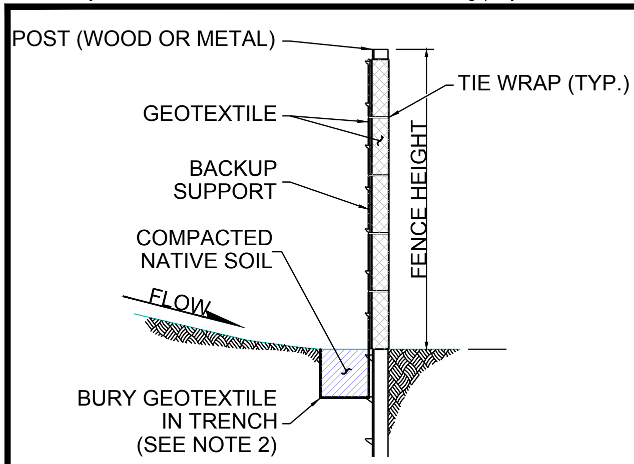
SOURCE: WASHINGTON DEPARTMENT OF TRANSPORTATION, 2012 PLANS AND DETAILS

PROJECT
MERIAN GOLD PROJECT

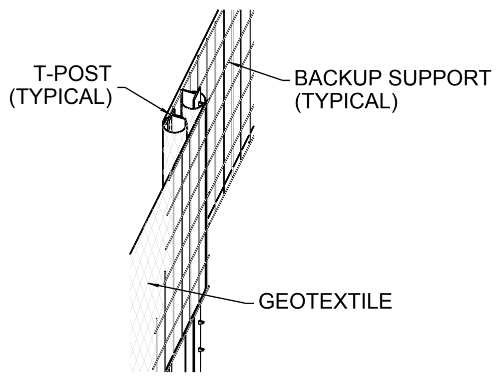
TITLE
TYPICAL FIBER ROLL DETAILS

Golder Associates

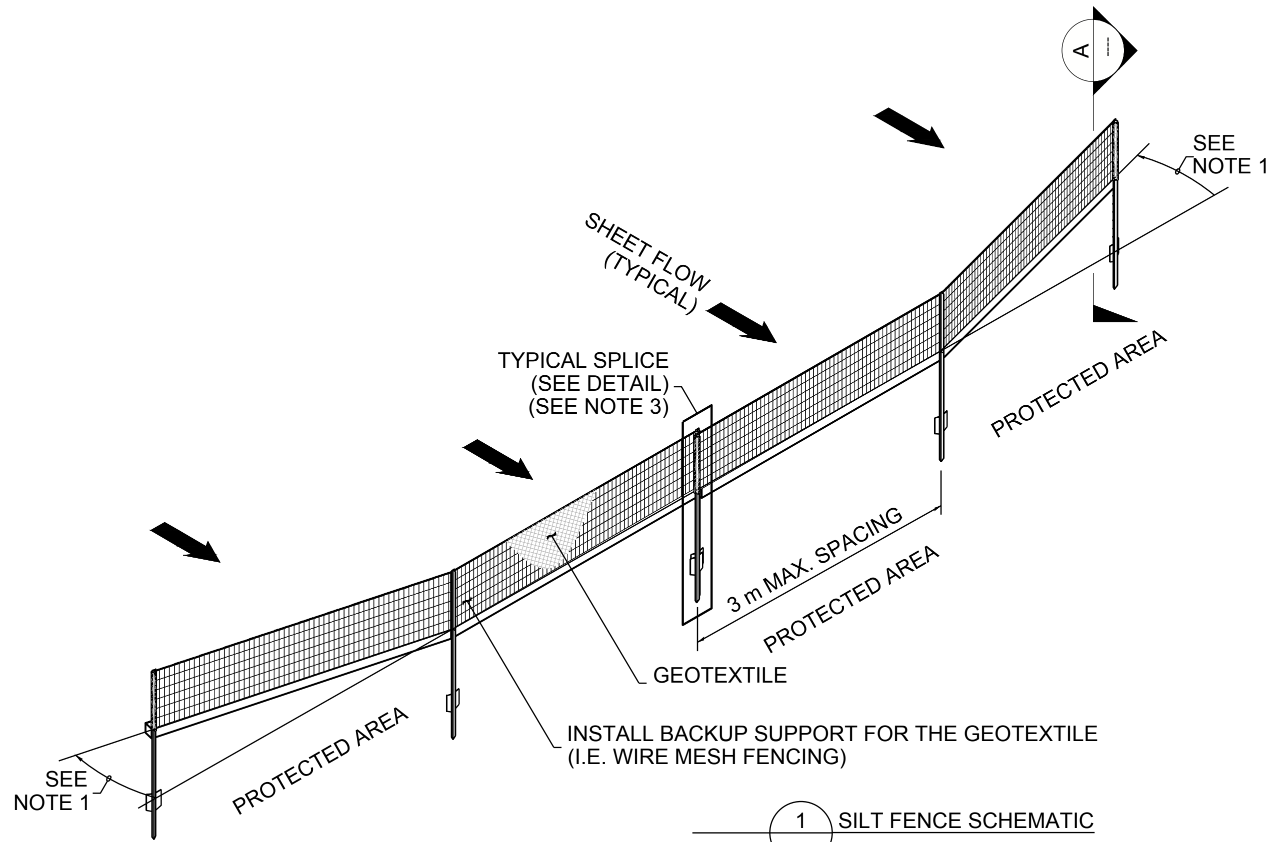
PROJECT No.		113-93245	FILE No.	ESC-Details
DESIGN	BJV	NOV. 2012	SCALE	NOT TO SCALE
CADD	BJV	NOV. 2012	**FIGURE A3**	
CHECK	DL	NOV. 2012		
REVIEW	MLB	NOV. 2012		



A SILT FENCE SECTION VIEW



2 SPLICE DETAIL



1 SILT FENCE SCHEMATIC

NOT FOR CONSTRUCTION

NOTES

1. INSTALL THE ENDS OF THE SILT FENCE TO POINT SLIGHTLY UP-SLOPE TO PREVENT SEDIMENT FROM FLOWING AROUND THE ENDS OF THE FENCE.
2. DURING EXCAVATION, MINIMIZE DISTURBING THE GROUND AROUND TRENCH AS MUCH AS IS FEASIBLE AND SMOOTH SURFACE FOLLOWING EXCAVATION TO AVOID CONCENTRATING FLOWS.
3. SPLICED FENCE SECTIONS SHALL BE CLOSE ENOUGH TOGETHER TO PREVENT SILT LADEN WATER FROM ESCAPING THROUGH THE FENCE AT THE OVERLAP. JOINING SECTIONS SHALL NOT BE PLACED IN LOW SPOTS OR IN SUMP LOCATIONS.
4. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.

SOURCE: WASHINGTON DEPARTMENT OF TRANSPORTATION, 2012 PLANS AND DETAILS

PROJECT

MERIAN GOLD PROJECT

TITLE

TYPICAL SILT FENCE DETAILS

Golder Associates

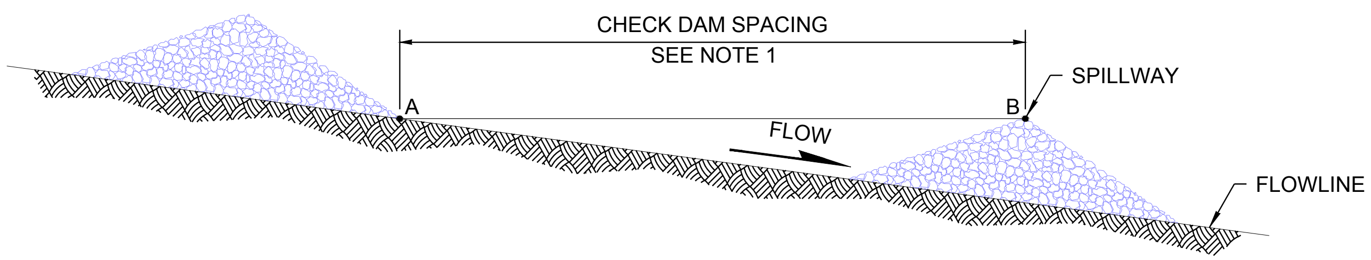
PROJECT No.	113-93245		
DESIGN	BJV	NOV. 2012	
CADD	BJV	NOV. 2012	
CHECK	DL	NOV. 2012	
REVIEW	MLB	NOV. 2012	

FILE No. ESC-Details

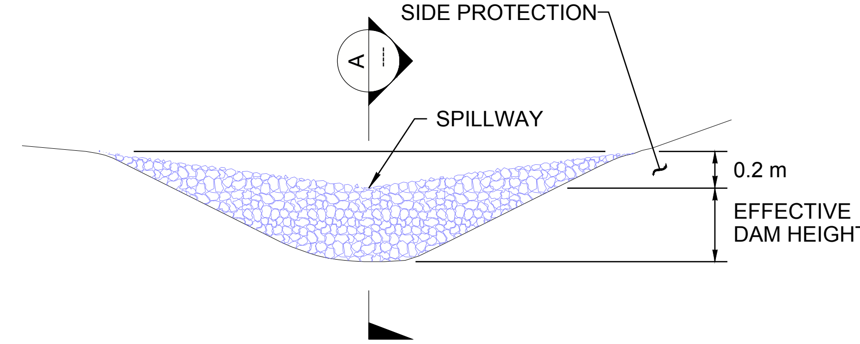
SCALE NOT TO SCALE

FIGURE A4

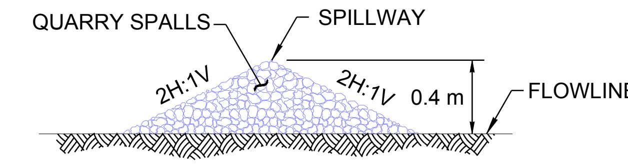
APPENDIX B
INTERMEDIATE CONTROL DETAILS



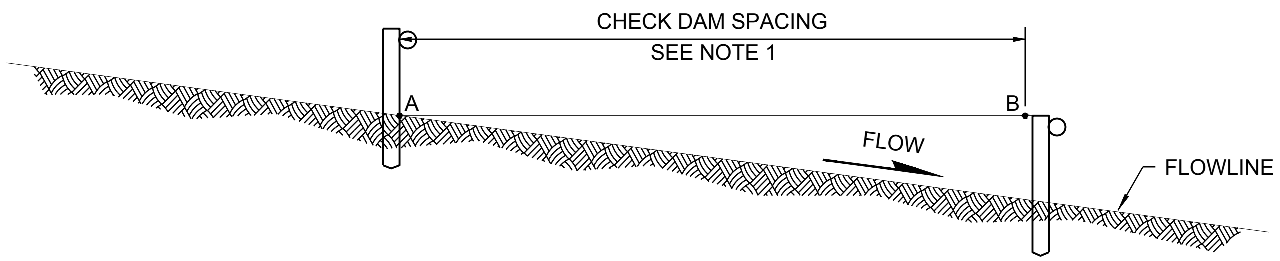
1 TYPICAL ROCK CHECK DAM SPACING



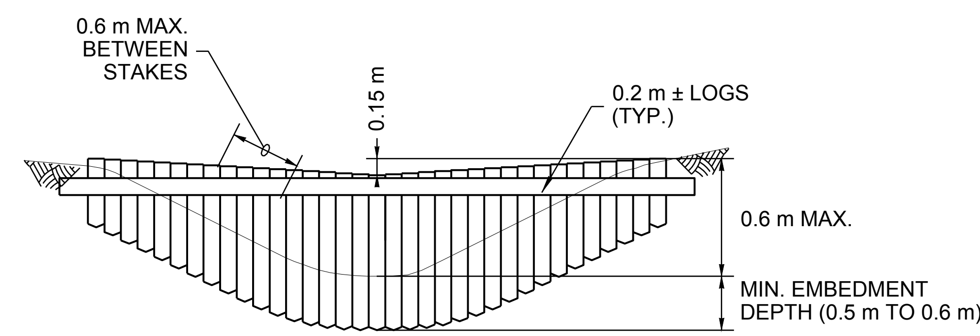
2 TYPICAL ROCK CHECK DAM - UPSTREAM VIEW



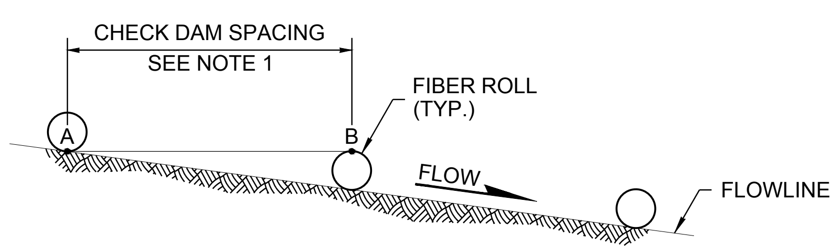
A ROCK CHECK DAM SECTION



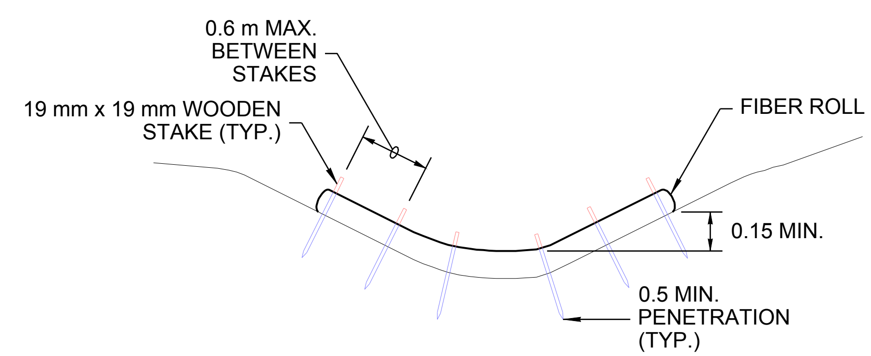
3 TYPICAL LOG CHECK DAM SPACING



4 TYPICAL LOG CHECK DAM - UPSTREAM VIEW



5 TYPICAL ROCK CHECK DAM SPACING



6 TYPICAL FIBER ROLL CHECK DAM - UPSTREAM VIEW

NOT FOR
CONSTRUCTION

NOTES

1. PLACE CHECK DAMS SUCH THAT POINTS "A" AND "B" ARE AT THE SAME ELEVATION.
2. INSTALL CHECK DAMS PERPENDICULAR TO THE FLOWLINE.
3. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.

SOURCE: WASHINGTON DOT, STANDARD PLANS AND DETAILS

PROJECT
MERIAN GOLD PROJECT

TITLE
TYPICAL CHECK DAM DETAILS

Golder Associates

PROJECT No.		113-93245	FILE No.	ESC-Details
DESIGN	BJV	NOV. 2012	SCALE	AS SHOWN
CADD	BJV	NOV. 2012	**FIGURE B1**	
CHECK	DL	NOV. 2012		
REVIEW	MLB	NOV. 2012		

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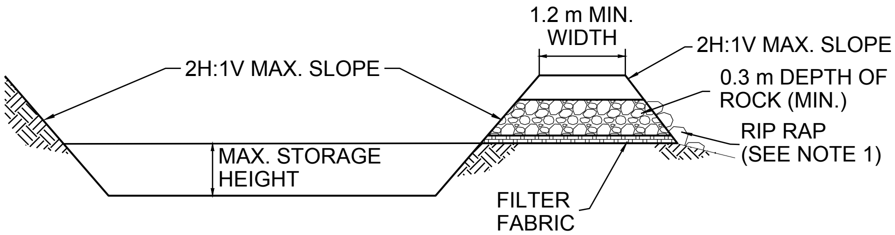
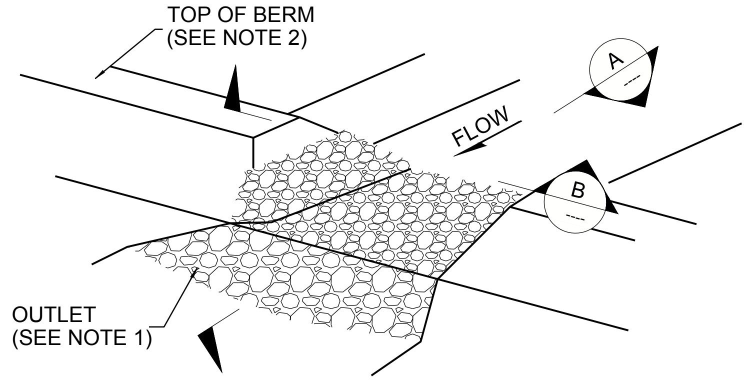
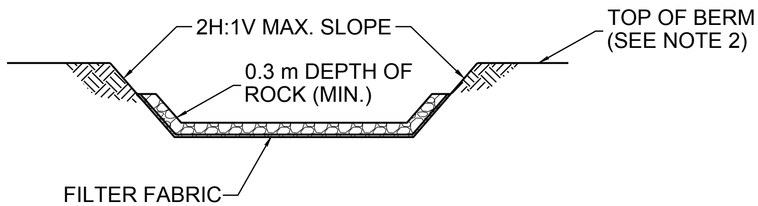


A SEDIMENT TRAP PROFILE VIEW



1 SEDIMENT TRAP SCHEMATIC



B SEDIMENT TRAP SECTION VIEW

NOT FOR
CONSTRUCTION

NOTES

1. OUTLET SHOULD USE RIPRAP, CONCRETE, OR OTHER APPROVED METHOD FOR EROSION PROTECTION AND ENERGY DISSIPATION.
2. BERM OR CHANNEL SIDE MAY BE CONSTRUCTED BY COMPACTED EMBANKMENT OR EXCAVATION INTO EXISTING GROUND, OR A COMBINATION OF THE TWO.
3. SEDIMENT TRAP OUTLET SHALL DISCHARGE TO A CONVEYANCE CHANNEL TO EITHER A NATURAL CHANNEL OR SEDIMENT POND.
4. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.

SOURCE: WASHINGTON DEPARTMENT OF TRANSPORTATION, 2012 PLANS AND DETAILS

PROJECT
MERIAN GOLD PROJECT

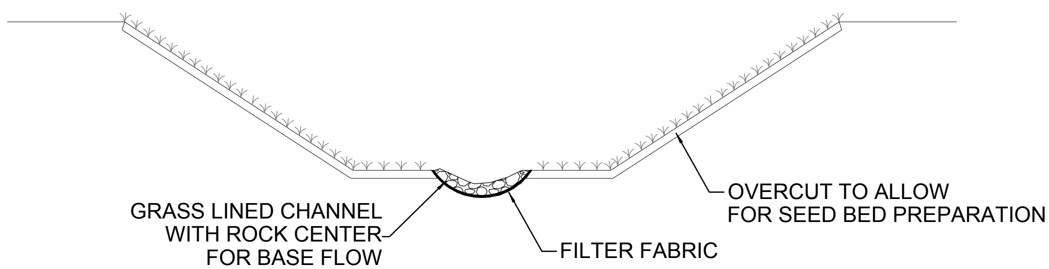
TITLE
TYPICAL SEDIMENT TRAP DETAILS

Golder Associates

PROJECT No.		113-93245	FILE No.	ESC-Details
DESIGN	BJV	NOV. 2012	SCALE	NOT TO SCALE
CADD	BJV	NOV. 2012	**FIGURE B2**	
CHECK	DL	NOV. 2012		
REVIEW	MLB	NOV. 2012		

1 ---- TYPICAL V-SHAPED CHANNEL SECTION

2 ---- TYPICAL PARABOLIC CHANNEL SECTION



3 ---- TYPICAL TRAPEZOIDAL CHANNEL SECTION

NOT FOR CONSTRUCTION

NOTES

1. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.

SOURCE: WASHINGTON DOT, STANDARD PLANS AND DETAILS

PROJECT

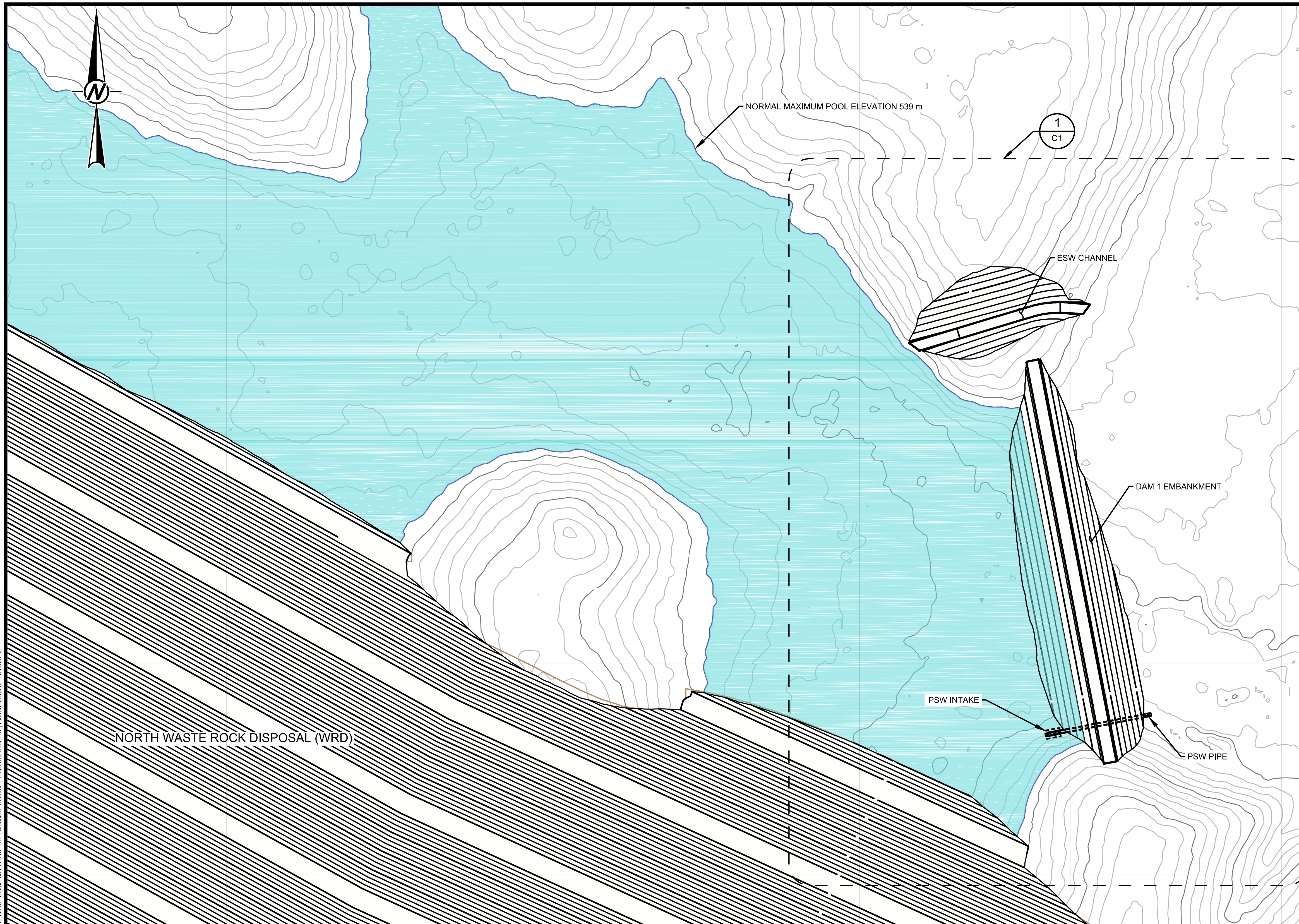
MERIAN GOLD PROJECT

TITLE

TYPICAL CONVEYANCE CHANNEL DETAILS

Golder Associates	PROJECT No.		113-93245	FILE No. ESC-Details
	DESIGN	BJV	NOV. 2012	SCALE NOT TO SCALE
	CADD	BJV	NOV. 2012	**FIGURE B3**
	CHECK	DL	NOV. 2012	
	REVIEW	MLB	NOV. 2012	

APPENDIX C
PERIMETER CONTROL DETAILS – TYPICAL SEDIMENTATION POND DESIGN



NOTES

1. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.
2. WRITTEN DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS.
3. WGS 84 DATUM - UTM ZONE 21 N. EXISTING GROUND CONTOURS FROM LIDAR SURVEY (MAY 2011). CONTOUR LINES ARE NOT THEIR ACTUAL ELEVATIONS THEY HAVE BEEN INCREASED 500M.

NOT FOR
CONSTRUCTION

0 40 80 120 m
SCALE

PROJECT

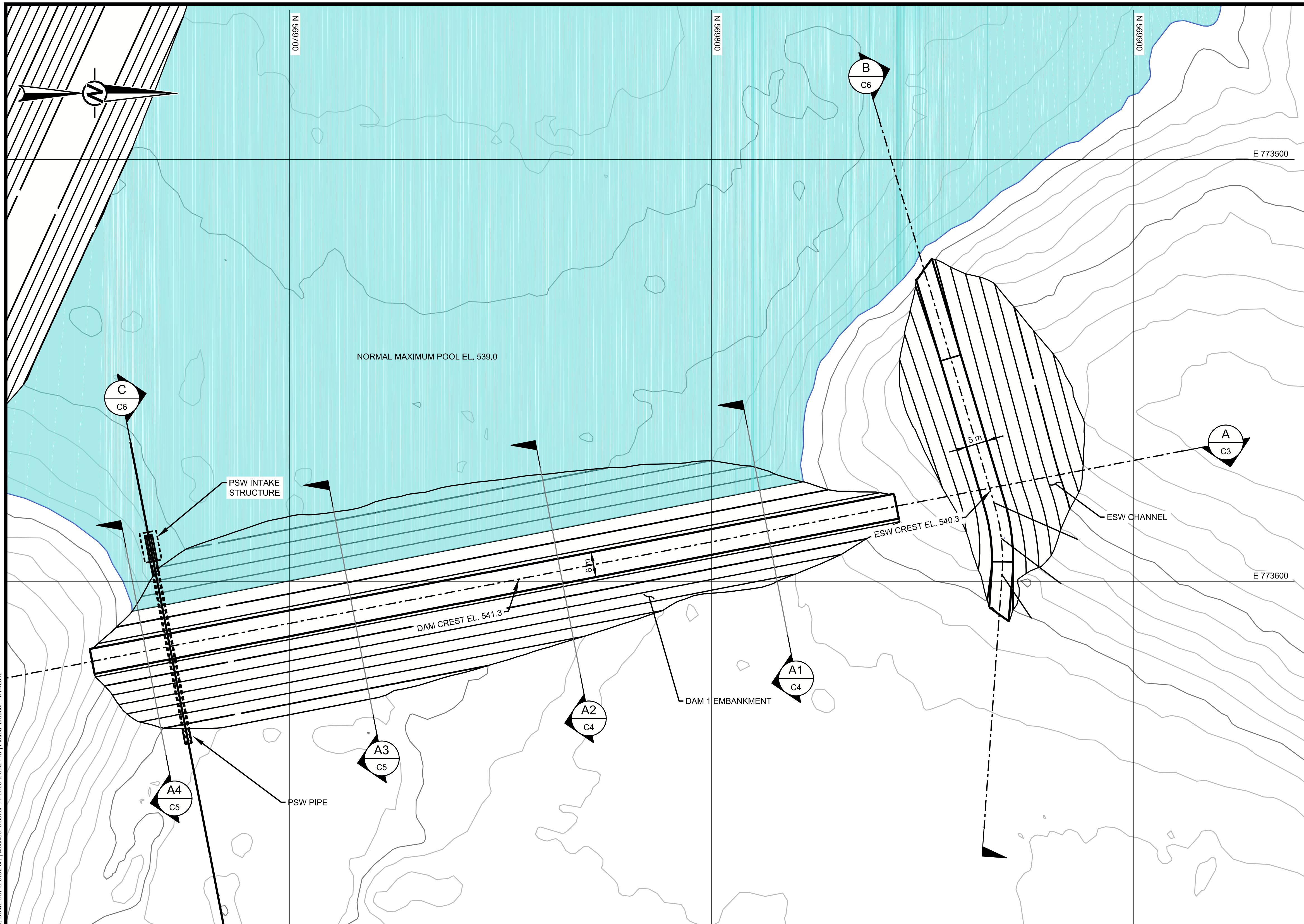
MERIAN GOLD PROJECT

TITLE

SEDIMENT DAM 1 AREA SITE PLAN

PROJECT No.		113-93245	FILE No.	850-Dam1_Area
DESIGN	BV	11-14-12	SCALE	AS SHOWN
CADD	ACF	11-14-12		
CHECK	DL	11-14-12	**FIGURE C1**	
REVIEW				

Golder Associates



NOTES

1. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.
2. WRITTEN DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS.
3. WGS 84 DATUM - UTM ZONE 21 N. EXISTING GROUND CONTOURS FROM LIDAR SURVEY (MAY 2011). CONTOUR LINES ARE NOT THEIR ACTUAL ELEVATIONS: THEY HAVE BEEN INCREASED 500M.

NOT FOR
CONSTRUCTION

0 20 40 60m
1:500

PROJECT				
MERIAN GOLD PROJECT				
TITLE				
SEDIMENT DAM 1 DAM SITE PLAN				
PROJECT No.		113-93245	FILE No.	850-Dam1_Site
DESIGN	BV	11-14-12	SCALE	AS SHOWN
CADD	ACF	11-14-12		
CHECK	DL	11-14-12	**FIGURE C2**	
REVIEW				

Golder Associates

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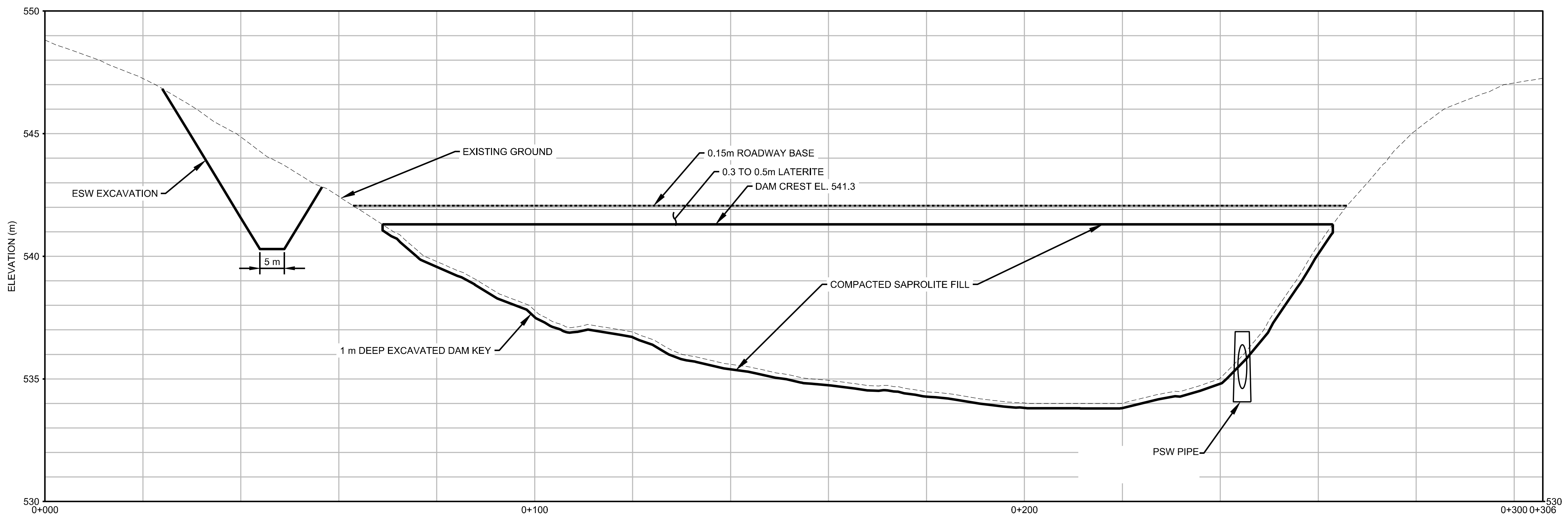
LEGEND

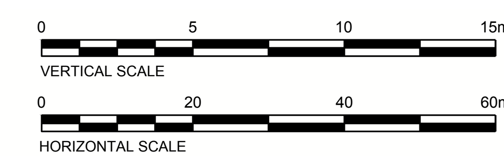
NOTES

1. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.
2. WRITTEN DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS.



A EMBANKMENT PROFILE
C2

NOT FOR
CONSTRUCTION



PROJECT					
MERIAN GOLD PROJECT					
TITLE					
SEDIMENT DAM 1 EMBANKMENT PROFILE					
Golder Associates	PROJECT No.		113-93245	FILE No.	850-Dam1_Em□_Prof
	DESIGN	BV	11-14-12	SCALE	AS SHOWN
	CADD	ACF	11-14-12	FIGURE C3	
	CHECK	DL	11-14-12		
	REVIEW				

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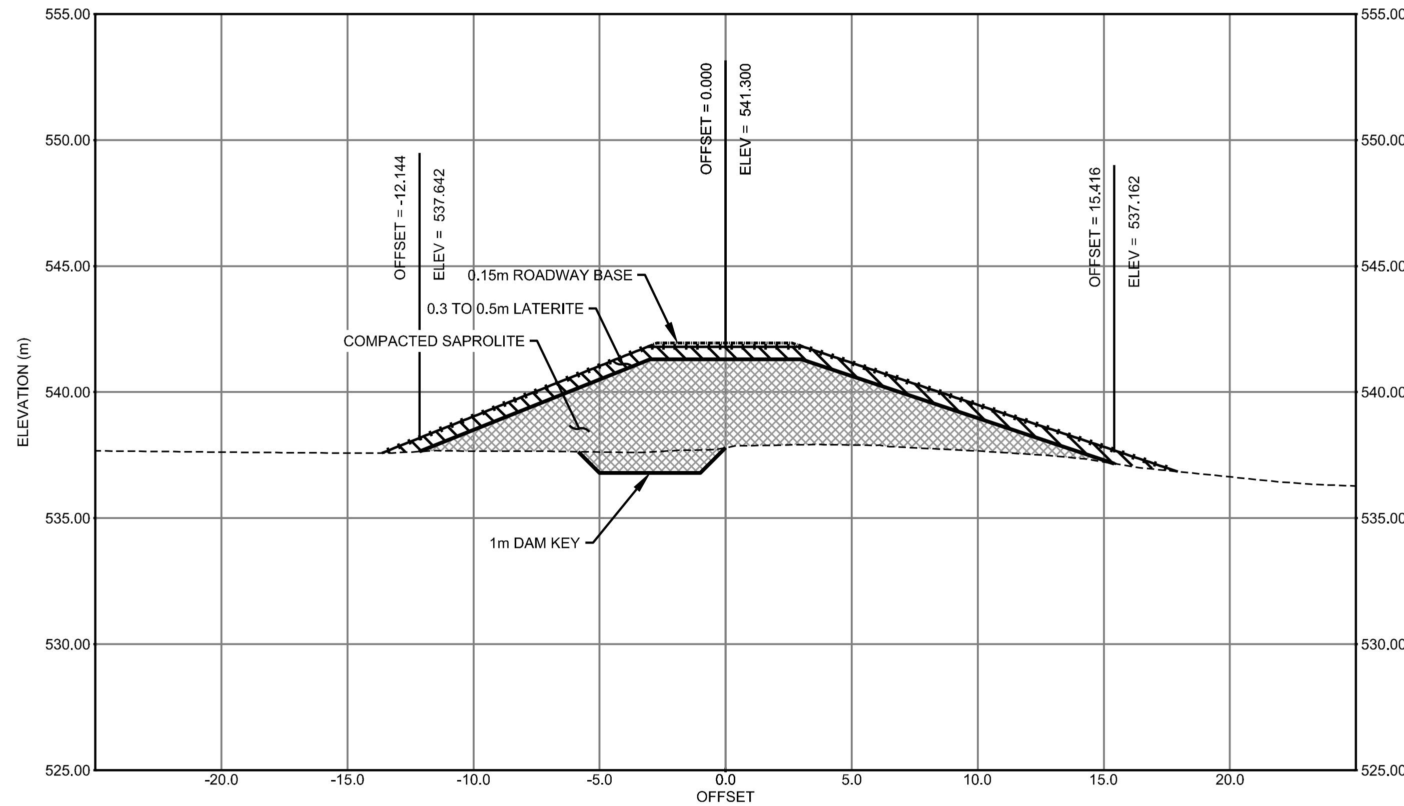
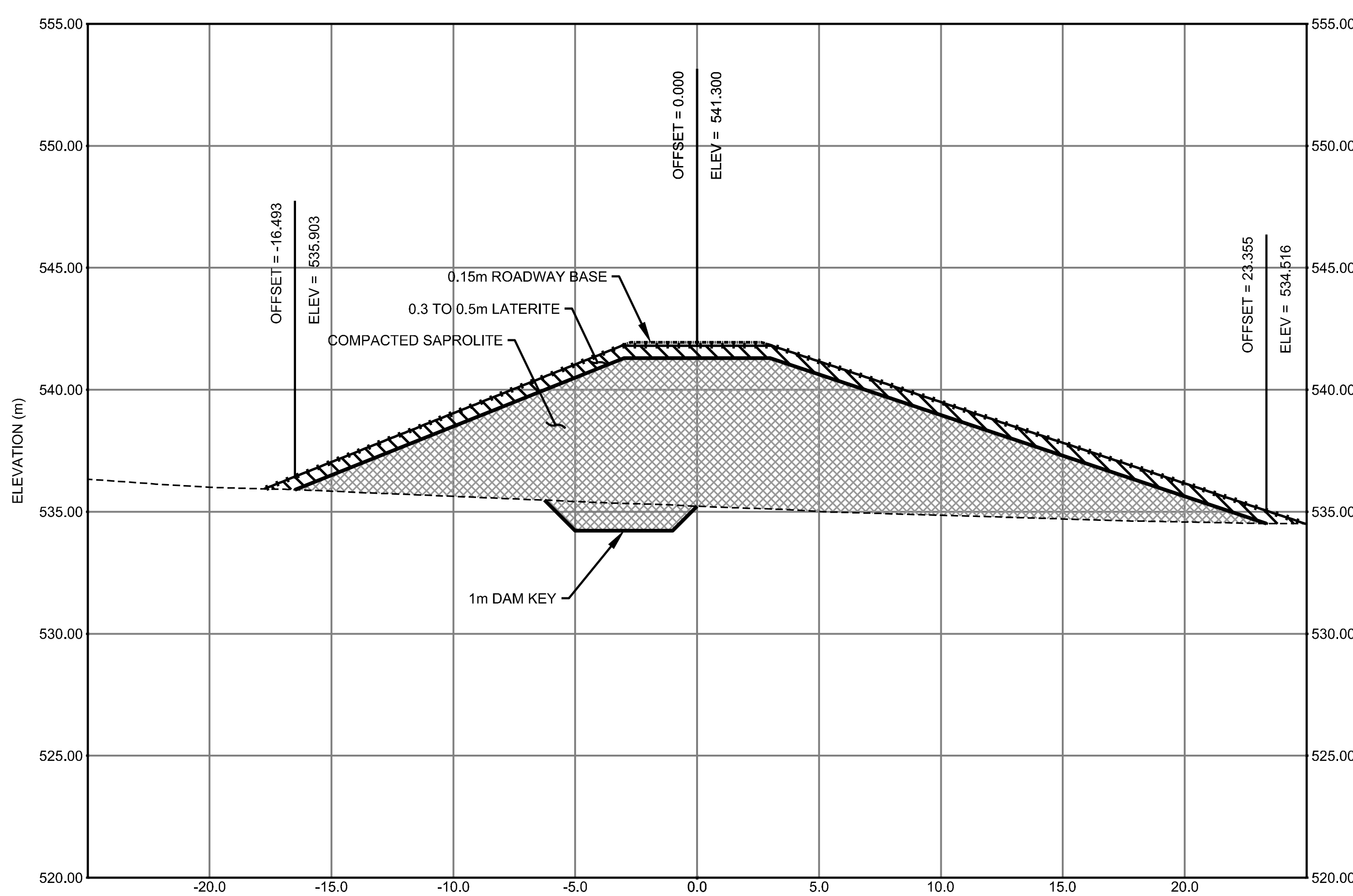


A1
C2
CROSS SECTION 1+00.00



A2
C2
CROSS SECTION 1+50.00

LEGEND

NOTES

1. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.
2. WRITTEN DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS.

NOT FOR
CONSTRUCTION

0 6 12 18m
VERTICAL SCALE

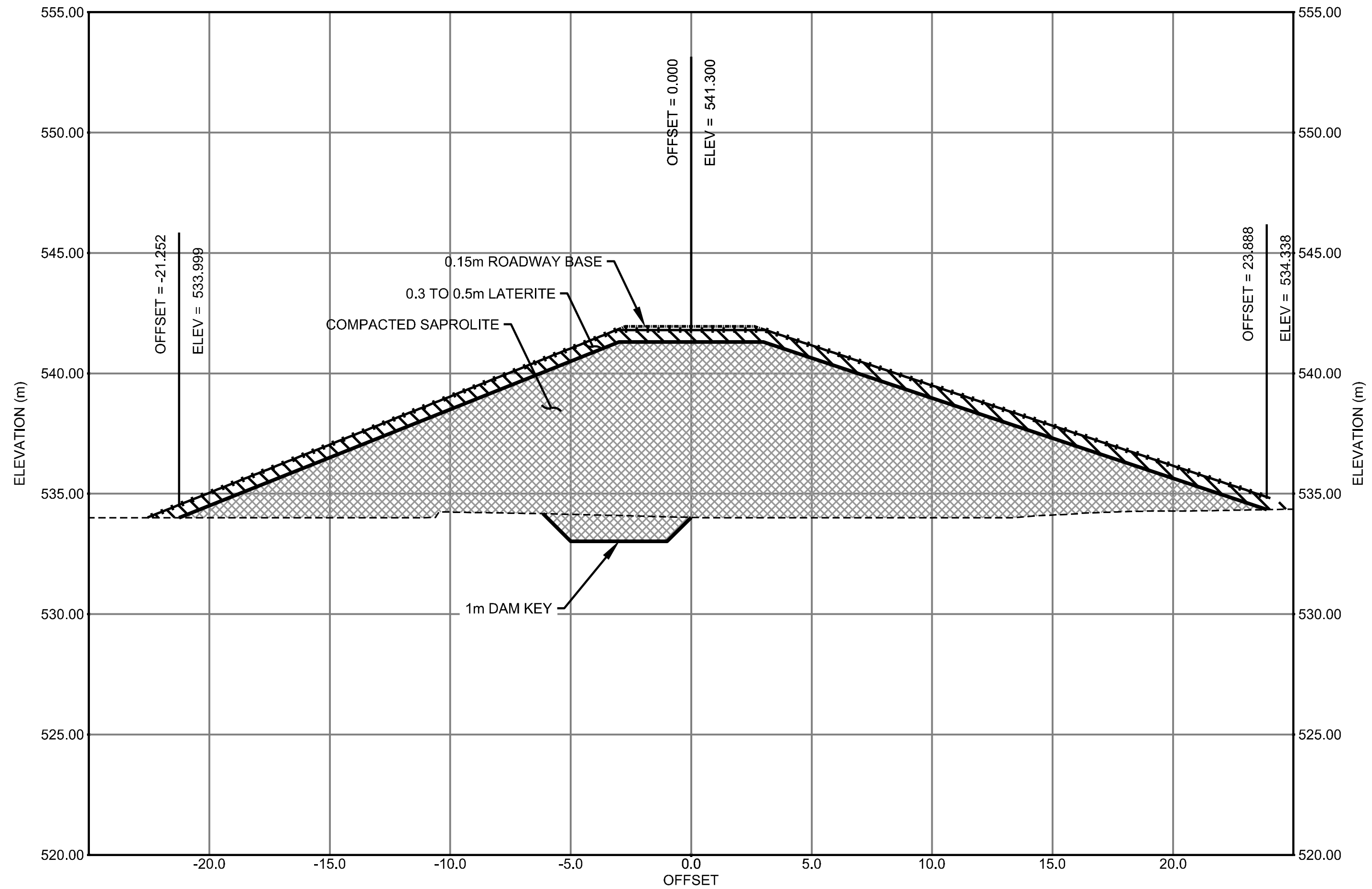
0 6 12 18m
HORIZONTAL SCALE

PROJECT
MERIAN GOLD PROJECT

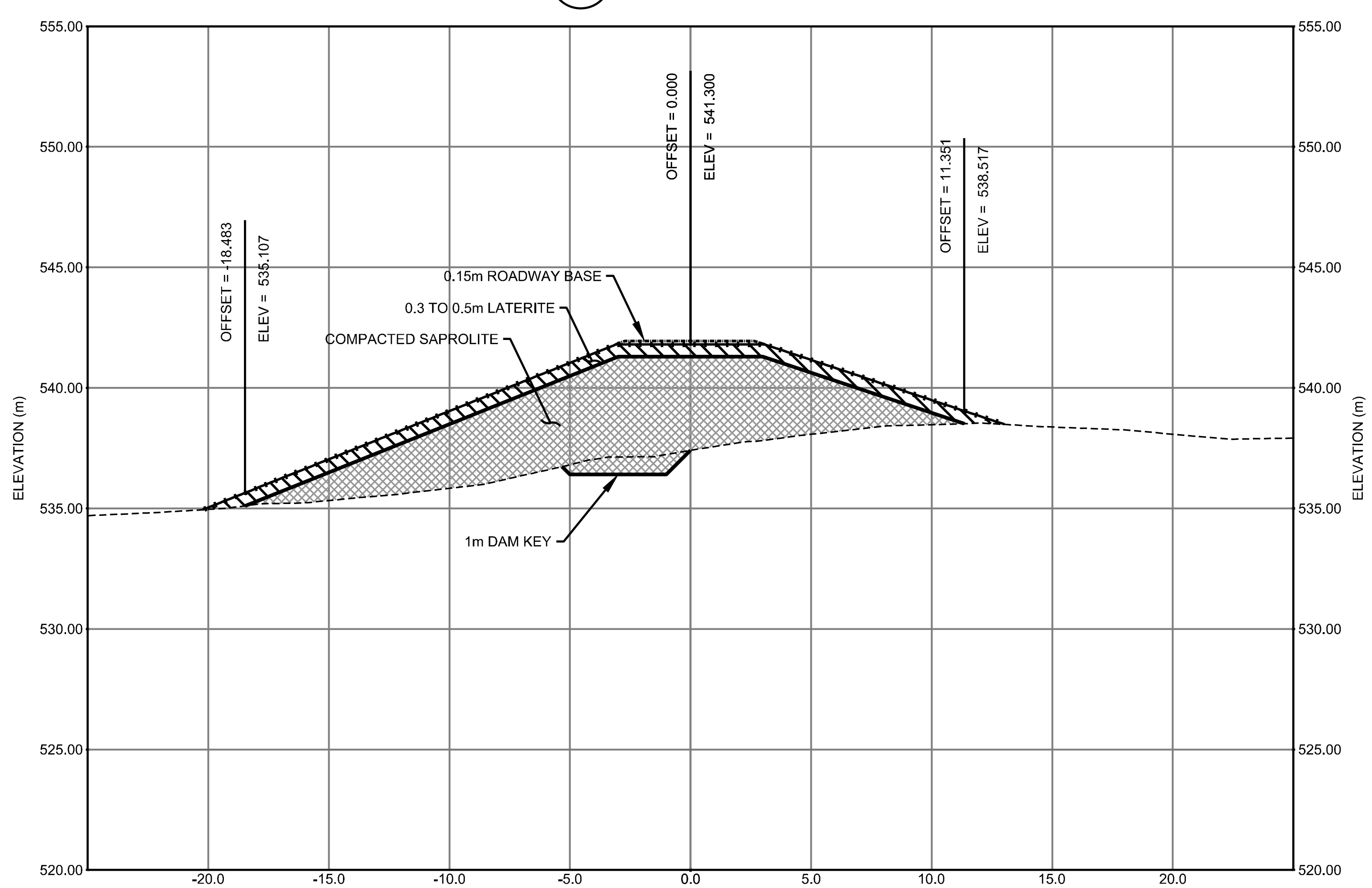
TITLE
SEDIMENT DAM 1 CROSS SECTIONS (1 OF 2)

Golder Associates

PROJECT No.		113-93245	FILE No.	850-Dam1_Sec1
DESIGN	BV	11-14-12	SCALE	AS SHOWN
CADD	ACF	11-14-12		
CHECK	DL	11-14-12	**FIGURE C4**	
REVIEW				



A3
C2
CROSS SECTION 2+00.00



A4
C2
CROSS SECTION 2+50.00

LEGEND

NOTES

1. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.
2. WRITTEN DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS.

NOT FOR
CONSTRUCTION

0 6 12 18m
VERTICAL SCALE

0 6 12 18m
HORIZONTAL SCALE

PROJECT
MERIAN GOLD PROJECT

TITLE
SEDIMENT DAM 1 CROSS SECTIONS (2 OF2)

PROJECT No.		113-93245	FILE No.	850-Dam1_Sec2
DESIGN	BV	11-14-12	SCALE	AS SHOWN
CADD	ACF	11-14-12		
CHECK	DL	11-14-12	**FIGURE C5**	
REVIEW				

Golder Associates

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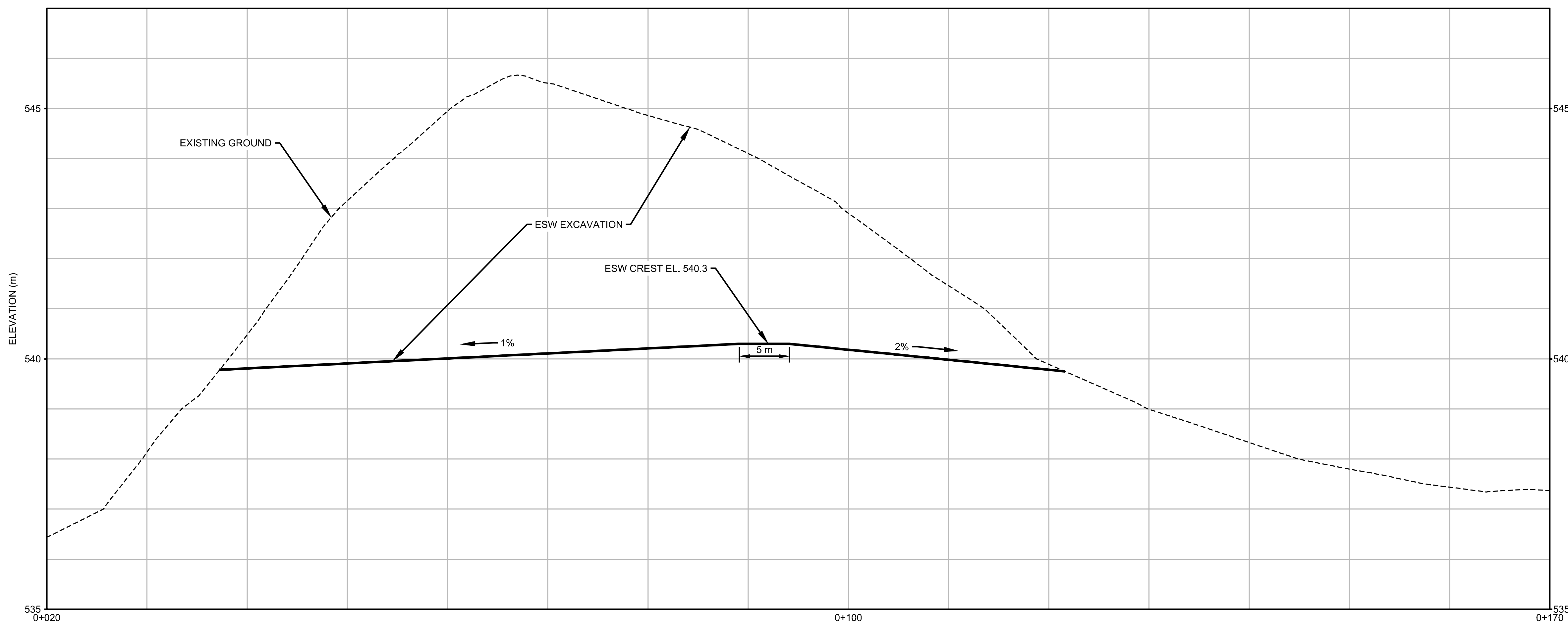
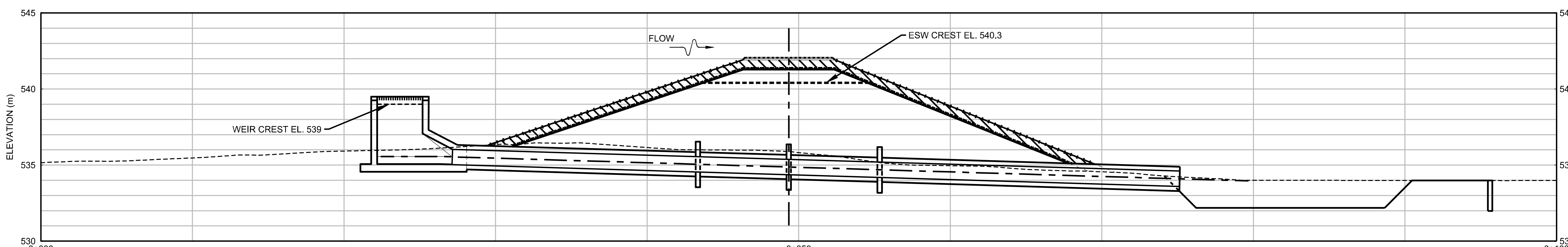


SCALE A:B (B / C2) EMERGENCY SPILLWAY PROFILE



SCALE C:D (C / C2) PRINCIPAL SPILLWAY PROFILE

LEGEND

NOTES

1. ALL WORK MUST BE APPROVED BY FIELD ENGINEER PRIOR TO CONSTRUCTION.
2. WRITTEN DIMENSIONS TAKE PRECEDENCE OVER SCALED DIMENSIONS.

NOT FOR
CONSTRUCTION

0 6 12 18 m
VERTICAL SCALE A

0 6 12 18 m
HORIZONTAL SCALE B

0 6 12 18 m
VERTICAL SCALE C

0 6 12 18 m
HORIZONTAL SCALE D

PROJECT
MERIAN GOLD PROJECT

TITLE
SEDIMENT DAM 1 SPILLWAY PROFILES

Golder Associates

PROJECT No.		113-93245	FILE No.	850-Dam1_SW-Prof
DESIGN	BV	11-14-12	SCALE	AS SHOWN
CADD	ACF	11-14-12		
CHECK	DL	11-14-12		
REVIEW				

FIGURE C6

APPENDIX D
PEAK FLOW ANALYSIS

PEAK FLOW ANALYSIS - SEDCAD RESULTS

Item	Return Period					
	2-year	5-year	10-year	25-year	100-year	500-year
DAM 1						
Existing Peak Flow (cms)	6.0	10.2	15.3	19.6	29.8	39.5
Disturbed Peak Inflow (cms)	8.8	12.8	17.2	20.9	29.3	37.1
Percent of Existing	147%	125%	113%	107%	98%	94%
Disturbed Peak Outflow (cms)	1.5	2.0	2.9	3.7	4.7	5.6
Percent of Existing	25%	20%	19%	19%	16%	14%
Peak Water Surface Elevation (m)	539.3	539.5	539.7	539.8	540.2	540.5
DAM 2						
Existing Peak Flow (cms)	21.3	37.6	57.5	74.5	115.5	155.0
Disturbed Peak Inflow (cms)	22.1	34.7	49.5	62.0	95.7	119.0
Percent of Existing	103%	92%	86%	83%	83%	77%
Disturbed Peak Outflow (cms)	1.2	3.3	4.7	4.9	5.3	8.2
Percent of Existing	6%	9%	8%	7%	5%	5%
Peak Water Surface Elevation (m)	533.4	533.7	534.2	534.6	535.5	536.2
DAM 3						
Existing Peak Flow (cms)	20.4	35.9	54.9	71.2	110.3	148.0
Disturbed Peak Inflow (cms)	27.1	41.1	57.2	70.4	101.3	130.6
Percent of Existing	133%	115%	104%	99%	92%	88%
Disturbed Peak Outflow (cms)	4.6	4.9	5.1	5.3	5.7	9.7
Percent of Existing	23%	14%	9%	7%	5%	7%
Peak Water Surface Elevation (m)	532.0	532.6	533.2	533.7	534.7	535.3
DAM 4						
Existing Peak Flow (cms)	16.3	28.6	43.7	56.7	87.7	117.7
Disturbed Peak Inflow (cms)	21.0	35.0	51.8	66.0	99.7	132.0
Percent of Existing	129%	122%	118%	116%	114%	112%
Disturbed Peak Outflow (cms)	3.0	4.7	4.9	5.1	5.5	9.4
Percent of Existing	18%	16%	11%	9%	6%	8%
Peak Water Surface Elevation (m)	530.7	531.1	531.6	532.0	533.0	533.6
DAM 5A						
Existing Peak Flow (cms)	5.2	9.2	13.9	18.0	27.7	37.1
Disturbed Peak Inflow (cms)	8.4	12.5	17.1	20.9	29.7	38.0
Percent of Existing	160%	136%	123%	116%	107%	102%
Disturbed Peak Outflow (cms)	2.1	3.7	5.1	5.2	5.5	8.3
Percent of Existing	39%	40%	37%	29%	20%	23%
Peak Water Surface Elevation (m)	543.5	543.8	544.1	544.3	545.0	545.5
DAM 5B						
Existing Peak Flow (cms)	5.5	9.5	14.4	18.6	28.5	38.1
Disturbed Peak Inflow (cms)	8.6	12.8	17.7	21.7	31.2	40.1
Percent of Existing	155%	134%	122%	117%	109%	105%
Disturbed Peak Outflow (cms)	3.1	5.1	5.3	5.4	5.8	9.0
Percent of Existing	56%	53%	36%	29%	20%	24%
Peak Water Surface Elevation (m)	546.7	547.0	547.5	547.9	548.7	549.4

Item	Return Period					
	2-year	5-year	10-year	25-year	100-year	500-year
DAM 6						
Existing Peak Flow (cms)	14.9	25.8	38.8	49.9	76.5	101.9
Disturbed Peak Inflow (cms)	27.3	43.0	61.3	76.7	112.8	147.1
Percent of Existing	183%	167%	158%	154%	147%	144%
Disturbed Peak Outflow (cms)	0.5	1.2	2.6	3.9	6.7	8.8
Percent of Existing	3%	4%	7%	8%	9%	9%
Peak Water Surface Elevation (m)	540.4	540.5	540.7	540.9	541.2	541.6
DAM 7						
Existing Peak Flow (cms)	6.6	11.1	16.4	20.9	31.3	41.2
Disturbed Peak Inflow (cms)	24.2	36.5	50.6	62.2	89.1	114.4
Percent of Existing	364%	328%	308%	298%	285%	278%
Disturbed Peak Outflow (cms)	4.2	4.8	5.0	5.2	5.7	9.7
Percent of Existing	63%	43%	31%	25%	18%	24%
Peak Water Surface Elevation (m)	535.9	536.4	537.0	537.5	538.5	539.2

TECHNICAL MEMORANDUM

Date: November 2, 2012 **Project No.:** 113-93245.961

To: Mike Brown **Company:** Golder Associates Inc.

From: Bridgette Hendricks
Almadoria Rettinger

cc: Pete Lemke
Kevin Conroy **Email:** bhendricks@golder.com

RE: **TSF WATER TREATMENT PLANT – CONCEPTUAL FEASIBILITY CONFIGURATION**

1.0 BACKGROUND AND EVALUATION BASIS

This technical memorandum presents a conceptual evaluation of water treatment for excess tailings water to support the Merian Gold Project site investigation and feasibility design. The water treatment plant (WTP) is required to treat excess water transferred from the tailings storage facility (TSF) prior to discharge to the treated water storage reservoir (TWSR). The proposed conceptual water treatment is part of the overall water management strategy that is based on influent and effluent storage and controlled release to achieve the in-stream water quality objectives for the project. This proposed strategy minimizes chemical utilization, power consumption, and generation of secondary waste in the proposed WTP while providing the required level of contaminant removal. This work is one of several parallel efforts in support of the overall mine feasibility evaluation.

The nominal WTP capacity for equipment sizing is 1,200 cubic meters per hour (m^3/hr) with the caveat that the WTP may require the flexibility to operate at higher or lower treatment rates. For chemical utilization purposes the mean annual flow to the WTP is expected to be approximately 800 m^3/hr. The WTP is intended to provide metals removal and occasionally ammonia removal (on an as-needed basis). Treated water would be discharged to the TWSR for controlled release for downstream compliance at EP-A0.

The water treatment and water storage requirements are determined by the season, the level of precipitation, the quantity and quality of any seeps from the TSF, and other similar factors.

Table 1 shows the values used as the influent basis for the WTP and the end-of-pipe treatment goals. Note that ammonia and copper drive the process design due to the potential for higher ammonia and copper levels in some of the other sources of water from the mine (such as the TSF seeps). Attenuation of other parameters to some extent is assumed through the use of the TWSR and the controlled release strategy. Several treatment scenarios of, controlled release and precipitation has been evaluated as one of the studies ongoing parallel to the water treatment evaluation.

Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, CO 80228 USA
Tel: (303) 980-0540 Fax: (303) 985-2080 www.golder.com

2.0 TREATMENT SYSTEM DESCRIPTION

The proposed water treatment system includes conventional lime and iron precipitation/co-precipitation for metals with the ability to provide removal of ammonia, as needed, by breakpoint chlorination. The equipment and features of the WTP are described in this section.

2.1 Approach and General Assumptions

The summary of the treatment approach and key criteria are as follows:

- Chemical precipitation/co-precipitation based system to target metal COPC similar to the treatment systems used at the Rosebel and Omai properties.
- Removal of ammonia by breakpoint chlorination utilized on an as needed basis only.
- Equipment and reagent consumptions based on the water quality projections shown in Table 1.
- Average design flow rate of 1,200 m^3/hr (5,300 gallons per minute).

General assumptions used to develop the treatment cost estimates include:

- Continuous treatment operation with influent storage available at the TSF and effluent storage in the TWSR.
- Nitrate and selenium treatment are not achieved; compliance is managed by controlled releases from the TWSR.
- Complete cyanide destruction occurs within the TSF prior to entering the WTP.
- Some flexibility to treat higher flows, lower flows, and short term increases in concentration may be required. In addition, some flexibility to achieve lower end-of-pipe treatment goals may be required.
- The treatment conditions are based on the data for the Omai and Rosebel mine water treatment systems provided by G Mining, literature reported values, and Golder experience. Water is not available for treatability studies at this time to confirm chemical dose assumptions, settling rates, sludge production or other assumed values.
- Clarifier underflow can be disposed of directly in the TSF by pumping and does not require further handling or dewatering. The impact of sludge return on the TSF has not been modeled or considered. A discussion on the alternate plan for sludge disposal is included in Section 3.3 if direct TSF disposal of clarifier underflow is not feasible.
- Space is limited and space-saving options are considered more favorable.

2.2 Treatment Process Overview

Figure 1 shows the Process Flow Diagram for treatment of the excess water from the TSF. The treatment system includes breakpoint chlorination, aeration, iron addition in the form of ferric sulfate, lime addition, polymer addition, and then coagulation/flocculation of precipitated solids. It is assumed that lime slaking and storage is required, however, if the WTP is located near the mill it may be possible to use slaked lime slurry from the mill as a potential cost saving measure. An inclined plate type clarifier is shown in Figure 1 to simplify installation and save space; however, a conventional circular clarifier could also be used for suspended solids settling. Due to the low concentration of precipitated solids, a solids recycle line has been included. A portion of the solids from the clarifier can be recycled back to the reaction tank or the lime feed tank. Increased solids in the reaction tank and clarifier can provide higher contaminant removal efficiency and better solids settling and removal.

The Omai and Rosebel treatment systems included carbon columns for gold recovery which may have provided some filtration of suspended solids and provided additional removal of metals. The carbon columns are not included in this evaluation since gold recovery was not a goal for the WTP. Effluent polishing filters are not included, however, are a contingency that could be added at a later date if required. The WTP effluent is discharged to a large reservoir (i.e., TWSR) which could provide some additional settling of suspended solids and metals if there is carryover from the clarifiers.

2.3 Ammonia Removal Conceptual Process Design

The breakpoint chlorination step includes the use of hypochlorite to oxidize ammonia to nitrogen gas. Sodium carbonate is also added to maintain the pH in the preferred range for the reactions to occur. Breakpoint chlorination can provide virtually 100 percent ammonia removal with precise chlorine dosing and pH controls. Other parameters can contribute to chlorine demand and increase the chemical requirements include iron, manganese, sulfide, nitrite, and organic parameters including algae and bacteria. The iron and manganese are low and should not contribute to the chlorine demand. Sulfide, nitrite, and organic loading are not known, however, are typically low for mining waters and assumed not to contribute significantly to chlorine demand.

The theoretical dose of chlorine (Cl_2) to ammonia is 7.6:1, however, actual practice on municipal water treatment systems is typically 15:1. This rule of thumb will be utilized for the Merian TSF water since there are some unknown components (organic loading) in the TSF water. It is expected that during actual operations both ammonia (via ion specific electrode) and free chlorine (simple test kits or test strips) will be monitored routinely to assure that chlorine is not overdosed and the desired ammonia removal is achieved. Because the target ammonia effluent is 4.5 milligrams per liter (mg/L [as N]) and does not require removal to very low values it will be possible to operate the breakpoint chlorination system so that minimal chemicals are used and chlorine residual is minimized. The most effective pH for ammonia removal is generally in the range of 7 to 8 and longer reaction times are typical. Dechlorination may be required if there are effluent toxicity (such as Whole Effluent Toxicity) testing requirements, however for the Merian WTP there are several treatment steps including mix tanks, and aeration step, and the TWSR that will allow dissipation if there is residual chlorine. Therefore no equipment for dechlorination is included but can be added as a contingency if necessary.

The breakpoint chlorination step is based on the following:

- Influent water quality as shown in Table 1.
- Removal of 8 or 12 mg/L of ammonia with chemical doses as shown on Table 2 for example purposes. The hypochlorite doses include a safety factor of two to account for chlorine demand from the background water matrix.
- Reaction time of 30 minutes at 1200 m^3/h influent flow.

Table 2 shows the chemical requirements for three forms of hypochlorite including the 12 percent liquid form of sodium hypochlorite, a 65 percent dry form of sodium hypochlorite, and a 70 percent dry calcium hypochlorite. The breakpoint chlorination system is not expected to be used on a continuous basis.

This system can be operated in an on/off mode and only used when ammonia removal is required. An ammonia probe can be used to provide real-time ammonia data on whether or not operation of the system is required and then also provide data for adjustment of the chemical dose rates so that excess chemical is not added to the system. The hypochlorite has a more limited shelf life than the other water treatment chemicals so the primary concern with intermittent operations will be to maintain chemicals, if needed, but to not stockpile and accumulate degraded chlorine based chemicals.

2.4 Metals Removal Conceptual Process Design

Table 3 shows the general influent quality for the Merian TSF water and for similar waters for which metals treatment data are available. This table is intended to show a range of treatment conditions (iron concentration, pH, and oxidation) with the Rosebel and Omai treatment systems at lower iron and pH values to higher levels of iron and pH conditions. The “Literature” reported data (Gallagher et al. 2012) are for a project that Golder recently completed for the State of Colorado to treat historic mining waters that are similar in quality to the projections for Merian. The Literature reported data are from bench-scale and pilot-scale treatability studies conducted in support of detailed design of the facility. The Literature reported data shows the impact of higher iron levels (78 mg/L naturally occurring) with and without aeration and with lime addition to achieve two pH levels. A paper reporting these results is provided as Attachment A. This data shows that even the very low “Adjusted Criteria” can be achieved by lime and iron co-precipitation for the specific metals of concern (aluminum, cobalt, copper, silver) at the Merian project.

The other treatment data shown in Table 3 are for the Rosebel mine and the Omai mine (G Mining) which included ferric addition (to approximately 17 mg/L of iron as [Fe]) and sodium hydroxide for pH adjust. Hydrogen peroxide addition was included in the Omai treatment system configuration but the data shown in Table 3 does not include hydrogen peroxide addition. These data show that a majority of the metals load can be removed with modest chemical treatment requirements. The treated effluent quality is close to the Merian treatment goals, however, does not quit achieve the end-of-pipe goals indicating that the iron dose required is greater than 17 mg/L. This data and the Literature reported data provide the bounding conditions for treatment for the Merian water treatment evaluation.

In addition to the treatability data from studies and operating systems, modeling was completed using Geochemist Workbench software to determine estimated chemical reagent consumption. Figure 2 shows a titration curve for the addition of hydrated lime to the water. The lime shown as “Lime Reacted, mg” is the hydrated lime dose expressed in milligrams per liter of water treated. Figure 3 shows the effect on pH from the addition of ferric sulfate at a dose of 50 mg/L as iron to one liter of water. Figure 4 shows a lime titration curve for Merian water that has been treated with 50 mg/L of iron.

Based on the information shown in Table 3 and Figures 2, 3 and 4, the following are used as the basis for the treatment of metals in the Merian TSF water:

- **Iron Dose:** 50 mg/L (as Fe) for the average water quality with potential increases and decreases in dose for high flow, low flow or other treatment conditions. The Omai water treatment facility showed a 75 percent removal of copper through the clarifier with an iron dose of 16.8 mg/L and an overall removal of 92 percent through the carbon columns. The Rosebel data shows an 82 percent removal of copper and the iron dose was not reported in the information available. The naturally occurring iron in the literature reported data on Table 3 is 78 mg/L and the copper removal ranges from 82 to greater than 99 percent depending on the treatment pH and whether oxidation is included. Merian’s average water quality requires a 97 to 98 percent removal of copper, so an iron dose greater than used at Omai and Rosebel but less than the 78 mg/L in the literature data is assumed.
- **Lime Dose:** The caustic dose used in the treatment of the Omai water was calculated at 8.3 mg/L (as NaOH) which is equivalent to 4.13 mg/L of quicklime (CaO) or 7.7 mg/L of hydrated lime ($Ca(OH)_2$). The ferric sulfate added as a co-precipitant has associated acidity and will decrease the pH. The ferric sulfate dose for the Merian water is higher than for the Omai water so the associated lime dose will be higher. The treatment pH required to achieve the desired copper removal is likely higher than the treatment pH for the Omai or Rosebel water. As shown in Figures 3 and 4 a lime dose of 200 mg/L is required to increase the pH to approximately 9 after a 50 mg/L iron dose is added to the Merian water. A lime dose of 200 mg/L as hydrated lime is assumed for reagent consumption and equipment design purposes with the flexibility to provide higher and lower quantities. The treatment system can be operated at higher pH values with associated higher lime doses than the 200 mg/L value, the frequency of chemical delivery will have to be increased.
- **Polymer Dose:** The polymer dose is assumed to be 1 mg/L for equipment sizing purposes. The polymer requirement may be lower for iron dose on the higher end of the range, however, treatability studies are required to confirm the polymer dose.

It is assumed that effluent neutralization will not be required as the dilution water pH is lower than neutral and is expected to have sufficient neutralization capacity for the WTP effluent.

2.5 Projected Effluent Quality

Table 4 shows the projected effluent quality for treatment with lime and iron at 25 mg/L (as Fe) and with lime and iron at 50 mg/L (as Fe) with breakpoint chlorination for ammonia removal. In addition to showing the residual ammonia and metals after treatment the increase in calcium, sulfate, sodium, and chloride from the water treatment chemicals is also shown. These projections are based on the treatment of similar water which is relatively low total dissolved solids (TDS) and low metals so the precipitated solids are low. The treatment pH and iron concentrations are a similar range as the expected operating range for the Merian TSF water.

3.0 EQUIPMENT AND PROCESS DESCRIPTION

3.1 Equipment

Table 5 shows the equipment list and key process basis for equipment sizing for treatment of 1,200 m^3/hr flow and the chemical consumption information in Section 2.3. A preliminary general arrangement to provide the footprint requirement is shown in Figure 5.

- **Major Reaction tanks:** The Aeration Tank and the Lime Reaction Tank are both sized at a 30 minute retention time at 1,200 m^3/hr flow. At the 800 m^3/hr typical flow the retention time would be 45 minutes. These are within typical ranges of 15 to 60 minutes depending on the constituents present, reactants, and concentrations.
- **Clarifier:** The clarifier is sized at a hydraulic load rate of 0.25 gallons per minute per square foot (gpm/ft^2) which is typical for metal hydroxide sludge clarification using an inclined plate type clarifier. Given that most of the metal precipitating is iron added as the co-precipitating agent it may be possible to operate the systems at a higher hydraulic loading. With additional settling capacity in the reservoir it may be possible to operate more aggressively for peak flow periods.

As shown in Figure 5, some of the processes require parallel units to accommodate the design basis and required flow, while utilizing commercially available equipment. For instance, there are four parallel clarifier units to accommodate the design flow. This parallel train configuration also provides more flexibility to allow operations over a wide range of influent flow rates.

3.2 Chemical Usage

Table 6 provides a summary of the daily chemical consumption requirements for treatment of 1,200 m^3/hr and 800 m^3/hr for the water quality shown in Table 1. The daily chemical consumption shown is directly related to the flow and water quality. The ability to increase the chemical dosage may also provide increased flexibility on increasing throughput, response to variability in influent water quality, and reduced quantities of dilution water. For instance if the flow increases a higher iron dose may provide more efficient settling and allow treatment at a higher flow with no loss of removal efficiency. An increase in treatment pH may also provide a similar treatment effect if flow is increased. Treatability studies are required to confirm these assumptions which can be efficiently performed with jar testing protocols once site water is available.

3.3 Solids Handling Contingency

If the clarifier underflow requires disposal either to reduce the volume disposed in the TSF or to dispose of the solids in another location a filter press can be installed at the WTP. Typically metal hydroxide sludge from conventional lime and iron treatment processes can be dewatered to a solids content of 15 to 25 percent. Dewatered sludge can be transferred to a rolloff or truck by loader for transport and disposal. The sludge typically passes hazardous waste leaching procedure tests such as the Environmental Protection Agency (EPA) Toxicity Characteristic Leaching Procedure (TCLP) test that allows for disposal in conventional landfill type facilities.

Filter press equipment is sized according to the quantity of dewatered sludge produced per day and the time that operations labor is available to run the equipment. The daily dewatered sludge production assuming 20 percent solids is 12.44 m^3/day (440 cubic feet per day ft^3/day). The time required per filter press cycle is in the range of 2 to 4 hours. Assuming a 2.3 cubic meters (m^3 [80 ft^3]) filter press would require 5 to 6 press runs per day with the flexibility to operate at up to 3 additional runs per day for higher flow periods.

In addition to the filter press a sludge tank will be required with a minimum size to accommodate approximately 8 hours of underflow from the clarifier. The sludge tank should be cone bottomed with a capacity of approximately 64 m^3. A feed pump will also be required. The filtrate can be returned to the front end of the treatment plant and is estimated to be approximately 7.3 m^3/hr.

4.0 SYSTEM FLEXIBILITY

The treatment system shown in Figure 1 provides a great deal of flexibility with regard to treatment of varying flow rates and water quality. Treatment at higher flow rates, particularly for short periods of time such as a high flow precipitation event or a wet season, may be possible. Operation of the reaction tanks at lower retention times, which result from higher flow rates, should be possible. Operation of the clarifier and filters at higher flow rates may be possible as the systems are based on the low end of the typical range for hydraulic load rate. Increased iron dose and/or pH may also allow for increased treatment rate.

For instance the clarifier sizing is based on a hydraulic load rate of 0.25 (gpm/ft^2) which is the typical rule of thumb for metal hydroxide sludge. For other applications, hydraulic load rates of up to 1 gpm/ft^2 are used, depending on the nature of the suspended solids. For municipal treatment systems published data shows hydraulic load rates from 0.34 to 0.66 gpm/ft^2 for iron or alum coagulated solids. If significantly increased flow rates must be managed in the WTP, it may be possible to increase the iron dose to increase the settling rate and allow efficient operation of the clarification equipment at higher flow rates.

Specific to the operations of the TSF and the overall water management system it is projected for certain precipitation cases operations of the WTP at 150 percent of capacity or 1,800 m^3/hr will be required. At this flow, the following are the changes in the operational parameters for the WTP from operations at 1200 m^3/hr.

Reaction time: reduced from 30 minutes to 20 minutes in each of the reaction tanks (chlorination, aeration/iron addition, and metals precipitation);

Clarifier load rate: increased from 0.25 gpm/ft^2 to 0.375 gpm/ft^2. Some clarity may be lost in the clarifier effluent quality. Increased iron dose to improve coagulation may restore some clarity, if required. Effluent filtration may also be required if these high flows are a common occurrence and the effluent quality is not acceptable. Effluent filtration is a contingency along with adding another clarifier unit for high flow periods.

Chemical usage: assuming at increased flow the influent concentrations are the same and not diluted by the increased precipitation the daily quantities of each chemical used will increase by 50 percent. Increased chemical deliveries may be required depending on the duration of the increased flow.

In addition to flexibility of the treatment system, there are other contingency features incorporated into the water management system including the large TSF for storage, blending of the influent water and the large reservoir (TWSR) for storage, and blending of the effluent. The effluent TWSR allows for strategic blending of the effluent with other site waters and also provides additional settling of particulate matter and overall blending of the effluent in the event of a process upset.

The lime and iron co-precipitation system also provides a beneficial increase in hardness and if the WTP effluent comprises a major portion of the discharge to EP-AO or B1 then the hardness of the receiving stream will increase. The estimated increase in calcium in the WTP effluent for the operating scenario at 25 mg/L of iron with an associated hydrated lime dose estimate of 100 mg/L is an additional 54 mg/L. This is equivalent to an increase in hardness of 135 mg/L as $CaCO_3$ over the projected influent value shown in Table 1 of 126 mg/L as $CaCO_3$. The hardness increase in the WTP effluent for the higher iron dose of 50 mg/L is 270 mg/L as $CaCO_3$. Increased hardness in the receiving stream will increase the limits for the hardness based parameters including copper. The overall impact of the increased hardness in the WTP effluent results in an increase in hardness in the receiving stream and at the compliance point in the receiving stream.

5.0 REFERENCES

G Mining – Rosebel and Omai data:

Omai Gold Mines Limited

- Omai Gold Mines Limited. 1999. Quarterly Environmental Report. December 7.
- Omai Gold Mines Limited. 2000. First Quarter Environmental Report. May 20.

SGS Laboratory. 2011. Rosebel Mine Laboratory Data Report No. CA11098-MAR11. Prepared for Rosebel Gold Mines NV – IAMGOLD Corp.

Gallagher et al. 2012. Integration of Bench and Pilot High Density Sludge Treatment of Acid Rock Drainage into Full Scale Treatment Facility Design at the Central City/Clear Creek Superfund Site Near Blackhawk Colorado", Neal Gallagher, Mary Boardman, Christopher Beck, Brian Huff, and Mike Holmes, to be presented at the International Water Conference, San Antonio Texas, November 2012.

List of Tables

List of Figures

List of Attachments

TABLES

Table 1: Influent Design Basis for Water Treatment Plant Conceptual Evaluation

Parameter	Units	WTP End-of-Pipe Treatment Goal [1]		WTP Influent [2]	Percent Removal Required	
Flow	m^3/hr			1,200		
	gpm			5,283		
Stream Hardness (assumed)	mg/L as $CaCO_3$	25	50		25	50
General Chemistry and Nutrients						
pH	s.u.	6.4-8.4	6.4-8.4	6.4 - 8.4	NA	NA
Nitrogen	mg/L-N			24	NA	NA
Nitrate	mg/L-N	10	10	12	NA	NA
Ammonia	mg/L-N	4.5	4.5	12	63%	63%
Phosphorous	mg/L				NA	NA
Major Ions						
Alkalinity	mg/L as $CaCO_3$			75	NA	NA
Chloride	mg/L	230	230	65	NA	NA
Fluoride	mg/L	1	1	1	15%	NA
Sulfate	mg/L	1000	1000	370	NA	NA
Calcium	mg/L			72	NA	NA
Magnesium	mg/L			1	NA	NA
Potassium	mg/L			24	NA	NA
Silicon	mg/L			4	NA	NA
Sodium	mg/L			191	NA	NA
Hardness (calculated)	mg/L as $CaCO_3$			126	NA	NA
Metals						
Aluminum	mg/L	0.087	0.087	**1.6**	94%	94%
Antimony	mg/L	0.006	0.006	0.004	NA	NA
Arsenic	mg/L	0.01	0.01	**0.02**	59%	59%
Barium	mg/L	0.10	0.21	0.1	29%	NA
Beryllium	mg/L	0.00007	0.00041	0.006	Disregard [3]	Disregard [3]
Boron	mg/L	0.5	0.5	0.06	NA	NA
Cadmium	mg/L	0.0008	0.0013	**0.002**	58%	30%
Chromium	mg/L	0.024	0.042	0.02	NA	NA
Cobalt	mg/L	0.1	0.1	**0.12**	18%	18%
Copper	mg/L	0.003	0.005	**1.2**	99.7%	99.6%
Iron	mg/L	1	1	**2.1**	53%	53%
Lead	mg/L	0.007	0.012	0.007	7%	NA
Manganese	mg/L	0.57	1.05	0.03	NA	NA
Mercury	mg/L	0.0008	0.0008	0.0006	Disregard	Disregard
Molybdenum	mg/L	0.18	0.18	0.07	NA	NA
Nickel	mg/L	0.02	0.03	**0.04**	60%	28%
Selenium	mg/L	0.005	0.005	**0.005**	Not Treated	Not Treated
Silver	mg/L	0.0001	0.0001	**0.006**	98%	98%
Thallium	mg/L	0.002	0.002	0.001	NA	NA
Zinc	mg/L	0.036	0.066	**0.3**	87%	77%

Notes:

1. End-of-pipe treatment goals are based on the criteria for the receiving stream at EP-A0 and are considered treatment targets for most parameters. Attenuation through controlled release will be achieved for some parameters. The driving parameters for process design of the TSF water treatment system are ammonia and copper.
2. TSF Pond Water Quality from FS(c)-A model predictions.
3. Parameters shown as "disregard" are the result of detection limit calculational issues and not expected to be present at the levels shown.

Yellow indicates the Merian water exceeds the Merian Treatment Goal at assumed hardness of 25 mg/L.
Bolded yellow indicates the Merian water exceeds the Merian Treatment Goal at assumed hardness of 50 mg/L.

Table 2: Chemical Requirements for Ammonia Removal by Breakpoint Chlorination

Chemical	Dose [1/] mg/L	kg/day Chemical for Influent Flow at 1200 m^3/h	800 m^3/h	Ion Added, mg/L Na	Cl	Ca
For removal of 8 mg/L of ammonia (as N)						
Hypochlorite						
NaOCl	99.3			31	47	
12% NaOCl		22886	15257	31	47	
NaOCl, 65% Dry		4401	2934	31	47	
$Ca(OCl)_2$, 70% Dry		3922	2615		47	27
Alkalinity Addition (based on 50 mg/L $CaCO_3$ alkalinity present in the influent)						
Na_2CO_3	68	1203	802	30		
For removal of 12 mg/L of ammonia (as N)						
Hypochlorite						
NaOCl	149			46	71	
12% NaOCl		34329	22886	46	71	
NaOCl, 65% Dry		6602	4401	46	71	
$Ca(OCl)_2$, 70% Dry		5883	3922		71	40.5
Alkalinity Addition (based on 50 mg/L $CaCO_3$ alkalinity present in the influent)						
Na_2CO_3	102	1805	1203	44		

1. Dose is based on removal of the indicated amount of ammonia and an influent alkalinity of 75 mg/L as $CaCO_3$. The hypochlorite includes a safety factor of 2 to account for chlorine demand in the background water quality.

Table 3: Summary of Data for Lime/Iron Treatment

Parameter	Units	Merian Treatment Goal		Influent [1]		Effluent Literature [1]				Rosebel [2]			Omai [3]				
				Merian	Literature	pH 8.8	pH 8.8/ox	pH 9.2	pH 9.2/ox	Influent	Effluent	Limit	Influent	Clarifier OF	Carbon Effluent	Effluent	Limit
pH		6.4 - 8.4		6.4-8.4						8.85	7.8		8.29	6.93		7.28	6.5-9.5
Flow	m^3/hr	-		1200									412				
	gpm	-		5283									1814				
Hardness	mg/L	25	50														
Select Parameters of Concern [4]																	
TSS	mg/L	-								25	16		140	13.8	7.6	2.9	25
Alkalinity	mg/L	-		75						100	83						
Aluminum [5]	mg/L	0.087	0.087	**1.6**	**1.9**		< 0.018	< 0.018	< 0.018	**0.65**	**0.09**						
Cadmium	mg/L	0.0008	0.0013	**1.2**	**0.022**	0.001	0.0002	0.0002	0.0001	0.0001	0.0001						
Copper	mg/L	0.003	0.005	**1.19**	**0.640**	**0.0120**	< 0.0014	0.0038	< 0.0014	**0.215**	**0.038**		**0.2260**	**0.0580**	**0.0190**	**0.0220**	**0.3000**
Iron	mg/L	1	1	**2.112**	**78**	**1.500**	< 0.022	0.660	< 0.022	0.722	0.096		0.292			0.112	**3.000**
Zinc	mg/L	0.036	0.066	**0.282**	**5.62**	**0.110**	< 0.005	0.047	< 0.005	0.005	0.004		0.008			0.007	**0.500**

Notes:

1. The Merian data is from the Golder projections for the Merian project with the metals data shown as dissolved. The "Literature" column shows the influent water quality for treatability studies conducted by Golder on a similar water. The results of the Golder treatability studies are reported in the article provided as Attachment A. Data shown is for dissolved.
2. Data from G Mining for Rosebel Mine. Data shown is for March 15, 2011 for point TP-2 as the influent and for point TWSP-D for effluent. Metal values are total. Blanks indicate no data available.
3. Data from G Mining for Omai Mine. Data shown is the monthly average for September 1999. Metals data is dissolved. Calculated Fe dose from ferric sulfate addition is 16.8 mg/L. Blanks indicate no data is available.
4. Selected Parameters of Concern are based on data availability not as a match to all of the Merian COPCs.
5. Aluminum values shown for the "Effluent Literature" are from the HDS/pilot test. Aluminum data from jar tests was not provided. Data shown was for pH 8.5 rather than 8.8 and 9 rather than 9.2.

Yellow indicates the Merian water exceeds the Merian Treatment Goal at assumed hardness of 25 mg/L.

Bolded yellow indicates the Merian water exceeds the Merian Treatment Goal at assumed hardness of 50 mg/L.

Blue indicates the water exceeds the Merian Treatment Goal at hardness of 25 mg/L.

Bolded blue indicates the water exceeds the Merian Treatment Goal at hardness of 50 mg/L.

Table 4: Projected Effluent Quality from TSF Water Treatment Plant

Parameter	Units	WTP End of Pipe Treatment Goal at Hardness in Receiving Stream of 25 mg/L	WTP Influent	WTP End of Pipe Effluent Quality	
Treatment Conditions				**Aeration, 25 mg/L Fe, 100 mg/L hydrated lime to appx pH 9**	**Aeration, 50 mg/L Fe, 200 mg/L hydrated lime to appx pH 9, with breakpoint chlorination for removal of up to 8 mg/L ammonia**
Flow	**m^3/hr**	-	1,200	1,200	1,200
	gpm		5,283	5,283	5,283
Discharge pH		6.4-8.4	8.02	9	**9**
Nitrogen					
Nitrate	mg/L-N	10	12	Not removed	Not removed
Ammonia	mg/L-N	4.5	12	Not removed	4
Major Ions					
Alkalinity as $CaCO_3$ [1]	mg/L		75	<75	<75
Chloride [1]	mg/L	230	65	65	112
Fluoride	mg/L	1	1.2	1.2	1.2
Sulfate	mg/L	1,000	370	435	499
Calcium	mg/L		72	126	180
Magnesium	mg/L		1.0	1	1
Potassium	mg/L		24	24	24
Silicon	mg/L		3.6	3.6	3.6
Sodium [1]	mg/L		191	191	252
Hardness (calculated)	mg/L		185	320	455
Metals					
Aluminum	mg/L	0.087	1.6	0.09	<0.09
Antimony	mg/L	0.006	0.004	-	-
Arsenic	mg/L	0.01	0.02	0.002	<0.001
Barium	mg/L	0.10	0.1	-	-
Beryllium	mg/L	0.00007	0.006	Disregard	Disregard
Boron	mg/L	0.5	0.06	no change	no change
Cadmium	mg/L	0.0008	0.002	0.001	0.0002
Chromium	mg/L	0.024	0.02	-	-
Cobalt	mg/L	0.1	0.1	-	-
Copper	mg/L	0.003	1.2	<0.02	<0.003
Iron	mg/L	1	2.1	0.1	<0.02
Lead	mg/L	0.007	0.007	No treatability data at this low of concentration	
Manganese	mg/L	0.57	0.03	no change	no change
Mercury	mg/L	0.0008	0.0006	-	-
Molybdenum	mg/L	0.18	0.07	-	-
Nickel	mg/L	0.02	0.04	0.015	0.01
Selenium	mg/L	0.005	0.005	No Change	No Change
Silver	mg/L	0.0001	0.006	No treatability data at this low of concentration	
Thallium	mg/L	0.002	0.001	-	-
Zinc	mg/L	0.036	0.3	0.01	<0.005

Notes:
1. Alkalinity, chloride and sodium concentrations are calculated values based on changes in water treatment plant.
Sulfate also increases due to treatment.
2. Sodium increases from breakpoint chlorination and assumes that sodium hypochlorite is used rather than calcium hypochlorite.

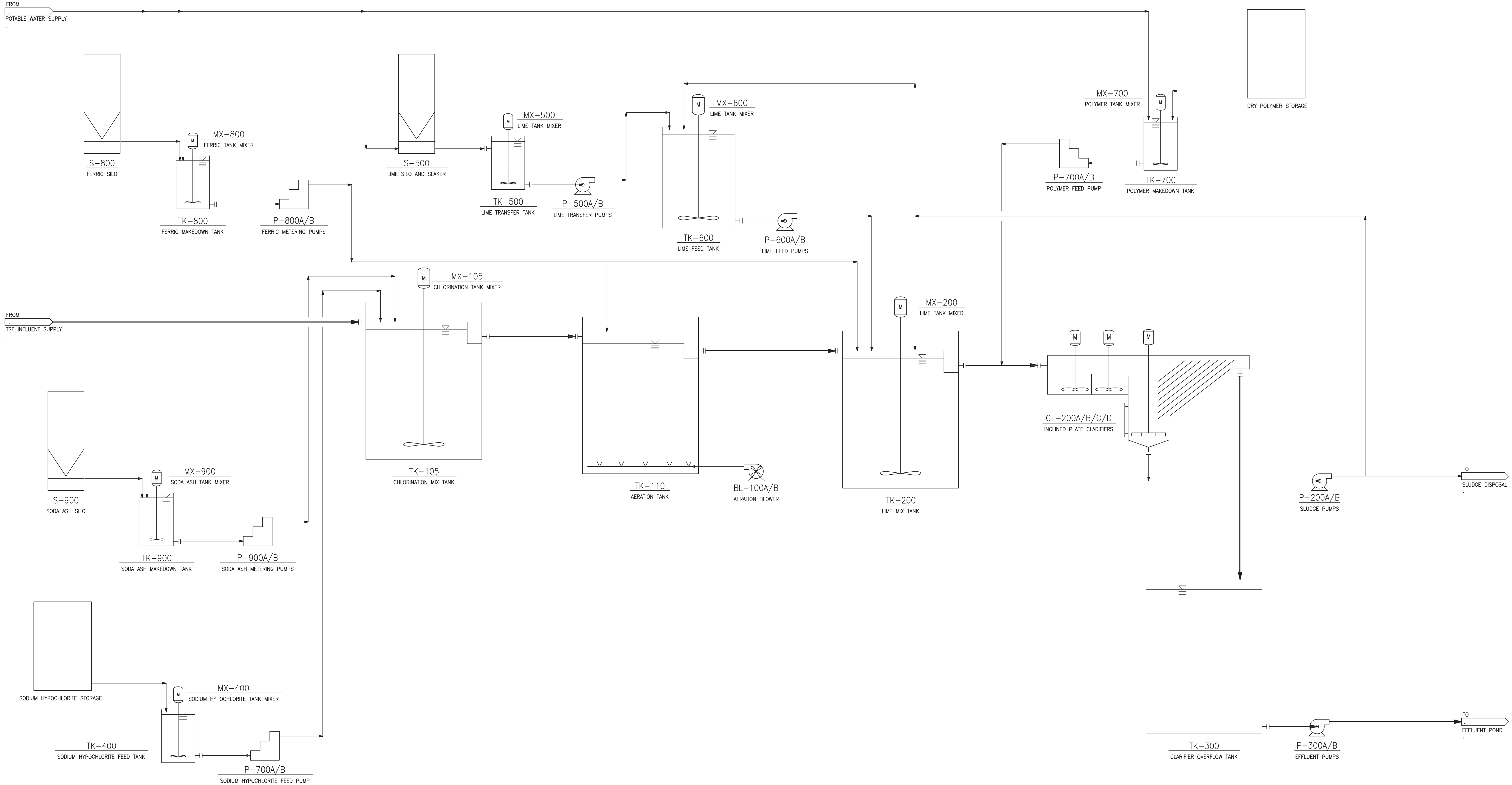
Table 5: Equipment Sizing Basis

Equipment Item	Equipment Sizing Basis
FM-100 - Influent Flow Meter	1,205 m^3/hr
TK-105 - Chlorination Mix Tank	30 minute hydraulic retention time @1,200 m^3/hr
MX-105 - Chlorination Mix Tank Mixer	Estimated to be <5 minute tank turnover time
TK-400 - Hypochlorite Feed Tank	1 to 2 day supply
MX-400 - Hypochlorite Feed Tank Mixer	Estimated to be <5 minute tank turnover time
P-400A/B - Hypochlorite Feed Pumps	Flow in range of 5 to 20 L/min
TK-450 - Hypochlorite Storage Tank	Minimum of 1 week supply
S-900 - Soda Ash Silo	Minimum of 1 week supply
TK-900 - Soda Ash Makedown Tank	2 day makedown storage @1,200 m^3/hr
MX-900 - Soda Ash Makedown Mixer	Estimated to be <5 minute tank turnover time
P-855A/B - Soda Ash Feed Pumps	Flow 0.5 to 10 m^3/hr to provide lime dose @1,200 m^3/hr
TK-110 - Aeration Tank	30 minute hydraulic retention time @1,200 m^3/hr
BL-100A/B - Aeration Blower	Minimum of 1.5 m^3 of air / m^3 water @1,200 m^3/hr
S-800 - Ferric Silo	2 month supply @1,200 m^3/hr
TK-800 - Ferric Makedown Tank	2 day ferric makedown storage @1,200 m^3/hr
P-800A/B - Ferric Metering Pumps	Minimum of 1 m^3/hr
TK-200 - Lime Mix Tank	30 minute hydraulic retention time @1,200 m^3/hr
MX-200 Lime Mix Tank Mixer	Estimated to be <5 minute tank turnover time
S-500 - Lime Silo & Slaker	Minimum 1 week supply
TK-500 - Lime Transfer Tank	Included with lime silo & slaker
MX-500 - Lime Transfer Tank Mixer	Included with lime silo & slaker
P-500A/B - Lime Transfer Pumps	23 m^3/hr
TK-600 - Lime Feed Tank	Min 2 day supply@ 10gpm =~30,000gal, max treatment conditions
MX-600 - Lime Feed Tank Mixer	-
P-600A/B - Lime Feed Pumps	Flow 0.5 to 10 m^3/hr to provide lime dose @1,200 m^3/hr
Polymer Makedown System	1 to 2 mg/L polymer dose @1,200 m^3/hr (includes TK-700 & P-700A/B)
CL-200A/B/C/D - Inclined Plate Clarifier	0.62 m^3/hr/m^2 (0.25 gpm/ft^2) overflow rate @1,200 m^3/hr
P-200A/B - Sludge Pumps	12 m^3/hr
TK-300 - Clarifier Overflow Tank	5 minute hydraulic retention time @1,200 m^3/hr
P-300A/B - Effluent Pumps	1,205 m^3/hr
pH Probes	-

Table 6: Summary of Chemical Usage

Chemical	Commercial Formula	Form	Daily Usage, kg/day
Influent Flow Rate- 1200 m3/hr			
Daily Chemical Requirements for Breakpoint Chlorination for 8 mg/L NH_4			
Hypochlorite	NaOCl	12% Soln	22,886
	65% NaOCl	Dry	4,401
	70% $Ca(OCl)_2$	Dry	3,922
Soda Ash	Na_2CO_3	Dry	1,203
Daily Chemical Requirements for 50 mg/L Fe Dose			
Quicklime	CaO	Dry	5,812
	88% Available CaO	Dry	6,604
Iron	$Fe_2(SO_4)_3$	Dry	5,157
	Ferrix 3 (20%Fe)	Granular	7,200
Polymer	Moderately Anionic	Dry	58
Influent Flow Rate- 800 m3/hr			
Daily Chemical Requirements for Breakpoint Chlorination for 8 mg/L NH_4			
Hypochlorite	NaOCl	12% Soln	15,258
	65% NaOCl	Dry	2,934
	70% $Ca(OCl)_2$	Dry	2,615
Soda Ash	Na_2CO_3	Dry	802
Daily Chemical Requirements for 50 mg/L Fe Dose			
Quicklime	CaO	Dry	3,875
	88% Available CaO	Dry	4,403
Iron	$Fe_2(SO_4)_3$	Dry	3,438
	Ferrix 3 (20%Fe)	Granular	4,800
Polymer	Moderately Anionic	Dry	38

FIGURES



PROJECT

MERIAN GOLD PROJECT

TITLE

PROCESS FLOW DIAGRAM
TSF WATER TREATMENT PLANT

Golder Associates

FILE No.	11393245AP100
PROJECT No.	11393245

FIGURE 1

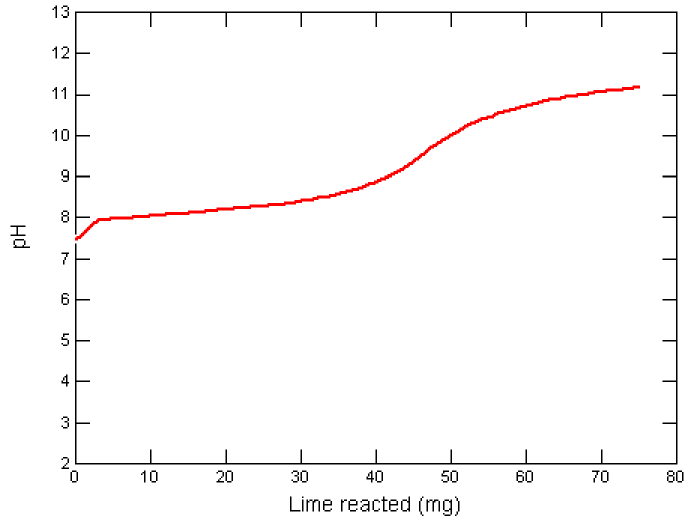


Figure 2: Hydrated Lime Titration Curve for Merian TSF Water (95% Recirc Case)

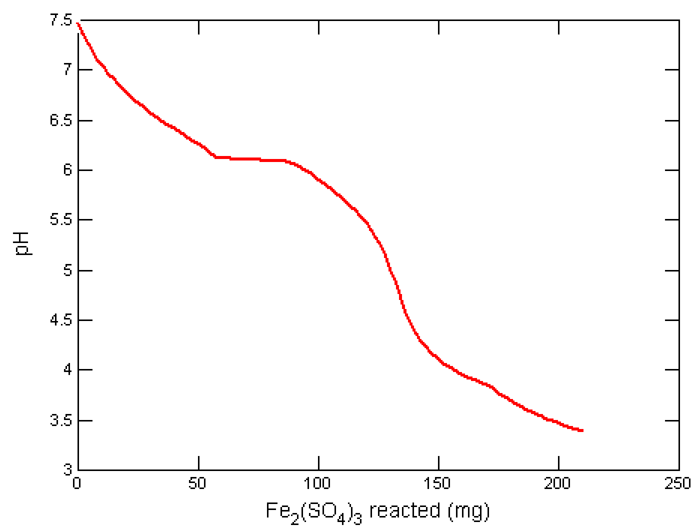


Figure 3: Ferric Sulfate Addition to Merian TSF Water. (Note: 50 mg/L as Fe is equivalent to 179 mg L as $Fe_2(SO_4)_3$ and 25 mg/L as Fe is equivalent to 89.5 mg/L as $Fe_2(SO_4)_3$).

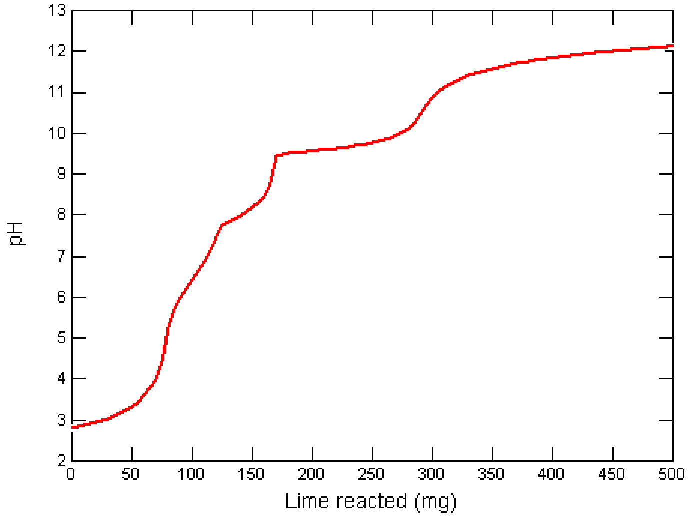
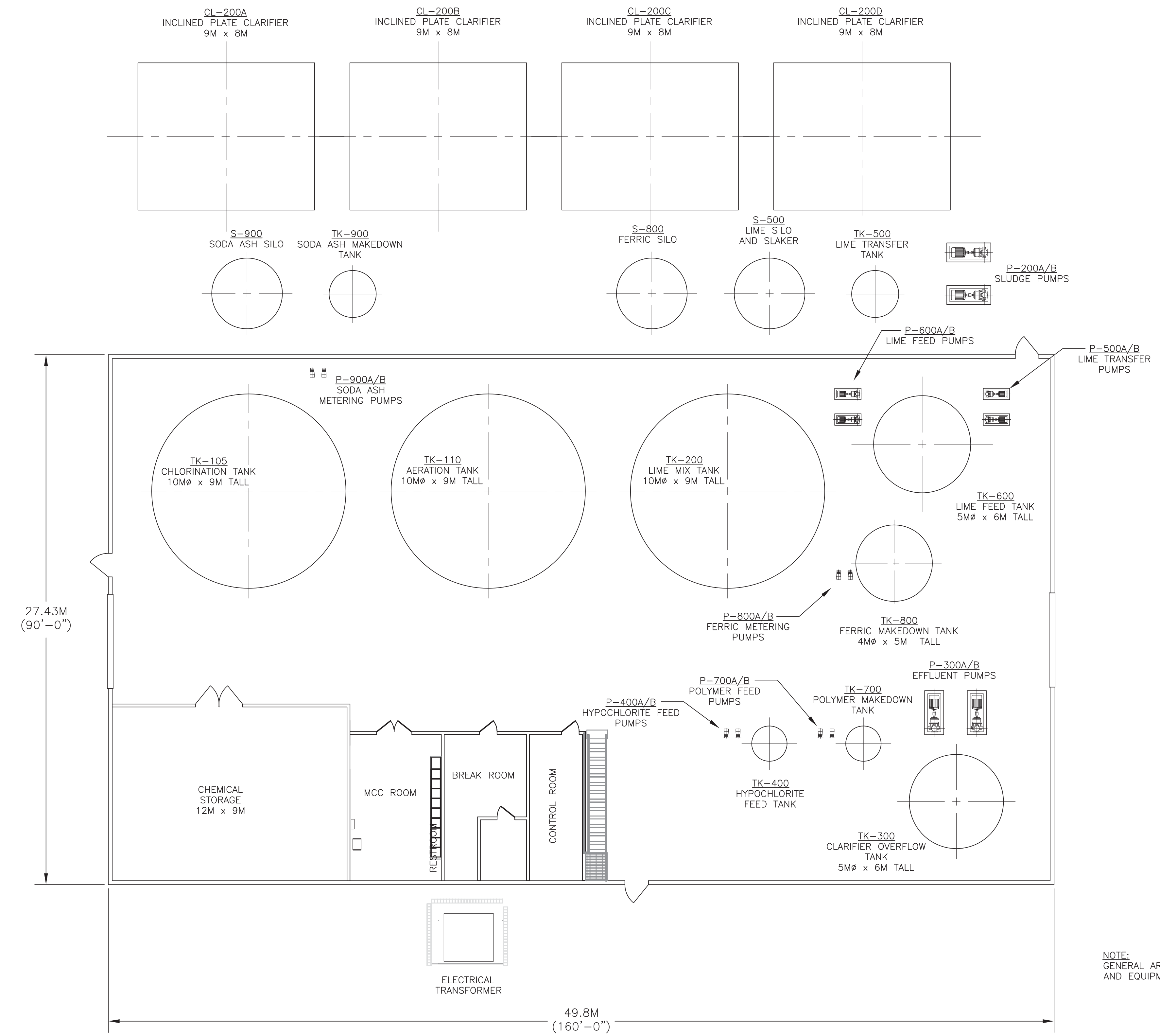


Figure 4: Titration Curve for Merian TSF Water After Fe Dose of 50 mg/L

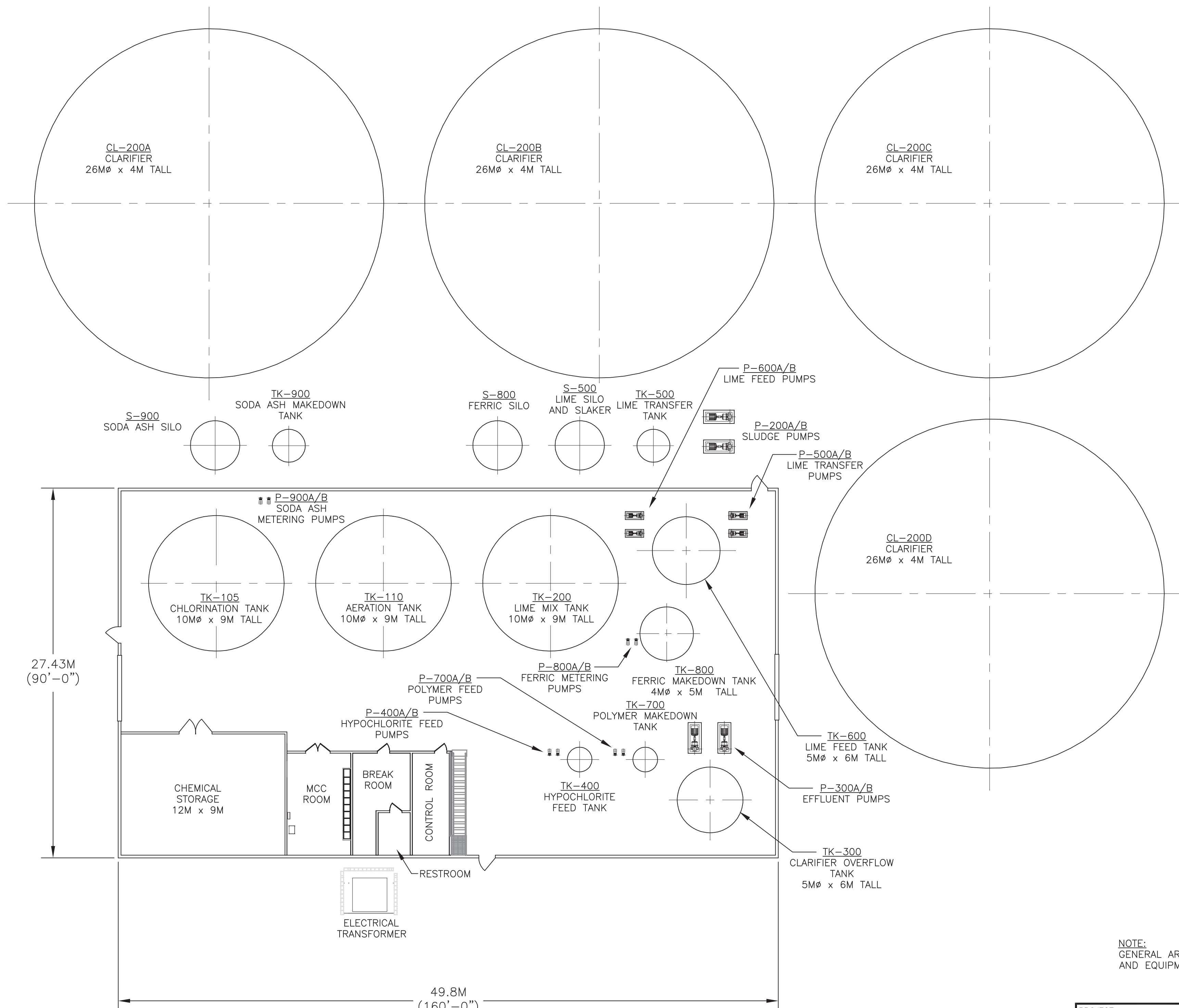


NOTE:
GENERAL ARRANGEMENT IS INTENDED TO SHOW ESTIMATED FOOTPRINT, AND EQUIPMENT LOCATION HAS NOT BEEN OPTIMIZED.

PROJECT	MERIAN GOLD PROJECT
TITLE	GENERAL ARRANGEMENT TSF WATER TREATMENT PLANT WITH INCLINED PLATE CLARIFIERS
FILE No.	11393245AP300
PROJECT No.	11393245

Golder Associates

FIGURE 5



NOTE:
GENERAL ARRANGEMENT IS INTENDED TO SHOW ESTIMATED FOOTPRINT, AND EQUIPMENT LOCATION HAS NOT BEEN OPTIMIZED.

PROJECT	MERIAN GOLD PROJECT
TITLE	**GENERAL ARRANGEMENT TSF WATER TREATMENT PLANT WITH CIRCULAR CLARIFIERS**
FILE No.	11393245AP301
PROJECT No.	11393245

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FIGURE 6

ATTACHMENT A

INTEGRATION OF BENCH AND PILOT HIGH DENSITY SLUDGE (HDS) TREATMENT OF ACID ROCK DRAINAGE (ARD) INTO FULL-SCALE TREATMENT FACILITY DESIGN AT THE CENTRAL CITY/CLEAR CREEK SUPERFUND SITE NEAR BLACKHAWK, COLORADO

IWC 12-04

Integration of Bench and Pilot High Density Sludge (HDS) Treatment of Acid Rock Drainage (ARD) into Full-Scale Treatment Facility Design at the Central City/Clear Creek Superfund Site near Blackhawk, Colorado

Neal T. Gallagher
Golder Associates Inc.
Lakewood Colorado

Mary Boardman
Colorado Department of Public Health & Environment
Denver Colorado

Christopher Beck
Golder Associates Inc.
Lakewood Colorado

Brian Huff
Golder Associates Inc.
Lakewood Colorado

Mike Holmes
U.S. Environmental Protection Agency
Denver Colorado

Keywords: lime precipitation, neutralization, mining influenced water (MIW), acid rock drainage (ARD), acid mine drainage (AMD), high density sludge (HDS), lab-scale, bench-scale, pilot-scale, full-scale design, superfund cleanup.

ABSTRACT

The OU4 high density sludge (HDS) water treatment plant (WTP) was designed to treat flows ranging 180 to 600 gpm from four separate sources of mining influenced wastewater (MIW) within the Central City/Clear Creek Superfund Site near Blackhawk, Colorado. Successful HDS treatment process parameters were defined through bench and pilot-scale testing. Variation in scaled test results provided insight into the advantages and disadvantages of scaled testing and incorporation of scaled test results into full-scale WTP design.

INTRODUCTION

The Central City/Clear Creek Superfund Site impacts over 400 square miles of the Clear Creek watershed located in the Rocky Mountains approximately 30 miles west of Denver, Colorado. Mining activity in the region around Central City began in 1860 with the discovery of gold and was soon touted as the leading hub of mining activities in Colorado as the next 20 years saw construction of mills to extract gold and silver from placer and hard rock mining (CDPHE, 2010a). Mining in the region began to decline near the turn of the century, remaining as a local industry until the 1950's.

Four sources of acid rock drainage from historical mining activity near the towns of Black Hawk and Central City, Colorado will be collected and combined for treatment by the United States Environmental Protection Agency (USEPA) and Colorado Department of Public Health and Environment (CDPHE) at the Operable Unit Four (OU4) high density sludge (HDS) water treatment facility (OU4 WTP). These sources include the Gregory Incline tunnel (GI), National Tunnel (NT), and surface (SW) and groundwater (GW) from the Gregory Gulch drainage, and contribute a continuous load of heavy metals into the North Fork of Clear Creek (North Fork). Cleanup of these sources will begin the process to improve habitat for aquatic insects and the return of brown trout to the North Fork as well as reduce the impacts of metal loads on the main stem of Clear Creek, a source of water supply for several downstream cities and industries.

Currently, sources discharge into the North Fork less than one mile upstream of the proposed plant location in Black Hawk, Colorado. Sources will be captured and piped along the North Fork to the plant in a common header. The OU4 WTP will accept flows from the sources in a 295,000 gallon below grade influent equalization vault. The plant will be located within a tight canyon where sufficient space to build the plant was made available adjacent to the North Fork by blasting of rock during rerouting of Colorado Highway 119. The OU4 WTP site is approximately 1.1 acres, bounded by the highway to the east and by the North Fork to the west.

As part of the design of the OU4 WTP, bench and pilot testing was performed on anticipated blends of the four sources expected as influent to the plant. Flows of the four sources vary substantially throughout the year; therefore it was necessary to perform influent characterization based on historical data to determine appropriate influent blend ratios for testing and as basis for plant design.

INFLUENT CHARACTERIZATION – Contaminants of concern in the OU4 WTP sources include Al, As, Cd, Cu, Fe, Pb, Mn, and Zn. The blend of sources based on historical average flow was developed for bench and pilot testing and full-scale design as: 48% GI, 14% NT, 28% SW, and 10% GW (v/v) (average influent) based on historical data. Slight variations of the average influent blend were used during bench and pilot testing as discussed later. Average influent is expected to occur during late spring into early summer. The average influent contains relatively low loads of metals and sulfate for mining influenced wastewater (MIW). Effluent limits have not been established. Therefore, Colorado Water Quality Control Division Stream Standards (stream standards) for Clear Creek Section 13b (CWQCD, 2010; CWQCD, 2011) were used for comparison purposes (Table 1). The majority of influent and effluent metals were in the dissolved (d) fraction during bench and pilot testing. Arsenic was below detection limits throughout bench and pilot studies and therefore will not be discussed further.

PROCESS DEVELOPMENT – Active lime-based treatment was recommended in the OU4 WTP Record of Decision (ROD) for its ability to consistently reduce metal loads, and contribution of effluent alkalinity to the North Fork, mitigating impacts of residual metal loads in the North Fork from other sources (USEPA, 2004; CDPHE, 2010b). HDS technology was selected for process development for reduced solids disposal and neutralization costs.

TREATMENT TECHNOLOGY – Lime treatment is based on the principle of heavy metal insolubility in the presence of elevated hydroxide ion concentration. Addition of hydrated lime to acidic wastewaters causes dissolution of lime, which raises pH by increasing the presence of hydroxide ions (Eq. (1)). Increased pH reduces the solubility of most metal cations (Me), and excess hydroxide ions promote formation of metal hydroxides (Eq. (2)).

Table 1 - Projected OU4 WTP influent quality, stream standards, and historical data

	Unit	Acute standard 1/	Chronic standard 1/	Historical average	Bench average blend	Pilot average blend	Pilot low flow blend influent
pH	su	6.5-9.0	-	5.1	4.54	3.45	3.46
Total suspended solids (TSS)	mg/L	-	-	-	80.75	38.7	4.8
Total dissolved solids (TDS)	mg/L	-	-	-	1,533	1,500	2,200
Aluminum, dissolved	mg/L	-	-	3.6	2.3	1.9	1.5
Arsenic, dissolved	mg/L	0.34	0.1	-	*< 0.0044*	*< 0.0044*	*< 0.0044*
Cadmium, dissolved	mg/L	0.00051	0.00015	0.03	0.0224	0.0265	0.011
Copper, dissolved	mg/L	0.0036	0.064	1.3	0.638	0.54	0.32
Iron, total recoverable	mg/L	-	5.4	87 2/	88 2/	77	120
Iron, dissolved	mg/L	-	-	82	77.6	57.5	120
Lead, dissolved	mg/L	0.0139	0.0005	-	0.019	0.022	0.033
Manganese, dissolved	mg/L	1.9	1	19	15.4	16.5	30
Zinc, dissolved	mg/L	-	0.74	7.5	5.62	6.75	6.8
Sulfate	mg/L	-	-	-	1,133	1,350	1,700

< indicates analytical results was below laboratory MDL

1/ Colorado Clear Creek Segment 13b stream standards

2/ Value represents total fraction

$$Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^- \qquad \text{Eq. (1)}$$

$$Me^{2+} + 2OH^- \rightarrow Me(OH)_2 \qquad \text{Eq. (2)}$$

The most basic conventional lime treatment consists of lime addition to raw influent to a pH setpoint, solids/liquid separation in a lined pond or tank, and discharge or reuse of decanted liquid (Figure 1). Complexity of lime treatment systems varies and may include multiple reaction tanks at varying pH setpoints for treatment of specific metals, oxidation of Fe^{2+} and Mn, polymer addition to enhance flocculation and solid/liquid separation, and sand filtration of treated effluent. Conventional lime treatment typically produces settled solids concentrations between 1-5% (w/w).

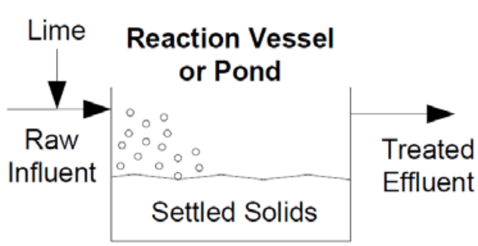

Figure 1 – Basic lime treatment

Oxidation is often provided in lime treatment to oxidize ferrous iron (Fe2+) to ferric iron (Fe3+). Ferrous was the primary species of Fe present in OU4 average influent. Fe3+, the oxidized form, is preferable, as $Fe3^+$ is less soluble at typical lime treatment and discharge pH range of 8-10 (USEPA, 1983). Oxidation of Fe species is pH dependent and the rate of oxidation depends on the availability of oxygen. Oxidation was explored during testing to oxidize Fe^{2+} and to examine effects of oxidation on treatment of Mn, which produces denser solids at higher oxidation states.

Metal solubility is related to solution pH, therefore lime treatment of metals is most effective at the optimal pH range for each metal which minimizes solubility. Cu, Cd, Fe, and Zn are typically effectively treated between pH 8.5 and 10. Mn requires somewhat higher pH for effective treatment, typically greater than pH 9.5. Al reaches minimum solubility between pH 6-8 and begins to become more soluble above pH 8 as AlO_2^- (Kuyucak et al., 2001). Therefore, selection of pH range is highly dependent on source water content and effluent discharge criteria.

HDS is an improvement on conventional (single pass) lime treatment which can produce underflow solids (underflow) concentrations upwards of 20% (w/w), reducing costs of solids disposal. HDS is an established and widely implemented technology used commonly in industry for active abiotic treatment of MIW dominated by Fe chemistry (Coulton et al., 2004). In the HDS process, underflow is recycled to an intermediate tank prior to the reaction tank referred to as the densification tank where solid particles are mixed with lime slurry (Figure 2). In the densification tank, contact between recycled solid particles and lime particles encourages lime to coat the solids. Lime coated solid particles provide greater surface area for contact with raw influent when introduced into the

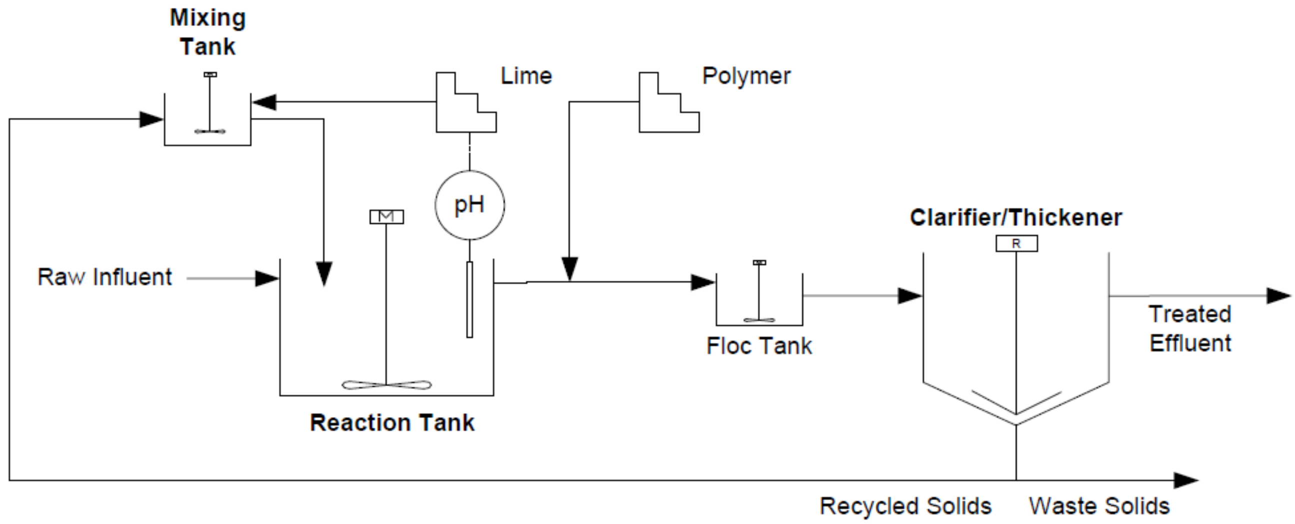

Figure 2 - Basic HDS process schematic

reaction tank. The larger lime coated surface area of particles as well as higher pH of particles in contrast to surrounding solution promotes precipitation reactions to occur on the surface of existing particles. Therefore, the size and density of formed particles is increased. (Aubé, 2007).

PRELIMINARY STUDY – Relatively low metal concentrations in source waters raised questions regarding the effectiveness of HDS treatment, as HDS is typically applied to MIW with substantially higher metal concentrations (Coulton et al., 2004). Therefore, bench and pilot studies were performed on the OU4 average influent to determine effectiveness of HDS treatment. Bench studies were performed using single pass lime treatment jar testing as well as simulated HDS testing. Pilot testing incorporated results from bench testing into a 0.5 gallon per minute (gpm) lime HDS pilot unit.

MATERIALS AND METHODS

INFLUENT CHARACTERIZATION – Four separate sources contribute influent to the OU4 WTP. To effectively size the hydraulic capacity of the OU4 WTP, as well as to design the associated unit processes and determine anticipated blend ratios of individual sources and associated metal loads, an influent design basis report was compiled (Golder, 2011). Average annual flows and metal loads for each source were determined using available data from previously performed source characterizations (Tetra Tech RMC, 2002; Tetra Tech RMC, 2004) as well as stream gauge data (USGS, 2011). The compiled data was used to develop the blend ratios used for bench and pilot testing, as well as full-scale design based on historical flows of individual sources.

BENCH TESTING – Bench testing was performed to provide a framework for process parameters necessary for pilot design. Bench test objectives were to determine effective treatment pH for metal removal, reaction time, as well as dosing of lime, polymer, and oxidant. Water used for testing was collected in two rounds from individual sources. The blend of source waters used for bench testing consisted of 45% GI, 15% NT, 30% SW, and 10% GW (v/v) (bench average blend). This was slightly different from average influent because additional individual source data was collected after bench studies were performed. Collected sources were blended in the laboratory volumetrically to produce the bench average blend.

Due to the large number of tests performed at the bench-scale, single pass jar testing was used for the majority of tests. Mimicking HDS at the bench-scale for all tests would have been prohibitively time intensive. Bagged industrial grade hydrated lime ($Ca(OH)_2$) was used in all tests and added as measured powder with dosing based on target pH determined from previous testing experience. Thirteen lime titration tests were performed to gauge treatment performance at pH between 7.8 and 10.7.

Nine additional lime titrations were performed at varying pH between 8.8 and 10.4 with oxidation using 7% H_2O_2 at both 1-times (0.0008 mol O_2/L) and 1.5-times (0.0014 mol O_2/L) the theoretical dose required to oxidize Fe and Mn in the bench average blend. The attempt was to mirror pH in tests performed at 1-times and 1.5 times theoretical oxidant dose for comparison of oxidation effects in the initial six titrations performed and results from these six titrations. The final three titrations in this series were performed at pH 8.8, 9.2, and 9.7 with 1-times the theoretical oxidant dose, which was proven to be more effective than 1.5-times theoretical oxidant dose during the initial six tests. This range of pH was targeted to compare treatment performance with lime only titration tests. Selected results are presented.

A basic visual polymer screening was performed on the bench average blend by adding three types of anionic polymer: BASF 4100, 4105, and 4110 to bench average blend without oxidation titrated to pH 10.1 and bench average blend titrated to pH 9.9 at dosing between 1 and 7 mg/L.

One round of bench HDS testing was performed out to 26 solids recycles to assist with pilot design to provide comparison with pilot results. A reaction time of 45 min raw water and recycled solids and 5 min densification time of lime and solids was used. Test pH was targeted at 10.0 and maintained between 9.7 and 10.3 with varying lime dosing between 0.35 to 0.50 g/L, adjusted during testing to reach target pH. Polymer dosing for HDS testing varied between 2.5 and 5.5 mg/L, gauged by visual observation to optimize flocculated particle formation. Analytical samples were taken from settled jar test decant.

PILOT TESTING – A 0.5 gpm pilot unit was designed around bench test results and operated intermittently between June and August 2011 at the CDPHE's Argo Water Treatment facility (Argo WTP) in Idaho Springs, Colorado. Pilot objectives were to further hone in on process parameters necessary for full-scale design including treatment pH, oxidation requirement, minimum reaction time to achieve effluent goals, thickener sizing, solids generation rate, ideal solids recycle ratio (SRR), solids dewaterability, dewatered solids toxicity, and effluent toxicity assessed using Whole Effluent Toxicity (WET) testing.

Pilot unit influent was collected in bulk using a 3 inch mud pump and 5,000 gallon water tanker. Two blends of water were used during pilot testing: a water representing average flow (pilot average blend); and a water representing worst case solids production (pilot low flow blend) which is expected during minimum flow to the plant (Golder, 2011). The average influent blend was intended to be used for pilot testing; however the pilot average blend had to be modified from the average influent ratios as the GW source well was not able to produce at a sufficient rate for bulk collection. For the pilot average blend, GW was replaced by SW, resulting in relatively similar metal concentrations as the bench average blend (Table 1) with the exception of TSS, which was likely due to the poorly developed nature of the well which GW was collected from during bench studies. The resulting pilot average blend consisted of 48% GI, 14% NT, and 38% SW (v/v). Pilot low flow blend consisted of 83% GI and 17% NT (v/v). Collected water was stored in a 10,000 gallon metal tank located outside Argo WTP.

Pilot unit equipment included a 5 gallon densification tank, 50 gallon reaction tank with adjustable hydraulic retention time (HRT) of 30, 20, and 10 min, and 100 gallon thickener with a rake (Figure 3). Peristaltic pumps were used for the influent, polymer push water, and underflow recycle. Polymer mixing was initially by static mixer and later in a 3 gallon flocculation tank after clogging occurred in the static mixer.

Lime ($Ca(OH)_2$), polymer (BASF 4105), and oxidant (H_2O_2) were dosed using metering pumps as 10%, 0.01%, and 0.7% (w/w) solutions respectively.

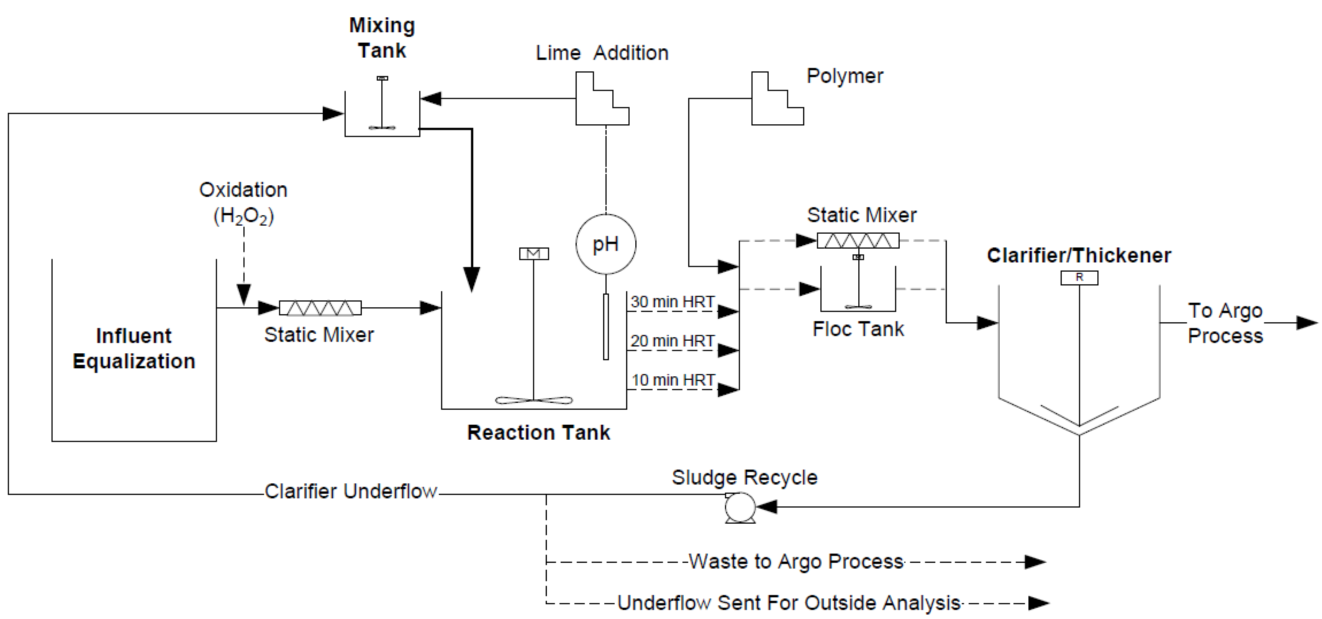

Figure 3 - Pilot unit design schematic

Lime slurry dosing was automated using 4-20 mA feedback from a pH probe in the reaction tank. Polymer dosing was performed based on visual settling tests run on thickener feed grab samples and ranged between 0.2 and 0.5 mg/L. Oxidant target dosing was theoretical for pilot water blend Fe and Mn oxidation (0.0011 mol O_2/L and 0.0019 mol O_2/L for pilot average and low flow blends respectively) but difficulties with the metering pump resulted in a steady addition of 0.009 mol O_2/L. Polymer pushwater, drawn from thickener effluent, was added with polymer feed prior to the reaction tank outlet to assist with polymer dispersion. SRR was optimized during commissioning of the pilot unit varying 120:1 to 20:1. No benefit in underflow percent solids concentration was observed above a SRR of 20:1; therefore this SRR was used for the remainder of pilot testing.

Pilot testing was performed in four distinct phases, Commissioning, Cycle A, Cycle B, and Cycle C. Commissioning involved startup of the pilot unit, optimization of SRR, and build-up of solids inventory. Cycle A intended to optimize treatment pH with oxidation and the pilot unit was operated with pilot average blend water at three distinct pH set points of 8.5, 9.0, and 9.5 with an oxidant dosing of 0.0009 mol O_2/L. Cycle B intended to optimize treatment pH without oxidation and the pilot unit was operated with pilot average blend water at three distinct pH set points of 8.5, 9.0, and 9.5. Cycle C intended to incorporate optimal conditions determined during Cycles A and B and optimize HRT while treating the higher metal loads found in the pilot low flow water blend. Cycle operated at a pH of 8.5 with oxidation at 0.0009 mol O_2/L and HRT varied 30, 20, and 10 min.

Cycle A and B analytical samples were taken from unfiltered settled thickener feed decant at each pH set point. During Cycle C, analytical samples were taken from unfiltered settled thickener feed decant at each HRT set point. Cycle C unfiltered settled thickener feed decant at a 30 min HRT was filtered through a Whatman 40 filter and neutralized to a pH of 6.9 and sampled for WET testing as well as analytical testing. Toxicity Characteristic Leaching Procedure (TCLP) samples were taken from thickener solids during Cycle C at 30 min HRT. Thickener solids were sent offsite for filter press analysis after testing was complete.

FULL-SCALE DESIGN – Bench and pilot test results were used as a foundation for full-scale design of unit processes and equipment including lime delivery, reaction tank HRT, optimal range of treatment pH, thickener sizing, underflow recycle pump sizing, solids storage requirements, polymer dosing, oxidation requirements, filter press sizing. Most importantly preliminary testing provided proof of HDS technology for successfully treating the projected OU4 WTP influent.

RESULTS AND DISCUSSION

SOURCE CHARACTERIZATION – In individual source samples taken during bench testing, the majority of the metal load in the GI and NT sources was Fe and Mn, while Zn made up the majority of the balance (Table 2). SW and GW source metal load was primarily Zn, while Mn and Cu made up the majority of the balance. In average influent, GI contributed the majority of Fe, Mn, and Zn load. The source of Cu in the average influent was divided somewhat evenly between GI, SW, and GW. The majority of Cd load came from the SW, followed closely by GW and GI.

Table 2 – Comparison of OU4 WTP individual source waters

	Cd (d)	**Cu (d)**	**Fe (d)**	**Mn (d)**	**Zn (d)**
Unit	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
GI	0.013	0.60	160	32	5.9
NT	0.0052	0.039	34	18	6.7
SW	0.039	0.74	0.11	2.2	5.2
GW	0.059	1.7	0.50	4.0	7.7
Bench average blend	0.021	0.6	75	14	5.2

The majority of Fe load in the expected OU4 WTP source water is Fe^{2+} (Table 3) indicating oxidation of titrated water will benefit effluent quality and settling characteristics of solids by oxidizing the majority of Fe^{2+} to Fe^{3+}.

Table 3 – Breakdown of Fe^{2+} and Fe^{3+} in OU4 WTP individual source waters

	Fe^{2+}	Fe^{3+}
Water Source	**mg/L**	**mg/L**
SW	0.4	3.7
GW	0.2	26.8
GI	213.3	1.2
NT	39.8	12.9
Pilot average blend	108.1	6.1
Pilot low flow blend	183.8	3.2

BENCH TESTING – Bench test results indicated that without oxidation, effective treatment below chronic stream standards could be achieved without oxidation at pH 9.7 and with oxidation at pH 9.2 (Table 4). At pH 9.2 without oxidation, all metals except Cd were below chronic standards. Without oxidation, Cd required a pH of 9.7 for effective treatment below the chronic standard. Oxidation had a noticeable effect on treatment of all metals with the exception of Mn at pH 9.2 and 8.8. At pH 9.2 and 8.8, superior Mn removal was observed without oxidation.

In HDS test results at pH 10.0, only Cd was above the chronic standard possibly because titrated water was not oxidized. HDS testing of the bench average blend provided a maximum underflow percent solids of 5.5% (Table 5). Polymer addition in HDS testing gradually increased with recycle, reaching a maximum of 5.5 mg/L.

Bench titration tests demonstrated that bench average blend lime demand was between 0.30 and 0.41 g/L to achieve pH range between pH 8.3 and pH 8.8. In bench HDS testing, lime demand varied between 0.35 and 0.50 g $Ca(OH)_2$ / L to achieve pH range between pH 9 .7 and pH 10.3.

Visual polymer screening indicated that a range of 3-5 mg/L of BASF 4105 was most effective in flocculated particle formation and removal of 'pin floc' in decanted jar test water after a 3 min observation period.

PILOT TESTING – During pilot testing, influent pH varied from pH 2.5 to 3.0 and influent temperature averaged 19.1°C ranging between 15.8°C and 22.4°C. Influent temperature fluctuated with daily outdoor temperatures resulting from the influent

Table 4 - Bench test titration results with and without oxidation

	pH	**Lime**	**Oxidant**	**Cd (d)**	**Cu (d)**	**Fe (d)**	**Mn (d)**	**Zn (d)**	**TSS**
Unit	**su**	**g/L**	**mol O_2/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Chronic standard [1/]	-	-	-	0.00015	0.064	5.4 [2/]	1	0.74	-
Bench average blend	4.5	-	-	0.0224	0.69	82	16.0	6.0	79
Test 1	8.8	0.300	-	0.0005	0.012	1.5	1.8	0.11	380
Test 2	8.8	0.254	0.0008	0.00022	< *0.0014*	< *0.022*	2.8	< *0.0045*	300
Test 3	9.2	0.325	-	0.00024	0.0038	0.66	0.67	0.047	440
Test 4	9.2	0.300	0.0008	0.000061	< *0.0014*	< *0.022*	0.60	< *0.0045*	400
Test 5	9.7	0.350	-	0.00012	< *0.0014*	0.24	0.29	0.017	460
Test 6	9.7	0.325	0.0008	0.000053	< *0.0014*	0.032	0.098	< *0.0045*	400
HDS	10.0	0.414	-	0.00045	< *0.0014*	0.022	0.020	< *0.0045*	-

< indicates analytical results was below laboratory MDL

1/ Colorado Clear Creek Segment 13b stream standards

2/ The iron chronic standard is for total recoverable iron, provided for reference

Table 5 - Bench HDS testing underflow percent solids and polymer dosing

	Solids Recycle Number						
	0	5	10	15	20	25	26
Polymer (mg/L)	2.5	3.0	3.0	4.5	5.0	5.5	5.5
Underflow Solids %	-	1.0%	2.0%	2.5%	3.8%	3.7%	5.5%

storage tank being located outside and unshaded. Dissolved Fe^{2+} was within the range expected in influent water directly after blends were collected from source waters. However, a decrease in dissolved Fe^{2+} concentration was observed with time as influent aged in the influent storage tank, indicating oxidation occurring within the influent storage tank. The TSS of titrated pilot average blend also indicates oxidation and settling of dissolved metals within the influent storage tank as the contents aged and is lower in TSS at similar pH when compared to the similar bench average blend which was stored in cubitainers with airspace minimized (Table 6).

Table 6 – Comparison of TSS in titrated pilot and bench average blends

	pH	TSS
Date	**su**	**mg/L**
Pilot Average Blend		
6/10/11	9.6	370
6/14/11	10.1	281
6/15/11	10.0	262
Bench Average Blend		
-	9.6	470
-	9.7	460
-	10.2	450

Oxidation of pilot influent increased lime demand, as expected, indicating increased production of metal hydroxide solids in oxidized water due greater availability of oxidized metals (Table 7).

Table 7 – Lime demand of pilot average and low flow with and without oxidation

	Un-oxidized		Oxidized	
	Average	**Low flow**	**Average**	**Low flow**
	$Ca(OH)_2$	**$Ca(OH)_2$**	**$Ca(OH)_2$**	**$Ca(OH)_2$**
	g/L	**g/L**	**g/L**	**g/L**
pH 8.5	0.17	0.17	0.18	0.21
pH 9.0	0.18	0.17	0.19	0.23
pH 10	0.21	0.2	0.22	0.26

Results demonstrate HDS treatment of pilot average blend influent was effective in removing metals below stream standards (Table 8). Aside from parameters for which the laboratory detection limit was higher than the stream standard, treated pilot average blend was below stream standards in all tests with the exception of Cu (d) in Cycle B at pH 9.0. Oxidation generally improved treatment at comparable pH. Results indicate that average influent to the OU4 WTP can be effectively treated at a pH of 8.5 with oxidation and pH 9.5 without oxidation.

During Cycles A and B, optimal conditions were identified as treatment at pH 8.5 with oxidation. The inherent advantage is that treated OU4 WTP effluent would not require neutralization pior to discharge. Cycle C operated at optimal conditions treating the pilot low flow blend and HRT was varied between 30, 20, and 10 min. A noticeable decrease in treatment performance was observed as HRT decreased (Table 9). Aside from parameters for

Table 8 - Pilot average blend test results sorted by measured pH

	Oxidant	**Al (d)**	**Cd (d)**	**Cu (d)**	**Fe (d)**	**Pb (d)**	**Mn (d)**	**Zn (d)**	**SO_4**
	mol O_2/L	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Average blend	-	1.9	0.0265	0.54	57.5	0.022	16.5	6.8	1,350
Acute standard 1/	-	-	0.00051	0.0036	-	0.0139	1.9	-	-
Chronic standard 1/	-	-	0.00015	0.064	-	0.0005	1	0.74	-
Cycle A pH 8.5	0.0009	< *0.018*	< *0.00045*	0.002	< *0.022*	< *0.0026*	0.0068	< *0.0045*	1,000
Cycle B pH 9.0	-	< *0.018*	< *0.00045*	0.005 2/	0.16	< *0.0026*	0.058	0.03	970
Cycle A pH 9.0	0.0009	< *0.018*	< *0.00045*	0.0015	0.027	< *0.0026*	0.0088	0.0068	980
Cycle B pH 9.5	-	< *0.018*	< *0.00045*	0.0015	< *0.022*	< *0.0026*	0.0012	0.0045	970
Cycle A pH 9.5	0.0009	< *0.018*	< *0.00045*	0.0024	< *0.022*	< *0.0026*	0.00064	< *0.0045*	990
Cycle B pH 10.0	-	< *0.018*	< *0.00045*	0.0029	0.03	< *0.0026*	0.012	0.013	960

< indicates analytical results was below laboratory MDL

1/ Colorado Clear Creek Segment 13b stream standards

2/ Exceeds acute stream standard

Table 9 – Pilot low flow blend testing results sorted by HRT

	Oxidant	Al (d)	Cd (d)	Cu (d)	Fe (d)	Pb (d)	Mn (d)	Zn (d)	SO_4
Unit	mol O_2/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Pilot low flow blend		1.5	0.011	0.32	120	0.033	30	6.8	1,700
Acute standard 1/	-	-	0.00051	0.0036	-	0.0139	1.9	-	-
Chronic standard 1/	-	-	0.00015	0.064	-	0.0005	1	0.74	-
Cycle C pH 8.5 HRT 10 min	0.0009	*< 0.018*	*< 0.00045*	*< 0.0014*	0.038	*< 0.0026*	1.4 3/	0.0067	1,800
Cycle C pH 8.5 HRT 20 min	0.0009	*< 0.018*	*< 0.00045*	*< 0.0014*	*< 0.022*	*< 0.0026*	0.63	*< 0.0045*	1,800
Cycle C pH 8.5 HRT 30 min	0.0009	*< 0.018*	*< 0.00045*	*< 0.0014*	*< 0.022*	*< 0.0026*	0.435	*< 0.0045*	1,800
Cycle C pH 8.5 HRT 30 min 2/	0.0009	*< 0.018*	0.00085 4/	0.0022	*< 0.022*	*< 0.0026*	0.66	0.11	1,900

< indicates analytical results was below laboratory MDL

1/ Colorado Clear Creek Segment 13b stream standards

2/ Whatman 40 filtered and HCL neutralized to pH 6.9 prior to analytical sampling

3/ Exceeds chronic standard

4/ Exceeds acute standard

which the laboratory detection limit was above the stream standard, Mn at 10 min HRT and Cu in the neutralized test at 30 min HRT (which is likely an outlier), and Se which is not effectively treated by HDS (solubility of Se compounds tends to increase with oxidation), treated pilot low flow blend was below stream standards in all tests.

Treated pilot low flow blend passed WET testing. No significant toxicity was found in the sample at all tested effluent blend concentrations up to 100% pure effluent. Results of TCLP testing on sampled thickener solids demonstrate that TCLP metal concentrations in pilot generated solids are well below the TCLP D-List maximum contaminant levels (MCLs) (Table 10). Therefore, pilot generated solids would not be considered a hazardous waste per RCRA guidelines and can be disposed of in a municipal landfill.

Table 10 – Pilot test underflow TCLP results

	Unit	Underflow TCLP	TCLP D-List MCL 1/
As	mg/L	0.022	5.0
Ba	mg/L	0.053	100
Cd	mg/L	0.028	1.0
Cr	mg/L	0.009	5.0
Pb	mg/L	0.013	5.0
Hg	mg/L	0.00003	0.2
Se	mg/L	0.025	1.0
Ag	mg/L	0.004	5.0

Metals are total fraction

1/ United States Resource Conservation and Recovery Act (RCRA)

Underflow percent solids was consistently measured upwards of 20% during testing with a maximum value of 23.1%. Settling tests performed on thickener feed provided insight into thickener sizing for the OU4 WTP. Tests indicated that design should be performed based on solids load for thickening in place of rise rate for clarification. Based on sizing calculations, a 59 ft diameter thickener would provide effective clarification and thickening at the full-scale. Underflow solids sent for offsite filter press performance testing indicated that the pilot produced solids were compressible to 53% solids at 100 psi pressure.

FULL-SCALE DESIGN – Parameters collected during bench and pilot testing provided insight into lime demand, polymer dosing, benefits of oxidation, achievable underflow and filter cake percent solids, settling and thickening characteristics of solids, and reaction time. Full-scale design incorporated information gathered during bench and pilot testing for design and sizing of OU4 WTP process equipment. Results from single pass jar testing and HDS testing performed at the bench-scale for some important design parameters varied substantially and required interpretation prior to incorporation into full-scale design.

Aeration was selected for oxidation in the OU4 WTP in place of chemical oxidation for human and environmental safety concerns. Oxidation of Fe^{2+} and Mn by aeration is expected to be more pH dependent than with chemical oxidation. An aeration system was provided within the reaction tank which was designed for a 30 minute HRT (Figure 4). For this reason contingency was built into the OU4 WTP for operation up to pH 10, higher than the optimal pH 8.5 observed during pilot testing, for periods of elevated Fe^{2+} and Mn that require enhanced oxidation to meet discharge

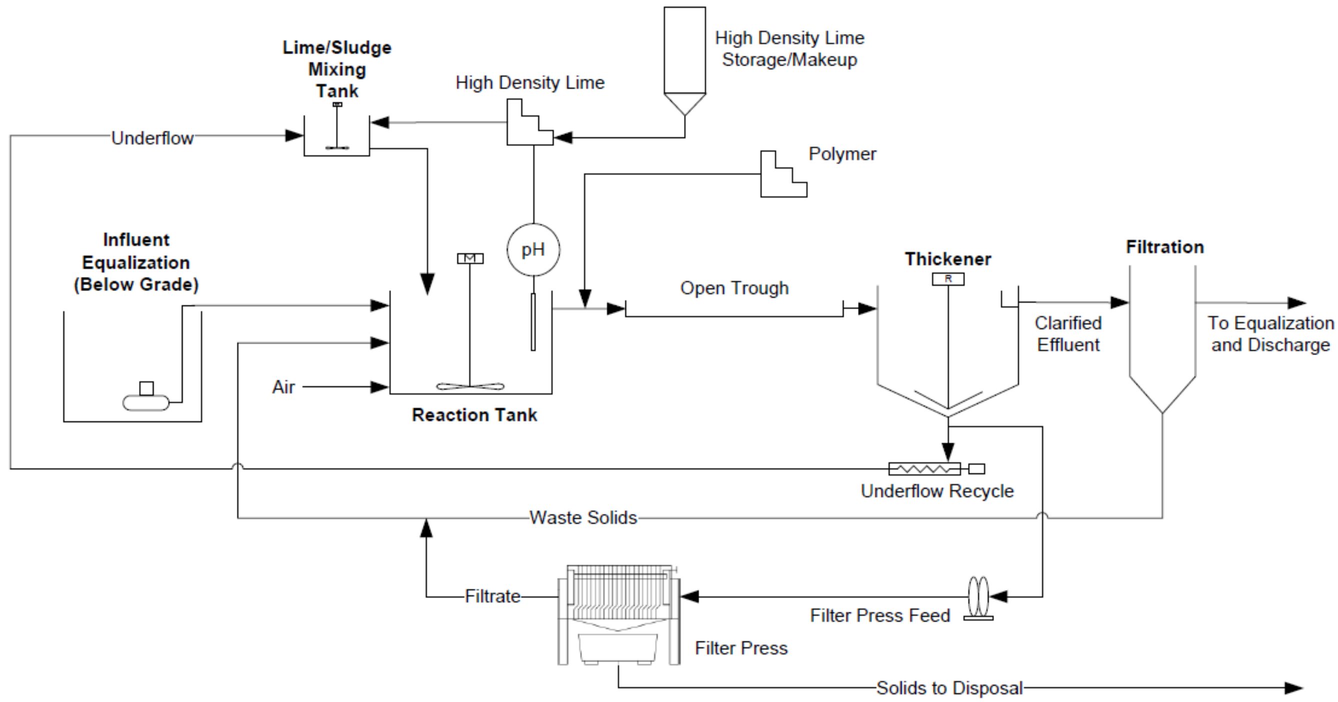

Figure 4 – OU4 WTP design schematic

standards. A CO_2 neutralization unit process was also incorporated to meet discharge standards when operating above pH 9.0.

Lime storage and delivery equipment was designed around the range of demands encountered in bench and pilot testing. Ultimately, bench test lime usage was used for full-scale design due to the issues encountered during pilot testing leading to lower titrated TSS and associated lower lime demands and sufficient turndown was provided, incorporating capacity to allow treatment of influent water ranging between 180 and 600 gpm at pH 8.5 to 10.0. Calculated lime demand was 4,005 lb/day, less than the 6,000 to 8,000 lb/day where quicklime typically becomes cost effective; therefore hydrated lime was selected for the process (NLA, 1995). Use of hydrated lime for the OU4 project allowed implementation of a high density lime (HDL) system, which delivers approximately 35% $Ca(OH)_2$ slurry to the process. HDL has been shown to not dewater over extended periods of time or scale piping and allows elimination of the recirculation typically required in lime delivery.

For Thickener sizing, settling tests performed at both the bench and pilot testing stages were useful in determining the range of effective sizing and whether to design around rise rate or thickening. Solids behaved somewhat differently in the pilot unit from bench testing, indicated by increased settling rate and darker solids as testing continued, likely due to the presence of higher oxidation states of Mn producing denser, faster settling flocculated particles. Underflow percent solids was only 5.5% after bench HDS testing at 26 recycles and upwards of 20% solids was maintained during pilot HDS testing at a SRR of 20:1 and therefore full-scale solids storage and underflow recycle design was based on pilot test results with some contingency built in for solids down to 10%. Solids storage was built into the thickener instead of a separate system due to space limitations on site.

Filter press testing performed during the pilot test indicated underflow solids were compressible to 53% solids at 100 psi pressure. Because bench tested solids were not nearly as dense as pilot tested solids, there was concern as to whether this result would be continually achievable at the full-scale. Contingency was therefore built into the OU4 WTP filter press, ultimately designed around solids dewatered to 35% solids and continual press operation throughout an 8 hour shift during high flow periods. The OU4 WTP is intended to operate 24-7, but only have personnel onsite for an 8 to 10 hour shift, and the filter presses are redundant, providing increased contingency during high flow and high solids load periods.

CONCLUSIONS

Bench and pilot testing of predicted OU4 average influent and low flow blended source waters shows effective treatment with HDS technology. Full-scale design of the 180-600 gpm OU4 WTP was based on bench and pilot study and prior project experience. Bench and pilot studies provided guidance for full-scale design parameters including lime demand, polymer dosing, oxidation, underflow and filter cake percent solids, settling and thickening characteristics of solids, and reaction time. The full-scale design was based on a treatment pH range between 8.5-10.0 to provide flexibility for operation under varying metal loads and influent flow anticipated throughout the year to effectively treat influent Mn. Oxidation was incorporated as aeration to promote formation of denser ferric hydroxide solids. A SRR of 20:1 was determined to be most effective for thickening of underflow solids. A thirty minute reaction time was determined to be the most efficient for treatment performance. Underflow percent solids reached 23.1% and tested bench and pilot influent was effectively treated to levels below stream standards.

Variation between bench and pilot test results provided insight into the contingency required for design of the OU4 WTP. Variation in Bench and pilot testing demonstrated the difficulty in modeling treatment performance of a full-scale WTP with bench and pilot testing. Developing an accurate blend of anticipated influent sources proved challenging when dealing with multiple influent sources that experience extreme seasonal variations in flow and metal load. It was necessary to design the OU4 WTP processes with sufficient contingency to effectively manage treatment performance when unpredictable changes in seasonal flow rate and metal load from influent sources were expected.

The OU4 WTP is expected to reduce metal loads in the North Fork sufficiently to allow reintroduction of brown trout into the creek and will improve the overall quality of Clear Creek, a source of drinking water for multiple municipalities downstream, mitigating the impacts of nearly a century of mining activity in the region around Central City.

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TECHNICAL MEMORANDUM

Date:	November 12, 2012	**Project No.:**	113-93245.850B
To:	Project File	**Company:**	Golder Associates Inc.
From:	Anna Moderski and John Edgerly		
cc:	Matt Gignac, Matt King, Mike Meyer Mike Brown, Peter Lemke Bridgette Hendricks, Cheryl Ross	**Email:**	jedgerly@golder.com
RE:	**CONCEPTUAL SIZING FOR NITRATE AND AMMONIA REMOVAL**		

This memo outlines a conceptual treatment strategy that could be implemented as a contingency measure for nitrate and ammonia removal downstream from waste rock disposal areas (WRD) for the Merian Gold Project.

Geochemical analysis indicates that treatment to address nitrate and ammonia may be needed downstream from WRD's depending on blasting practices. If blasting practices are successful at limiting wastage to one percent, the concentrations of nitrate and ammonia are expected to meet the Merian Project Environmental Design Criteria (EDC) at the compliance points. During operations, if monitoring indicates that nitrate or ammonia concentrations are higher than expected in WRD seepage, treatment systems will be added downstream from the sediment control dams.

1.0 BACKGROUND

This conceptual cost estimate was prepared for capital and operation and maintenance of four treatment systems. These systems may be required downstream of sediment control dams to treat ammonia and/or nitrate. Design flows and concentrations used for this conceptual treatment system design are shown in the Table 1. Concentrations shown for the dam outlets in Table 1 were estimated for low baseflows during the driest month (September) assuming there will be 1% wastage from blasting. The nitrate and ammonia concentrations estimated at the sediment dam outlets, where there is no treatment requirement, are so close to the EDC that it can be assumed that additional flow from unimpacted portions of the basins draining to the evaluation points will provide sufficient dilution to avoid exceedances where compliance is required downstream.

It was assumed that Dam 1 requires treatment for both ammonia and nitrate, Dams 2 and 3 require treatment for ammonia only, and Dam 4 does not require treatment.

Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, CO 80228 USA
Tel: (303) 980-0540 Fax: (303) 985-2080 www.golder.com

Table 1: Influent Design Basis at Sediment Dam Locations and Treatment Targets at Evaluation Points

	Flow Rate		Nitrate Concentration at Dam Outlet	Nitrate Treatment Target at EP	Ammonia Concentration at Dam Outlet	Ammonia Treatment Target at EP
	m^3/d	gpm	mg/l	mg/l	mg/l	mg/l
Dam 1A	310	57	12.7	10	12.7	4.5
Dam 2	1760	323	5.3	10	5.3	4.5
Dam 3	1670	306	5.9	10	5.9	4.5
Dam 4	1260	231	3.5	10	3.5	4.5

2.0 AMMONIA AND NITRATE TREATMENT

Breakpoint chlorination is developed for treatment at Dams 1, 2 and 3. Biological treatment is proposed for ammonia and nitrate removal at Dam 1. As discussed in Section 1.0, a more detailed feasibility evaluation is recommended when additional information is available. Removal of ammonia and nitrate is designed to meet treatment targets outlined in Table 1.

2.1 Breakpoint Chlorination – Ammonia Removal

Ammonia treatment is planned at the Tailings Storage Facility (TSF) excess water treatment plant using breakpoint chlorination. During breakpoint chlorination, hypochlorite is used to oxidize ammonia to nitrogen gas. Sodium carbonate is also added to maintain the pH in the preferred range for the reaction to occur. Ammonia removal is efficient, and with precise chlorine dosing and pH controls the removal of ammonia can be controlled to provide only the level required. For example, at Dam 2 removal of approximately 0.8 milligrams per liter (mg/L) of ammonia is required and chemical addition can be controlled so approximately 1 mg/L of ammonia is removed. Other parameters including iron, manganese, sulfide, nitrite, and organic parameters such as algae and/or bacteria can contribute to chlorine demand and increase the chemical requirements necessary to treat nitrate and ammonia. Detailed water quality information is not available, so it was assumed that other parameters present will increase the hypochlorite required for ammonia destruction by a factor of two.

It is expected that during actual operations both ammonia (via ion specific electrode) and free chlorine (simple test kits or test strips) will be monitored routinely to ensure chlorine is not overdosed and the desired ammonia removal is achieved. Because the target ammonia effluent concentration is 4.5 mg/L as nitrogen and does not require removal to very low values, it is possible to operate the breakpoint chlorination system to minimize chemical dosing and the chlorine residual. The most effective pH for ammonia removal is generally in the range of 7.0 to 8.0. It is assumed that the influent pH is within the optimal range and an additional pH adjust step is not required. Dechlorination may be required if there are effluent toxicity (such as Whole Effluent Toxicity) testing requirements; however for initial evaluation purposes no dechlorination has been included.

2.2 Biological Treatment – Ammonia and Nitrate Removal

Ammonia and nitrate treatment may be required at Dam 1. The Dam 1 contingency design treatment train includes an aerobic lagoon for ammonia conversion to nitrate followed by a wetland system for nitrate removal, with polishing by an aerobic pond to increase dissolved oxygen and polish the effluent. This analysis evaluates biological treatment at Dam 1 only.

Ammonia in water exists in two forms – the ammonium ion and unionized ammonia. Below a pH of 8.5, almost all of the ammonia in solution exists in the ammonium ion. Under aerobic conditions, with sufficient alkalinity, and a favorable temperature, ammonia is oxidized to nitrite, which in turn oxidized to nitrate. The first step, the oxidation of ammonia to nitrite is typically the slowest step and when nitrate is formed it is rapidly oxidized to nitrate, herein referred to as nitrification. To oxidize the ammonia, dissolved oxygen levels greater than 2 mg/L are required.

Nitrification is affected by a number of environmental factors including pH, toxicity, metals, and unionized ammonia. Nitrification is pH-sensitive and rates decline significantly at pH values below 6.8. When pH values approach 5.8 to 6.0, the rates may be 10 to 20 percent of the rate at pH 7.0. Optimal nitrification rates occur at pH values in the 7.5 to 8.0 range, therefore a pH of 7.0 to 7.2 is used to maintain reasonably nitrification rates.

The conversion of ammonia to nitrate produces hydrogen ions, which are neutralized by bicarbonate ions. This reaction results in the decrease of bicarbonate alkalinity as well as an increase in the carbon dioxide concentration which in turn lowers the pH. If the wastewater has a relatively low alkalinity, the change in pH can be dramatic. Alkalinity is consumed at the rate of 7.2 grams of calcium carbonate per gram of ammonia nitrified. Alkalinity, in the form of calcium carbonate is supplemented in biological treatment systems.

Aerated lagoons are considered to be viable processes for nitrification. The lagoon process is fitted with mechanical surface aerators that provide a power intensity of about 8 horsepower per million gallons (hp/MG). At lower mixing intensities, algae growth is likely. In addition to the above factors a minimum hydraulic retention time (HRT) can be established; depending on the prevailing nitrifying bacteria growth rates. The proposed aeration lagoon HRT for nitrification is 7 days.

Properly designed wetlands have been shown to effectively remove nitrate once the system is established. Once the ammonia has been nitrified to nitrate, wetlands can remove nitrate via a combination of plant uptake and biological conversion to nitrogen gas.

As wetlands are mechanically simple systems, costs for treatment in a lagoon will likely be in the low range for biological treatment. However, wetlands may not be the preferred type of biological treatment system for nitrate treatment at the Merian site because it can be difficult to control the microbiology of treatment, particularly with a tropical climate. This occurs from a combination of factors, including continuous oxygen transfer at the surface of the pond, uncontrolled mixing, sunlight exposure, warm water temperatures, and nutrient addition. These factors promote undesired microbial growth, including algal blooms, and lead to higher nutrient consumption and therefore higher operating costs. In addition, excess nutrients can lead to sulphate reduction, which can cause nuisance odors and create health and safety concerns.

The chemistry of nitrate removal in conventional wastewater systems has been studied in detail and an electron donor (i.e., carbon substrate) is required. A stoichiometric relationship between methanol requires 1.07 grams of carbon to support the denitrification of one gram of nitrate. In the absence of the carbon source, denitrification is inhibited. A carbon source, in the form of methanol is supplemented in the treatment system along with phosphoric acid for biological reduction of nitrate. In addition to the above factors a minimum HRT is established for denitrification at 5 days.

Typically discharges cannot cause reduction in dissolved oxygen concentrations in receiving waters. An aeration polishing cell is included after the wetland to introduce dissolved oxygen in the effluent prior to discharge.

3.0 COST DEVELOPMENT

The costs of the conceptual ammonia and nitrate water treatment options were estimated. The capital and annual operating costs were developed based on North American pricing with the exception of power, labor and chemical costs. The unit pricing for power, labor, and chemical costs (excluding methanol and phosphoric acid) were developed based on site specific pricing developed for the excess TSF water treatment plant. It is assumed labor support will be available from the TSF water treatment plant, and minimal additional labor will be required for these ammonia treatment facilities.

Table 2: Estimated Order-of-Magnitude Costs for Ammonia and Nitrate Treatment Systems

	Dam 1		**Dam 2**	**Dam 3**
Alternative	**Biological Ammonia and Nitrate Treatment**	**Breakpoint Chlorination Ammonia and Biological Nitrate Treatment**	**Breakpoint Chlorination Ammonia Treatment**	**Breakpoint Chlorination Ammonia Treatment**
Capital	$863,200	$669,800	$771,000	$730,400
Annual O&M	$199,900	$191,400	$155,800	$201,700

4.0 RECOMMENDATIONS

If the adaptive water management plan implementation determines that ammonia and nitrate removal are necessary, we recommend that site factors, including specific information on seasonal temperatures, rainfall, labor availability, power availability, and space availability be incorporated into a formal conceptual pre-feasibility evaluation. Along with breakpoint chlorination and wetlands treatment, engineered bioreactor systems should also be considered for nitrogen removal. This information can be readily incorporated into the next and more detailed iteration of water treatment requirements, which is also expected to include more detailed water quality modeling and water balance information. In addition, associated space constraints and other site or logistical factors with installing water treatment systems should be evaluated for this site when more information is available.

TECHNICAL MEMORANDUM

Date:	November 13, 2012	**Project No.:**	113-93245-961-M20
To:	Michael Meyer, David Blaha and Matt King	**Company:**	Newmont/Surgold/ERM
From:	Mr. Michael L. Brown, P.E.		
cc:		**Email:**	mbrown@golder.com

RE: SEEPAGE COLLECTION SYSTEMS
TAILINGS STORAGE FACILITY
MERIAN GOLD PROJECT
SURINAME, SOUTH AMERICA

INTRODUCTION

This Technical Memorandum (memo) provides a summary of the preliminary layout and design of seepage collection systems upstream and downstream of the Tailings Storage Facility (TSF). The preliminary design was prepared to support ongoing project activities and to support the Water Management Plan being prepared for the Environmental and Social Impact Assessment (ESIA). The project location is shown in the Key Plan, Figure 1.

This memo was prepared with the support of Philip R. Bedell, P.Eng. under subcontract to Golder Associates Inc. (Golder).

1.0 TAILINGS STORAGE FACILITY

The Tailings Storage Facility (TSF), Phases 1 and 2, is shown in Figure 2 and is located in the Commewijne watershed. The TSF Phase 1 area (the Base configuration) is approximately 6.7 square kilometers (km2) in size. With the Phase 2 TSF area included, the Expansion configuration, the TSF area is approximately 10.7 km2 in size. The site topography consists of a series of steep sided valleys with flat floors of variable width. The main TSF Phase 1 valley trends southeast to northwest. The ground surface elevations vary from about 530 meters to 600 meters (mine datum), (mine datum equals geodetic datum plus 500 meters), in the TSF Phase 1 area.

The site geology is reported to consist of folded and faulted, inter-bedded graywackes, mudstones, siltstones, sandstones of the Armina Formation. These rocks have been subjected to weak to moderate, low-grade, greenschist facies regional metamorphism. Often, the original bedding in the sedimentary strata can still be identified in the meta-sediments, predominantly at boundaries of units of different grain sizes. No known intrusive rocks have been identified on the property to date.

Prolonged chemical weathering from a humid, tropical paleo-climate has produced a laterite / saprolite profile that extends typically 80 to 100 meters below the surface in the Merian project area. Sedimentary

Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052 USA
Tel: (425) 883-0777 Fax: (425) 882-5498 www.golder.com

rocks of the Armina Formation in the saprolite zone are weathered and oxidized to a mixture of silts and clays such as kaolinite and iron oxides. The primary rock texture may be difficult to distinguish but quartz and quartz veining remain intact.

Geotechnical units are differentiated by degree of weathering and are generally not dependent on protolith type. The major geotechnical units are outlined below:

- Saprolite – A residual soil that is formed in place by chemical weathering of a parent rock. Saprolite commonly develops above the historic water table in tropical environments and can be found to depths of up to 150 meters in the Merian Project area. Relic rock structures are preserved while entire rock mass has weathered to a soil. For stability, saprolite was modeled using soil properties.
- Saprock – The transition zone between fresh bedrock and saprolite where bedrock has not been weathered to soil. For stability evaluation purposes, saprock is treated as a weak rock mass, instead of a soil. For stability analysis and modeling, the saprolite-saprock contact was defined as the last occurrence of saprolite by depth.
- Fresh Rock (also referred to as bedrock) – Fresh, unweathered rock, generally meta-siltstone or meta-sandstone.

For the purposes of this memo, the units noted above have been differentiated based on engineering properties and behavior and, as such, may vary somewhat from those defined based on geological descriptions.

The TSF Phase 1 is designed to contain approximately 130 million tonnes (Mt) of tailings, a working pond of 5 Mm^2, and the probable maximum flood (PMF) with a freeboard of 1 meter. (Note that the anticipated Base case configuration total storage requirement for the first 10 years is 90 Mt, so there is capacity for the Expansion configuration before Phase 2 needs to be built). The design crest elevation is 578 meters (mine datum) and the lowest point in the basin is approximately elevation 530 meters.

The subsurface soil, rock and groundwater conditions in the TSF Phase 1 have been investigated with geotechnical and hydrogeological explorations. Preliminary geotechnical investigation of the Phase 2 TSF has also been completed. The conditions below the TSF (Phase 1 and Phase 2) consist of a weathered tropical profile consisting of a thin surficial layer of laterite and/or alluvial soils overlying saprolite. Based on the geotechnical investigations, the saprolite extends to depths of 17 to 78 meters (typically around elevation 500 meters) and overlies a saprock transition zone some 1 to 33 meters thick and fresh rock. The upper portion of the fresh rock is fractured. Weathered quartz veins are found in the saprolite, saprock transition material and underlying upper fractured fresh rock. Saprock “blocks” are frequently encountered in the lower portions of the saprolite. In addition, the saprolite was noted to have a near vertical, relic bedding structure. Quartz veins, saprock transition, and the upper fractured fresh rock zones generally represent higher permeability flow paths.

2.0 DESIGN CRITERIA

Newmont's Environmental Standard, NEM-ENV-S.041, Tailing Management, requires minimum factors of safety of 1.4 and 1.0 for static and pseudo static (seismic analyses), respectively. In addition, the dams must be designed to accommodate the anticipated settlements as well as the dispersive nature of the saprolite. Furthermore, the design must recognize that, following the initial construction of starter dams, the dam construction will be carried out throughout the 10-year life of the mine. To enhance dam stability and minimize seepage flows through the dams, tailings will be spiggotted from the upstream face of all dams to maximize the development of beaches in front of the dams.

Stability analyses carried out under steady state seepage conditions using estimated phreatic surfaces indicated factors of safety in excess of 1.7 and 1.6 for static and pseudo static seismic analyses (using an acceleration of 0.025 g) conditions, respectively. These satisfy the Newmont criteria. Figures 4, 5 and 6 show the analyzed TSF dam configurations.

Internal drainage of the dams to control the phreatic surface and enhance the stability of the downstream face will be provided by constructing a toe drain consisting of a 1-meter thick layer of 25 millimeter crushed rock enveloped in a heavy, non-woven, geotextile (such as Geotex 1701 or equivalent) or well graded sand and gravel; the toe drain will have a length equal to dam height. To permit collection and analysis of any discharge water, the toe drain will be provided with outlets to a sump not connected to the surface water drainage systems. Toe drains are shown in Figures 4, 5 and 6. The downstream faces of the dams will be protected by a 1-meter thick layer of fresh rock fill (rip rap) placed on a 0.3-meter thick sand cushion and a heavy separation geotextile (Geotex 1701 or equivalent). The toe drain and rock protection blanket are critical items for long-term performance of the dams and will be carefully inspected during project construction so that these features are protected from potential soil clogging during construction.

Since the TSF is designed as an unlined facility, additional groundwater lowering beneath the dams will occur as a result of the installation of the seepage collection systems downstream of the dams. The initial stage of this system, 5-meter deep, 1- meter wide trenches backfilled with well graded filter sand and capped with saprolite, will be installed in conjunction with the starter dams at the Main Dams (MD-1, MD-2, MD-4, MD-5, MD-6 and MD-7) and at Main Dam MD-3 (no starter dam) and Saddle Dam SD-1 along with seepage collection wells and monitoring wells. A drainage system may also be installed upstream of MD-6 to lower the piezometric heads on the saprolite and quartz veins at the base of the TSF, and elsewhere if required, reducing seepage quantities. Later stage construction and other features in the upstream and downstream systems are described subsequently in this memo.

3.0 SEEPAGE COLLECTION AND UPSTEAM DRAINAGE SYSTEM

Since the TSF (both Phase 1 and Phase 2) will be constructed over the native saprolite soils, a downstream seepage collection system (trench and wells) is required to collect potentially impacted seepage and return it to the TSF. Additionally, to reduce seepage from the TSF Phase 1, particularly in the early years of operation, a drainage system will be constructed upstream of Main Dam 6. A similar drainage would be constructed upstream of the main Phase 2 TSF dam (on North Fork A3 Creek and unnamed creek) and elsewhere if required in both TSF Phase 1 and Phase 2 areas. Note that the discussion provided in this memorandum is focused on the Base configuration with the TSF Phase 1 layout. The same proposed seepage collection approach would also be used for the Phase 2 TSF, Expansion case.

3.1 Seepage Collection System

The proposed seepage collection system consists of a simple, multi-staged system that can be readily modified based on the results of an on-going monitoring program.

As shown in Figures 7, 8 and 9, the downstream seepage collection system includes:

- Seepage collection drains
- Seepage collection wells
- Surface seep control drains

The seepage collection components shown in Figure 8 have been located based on groundwater modeling of the TSF Phase 1 at the end of mine operations and other evaluations of groundwater flow. Additional information about this modeling is provided in the Groundwater Impacts Assessment (Golder 2012a). The findings from the hydrogeological baseline studies and groundwater modeling indicated that there were different primary modes of groundwater seepage from the TSF: 1) shallow seepage paths through alluvium underlying the main valley floor, 2) relatively rapid seepage through the near-vertical quartz vein systems found within the saprolite, saprock and fractured bedrock, 3) slower seepage paths through saprolite, and 4) slower seepage paths through saprolite and into the underlying saprock and fractured upper bedrock that functions as a regional underdrain below the TSF. Seepage path type 1 (through alluvium) will be largely cut off by dam construction and dam keys. The seepage pathway within the quartz vein system will provide the least amount of attenuation of constituents of concern (e.g. copper) so the seepage collection system is focused on addressing seepage pathway type 2. Seepage through the saprolite will be strongly attenuated because of the slower travel time and geochemical properties of the saprolite. The seepage collection system will include:

- Seepage collection drains to capture shallow seepage through the shallower parts of the quartz vein system

- Seepage collection wells to capture seepage through deeper parts of the quartz vein systems and the fractured saprock and fractured bedrock layers

In addition to downstream seepage collection, the TSF dam keys will be excavated into saprolite, cutting off seepage though the shallow alluvium.

In addition to the features described above, surface seep control drains will be installed perpendicular to the larger dams (e.g., MD 6) to capture seepage that is predicted to reach the ground surface close to the dam toes.

Additional information about the groundwater model and predicted outcomes is provided in the Hydrogeology Baseline Report (Golder 2012a) and the Groundwater Impact Assessment (Golder 2012b). The locations of all seepage collection features should be considered approximate and subject to change from additional investigations, further characterization, refined evaluations, and observations of geologic conditions during construction.

TSF Phase 1 seepage collection drains will be generally constructed as shown in Figure 7. These drains will consist of a 5-meter-deep sand-filled trench, with seepage pumped using an eductor system and returned to the TSF. Seepage collection wells will be extended into the fractured rock zone between the saprock layer and fresh rock. Seepage collection wells will be sited to encounter quartz vein systems that convey seepage from the TSF. The approximate seepage collection well locations for the TSF Phase 1 are shown in Figure 8. Multiple collection wells may be needed at each location. Initially, the water quality in these wells would be monitored and seepage collection pumps would not be activated until predefined water quality triggers are reached. Surface seep control drains, Figure 9, are shallow features designed to capture seepage that may reach the ground surface upstream of a seepage collection system. The surface seep control drains are shallow features (2 meter depth) that may be needed downstream of the larger dams such as MD 6.

The seepage collection for the TSF Phase 1 will be implemented in three stages:

- Stage 1 seepage collection is associated with the main dams (MD 1 through MD 7) and will be installed in year 0 as the starter dams for the main dams are constructed. The Stage 1 components include seepage collection drains and seepage collection wells. In addition to collection drains and wells near the main dams, a collection drain and wells system would be installed downstream of Saddle Dam 1. Stage 1 would also include installing a seepage collection system downstream of the TWSR.
- Stage 2 will be installed at other locations (such as downstream of saddle dams, berms, and at inferred quartz vein locations) concurrent with the construction of the saddle dams and berms.
- Stage 3 seepage collection components would be installed downstream of Stage 1 or 2 (as applicable) components if groundwater or surface water quality impacts are observed at monitoring locations downstream of the seepage collection systems.

3.2 Upstream Drainage System

The amount of impacted seepage through the quartz vein system (and through the saprolite) can be reduced if groundwater piezometric heads at the base of the TSF upstream of the main dams are reduced. Because the quartz vein seepage is not substantially attenuated, lowering piezometric heads on the quartz veins will provide an effective means of reducing the quantity and impact of TSF seepage.

The proposed upstream drainage system for the TSF Phase 1 is focused on the area upstream of Main Dam 6. This is the largest existing drainage channel in the TSF Phase 1 and is underlain by a relatively thin layer of coarse-grained alluvium (sand and silt). In addition, the site geological interpretation suggests that quartz vein systems may be more common beneath existing surface water drainages.

The upstream drainage system will be built at the start of TSF construction and will need to incorporate a cofferdam being constructed to divert drainage during construction of MD 6. The upstream drainage system for the TSF Phase 1 includes:

- A 1 m thick compacted saprolite layer (blanket) placed on the cleared /grubbed ground surface between the main dam (MD 6) and the cofferdam
- A cofferdam keyed into saprolite (the cofferdam is needed to divert stream flows so that the TSF dams can be constructed)
- A sand-filled lateral drain system, or sand blanket, upstream of the cofferdam constructed through the alluvium into saprolite, intercepting any quartz veins that are present
- An eductor pumping system with pipes traversing from the lateral drain in the base of the TSF up adjacent slopes (Figure 10)

The saprolite blanket would be placed between the cofferdam and MD 6 to cover alluvium and exposed quartz veins in this area, thus reducing TSF seepage close to MD 6. The saprolite layer would be compacted to approximately 95 percent Modified Proctor maximum dry density (MPMDD) at moisture slightly higher than laboratory optimum to reduce the permeability of the layer.

The cofferdam would be constructed to allow MD 6 to be constructed in dry conditions. Cofferdam construction would include removing alluvium from beneath the base of the cofferdam and a key that is extended into saprolite. This design feature would reduce shallow seepage in the valley that has the potential to travel beneath the TSF dams.

The lateral drains upstream of the cofferdam would be excavated into the saprolite and filled with well-graded sand and a perforated pipe to collect water. The lateral drains in the base of the TSF would be connected to pipes that traverse up nearby slopes and are connected to an eductor pump system to lower piezometric heads in the drain system.

3.3 Monitoring

Monitoring wells will be installed in the drainages downstream from the TSF Phase 1 and the TWSR adjacent to stream channels, where groundwater flow paths converge, at a sufficient distance downstream to detect impacted seepage escaping from the TSF Phase 1 seepage collection systems. Surface water quality will be monitored to detect impacted seepage discharging to streams downstream of the TSF and the TWSR.

If adverse water quality impacts are detected at a monitoring well or surface water monitoring station, a Stage 3 seepage collection component will be installed. The Stage 3 component could be either a seepage collection drain or seepage collection well(s) depending on the location topography and geology.

The upstream drainage system could be monitored for piezometric head and discharge water quality and quantity via the piping and eductor system. This information would assist in evaluating the performance of the drainage system.

4.0 CLOSURE

Details of the hydrogeological modeling and analyses of the TSF are provided in Golder's Groundwater Impacts Assessment (Golder 2012a). This memorandum has been prepared based on the information currently available. Design revisions may be made when the analyses of all of the field investigations data have been completed and the results of all of the related laboratory testing are available.

LIST OF FIGURES

Distribution
Mr. T. Muth, Newmont Mining Corp.
Mr. David Buras, Newmont Mining Corp.
Dr. Louis Gignac, D.Eng., G. Mining Services Inc.
Mr. Phil Bedell, P.Eng., Bedell Engineering Inc.
Mr. Gil Aubertin, Bedell Engineering Inc.
Ms. Deborah Ladd, P.E., Golder Associates Inc.

5.0 REFERENCES

Golder Associates Inc. (Golder). 2012a. Hydrogeology Baseline Report. November 5.

Golder. 2012b. Groundwater Impact Assessment. November 9.

FIGURES

NOTES

1) THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

SOURCE:
COMMERCIAL MAP OF SURINAME PUBLISHED IN 1998 BY INTERNATIONAL TRAVEL MAPS

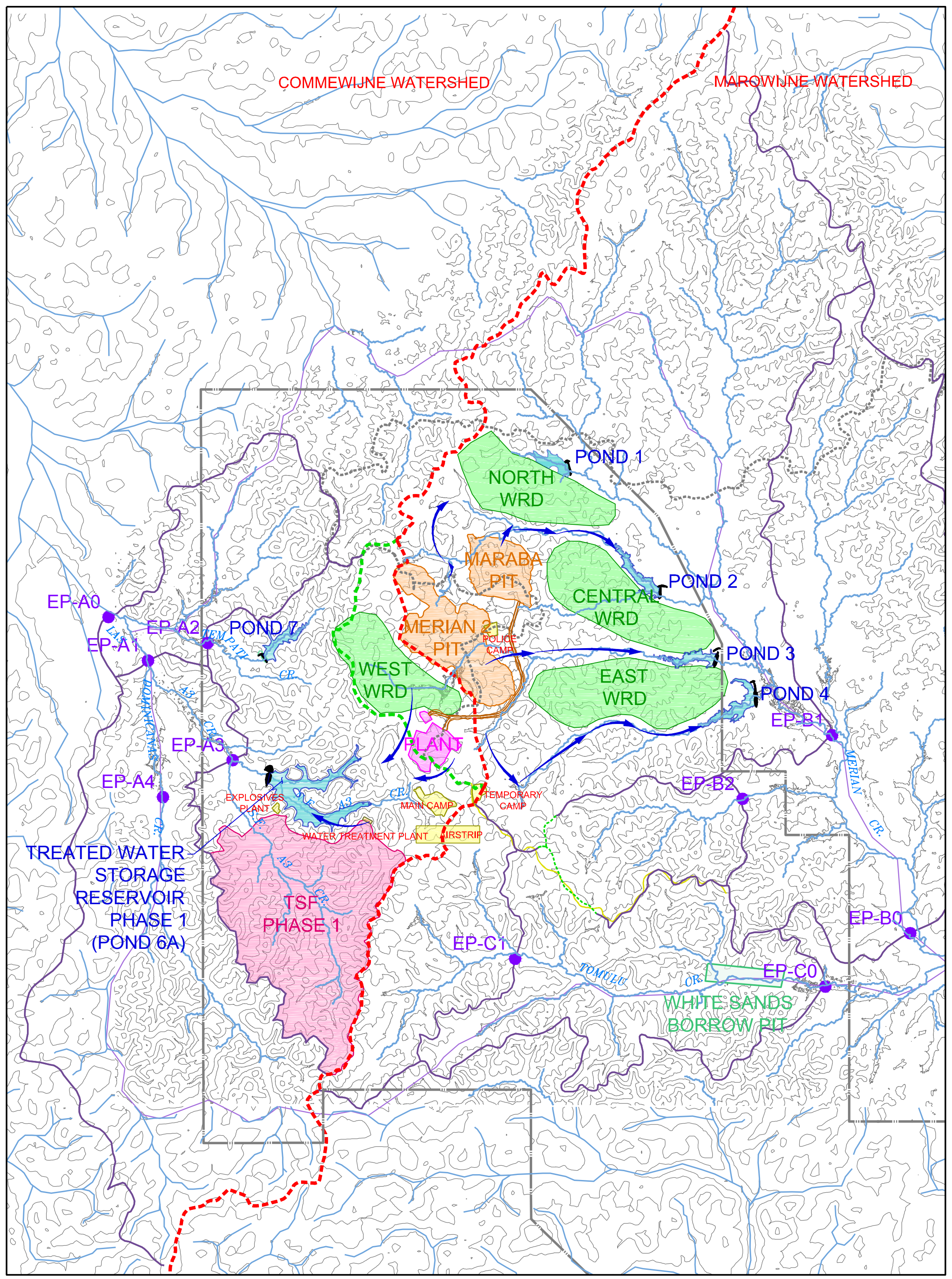
PROJECT
MERIAN GOLD PROJECT
SURINAME, SOUTH AMERICA

TITLE
KEY PLAN

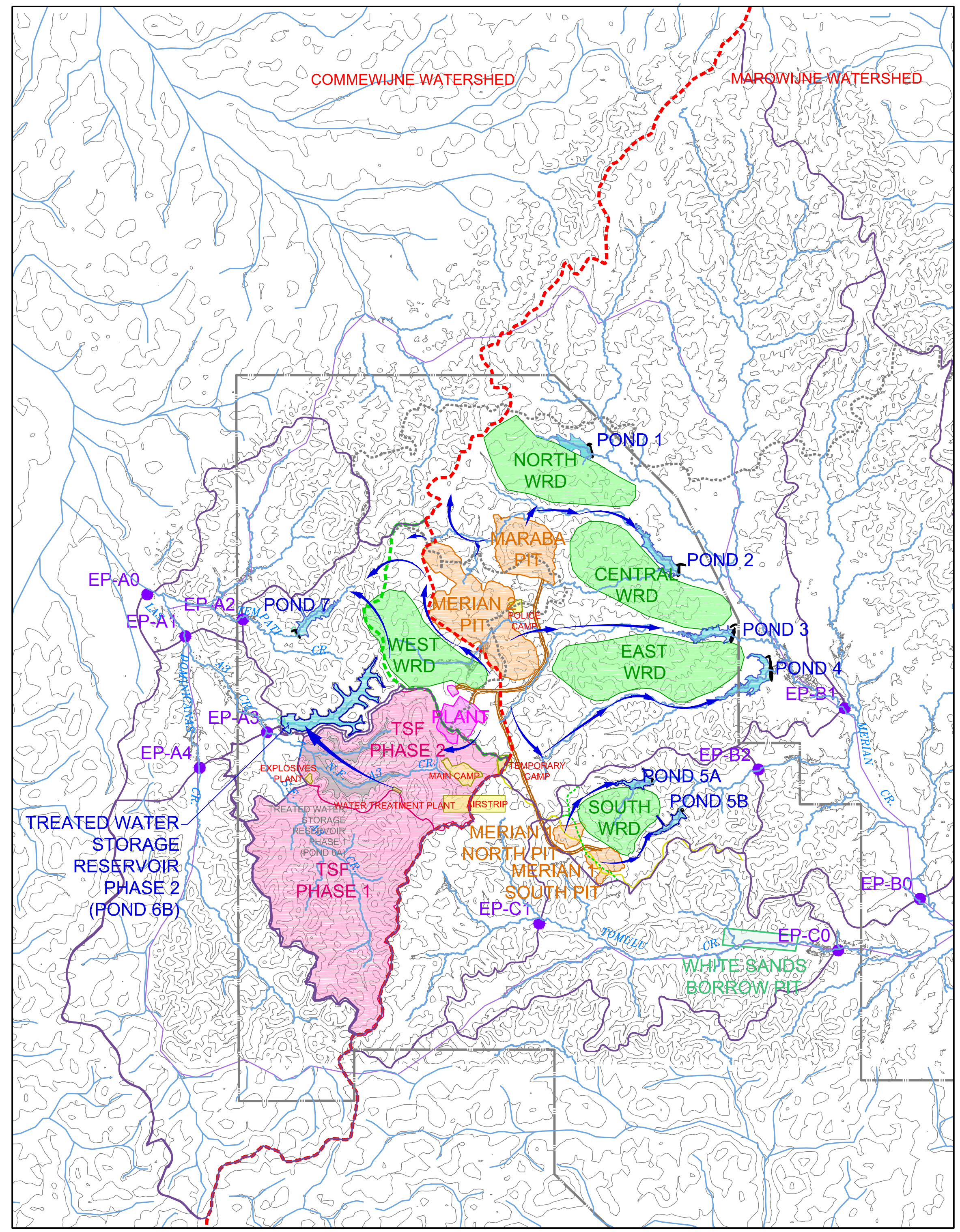
PROJECT No.		11393245	FILE No.	961-M20-KEY_PLAN
			SCALE NOT TO SCALE	REV. 0
CADD	WDF	Aug. 14/12		
CHECK	DL	Aug. 21/12	**FIGURE 1**	

Golder Associates
LONDON, ONTARIO

Drawing file: 961-M20-Key_Plan.dwg Nov 14, 2012 - 8:07am



MERIAN BASE CONFIGURATION



MERIAN EXPANDED CONFIGURATION

LEGEND

- CONTOUR (25m INTERVAL)
- WATERSHED DIVIDE (MAROWIJNE-COMMEWIJNE)
- SURFACE WATER DIVIDE
- GROUNDWATER DIVIDE
- RIGHT OF EXPLOITATION
- CREEK (APPROXIMATE)
- PLANT
- PIT
- WASTE ROCK DISPOSAL AREA (WRD)
- TAILINGS STORAGE FACILITY (TSF)
- SEDIMENTATION POND
- EP-A0 EVALUATION POINT
- FLOW DIVERSION

NOTES

1. LOCATION 6A OF THE TREATED WATER STORAGE RESERVOIR WILL BE IN SERVICE DURING PHASE 1 OF THE TAILINGS STORAGE FACILITY AND WILL ACT AS A STARTER DAM FOR THE PHASE 2 TAILINGS STORAGE FACILITY.

2. LOCATION 6B OF THE TREATED WATER STORAGE RESERVOIR WILL BE IN SERVICE DURING PHASE 2 OF THE TAILINGS STORAGE FACILITY AND WILL ACT AS A STARTER DAM FOR THE PHASE 3 TAILINGS STORAGE FACILITY (ANNEX).

0 2,000 4,000 6,000m

1:50,000

NOTE: WGS 84 DATUM - UTM ZONE 21N - GEOID EGM2008 - CONTOUR INTERVAL : 1m. CONTOURS FROM LIDAR SURVEY (MAY 2011)

CONTOUR LINES ARE NOT THEIR ACTUAL ELEVATIONS,THEY HAVE BEEN INCREASED 500m

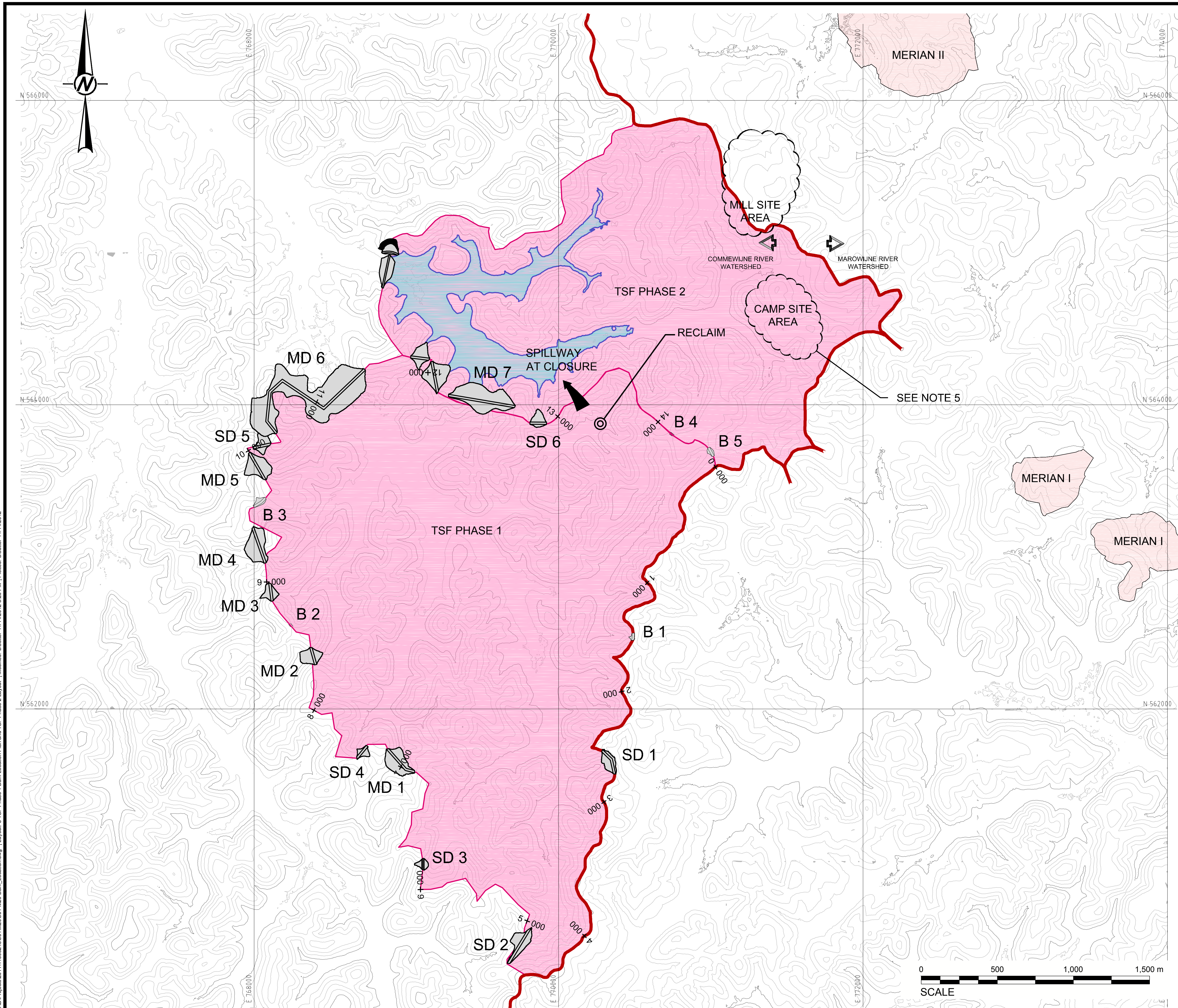
PROJECT

MERIAN GOLD PROJECT

TITLE

BASE AND EXPANDED CONFIGURATIONS

PROJECT No.	113-93245	FILE No. 961-M20-Base_Exp_Config	
DESIGN		SCALE	AS SHOWN
CADD		FIGURE 2	
CHECK			
REVIEW			



LEGEND

PROPOSED DAM FOOTPRINT

NOTES

1. ALL ELEVATIONS ARE REFERRED TO MERIAN MIN DATUM.
2. CONTOURS SHOWN ARE 10m INTERVAL
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.
4. DAM LOCATIONS ARE FOR GENERAL INFORMATION ONLY.
5. THE SHADING SHOWS THE OUTER PERIMETER OF THE TAILINGS BASIN. THE ACTUAL EXTENT OF THE TAILINGS DEPENDS ON THE LEVEL TO WHICH THE BASIN IS FILLED. IN ANY CASE, THE TAILINGS WILL NOT ENCROACH ON THE MINE INFRASTRUCTURE SUCH AS THE PLANT AND AIR STRIP WHICH ARE LOCATED ON HIGH GROUND.

REFERENCES / SPECIFICATIONS

LIDAR CONTOURS PROVIDED BY GMINING, 2011

NOT FOR
CONSTRUCTION

PROJECT

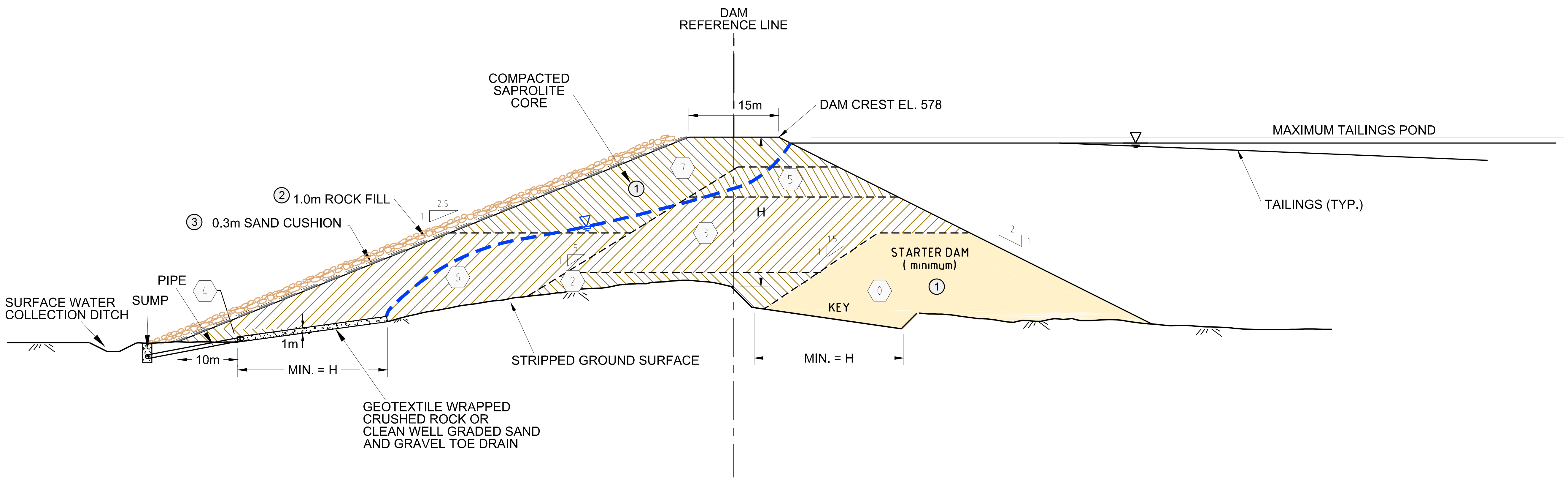
MERIAN GOLD PROJECT

TITLE

TSF PHASE 1 DAM LOCATION PLAN AND TSF PHASE 2 LAYOUT

PROJECT No.		113-93245	FILE No.	961-M20-Dam_Location
DESIGN	--	--	SCALE	AS SHOWN
CADD	ACF	11.14.12		
CHECK	--	--	FIGURE 3	
REVIEW	--	--		

Golder Associates



SCALE IN METRES
0 12.5 25 m

NOT FOR
CONSTRUCTION

LEGEND

1. SAPROLITE
2. ROCK FILL
3. SAND CUSHION

GEOTEXTILE (GEOTEX 1701 OR EQUIVALENT)

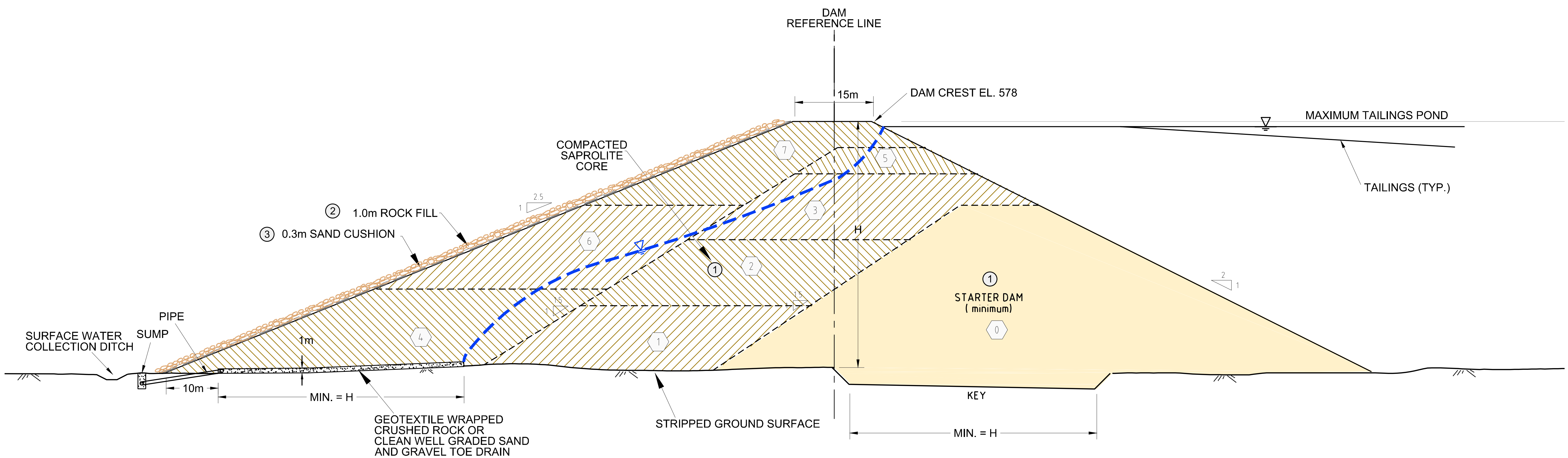
0 – 7 APPROXIMATE DAM CONSTRUCTION SEQUENCE BY YEAR. FOR ADDITION INFO SEE GOLDER, M16 REPORT DATED AUGUST 3, 2012

INFERRED PHREATIC SURACE

NOTE

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

PROJECT	MERIAN GOLD PROJECT			
TITLE	TYPICAL (MAIN DAMS - 25M)			
Golder Associates	PROJECT No.	113-93245	FILE No.	961-M20-Typical_Sections
	DESIGN		SCALE	AS SHOWN
	CADD	WDF	Aug. 14/12	FIGURE 4
	CHECK	DL	Aug. 14/12	
	REVIEW			



SCALE IN METRES
0 12.5 25 m

NOT FOR
CONSTRUCTION

LEGEND

1 SAPROLITE
2 ROCK FILL
3 SAND CUSHION
GEOTEXTILE (GEOTEX 1701 OR EQUIVALENT)
0 – 7 APPROXIMATE DAM CONSTRUCTION SEQUENCE BY YEAR. FOR ADDITION INFO SEE GOLDER, M16 REPORT DATED AUGUST 3, 2012
INFERRED PHREATIC SURACE

NOTE

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

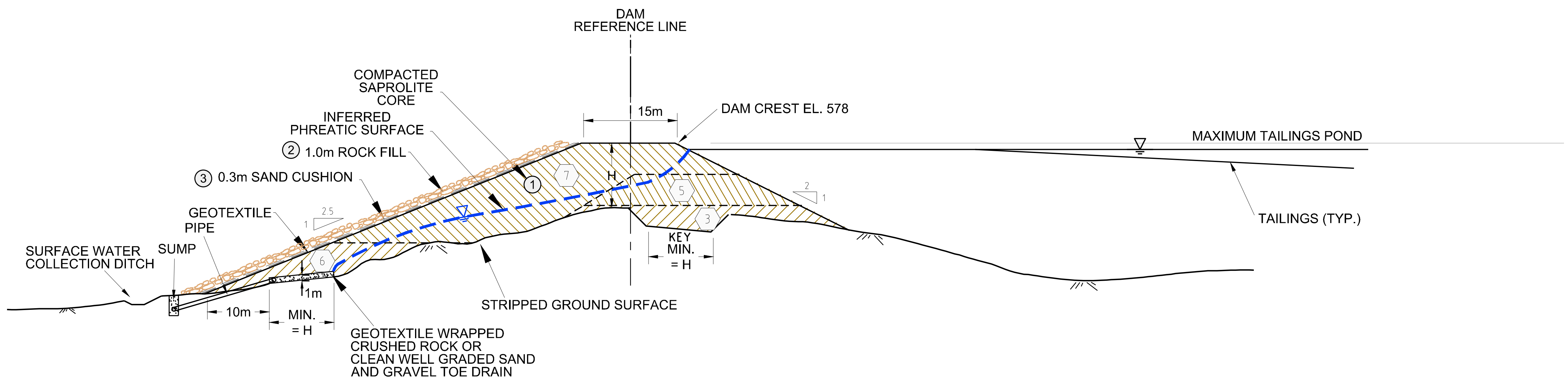
PROJECT
MERIAN GOLD PROJECT

TITLE
TYPICAL (MAIN DAMS - 45M)

PROJECT No.		113-93245	FILE No. 961-M20-Typical_Sections
DESIGN			SCALE AS SHOWN
CADD	WDF	Aug. 14/12	**FIGURE 5**
CHECK	DL	Aug. 14/12	
REVIEW			

Golder Associates

K:\CAD\Projects\2011\1139324S\961\M20\961-M20-Typical_Sections.dwg | Layout: 5 Typical (Main Dams - 45m) | Modified: aforcier 11/13/2012 2:49 PM | Plotted: aforcier 11/14/2012



SCALE IN METRES
0 12.5 25 m

NOT FOR
CONSTRUCTION

LEGEND

① SAPROLITE

② ROCK FILL

③ SAND CUSHION

GEOTEXTILE (GEOTEX 1701 OR EQUIVALENT)

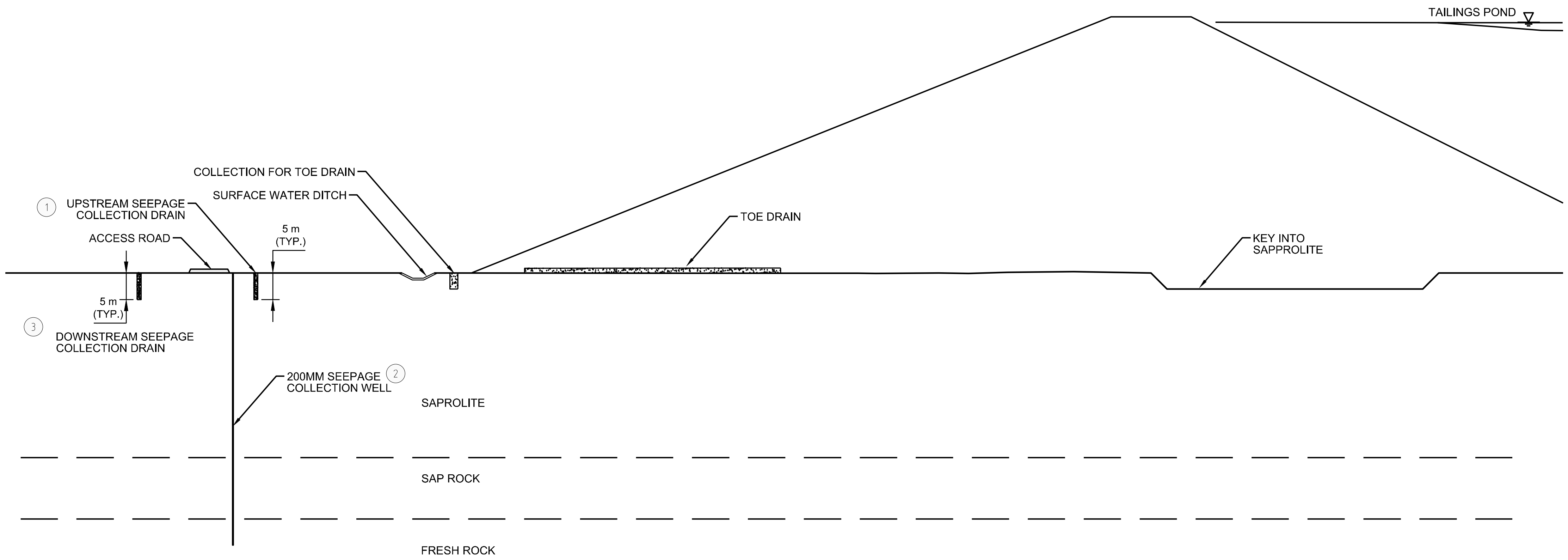
0 – 7 APPROXIMATE DAM CONSTRUCTION SEQUENCE BY YEAR. FOR ADDITION INFO SEE GOLDER, M16 REPORT DATED AUGUST 3, 2012

INFERRED PHREATIC SURACE

NOTE

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

PROJECT	MERIAN GOLD PROJECT			
TITLE	TYPICAL (SADDLE DAMS - 10M)			
Golder Associates	PROJECT No.	113-93245		FILE No. 961-M20-Typical_Sections
	DESIGN			SCALE AS SHOWN
	CADD	WDF	Aug. 14/12	FIGURE 6
	CHECK	DL	Aug. 14/12	
	REVIEW			



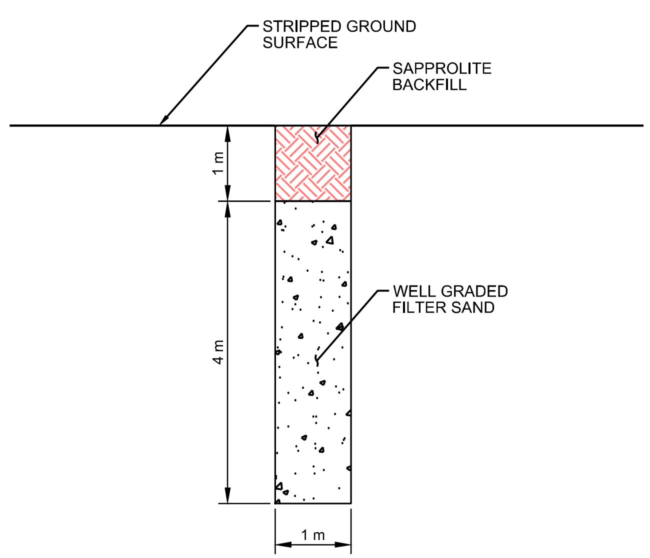
1 SCHEMATIC SECTION - SEEPAGE COLLECTION SYSTEM

LEGEND

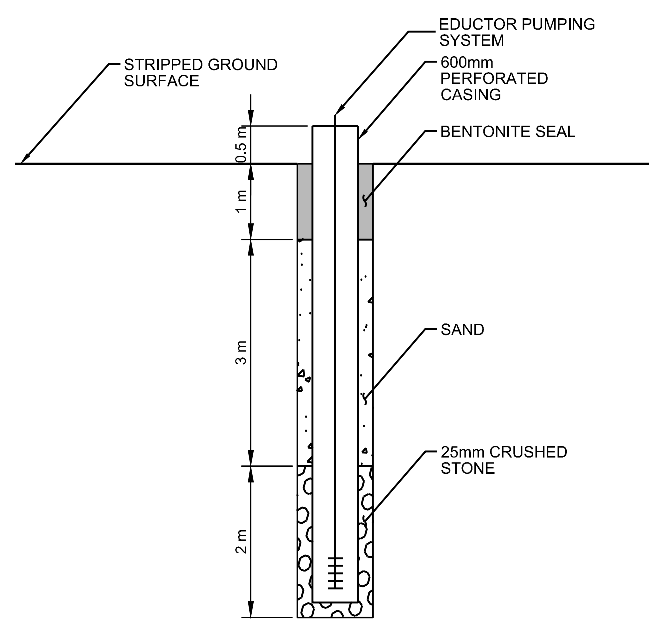
1. UPSTREAM SEEPAGE COLLECTION DRAIN
2. SEEPAGE COLLECTION WELL
3. DOWNSTREAM SEEPAGE COLLECTION DRAIN

NOTE

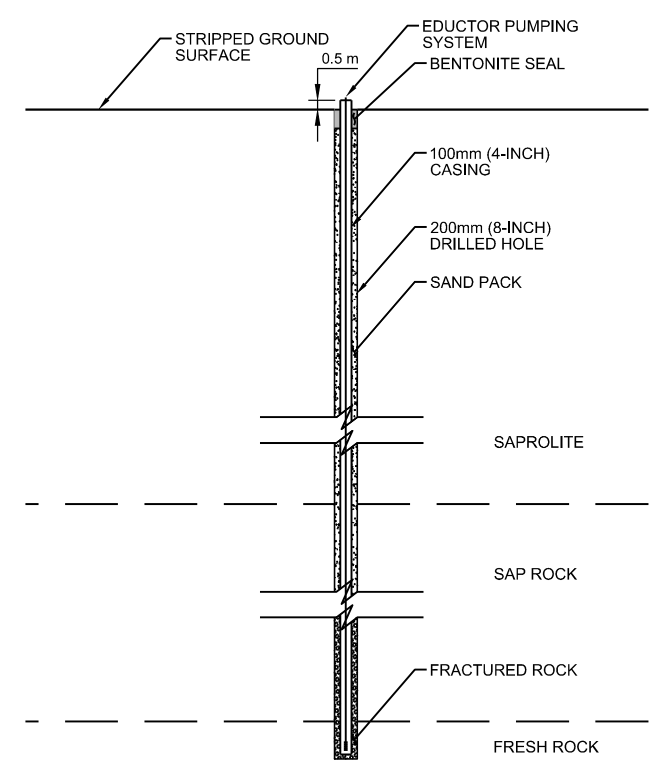
1) THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.



2 5m DEEP SEEPAGE COLLECTION TYPICAL DETAIL



3 PUMPING CHAMBER IN SEEPAGE COLLECTION DRAIN TYPICAL DETAIL



4 SEEPAGE COLLECTION WELL DETAIL

NOT FOR CONSTRUCTION

PROJECT

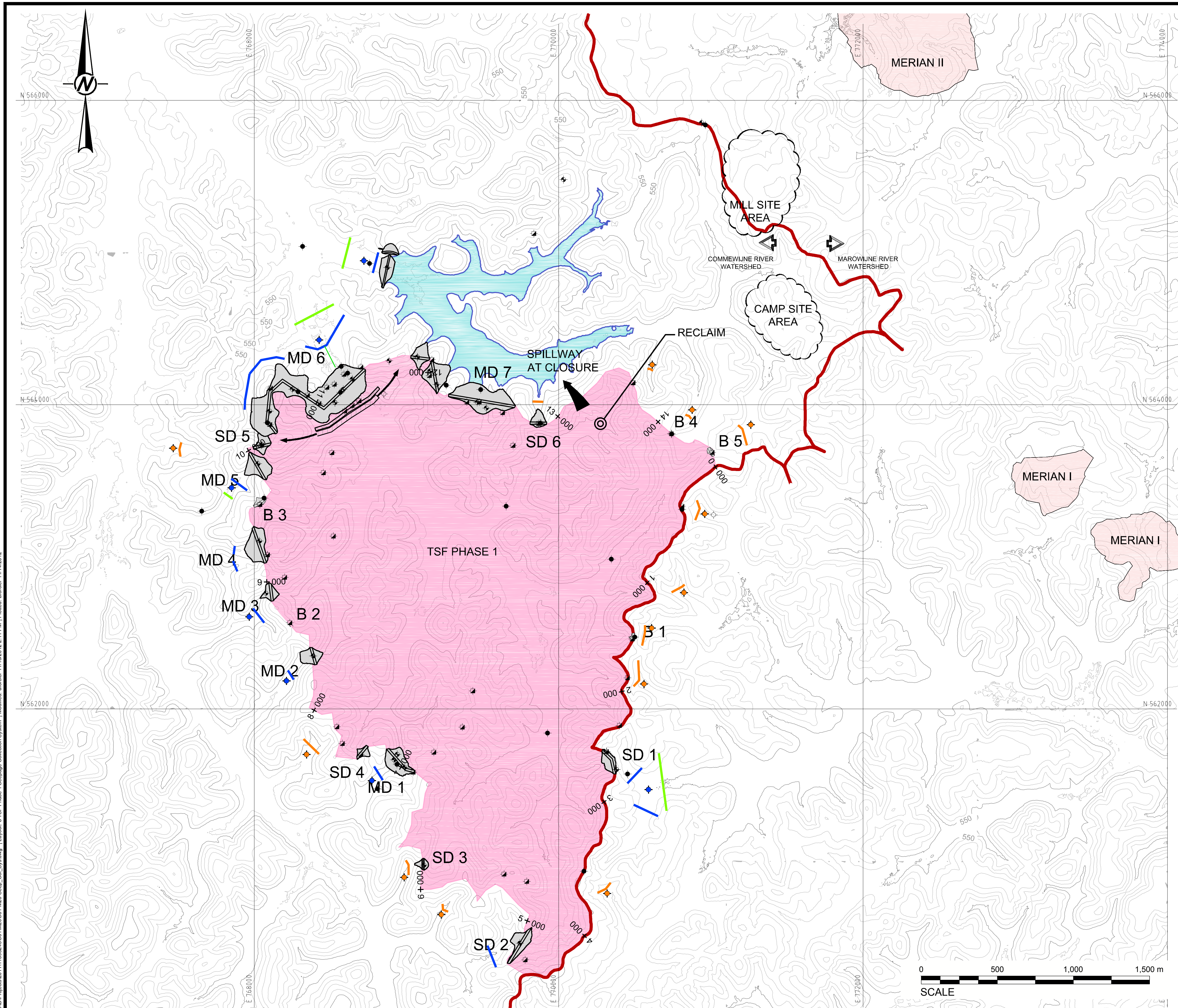
MERIAN GOLD PROJECT

TITLE

SCHEMATIC SEEPAGE COLLECTION SYSTEM

Golder Associates

PROJECT No.		113-93245	FILE No. 961-M20-Schem_Seep_Col
DESIGN			SCALE AS SHOWN
CADD	WDF	Aug. 14/12	
CHECK	DL	Aug. 14/12	FIGURE 7
REVIEW			



LEGEND

PROPOSED DAM FOOTPRINT

UPSTREAM DRAINAGE SYSTEM

EXISTING BOREHOLE

EXISTING PIEZOMETER OR WELLS (GENERAL CLUSTER LOCATION ONLY)

TEST PIT LOCATION

EXPLORATION DRILLHOLE

STAGE 1 STAGE 2 STAGE 3

SEEPAGE COLLECTION WELLS (SEVERAL WELLS MAY BE INSTALLED AT EACH LOCATION)

SEEPAGE COLLECTION DRAINS

SURFACE SEEP CONTROL DRAIN

NOTES

1. ALL ELEVATIONS ARE REFERRED TO MERIAN MINE DATUM.
2. DAM FOOTPRINTS SHOWN ARE BASE ON EXISTING TOPOGRAPHY (PRE STRIPPING), FINAL FOOTPRINT MAY VARY.
3. CONTOUR INTERVAL 5m
4. FOR DETAILS ON DRAINS AND WELLS SEE DRAWING G-0111.
5. DRAINS AND SEEPAGE COLLECTION WELLS ARE SHOWN FOR THE PURPOSE OF THE VARIANCE STUDY AND FEASIBILITY ASSESSMENT. THESE DRAINS AND WELLS ARE BASED ON GROUNDWATER MODELING AND KNOWN AND INFERRED GEOLOGIC CONDITIONING AND ARE CONCEPTUAL DESIGNS ONLY. ACTUAL CONFIGURATION OF DRAINS AND WELLS WILL BE BASED ON ACTUAL GEOLOGICAL AND HYDROGEOLOGICAL CONDITIONS.

REFERENCES / SPECIFICATIONS

LIDAR CONTOURS PROVIDED BY GMINING, 2011

NOT FOR
CONSTRUCTION

PROJECT

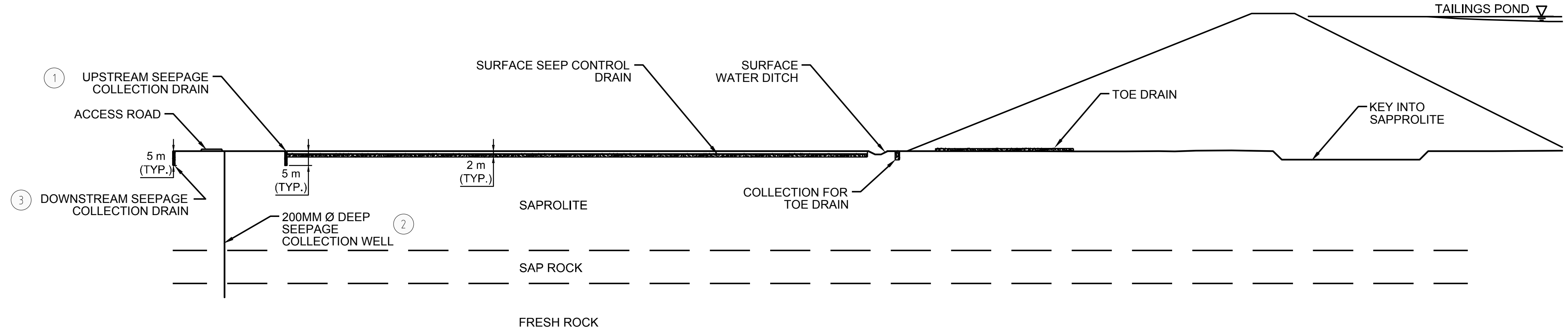
MERIAN GOLD PROJECT

TITLE

TSF PHASE 1 SEEPAGE COLLECTION SYSTEM

Golder Associates

PROJECT No.		113-93245	FILE No.	961-M20-Seep_Col_Sys
DESIGN	--	--	SCALE	AS SHOWN
CADD	LPD (INITIALS)	DD.MM.YYYY		
CHECK	--	--		
REVIEW	--	--	**FIGURE 8**	



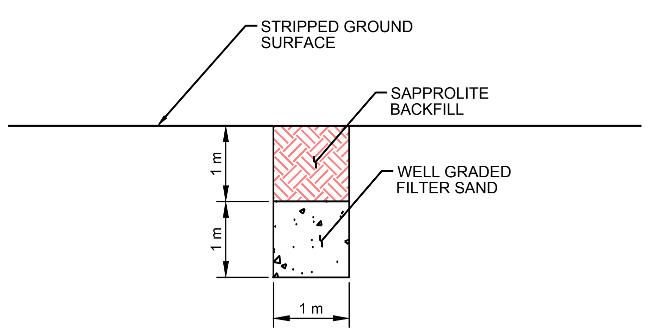
1 SCHEMATIC SECTION - SEEPAGE COLLECTION SYSTEM

LEGEND

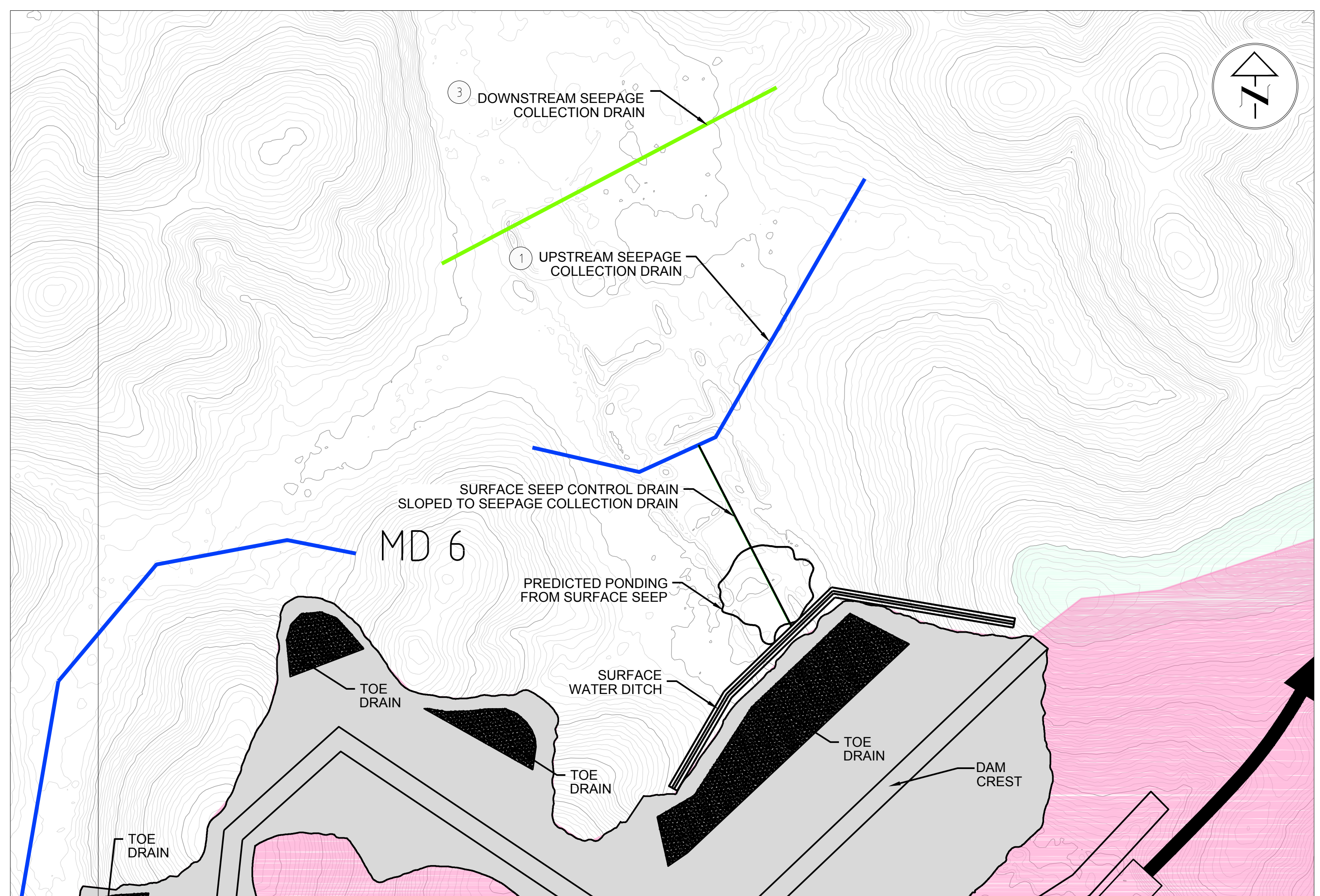
1. UPSTREAM SEEPAGE COLLECTION DRAIN
2. SEEPAGE COLLECTION WELLS
3. DOWNSTREAM SEEPAGE COLLECTION DRAIN

NOTE

1) THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.



2 2m DEEP SURFACE SEEP CONTROL DRAIN DETAIL



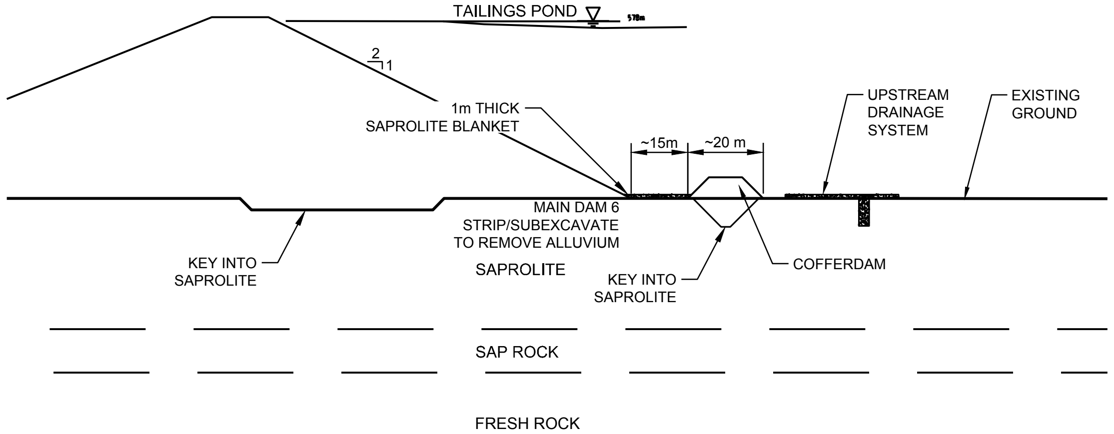
3 SCHEMATIC PLAN - SURFACE SEEP CONTROL DRAIN

NOT FOR
CONSTRUCTION

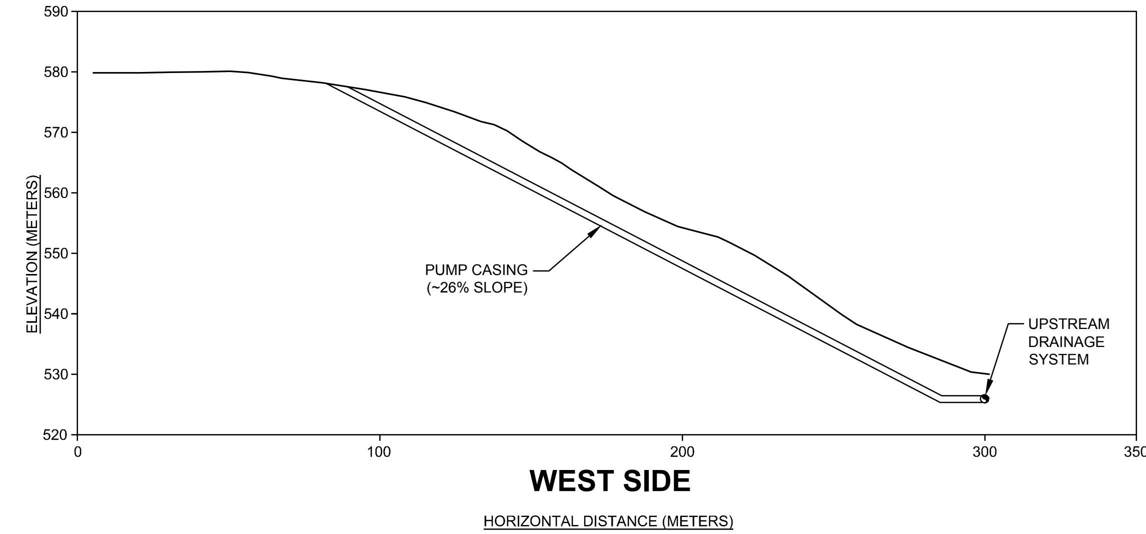
PROJECT	MERIAN GOLD PROJECT
TITLE	SURFACE SEEP CONTROL DRAIN SYSTEM TSF PHASE 1 DAM 6

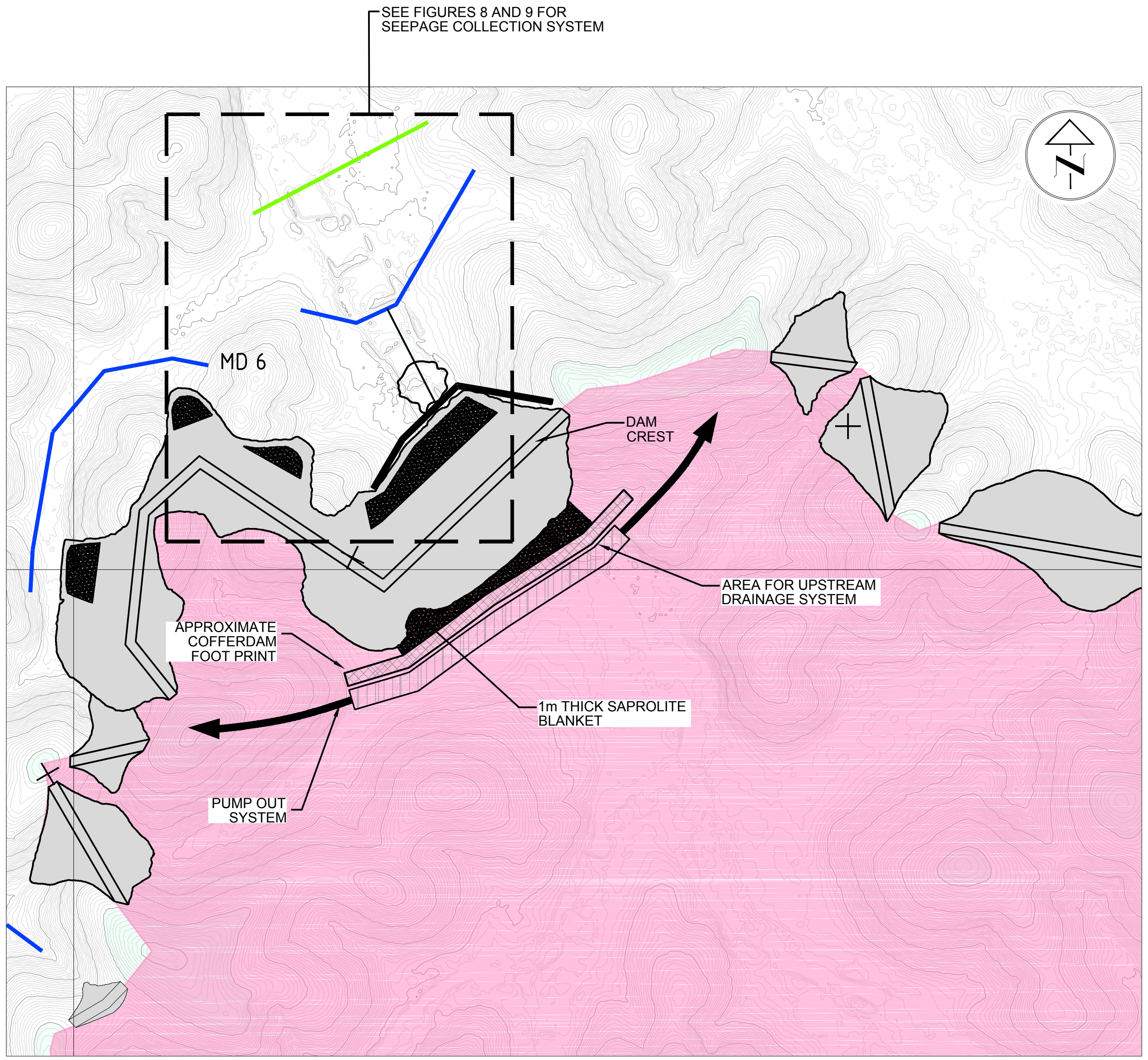
PROJECT No.		113-93245	FILE No. 961-M20-Seep_Cntrl_Drain_MD6
DESIGN			SCALE AS SHOWN
CADD	WDF	Aug. 14/12	FIGURE 9
CHECK	DL	Aug. 14/12	
REVIEW			

Golder Associates

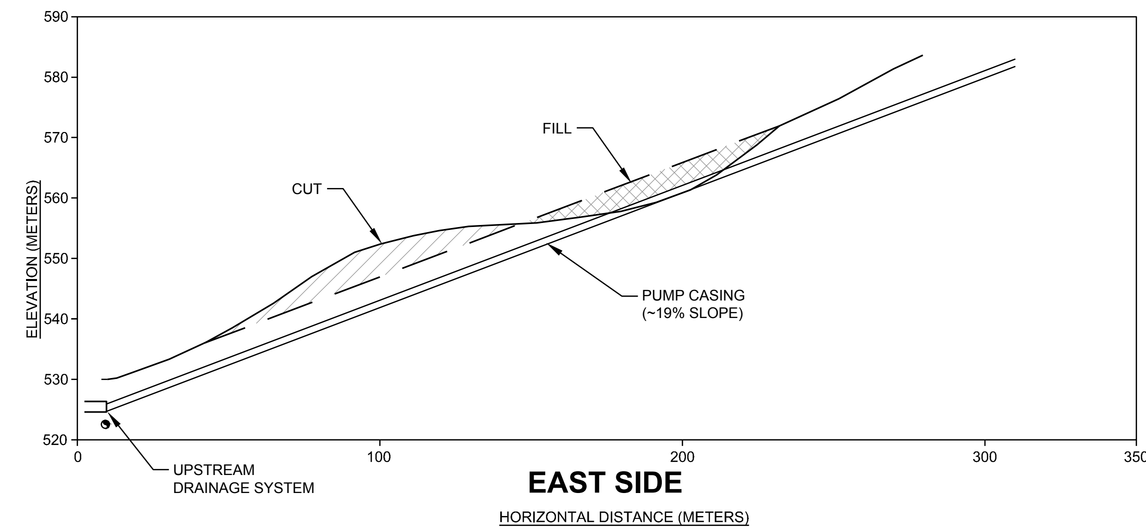


1 SCHEMATIC SECTION - UPSTREAM DRAINAGE SYSTEM





3 SCHEMATIC PLAN - UPSTREAM DRAINAGE SYSTEM



4 POSSIBLE PUMP CASING PROFILES

NOT FOR CONSTRUCTION

NOTE

1) THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

PROJECT

MERIAN GOLD PROJECT

TITLE

UPSTREAM DRAINAGE SYSTEM TSF PHASE 1 MAIN DAM 6

Golder Associates

PROJECT No.		113-93245	FILE No. 961-M20-Upstrm_Drain_Sys	
DESIGN			SCALE	AS SHOWN
CADD	WDF	Aug. 14/12	FIGURE 10	
CHECK	DL	Aug. 14/12		
REVIEW				

Volume IV

Appendix IV-C

Conceptual Closure and Reclamation Plan – Merian Gold Project

REPORT

CONCEPTUAL CLOSURE AND RECLAMATION PLAN

MERIAN GOLD PROJECT

Submitted To: Newmont/Surgold

Submitted By: Golder Associates Ltd.
102, 2535 – 3rd Avenue S.E.
Calgary, Alberta T2A 7W5

November 15, 2012 **Project No. 113-93245.953**

A world of capabilities delivered locally

ACRONYM AND ABBREVIATIONS

>	greater than
%	percent
CC&R	Conceptual Closure and Reclamation
cm	centimeters
km	kilometers
km^2	square kilometers
LFH	Litter, Fibric, Humus
m	metres
masl	meters above sea level
mm	millimeters
N	nitrogen
Newmont	Newmont Overseas Exploration Limited
oz	ounces
the Project	Merian Gold Project
SOM	soil organic matter
Surgold	Suriname Gold Company, LLC
TSF	tailings storage facility
WRD	waste rock dumps

GLOSSARY

Agroforestry	An integrated approach of using the interactive benefits from combining trees and shrubs with crops
dendritic	Branched or tree like pattern
friable	The ability of a solid substance to be reduced to smaller pieces with little effort
illuviation	Accumulation of dissolved or suspended soil materials in one area or layer as a result of leaching from another
laterite	A soil type rich in iron and aluminum oxides
LFH	An organic soil horizon containing litter, fibric litter and humus
parent material	underlying geological material in which soil horizons form
podzolization	the process of mobilization and precipitation of dissolved organic matter, together with aluminum Al and iron Fe as they are leaching down from the A and E horizons to the B horizon
regolith	a layer of loose, heterogeneous material (soil) covering solid rock
Subsoil	All types of B horizons (Bm, Bt, Bg, Bnt), plus gleyed (g) and juvenile (j) versions of them were considered to be part of the upper subsoil for depth calculations. The BA horizons were also included if they were transitional to an underlying B horizon.
Surface Soil	A stratum salvaged from an upland soil that includes the LFH, A horizon and in some cases part or the entire B horizon.
Terra preta	A tropical soil type with charcoal mixed through the surface and subsoil

Table of Contents

1.0 INTRODUCTION

1.1 Project Description

This Conceptual Closure and Reclamation (CC&R) Plan (The Plan) has been developed as part of Suriname Gold Company, LLC (Surgold) Application for the Merian Gold Project (The Project) to describe mitigating actions for potential impacts to environmental resources in the Project area caused by Project development and operation. Surgold is a limited liability company owned equally by Newmont Overseas Exploration Limited (Newmont) and Alcoa Worldwide Alumina, LLC. Newmont is the manager of Surgold. The Project site is located about 66 kilometers (km) south of Moengo and 30 km north of the Nassau Mountains in the north-eastern part of Suriname. Currently, Newmont has a Right of Exploration within the Project area and is seeking Right of Exploitation with the Suriname Government.

A complete Project description can be found in Chapter 3 of the ESIA.

1.2 Closure and Reclamation Guidelines

This CC&R Plan has been designed to comply with the recommended guidelines found within the Newmont Environmental Standard for Closure and Reclamation Planning (Newmont 2008) and World Bank Group: Environmental, Health and Safety Guidelines for Mining (World Bank Group 2007).

1.3 Reclamation Objectives

The reclamation objectives for the Project area are to establish stable structures and self-sustaining plant communities that blend with the surrounding landscape.

1.4 Incorporation of Community Consultation Findings

As part of the community consultation program, local communities will be asked for input into the potential design of the closure landscape. This may include input into specific end land uses, important plant species and target wildlife habitat types. In addition, Surgold will take steps to involve the local community in reclamation and closure activities which may include:

- woody debris handling
- seed collection
- establishment of a propagation nursery
- erosion control
- other potential employment opportunities

Surgold will work with local communities to determine if any other social enhancements such as retention of specific Project facilities after closure may be incorporated into the plan to provide longer term benefit to local residents.

1.5 Development and Implementation of a Final Closure and Reclamation Plan

The reclamation plan will be refined further when a comprehensive mine plan is in place and feedback has been received from the social consultation program. Operational reclamation plans that reflect actual landforms, soils and conditions will be designed on a site by site basis, with consultation of local communities. The final reclamation plan will be further defined when additional information on reclamation technologies, species suitability and, reclamation material physical and chemical properties have been identified and field trials completed. The CC&R Plan is a living document that will require updating, when appropriate, to include new reclamation technologies, strategies and tools that become available. As the mine plan evolves, the CC&R Plan will be adapted to incorporate these changes. Adaptive management will be applied to ensure closure and reclamation goals are met with the most economical and successful reclamation techniques available at the time.

2.0 PRE-DISTURBANCE LAND DESCRIPTION

For information regarding the pre disturbance landscape, flora and fauna, soil assemblages and hydrology refer to Chapters 6 through 12 of the ESIA.

2.1 Pre Disturbance Hydrology

The Merian site elevation ranges from approximately 20 to 120 meters above sea level (masl), at a latitude of approximately 5 degrees north and a longitude of approximately 54 degrees west. In general, the climate is hot and wet, with a mean annual temperature of 26.3°Celcius (C) and a mean annual precipitation of 2,382 millimeters (mm) (Golder 2012a). The forest canopy, in upland areas in particular, is dense and the ground surface is covered with dense vegetation and litter, although soils are thin and water is not retained. Hillslopes are typically short but moderately steep with typical slopes of 30 to 50%. Valley bottoms are generally wide and flat.

The Merian site is situated on the divide between two river basins: the Commewijne Basin to the west and the Marowijne Basin to the east, both of which flow north and drain into the Atlantic Ocean.

Las Dominicanas Creek flows into a tributary of the Commewijne River approximately 3 km below the lowermost monitoring station on Las Dominicanas Creek (SW-29). This tributary flows into the mainstem of the Commewijne River near the village of Java, which is about 40 km north of the Merian site. Tempati Creek and A3 Creek are the primary tributaries to Las Dominicanas Creek that drain the west side of the Merian site. Las Dominicanas Creek (at Monitoring Station SW-27) has a drainage area of 38.6 square kilometers (km^2).

Merian Creek flows into the Marowijne River approximately 4 km below the lowermost monitoring station on Tomulu Creek (SW-4A) and 10 km downstream of the village of Langa Tabiki. Tomulu Creek is the largest tributary to Merian Creek. Merian Creek itself has several small tributaries that flow east and drain a large portion of the east side of the Merian site. Tomulu Creek (at Monitoring Station SW-4B) has a drainage area of 19.6 km^2. Merian Creek near its confluence with Tomulu Creek, at SW-34, has a drainage area of 87.8 km^2.

The Marowijne River basin originates approximately 300 km south of the Merian site, near the border with Brazil. It flows northward along an alignment that brings it within 10 km east of the Merian site. From there it continues north approximately 100 km to the Atlantic Ocean. The Marowijne River serves as the border between Suriname and French Guiana. The Marowijne River has a drainage area of over 60,000 km^2 at the streamflow station at the village of Langa Tabiki. The available flow data show that the highest average monthly flows were recorded between April and June, while the lowest average monthly flows typically occurred between October and December (Golder 2012b). The long-term average annual flow is about 1,700 cubic meters per second (m^3/s), the annual average unit-discharge is 0.29 $m^3/s/km^2$, and the mean annual water yield is about 90 centimeters (cm).

Streamflow data are also available for 10 regional gauges, with basin areas ranging from 3,500 km^2 to 52,000 km^2. The typical dry season (September to February) water yield is approximately 2 to 4 cm per month, while the average wet season (April to July) water yield is approximately 10 to 14 cm per month. The mean annual water yield varies from 54.5 cm (Nickerie River) to 124.3 cm (Sinnamary River) and the average among the gauges is 84.5 cm. For all the regional gauges, the standard deviation of the mean annual water yield averages 20.1 cm, or approximately 25% of the mean.

A local streamflow monitoring program is underway at the Merian site. However, the available data is currently limited by the short period of record. Preliminary analyses suggest that the local streamflow peaks are “flashy” and respond quickly to precipitation events. Additional data collection is ongoing; the latest monitoring update can be found in the Baseline Hydrology Report (Golder 2012b)

The surface water hydrology of the Merian site is strongly influenced by small-scale, artisanal gold mining (ASM) operations, known locally as pork knocking. Artisanal mining activities involve excavation of saprolite soils containing quartz sand and gravel, particularly in the alluvium (streambeds). In recent years artisanal mining was done across nearly all the Merian site. Active artisanal mining continues outside of the industrial area and appears to be focused primarily in the creek beds of the larger drainages adjacent to the Merian site. During a site reconnaissance in August 2011, the area’s most affected by active artisanal mining were in the lower reaches of Las Dominicanas Creek, A3 Creek, and Tempati Creek on the west side of the Merian site, and the lower reaches of Tomulu Creek on the east side of the Merian site. Visual inspection of recent aerial photographs and LiDAR-generated hillshade maps shows that, to some extent, virtually all of the drainages on or adjacent to the Merian site have been affected by past or current artisanal mining.

The end result of artisanal mining practices is that vegetation is removed from valley bottoms, the valley bottoms are widened, and remnant pit excavations and a large amount of coarse sediment are left in the floodplain. Artisanal mining activities have been shown to increase sediment loads and suspended sediment concentrations, stream turbidity, and heavy metal concentrations (Mol and Ouboter 2004). The impacts of artisanal mining activities on streamflows have not been fully quantified but may include increased runoff from areas where vegetation has been removed, and dampening of peak flows due to increased storage on the floodplains resulting from the prevalence of pit excavations.

3.0 RECLAMATION CHALLENGES IN TROPICAL BIOMES

3.1 Natural Tropical Forest Soils

The majority of tropical forest soils are old and highly weathered, with low levels of available plant nutrients. Very few weatherable minerals remain in these soils; therefore, the influx of organic material from forest vegetation constitutes the most important nutrient source. The largest portion of plant available nutrients in these soils is often found in the uppermost soil layer, where microorganisms and fine roots are most active. The surface leaf litter layer is usually thin or nonexistent. The amount of soil organic matter in the topsoil (A horizon) is low when compared to temperate forest topsoils.

3.2 Reduction in Tropical Forest Soil Quality Related to Project Development

Soil quality refers to the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (Karlen et al. 1997). Project development is expected to change key soil properties necessary for the successful establishment of a secondary forest following project closure. The synergistic effects of vegetation clearing and soil stockpiling are expected to reduce soil quality, specifically fertility and structure.

3.3 Vegetation Clearing

The removal of forest vegetation is expected to impact both soil fertility and structure. Soil fertility in tropical forests is highly dependent on organic input from forest vegetation. Generally, the majority of nutrients in these ecosystems are sequestered within forest biomass and decaying organic material. Nutrient inputs in tropical forest systems are derived from the recycling of organic material bounded within vegetation. Disruptions to this cycle will likely pose problems in establishment of secondary forest vegetation.

During Project development, forests within the Project boundaries will be cleared, removing sequestered nutrients within the biomass material. This can cut off the most important nutrient source to these soils which may inhibit successful establishment of secondary forest vegetation during reclamation. In small areas and narrower corridors on decompacted soils, revegetation is expected to occur naturally in a relatively short time period. However, for larger areas, additional steps may need to be taken to re-introduce nutrients to the cover soil amendment following mine closure.

Soil organic matter is expected to decrease following vegetation clearing operations due to a loss of litter influx (Ross 1993). Soil organic matter plays a central role in tropical soil fertility. Nutrients are supplied through organic matter decomposition and nutrient availability is provided on soil-organic matter ion exchange sites (Ross 1993). Soil organic matter is also important in the maintenance of soil structure increasing aeration, water percolation and moisture retention.

Soil erosion potential is expected to increase following canopy removal. Soils will no longer be protected by above ground vegetation, which intercepts precipitation, reduces the erosive impacts of falling rain, and also acts as a soil stabilizer through root interactions. Changes in soil structure will also influence soil water holding capacity, encourage over-land drainage and enhance erosion.

4.0 PROJECT CONSTRUCTION

4.1 Timber Salvage and Vegetation Clearing

Vegetation clearing will commence in initial mine “start-up areas”. Areas cleared will be limited to the immediate footprint of the Project and will extend to an area where work productivity and worker safety are not jeopardized. It is estimated that 5% of timber within the Project area is merchantable. Merchantable timber will be harvested and transported to an appropriate processing facility. The remaining vegetation will be felled, windrowed and stockpiled at a designated location in the Project area. Woody debris may be passed through a wood chipper, facilitating ease of biomass transport or burned in place if logistics (e.g., topography) prevents storage. Some of this material may be used for progressive reclamation, where feasible. Consideration will be given to transferring live vegetative material from newly disturbed sites to areas ready for closure to enhance soil microbial communities and vegetation establishment on the reclaimed landscape.

4.2 Proposed Organic Material Salvage

Organic material, including the topsoil veneer, will be used for concurrent reclamation by supplementing the use of saprolite as a growth media for revegetation, where possible. Topsoil will not be stockpiled independently due to the reduction in soil quality that will result from long-term storage.

4.3 Proposed Saprolite/Subsoil Salvage and Storage

A sufficient quantity of subsoil/saprolite will be salvaged and stockpiled for use as a reclamation material at closure/reclamation. It is estimated that the upper 2 to 3 meters (m) of subsoil/saprolite will need to be salvaged and stockpiled, assuming the material is of good quality to these depths (i.e., appropriate texture and pH) to reclaim the site. The volume of material to salvage will be reassessed as more detail regarding the mine plan and the soil conditions become available. The West Waste Rock Dump (WRD) is the most likely source for reclamation material. Surgold will investigate the potential for additions of organic material to the saprolite to increase volume and effectiveness as a reclamation material.

Further investigation into the salvage, enhancement and storage of reclamation material will be conducted through mine life to ensure that sufficient quality material is available to successful reclaim the mine site.

4.4 Interim Vegetation and Stabilization of Reclamation Material Stockpile

During operations, the reclamation material stockpiles will be revegetated to prevent erosion and build up soil organic matter and soil structure. Mulch from the non-merchantable forest vegetation may be used for initial erosion control. It is expected that over time this mulch will decompose and become incorporated into the reclamation material. The reclamation material stockpiles will also be revegetated for erosion control.

4.5 Progressive Reclamation

Progressive reclamation is any interim or concurrent reclamation undertaken during mine operations that acts to reduce the amount of land that must be reclaimed at the end of a mining operation. The pace of progressive reclamation is governed by the availability of areas that are no longer required as a part of operations. Surgold's goal is to complete reclamation activities as soon as practicable after development areas are no longer required as part of operations.

Although the majority of reclamation for the Project will occur near end of mining, progressive reclamation will be incorporated into the Mine Plan, where feasible, to minimize the total disturbance at any time during mine life. Progressive reclamation will take advantage of existing seeds, propagules and nutrients, will provide pockets of habitat for local wildlife and will reduce the overall visual impact of the active mine site. Areas that are reclaimed earlier in the mining process will have time to mature and will provide shelter, erosion control and a source of seeds for adjacent, newly reclaimed areas. Detailed progressive reclamation timelines and locations will be updated on an annual basis to reflect the most current mine plan and on site conditions. The operations and closure teams will work closely together to ensure that opportunities for progressive reclamation are identified and implemented, where feasible.

5.0 RECLAMATION PROCEDURES DURING LIFE OF MINE

Reclamation and closure of the mine site will be based on the following general objectives:

- Reclamation goals and objectives will be considered during design and planning of construction and operations.
- Progressive reclamation will be implemented where it is possible and timely.
- The reclamation and closure design will ensure that long-term physical and chemical stability is provided.
- The long-term aim of reclamation is to return the site to a forested habitat consistent with the surrounding forest.
- Social input will be incorporated into reclamation planning.
- The reclamation process and closure landscape will provide opportunities for social development.

5.1 Proposed Salvage and Reclamation Strategy

Salvaged subsoil/saprolite will be placed on closed facilities as a medium for plant growth. This material will be ameliorated and revegetated.

5.2 Proposed Vegetation Establishment Strategy

Currently, Surgold believes the general revegetation approach is best conducted in four distinct conceptual phases, including:

- erosion control, soil preparation and revegetation
- establishing native trees
- inducing natural succession
- maintaining adaptive management principles

5.3 Erosion Control, Soil Preparation and Revegetation;

Because of availability, the dominant type of reclamation material is likely to be derived from saprolite that will have low organic matter content and low nutrient status. It will also be prone to sheet, rill and gully erosion that could produce high loads of suspended solids in surface water. The existing saprolite substrate is nutrient depleted so the creation of an organic layer to enhance soil aggregation and plant growth is highly desirable.

Vegetation will be established immediately following placement of reclamation material as both an erosion control measure and to build up soil organic matter in the reclamation material. Surgold may choose to plant legume vegetation that will fix atmospherically derived nitrogen into the soil.

The use of temporary erosion control measures such as downed trees, mats, netting, or silt fences will be implemented where necessary to control erosion prior to establishment of a protective vegetative cover.

5.4 Establishing Native Trees

Native tree species and legume plugs may also be planted at varying densities across reclamation areas to create diversity in species and structure on the reclaimed landscape. In areas prone to erosion, trees will be planted in rows between cover crops. Nitrogen fixing tree species can be used to sequester atmospherically derived nitrogen into reclaimed soils to increase soil fertility (Chaer et al., 2011). De Faria et al. (2010) provides a list of nitrogen fixing tree species as well as climatic variables that help guide appropriate species selection during reclamation. In the event that vegetation establishment and growth requires acceleration, organic (manure) or synthetic fertilizers will be used.

5.5 Inducing Natural Succession

As the reclamation landscape matures, established trees will act as shelter to allow for establishment of understory species. Reclaimed forests are expected to undergo natural successional processes after establishment. In the long-term (>50 years), the ligneous species composition of the secondary forest on the reclaimed land is expected to be similar to that of the surrounding secondary forest types.

5.6 Wildlife Habitat and Biodiversity Establishment

5.6.1 Biodiversity

Surgold will use the ecosystem approach to re-establish biodiversity on reclaimed sites. This involves a focus on ecosystem structure, function and process at the species, ecosystem and landscape levels. As the reclaimed landscape evolves, it will increasingly resemble conditions found on comparable sites in the surrounding region.

Reclamation activities will be designed to establish soils with structural and chemical properties that will facilitate the establishment of soil biota (e.g., micro-organisms such as bacteria, arthropods, algae, protozoa and nematodes). These micro-organisms drive ecological functions that support above-ground plant and animal communities. By restoring soil properties, ecological function within terrestrial habitats is expected to re-establish over time.

Revegetation of reclamation areas will be through natural regeneration, where possible, to allow for the establishment of a variety of locally adapted species. Where planting is required, a variety of locally common species typical to the surrounding ecosystem will be planted. Surgold will strive to integrate reclamation areas with the adjacent area. The biophysical features of the reclaimed landscape are expected to follow a successional pattern similar to the natural landscape.

Techniques that may be used to enhance biodiversity on the reclaimed landscape include:

- Planting tree species in random patterns with varying ratio, abundance and density of prescribed species.
- Planting food plants to attract specific wildlife species.
- Creating micro and meso-topographic variation during site contouring and reclamation material placement.

5.6.2 Wildlife Habitat

Over the long term, ecosystems that are re-established on disturbed lands are expected to be self-sustaining, capable of maturing naturally, and will provide suitable habitat for resident and migratory wildlife species. The CC&R Plan aims to establish wildlife habitats compatible with similar areas in the surrounding landscape. This habitat will be achieved through recontouring disturbances to blend with the surrounding environment, re-establishing functional hydrology, replacing reclamation soils and revegetating to locally common, tropical forest species.

5.7 Facility Specific Closure and Reclamation

The Project footprint is approximately 4,965 hectares (ha) including mine pits, WRDs, processing plant, tailings storage facility (TSF), air strip, camp facilities, haul roads, communications tower, and other facilities (access roads, stockpiles, laydown areas, embankments, drainage works and sedimentation ponds). Building and structures related to the Project will be decommissioned and removed from the Project area prior to reclamation. Consideration will be given to retaining certain facilities that may be of ongoing benefit to local residents. Furthermore, any remediation activities in contaminated areas will have been completed following appropriate guidelines and procedures in place at the time of decommissioning.

5.7.1 Mine Pits

Three mine pits will be developed over the Project life; Merian I, Merian II and Maraba. The pits are expected to extend approximately 170 m below the surface and span 480 ha. At closure, pit lakes are planned to be established in the exhausted pits. The final closure design will be determined based on what can be technically and economically supported by the Operational Mine Plan.

At closure, water will slowly inundate the pits, creating end pit lakes. Reclamation material will be placed around the perimeter of the pit to establish a rooting zone for terrestrial ecosystem above the water line and vegetated according to Section 5 of this Plan.

Fencing and or berms with appropriate signage will be in place, until water level, water quality and pit edges have stabilized.

5.7.2 Waste Rock Disposal Areas

A total of five WRDs are planned during Project operation, occupying an estimated 1,400 ha. The height of individual WRD will not exceed the elevation of regional topography, with expected top elevations from 125 to 150 m. At the time of closure, WRD will be reclaimed smoothing and recontouring the benches to mirror surrounding local hills. Once the WRD benches are recontoured, 20 to 100 cm of reclamation material will be placed over the WRD surface if needed to cover saprock or freshrock. The reclamation material thickness will be adjusted for each WRD to provide an appropriate rooting zone for plants/tree establishment. Slopes will then be stabilized and revegetated according to Section 5 of this Plan. WRD benches may be left in place where it is difficult or not feasible to re-slope the waste rock particularly in areas with large aggregate. These WRD benches will be filled in with reclamation material so that slopes are geomorphically stable and not prone to concentrated water flows and associated soil erosion. Slopes will then be contoured to mirror local hill features, stabilized and revegetated according to Section 5 of this Plan. Naturally occurring drainages may need to be armored to prevent gullying and increased sedimentation loading to discharge watercourses.

5.7.3 Processing Plant, Haul Roads, Air Strip, Camp Facilities, Communications Tower, Access Roads and Laydown Areas.

These components cover about 105 ha of the site. At the time of reclamation, construction material (sand, gravel, concrete, and pavement) will be moved to an appropriate disposal area. The residual soil is expected to be compacted following decommissioning. Bulldozers will deep rip this soil, to ameliorate compaction issues, and attempt to encourage water percolation through this layer. Contours and flat areas will be re-established to control drainage and encourage heterogeneous vegetation cover during forest succession. A 20 to 50 cm reclamation material will then be spread over the facility footprint. Reclamation material placement thickness will be adjusted, as necessary, to provide an appropriate rooting zone for vegetation re-establishment. Revegetation will commence immediately following contouring to limit erosion, according to Section 5 of this Plan.

5.7.4 Tailings Storage Facility

Tailings dam slopes will be reclaimed as soon as is reasonably possible, while still allowing for stability and visibility of dam slopes for the purposes of inspection. Dam slopes may be covered in rip rap or saprolite in erosion prone areas. These areas will be capped with reclamation material prior to revegetation. Earthen dam slopes will be vegetated with tree species where possible and with low-growing grass and legumes on the remaining areas.

Tailings trafficability is expected to be variable during the rainy and dry seasons throughout life of mine Progressive revegetation efforts of the tails will therefore focus on permanently trafficable areas as they become available throughout life of mine.

At the time of closure, tailings are not expected to be entirely trafficable. The tailings are expected to stabilize through consolidation, drainage and evaporation over time. Phytostabilization of gold mine tailings using rye corn has been successfully demonstrated by Mains et al. (2006) and may be considered in encouraging tailings trafficability. Berming, fencing and appropriate signage will be in place until tailings have been successfully revegetated.

At Closure, tailings chemistry is expected to be within acceptable guidelines for direct discharge to surface waters. A permanent spillway will be excavated in the retention dam wall along with the installation of finger drains in appropriate locations throughout the TSF allowing for gradual discharge of tailings water. Hydrological engineering should aim to maintain some open water to aid in sedimentation control. Closure re-vegetation efforts will remain focused on permanently trafficable areas, with natural ingress of wetland species in flood prone areas.

Once tailings are trafficable, consideration may be given to capping the surface with a clay layer or pushing the embankments in over the tailings surface if permanent infrastructure is not jeopardized. If the tailings are found to have suitable chemical and physical properties, capping may not be required and growth medium will be placed directly over trafficable tailings surface and revegetated according to Section 5 of this Plan.

6.0 RESEARCH

6.1 Field Trials

During the Project life, field trials will be initiated and conducted in concurrent reclamation areas to test potential reclamation technologies and to adapt reclamation procedures to Project specific requirements. Optimizing reclamation material content, reclamation material placement thicknesses and revegetation species assemblages are among the trials expected to occur. Test / experiments in concurrent reclamation areas will be used to improve and seek better closure techniques during the life of the mine

6.1.1 Long Term Monitoring

A long term reclamation monitoring program will be developed and implemented for the Project. The program will monitor:

- Soil physical and chemical properties
- Soil flora
- Erosion
- Vegetation establishment
- Vegetation growth and cover
- Vegetation health
- Vegetation diversity
- Comparability of reclaimed communities to natural analogues
- Wildlife usage of reclaimed environments
- Social

Monitoring results will be compared to baseline conditions and analogous undisturbed areas. Findings will be used to adapt reclamation strategies and apply mitigations where necessary.

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Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com