Environment - Risk Management - Feasibility Study - Social Development - Statistics - Management - Communications - Training and Advocacy

EPEP of the Siana Gold Project

Prepared by BMP Environment & Community Care, Inc. for:

MERRILL CROWE CORPORATION

Greenstone
Resources Corporation

Republic of the Philippines
Department of Environment and Natural Resources
MINES & GEOSCIENCES BUREAU
Caraga Regional Office No. XIII
MGB Bldg. Km. 2, National Highway, Surigao City
Tel No. (086) 826-5256 : Fax (086) 826-1058

October 13, 2009

DENR - MGB RA ...
SURIGAO CITY
RELEASED
OCT 13 2009
DATE:
TIME: 8:00

MEMORANDUM

FOR : **HON. HORACIO C. RAMOS**
Director
DENR-Mines & Geosciences Bureau
North Avenue, Diliman, Quezon City

ATTENTION : **THE CONTINGENT LIABILITY REHABILITATION FUND COMMITTEE (CLRFC)**

FROM : **ALILO C. ENSOMO, JR.**
OIC, Regional Director
Mines and Geosciences Bureau RXIII
Surigao City

SUBJECT : **EVALUATED ENVIRONMENTAL PROTECTION AND ENHANCEMENT PROGRAM (EPEP) SUBMITTED BY** MERRILL CROWE CORPORATION (MCC) / GREENSTONE RESOURCES CORPORATION (GRC).

DOCUMENT ATTACHED : **COPY OF THE EPEP AND MRFC RESOLUTION**

Respectfully recommending herewith for FINAL REVIEW, DELIBERATION AND APPROVAL the ENVIRONMENTAL PROTECTION AND ENHANCEMENT PROGRAM (EPEP) of MERRILL CROWE CORPORATION (MCC) / GREENSTONE RESOURCES CORPORATION (GRC).

Please be informed that the herein EPEP was presented and deliberated during the Interim Mine Rehabilitation Fund Committee (MRFC) Meeting held in October 12, 2009 in accordance with sections 170 and 187 of D.A.O. No. 96-40.

The said EPEP is hereby favorably endorsed for final approval per MRFC Resolution No. 01 series of 2009, a copy of which is hereto attached.

ALILO C. ENSOMO JR.
OIC, Regional Director

Republic of the Philippines
DEPARTMENT OF
ENVIRONMENT AND
NATURAL RESOURCES

MINES AND GEO-SCIENCES BUREAU
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Excerpts from the minutes of the MERRILL CROWE (GREENSTONE) CORPORATION Interim Mine Rehabilitation Fund Committee (MRFC) Meeting October 09, 2009, MGB RXIII Training Center, Surigao City

RESOLUTION NO. 01
Series of 2009

RESOLUTION ENDORSING THE APPROVAL OF THE ENVIRONMENTAL PROTECTION AND ENHANCEMENT PROGRAM (EPEP) OF MERRILL CROWE (GREENSTONE) CORPORATION

WHEREAS, in accordance with R.A. 9742 otherwise known as the Philippine Mining Act of 1995, MERRILL CROWE (GREENSTONE) CORPORATION is a duly organized corporation with a mining project in Brgys. Siana and Dayano, Municipality of Mainit and Brgy. Cawilan, Municipality of Tubod, Province of Surigao del Norte.

WHEREAS, pursuant to DAO No. 96-40 and its amendment DAO No. 2005-07, the company is mandated to submit an Environmental Protection and Enhancement Program (EPEP).

WHEREAS, the submitted Environmental Protection and Enhancement Program (EPEP) of the Company for its Mining Project has complied with the mandated requirements and has made appropriate consideration of the relevant environmental issues and concerns that needs to be addressed during the life of the mine;

THEREFORE BE IT RESOLVED, that the submitted EPEP of MERRILL CROWE (GREENSTONE) CORPORATION is hereby endorsed to the Contingent Liability Rehabilitation Fund Steering Committee (CLRF) for approval;

BE IT FURTHER RESOLVED, that copies of this EPEP be furnished to the MGB Caraga Regional Office and Central Office.

APPROVED AND PASSED this 9th Day of October 2009 at the MGB RXIII Training Center, Surigao City.

I hereby certify to the correctness of the above resolution.

JOSE HERTEODELUS B. BAYANA
Secretariat

ATTESTED BY:

REYNALDO Y. GONZALES
MGB RXIII/ Adhoc Presiding Officer

MARIETTA P. TUMULAK
DENR-MGB RXIII

JESSNAR MOSENDE
Municipal Vice Mayor
Municipality of Mainit

ARCELI T. NAPALAN
REACH Foundation

ERNESTO ODJINAR
Municipal Vice Mayor
Municipality of Alegria

ROMANITO R. TAER
Punong Barangay
Barangay Pongtud

CARMELITO B. MANLIGUEZ
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Project Incharge
GRC/MCC

JOSEFINO J. BERNALDEZ
Diocese of Surigao
Surigao City

ENVIRONMENTAL PROTECTION AND ENHANCEMENT PROGRAM FOR THE SIANA GOLD PROJECT

Prepared for

Greenstone Resources Corporation

By

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22 September 2009

AUTHORSHIP AND REVIEW

Document Title: Environmental Protection and Enhancement Program for the Siana Gold Project

Date: 22 September 2009

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Marita G. Cuaño	Social issues and management planning
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Revision History

Revision	Date of Issue	Description	Authority	
			Name	Signature
0	13 August 2009	The document is issued to GRC for review.	Rolando V. Cuaño, Ph.D. President	
1	4 September 2009	Comments of GRC considered and the document is issued to GRC for final review.	Rolando V. Cuaño, Ph.D. President	
2	22 September 2009	Final comments of GRC considered and the document is issued to the MGB for review.	Rolando V. Cuaño, Ph.D. President	

TABLES

FIGURES

PHOTOS

ANNEXES

A&D	Alienable and disposable
AAS	Atomic absorption spectrophotometer
Ag	Silver
AMD	Acid mine drainage
ANR	Assisted natural regeneration
AO	Administrative Order No.
As	Arsenic
ASTM	American Society for Testing and Materials
Au	Gold
AWD	All-wheel drive
bcm	Bank cubic meters
BMP	BMP Environment & Community Care, Inc.
BOD_5	Biochemical oxygen demand 5 days
Brgy	Barangay
CBC	Complete blood count
Cd	Cadmium
CIDSS	Comprehensive and Integrated Delivery of Social Services
CIL	Carbon-in-leach
CLF	Community livelihood farm
CN	Cyanide
CSIRO	Australian Commonwealth Scientific and Industrial Research Organization
CT	Current transformer
$CuSO_4$	Copper sulfate
d	Day
dBA	A-weighted decibels
DENR	Department of Environment and Natural Resources
DMF	Declaration of mining feasibility
DOLE	Department of Labor and Employment
DOST	Department of Science and Technology
DSWD	Department of Social Welfare and Development
EA	Environment Australia
ECC	Environmental compliance certificate
EIS	Environmental impact statement
EMP	Environmental Management Program
EMoP	Environmental Monitoring Program
EPCM	Engineering, Procurement, and Construction Management

EPEP	Environmental Protection and Enhancement Program
Fe	Iron
FGD	Focus group discussion
FOSs	Factors of safety
g	Grams
GRC	Greenstone Resources Corporation
H	Horizontal
h	Hour
ha	Hectares
HCl	Hydrochloric acid
HDPE	High-density polyethylene
Hg	Mercury
ICOLD	International Committee on Large Dams
JCG	JCG Resources Corporation
k	Kilo
KCGM	Kalgoorlie Consolidated Gold Mines Pty Ltd
km	Kilometers
kPa	Kilopascal
kV	Kilovolts
kVA	Kilovolt-amperes
kW	Kilowatts
L	Liters
lcm	Loose cubic meters
LG	Low-grade ore
LOM	Life-of-mine
LV	Low voltage
L/s	Liters per second
m	Meters
masl	Meters above sea level
mbsl	Meters below sea level
MCC	Merrill Crowe Corporation
MCE	Maximum credible earthquake
mg	Milligrams
MGB	Mines and Geosciences Bureau
Mn	Manganese
mo	Month

MPN	Most probable number
MPSA	Mineral Production Sharing Agreement
MWES	Meyer Water Environmental Solutions
N	Nitrogen
NAAQGVs	National Ambient Air Quality Guideline Values
NAAQSs	National Ambient Air Quality Standards
NaCN	Sodium cyanide
NAF	Non-acid-forming
NaOH	Caustic soda or sodium hydroxide
NAG	Net acid generation
NCR	Non-conformance report
NFPA	National Fire Protection Agency
NO_2	Nitrogen dioxide
NO_3	Nitrates
NPCC	National Pollution Control Commission
OBE	Operating basis earthquake
OHSS	Occupational health and safety standards
oz	Ounces
PAF	Potentially acid-forming
PAGASA	Philippine Atmospheric, Geophysical, and Astronomical Services Administration
PAL	Philippine Airlines
Pb	Lead
PD	Presidential Decree
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PM-10	Particulate matter 10 microns or less
PO_4	Phosphates
PPE	Personal protective equipment
ppm	Parts per million
QA	Quality assurance
QC	Quality control
RA	Republic Act No.
RAP	Resettlement Action Plan
RCNM	Roadway Construction Noise Model
RH	Road header
RL	Reduced level
ROM	Run-of-mine

s	Second
SAG	Semi-autogenous grinding
SDMP	Social Development and Management Program
SMBS	Sodium metabisulfite
SO_2	Sulfur dioxide
SO_4	Sulfate
STD	Sexually transmitted diseases
SURICON	Surigao Consolidated Mining Company
SURNECO	Surigao del Norte Electric Cooperative, Inc.
t	Tonnes
TDS	Total dissolved solids
TPY	Tonnes per year
TSF	Tailings storage facility
TSP	Total suspended particulates
TSS	Total suspended solids
µ	Micro
UG	Underground
USEPA	United States Environmental Protection Agency
USFHWA	United States Federal Highway Administration
V	Vertical
VAT	Value-added tax
WRD	Waste rock dump
Zn	Zinc

1 CORPORATE DATA AND BRIEF BACKGROUND

1.1 Project Name

Siana Gold Project

1.2 Project Proponent's Name and Address

Merrill Crowe Corporation and Greenstone Resources Corporation

Main Office:

Greenstone Resources Corporation

Level 5, NOL Tower

Commercial Avenue cor. Acacia Avenue

Madrigal Business Park, Ayala Alabang

Muntinlupa City

Project Site Location:

Brgy. Cawilan, Municipality of Tubod and

Brgys. Siana and Dayano, Municipality of Mainit

Province of Surigao del Norte

1.3 Contact Details

Gregory C. Edwards

Managing Director

Greenstone Resources Corporation

Tel/Fax Nos. +632 8072790, 8072667/+632 8076658

Email: gedwards@red5limited.com

1.4 Brief Background

The Siana Gold Project will redevelop the former Siana Mine of Surigao Consolidated Mining Company (SURICON) to produce gold and silver dore bars.

SURICON operated the Siana property as an underground mine between 1938 and 1960. Beginning in 1981, the property was operated as an open pit mine. Two major pit wall failures led to the premature closure and abandonment of operations in 1990. The remnants of the SURICON operations are a flooded open pit, two dried and grassy tailings pond, one tailings pond with a pool of water, three grassy waste rock dumps, and a workshop.

JCG Resources Corporation (JCG) acquired the Siana property. In September 1997, it applied for a Mineral Production Sharing Agreement (MPSA) covering the Siana property and other areas. In June 2002, Bremer Resources NL executed a Siana Joint Venture Heads of Agreement with JCG. The Agreement has several phases, namely, due diligence and technical review, initial drilling, exploration, and mining joint venture. In December 2002, MPSA No. 184-2002-XIII which covered the Siana property was issued to JCG (Annex 1). Bremer later assigned its interest in the joint venture to Greenstone Resources Corporation (GRC).

GRC commenced reverse circulation percussion and diamond drilling in February 2003. A major resource diamond drilling program followed from November 2003 to February 2005. By October 2006, a total of 64 holes with an aggregate length of 25,133 m were completed and became the basis of the Bankable Feasibility Study for the Siana Gold Project.

On 15 August 2005, through a Deed of Assignment, JCG assigned to Merrill Crowe Corporation (MCC) its rights and obligations on the Siana MPSA and conveyed to the same entity full possession and control of the entire land area covered by the MPSA. On 19 August 2005, through an Agreement, GRC, among others, affirmed its consent to the assignment of claims. The Agreement likewise provided that MCC will immediately cause the transfer of the Siana MPSA from JCG to MCC and immediately thereafter to a Project company. This Project company is the restructured GRC where 60 % of the shareholdings is Filipino. MCC owns 10 % of GRC's shareholdings.

On 11 March 2008, the Mines and Geosciences Bureau (MGB) approved the transfer of the Siana MPSA to MCC (Annex 2).

On 21 April 2009, the Department of Environment and Natural Resources (DENR) issued the Siana Gold Project an environmental compliance certificate (ECC Reference Code: 0811-030-1010, Annex 3).

This Environmental Protection and Enhancement Program (EPEP) has been prepared in compliance with Condition No. 7a of the Project's ECC and DENR Administrative Order No. 1996-40 as amended which is also known as the revised implementing rules and regulations of the Philippine Mining Act.

2 PROJECT DESCRIPTION

The Siana Gold Project will involve the following:

- Dewatering of the roughly 100-m deep open pit
- Construction and use of a 1.7-km all-weather access road and a 75-t causeway crossing
- Development and use of a mine camp, workshop, administration office, and 750 KVA standby generator
- Construction and operation of a 750,000 t per year (TPY), expandable to 1 million TPY, cyanidation plant
- Construction and operation of tailings storage facilities and waste rock dumps
- Mining of the Siana gold deposit by open pit mining to an approximate depth of 215 m below the surface from the existing floor depth of about 100 m, then by underground mining over an approximately 355-m vertical interval and
- Mine decommissioning and rehabilitation.

The major features of the Siana Gold Project are shown in Figure 2-1.

The facilities and works of the Project were designed by various consultants. The consultants and their responsibilities are shown in Table 2-1. It should be noted that the designs are in various stages of completion. The designs may be changed by the EPCM contractor.

Table 2-1. Project facilities, works, and designers

Project Facilities and Works	Designer
Tailings storage facility (TSF) 3 and TSF 4	GHD Pty Ltd
Waste rock dump (WRD) and Community Livelihood Farm (CLF)	GRC
Open pit mine	RSG Global Consulting Pty Ltd
Underground mine	Red Rock Engineering Pty Ltd
Process plant and Mine services area	GRC and Intermet Engineering
Paste fill plant	Revell Resources Pty Ltd
Explosives magazine	GRC
Nursery, landfill, and geotextile tubes	BMP
Drainage channels, TSF emergency spillway, and settling ponds	GHD and MWES
Main access road	GHD
Pit perimeter road	GRC
Accommodations area	GRC
Pit dewatering	MWES
Mine decommissioning and rehabilitation	BMP

Note: The consultants' reports are referenced in the EPEP.

2.1 Project Details

2.1.1 Project Location

The Siana Gold Project is located approximately 39 km south of Surigao City in northeastern Mindanao (Figure 2-2). It is within the 240-ha Siana mine property formerly operated by SURICON. Portions of the property fall within Brgy. Cawilan of Tubod Municipality and Brgys. Siana and Dayano of Mainit Municipality, province of Surigao del Norte.

Access to the Project is either from Surigao City through a 40-minute land trip or from Butuan City through a 2-hour land trip, both via the National Highway. Surigao City and Butuan City can be reached from Manila through commercial planes.

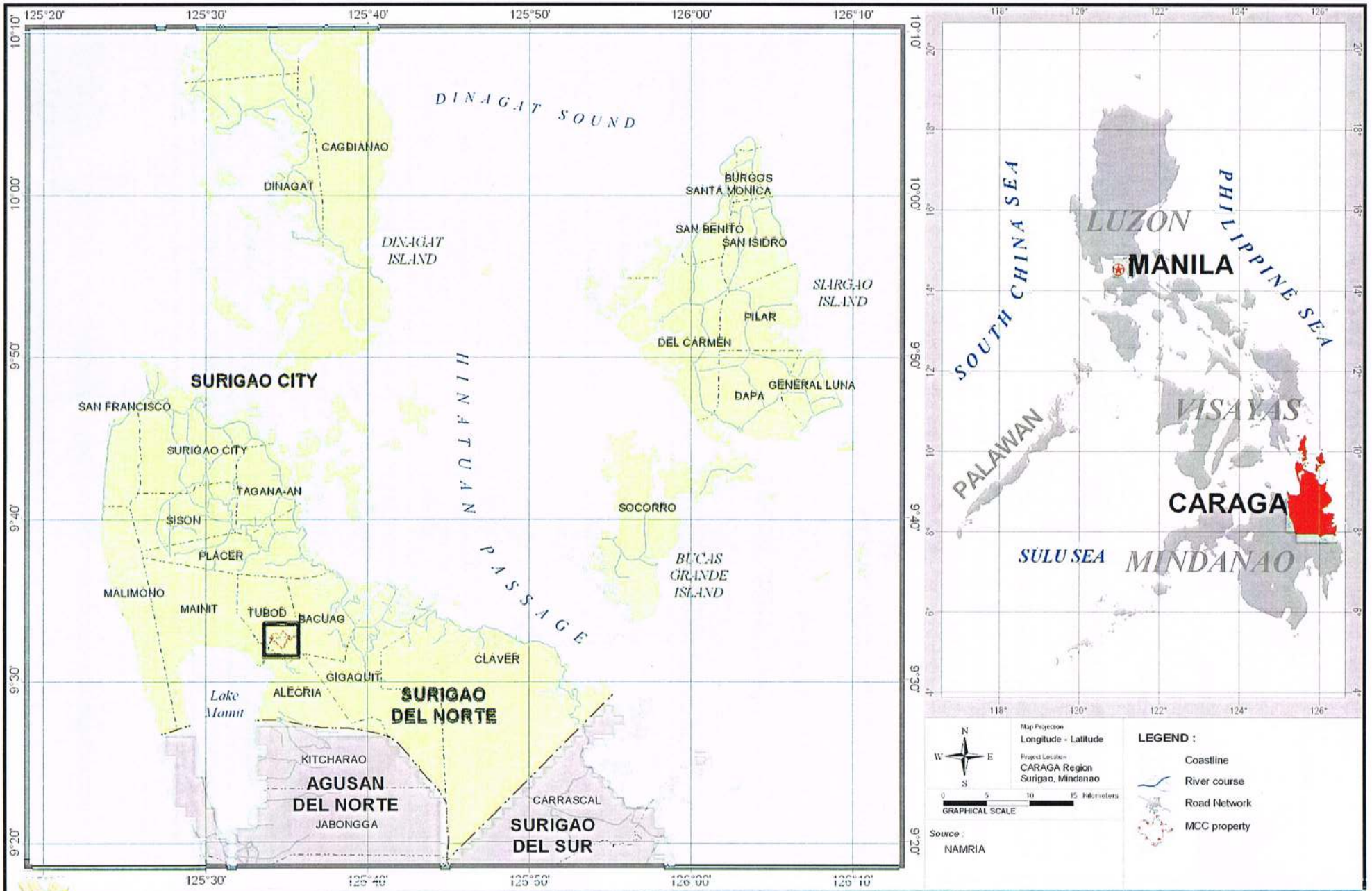
The Project site is within MPSA No. 184-2002-XIII. The MPSA comprises two non-contiguous blocks with an aggregate area of 3,288.8 ha (Figure 2-3).

2.1.2 Estimated Capital Cost

Table 2-2 presents the estimated life-of-mine (LOM) capital cost of the Project.

Table 2-2. Estimated LOM capital cost of the Siana Gold Project

CAPITAL ITEM	Cost US$	Contingency	Total US$	Total PhP
PROCESS PLANT				
Crushing	2,147,755	388,257	2,536,012	122,108,978
Milling	3,586,335	435,036	4,021,371	193,629,014
CIL	1,948,163	312,585	2,260,748	108,855,016
Gold Recovery	1,416,034	175,382	1,591,416	76,626,680
Reagents	385,485	65,887	451,372	21,733,562
Services	378,976	51,258	430,234	20,715,767
Tailings Reclaim	108,696	11,675	120,371	5,795,864
Plant Infrastructure	1,335,322	267,064	1,602,386	77,154,886
Mobile Plant	658,000	65,800	723,800	34,850,970
Earthworks	1,458,526	145,853	1,604,379	77,250,849
Electrical	3,378,748	337,875	3,716,623	178,955,397
Tailings Storage Facility	4,597,769	459,777	5,057,546	243,520,840
Construction Costs	3,538,100	353,810	3,891,910	187,395,467
EPCM	3,764,320	376,432	4,140,752	199,377,209
Indirect Costs	1,008,947	50,447	1,059,394	51,009,821



bmp

Project site location

EPEP of the Siana Gold Project

Figure No. 2-2

VILLAGE OF TUBOD

VILLAGE OF CAWILAN

AMASIWANG RIVER

ACCOMMODATION & MESSING

LAKE

BRIDGE

ACCESS ROAD

POWERLINE

SITE SECURITY FENCE

PLANT SITE

MAIN OFFICE

FUEL STATION

Geotextile Tubes E

SITE SECURITY FENCE

REAG. STORE

CONTAINMENT POND

CYANI STOR

TSF 4

COMMUNITY LIVELIHOOD FARM

WASTE ROCK DUMP

MINE FLEET WORKS

DECANTS

TSF 3

EMERGENCY DECANT SPILLWAY FROM TSF3

VILLAGE OF SIANA

POND B

Silt Trap C

Silt Trap

POND B OVERFLOW CHANNEL (INDICATIVE)

PIT ACCESS ROAD

PROPOSED NURSERY AREA

PROPOSED LANDFILL AREA

VILLAGE OF DAYANO

PRELIMINARY

C	ALL PONDS REVISED	MB	AW		14/07/09
B	TSF3 TOELINE ADJUSTED	JTP	AW		12/06/09
A	ISSUED FOR COMMENTS	JTP	AW		03/02/09
No	Revision Note: * indicates signature on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date

0 100 200 300m

SCALE 1:10,000 AT ORIGINAL SIZE

Sources:
Various as listed in Table 2-1

DO NOT SCALE

Xref: ...\GIS\SIANA_F2_1001.dwg

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Drafting Check		Design Check	
Approved			
Date			
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

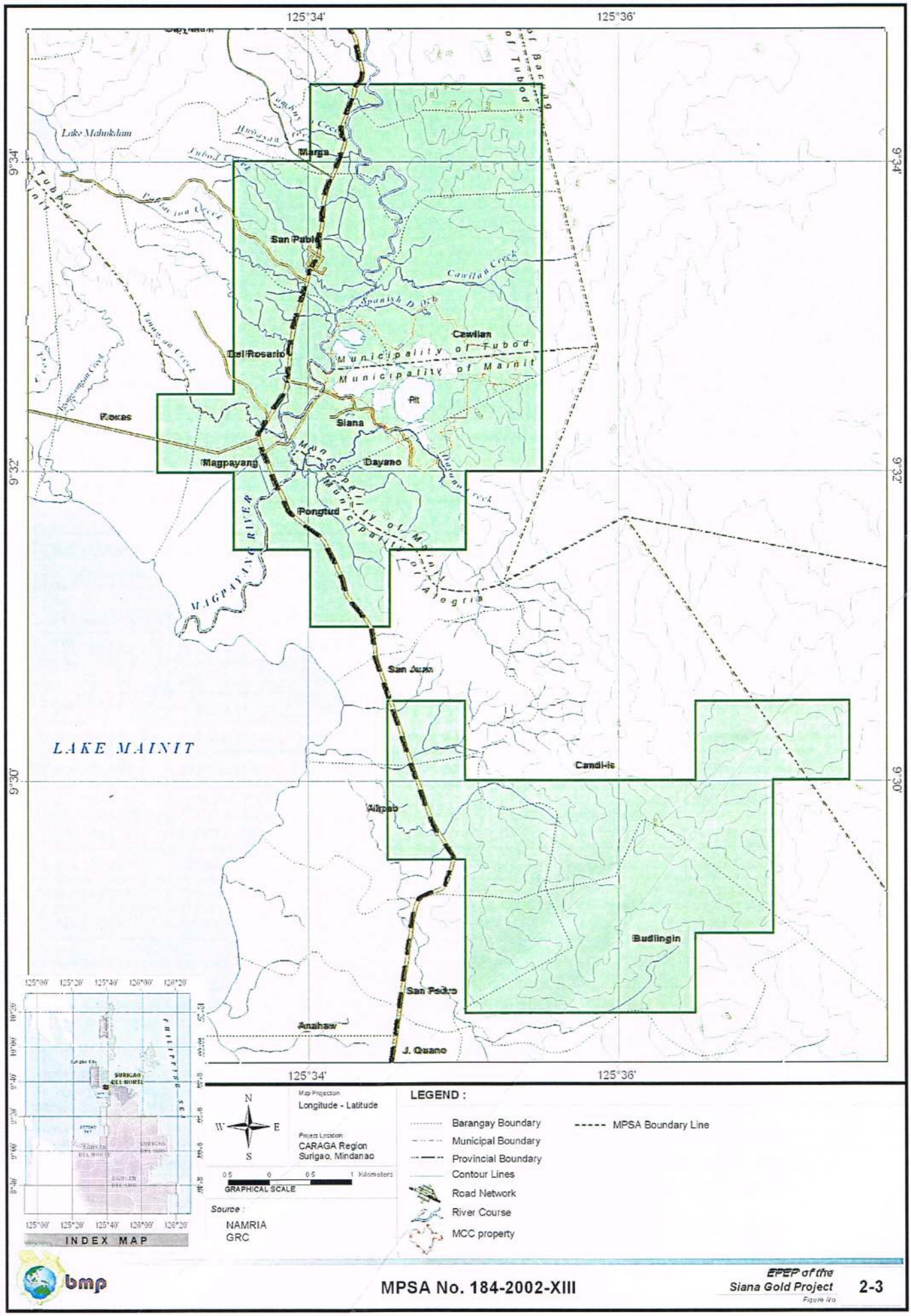
Client: RED 5 LIMITED

Project: SIANA GOLD

Title: Figure 2-1 General arrangements map

Original Size: A3 Drawing No: 61-22730-C002 Rev: C

Plot Date: 29 September 2009 - 12:02 AM Old File No: E:\Spacetime_EMEA\Figures\Figure 2-1 Gen_General arrangements.dwg



MPSA No. 184-2002-XIII

EPEP of the Siana Gold Project

Figure No. 2-3

CAPITAL ITEM	Cost US$	Contingency	Total US$	Total PhP
EPCM Site Expenses	427,069	42,707	469,776	22,619,714
Indirect Client Costs	150,000	15,000	165,000	7,944,750
First Fill	1,589,110	158,911	1,748,021	84,167,211
Spares	484,563	48,456	533,019	25,664,865
Sub-Total	**32,361,918**	**3,762,212**	**36,124,130**	**1,739,376,860**
INFRASTRUCTURE				
Power Distribution	2,238,124	223,812	2,461,936	118,542,218
Admin & Accommodation	468,117	93,623	561,740	27,047,781
Relocation Housing	516,905	103,381	620,286	29,866,771
Site Access Roads	583,863	29,193	613,056	29,518,646
Miscellaneous Capital (incl. Owner Costs)	4,094,029	409,403	4,503,432	216,840,251
Sub-Total	**7,901,038**	**859,412**	**8,760,450**	**421,815,668**
OPEN PIT MINING				
Mine Dewatering Operating	715,141	71,514	786,655	37,877,438
Mine Dewatering Equipment	1,601,394	160,139	1,761,533	84,817,814
Mining Equipment	3,263,963	163,197	3,427,160	165,017,754
Site Establishment	350,000	35,000	385,000	18,537,750
Pre-Strip	12,954,824	827,569	13,782,393	663,622,223
Sustaining Capital	265,000	26,500	291,500	14,035,725
Demobilization	200,000	20,000	220,000	10,593,000
Sub-Total	**19,350,322**	**1,303,919**	**20,654,241**	**994,501,704**
UNDERGROUND MINING				
Plant & Equipment	18,342,049	1,834,205	20,176,254	971,486,630
Non Plant & Equipment	1,373,386	274,677	1,648,063	79,354,233
Drive Development	9,874,132	1,974,826	11,848,958	570,527,328
Rise Development	1,193,826	238,765	1,432,591	68,979,257
Underground Escalation (at 2%pa)	3,181,098		3,181,098	153,169,869
Sub-Total	**33,964,491**	**4,322,473**	**38,286,964**	**1,843,517,317**
TOTAL LOM PROJECT CAPITAL	**93,577,769**	**10,248,016**	**103,825,785**	**4,999,211,548**

Source: MCC

The total LOM capital cost is P 4.999 billion. This is broken down into P 1.739 billion or 35 % for the process plant, P 0.422 billion or 8 % for infrastructure, P 0.995 billion or 20 % for the open pit mine, and P 1.844 billion or 37 % for the underground mine.

Table 2-3 shows the total capital cost estimate from detailed design to first gold production. Totaling P 3.035 billion, about P 1.641 billion or 54 % is for the process plant, P 0.972 billion or 32 % is for the open pit mine, P 0.205 billion or 7 % is for infrastructure, and P 0.217 billion or 8 % is miscellaneous capital. The process plant cost covers EPCM, VAT, spares, first fill, insurance, owner's cost, and working capital. The open pit cost includes dewatering, fleet purchase and hire, pre-strip, sustaining capital, and demobilization. Infrastructure cost is for power, access roads, land, and buildings.

Table 2-3. Estimated capital cost to first gold production

Capital Item	2009	2010		Total US$	Total PhP
		First Half	Sec. Half		
Open pit mine	1,761,533	11,920,875	6,510,406	20,192,814	972,283,994
Process	6,449,233	19,854,132	7,781,166	34,084,531	1,641,170,168
Infrastructure	1,795,082	2,461,936		4,257,018	204,975,417
Sub-total	10,005,848	34,236,943	14,291,572	58,534,363	2,818,429,578
Miscellaneous Capital	564,129	2,079,404	1,859,899	4,503,432	216,840,251
Total (period)	10,569,977	36,316,347	16,151,471	63,037,795	3,035,269,829
Total US$ (cumulative)	10,569,977	46,886,324	63,037,795		

Source: MCC

2.1.3 Minerals for Extraction

The Siana gold (silver-lead-zinc) mineralisation is characterized as a high sulphidation regime of epithermal affiliation, hosted predominantly within tectonized and altered carbonate and basaltic lithological assemblages.

Gold is generally fine-grained and well-distributed within the altered host rocks. Field showings, examinations, and tests indicate that the grain size is generally finer than 75 µm and that the gold is essentially free-milling. Table 2-4 summarizes the gold petrographic characteristics.

Table 2-4. Gold petrographic characteristics

Data Source	Grainsize	Occurrence
SM4990 (Core)	2 µm to 20 µm	Quartz/carbonate vein, as inclusions in galena/sphalerite
SM5017 (Core)	50 µm (2 grain composite)	In clay alteration matrix
SM5391 (Core)	20 µm x 50 µm and 20 µm	Inclusions in a carbonate (siderite) lens or vein with scattered pyrite and galena
SM5656 (Core)	20 µm, 30 µm and 50 µm	Interstitial within pyrite aggregate
SM6000 (Core)	25 µm x 50 µm, 5 µm	Quartz galena vein
SM6000 (Core)	2 µm	Micro fissure within the same quartz vein
SM6271 (Core)	25 µm x 70 µm, 10 µm, 15 µm	Interstitial within pyrite aggregate
SM6297 (Core)	30 µm	Inclusion in pyrite, in a pyrite aggregate
Basalt (Gravity concentrate)	20 µm x 5 µm,18 µm x 2 µm and 10 µm x 1 µm	Elongate gold, within pyrite and on margins

Data Source	Grainsize	Occurrence
Carbonate (gravity concentrate)	40 μm composite	Pyrite margin
Carbonate (gravity concentrate)	8 μm and 11 μm	Argentian gold on pyrite margins
Carbonate (gravity concentrate)	5 μm and 2 μm	Petzite (Ag_3AuTe_2), in 30 μm x 15 μm hessite grain, attached to galena and pyrite

Source: MCC

Recent petrographic study suggests that silver-rich phases are possibly associated with galena. Further investigation by microprobe analyses which will also look at the silver content of visible gold is required. Silver is also present in the silver telluride hessite and gold-silver telluride petzite, both of which were identified only in trace quantities.

2.1.4 Mining Methods

Mining of the Siana deposit is firstly by open pit which will deepen the pit floor by 115 m from the current elevation of -50 m RL to -165 m RL, then by underground mining down to -520 m RL (Figure 2-4). The development works for the underground mine will commence on the third year of open pit operations.

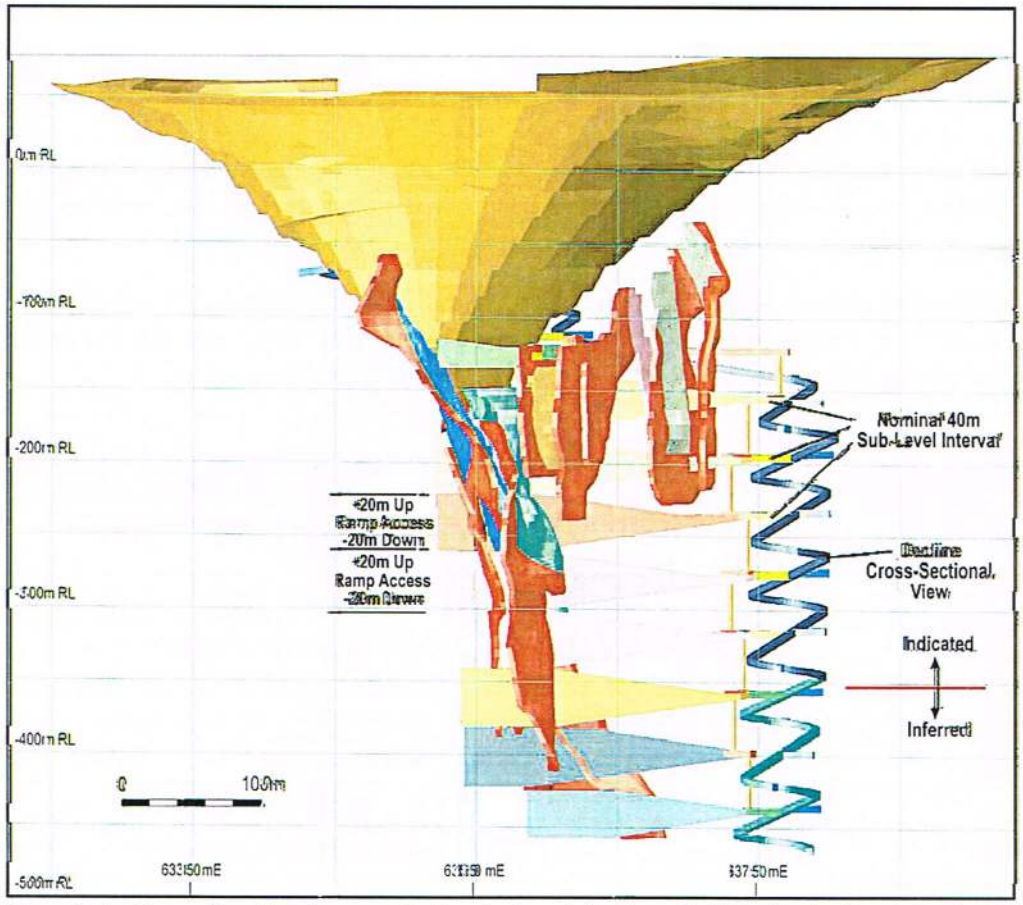


Figure 2-4. Open pit and underground mine design of the Siana Gold Project looking NNW (MCC).

2.1.4.1 Open Pit Mining

A 6-month dewatering to remove the approximately 8.2 million m^3 of water in the pit will precede open pit works. After the ground has stabilized, a 9-month pre-strip using conventional open pit techniques of drilling, blasting, and hauling will follow. The open pit operation is expected to last for roughly 5 years.

Benches will be blasted in 5-m vertical lifts. Excavation is at 2.5-m intervals using a hydraulic excavator in backhoe configuration. Six-wheel all-wheel-drive (AWD) articulated trucks will transport the blasted materials. The operation will deliver roughly 750,000 t of ore per year at an overall strip ratio by volume of 7:1.

The open pit will have batter angles and overall slopes that vary depending on the rock mass quality. At the north end of the pit, the batter angles range from 63 to 63.5° and the overall angle is 40°. At the east wall, the batter slopes vary from 55.5 to 63° and the overall angle is 44°. At the south end, the batter slopes are from 62.5 to 63° and the overall angle is 41°. At the west wall, the slopes are 62.5 to 63° and the overall angle is 44°. Berms of 6-m width will be left at 15-m vertical intervals. The access ramp which is designed at 12.5 % gradient and 16-m width will emerge at the northwest corner of the pit to lead directly to the waste rock dump and run-of-mine (ROM) pad access ramp.

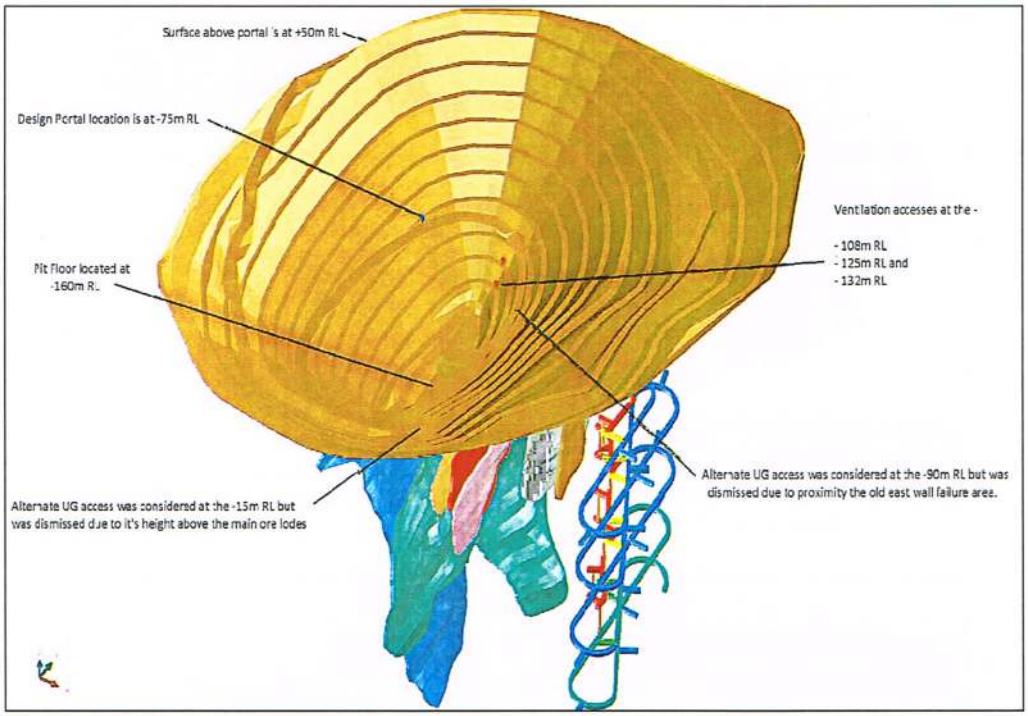


Figure 2-5. Portal location and decline (MCC)

2.1.4.2 Underground Mining

Access to the underground workings is via a 5 m x 5 m decline at 1:7 gradient commencing from a portal off the northwestern side of the new open pit at -75 m RL. All decline corners are developed with a 25-m centerline radius to accommodate a road header, twin-boom jumbo, and 50-t trucks (Figure 2-5). Portal development will start on the third year of open pit operations and will require seven months before ore

production. Hard materials along the decline will be extracted using jumbo drill and blast. A road header will be used for the soft materials.

Cross cuts from the decline spaced at 40 m vertical distance will provide ramps going up and going down to the ore panels (Figure 2-4). The driving of production drifts and stoping on the ore panels are through nominal 4 m x 4 m openings cut by the road header. Stoping will be by underhand cut and fill involving two basic steps:

- Step 1 includes sidewall support and mechanical cutting using the road header. After completion of a stope run, the road header moves into another stope on the same level or it begins to drop down to the next level.
- Step 2 is the fill cycle which is undertaken once the panel is fully mined. The fill, placed under low pressure, incorporates pre-placed steel support which allows the subsequent extraction lift below the fill to be taken without the need for overhead support. Fill is supplied to the level via a bore hole and reticulation pipes which are installed into the fill mass as it extends down.

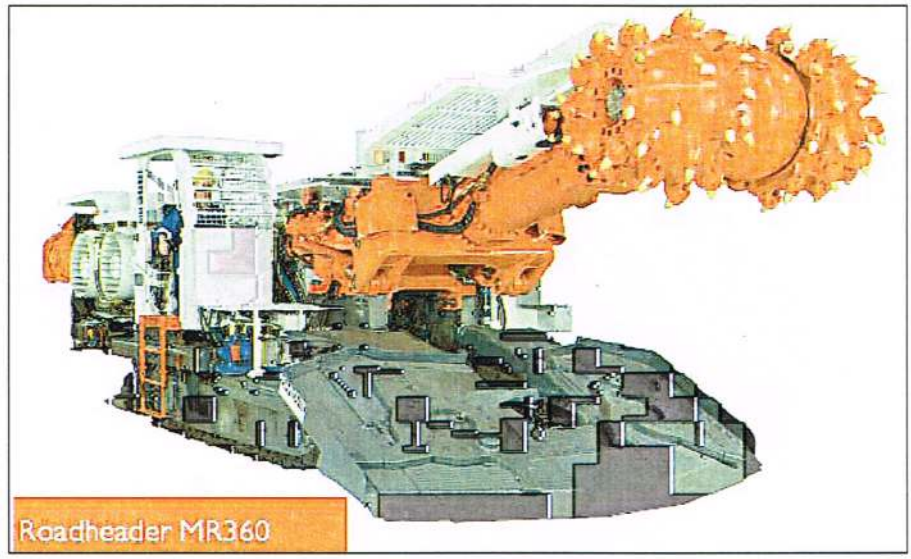


Photo 2-1. Two units of this and one unit MR620 will be used for the underground works.

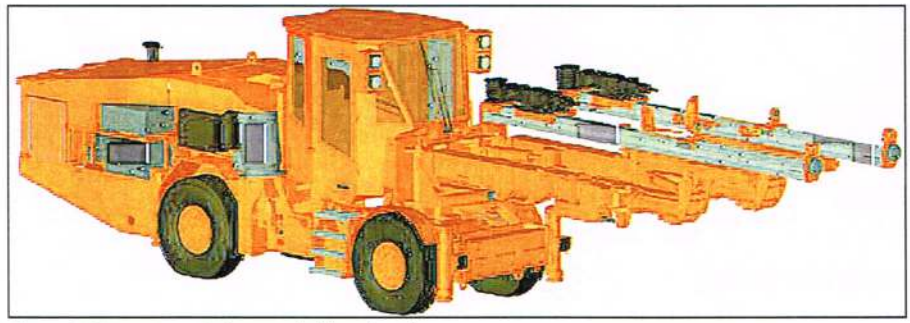


Photo 2-2. A twin boom drilling jumbo.

For harder ground, a twin-boom jumbo instead of a road header will be used.

A loader will pick up and load the broken materials into 50-t trucks for haulage to the surface ROM pad.

The ventilation circuit design will use the decline as the primary air intake. The return air way is the rise system adjacent to the level access drives (Figure 2-6). This allows for a fresh air split feeding each active work area and dirty air to be drawn to the return air way prior to getting to the decline.

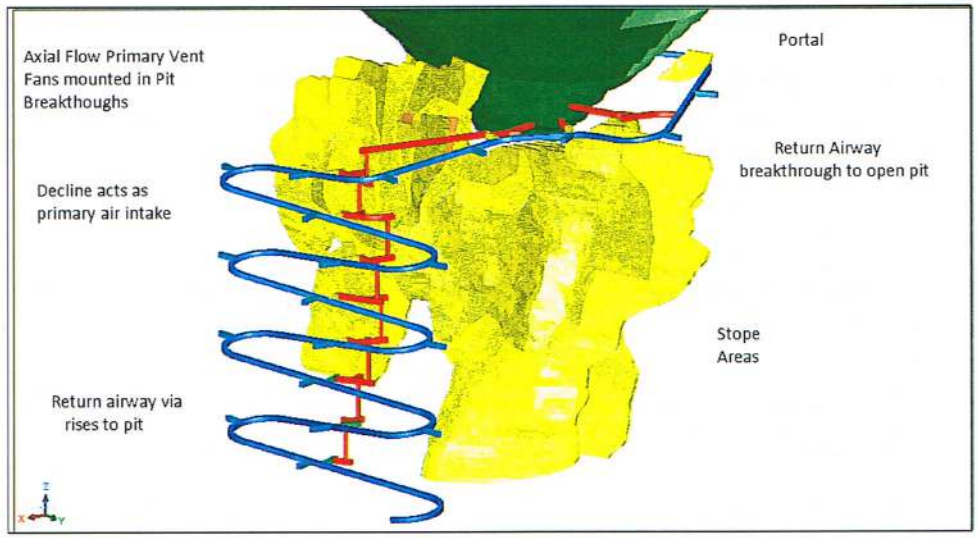


Figure 2-6. The ventilation circuit design of the underground mine (MCC).

2.1.5 Estimated Production

Table 2-5 is the open pit mining production schedule. A total of 3,109,000 t of ore grading 3.42 g/t Au and 8.71 g/t Ag is programmed for extraction from the open pit over an approximately 5-year period. Also to be extracted are around 9,034,000 t of waste rocks. During the five years of operations, annual ore production will vary from 368,000 t on the fifth year to 812,000 t on the third year.

Table 2-5. Open pit mining production schedule

Mined	Unit	Total	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5
Waste	Kbcm	9,034	3,724	3,549	857	611	206	88
Ore	Kbcm	1,287	2	213	313	339	264	156
LG	Kbcm	1		0.5	0.5			
Total	Kbcm	10,322	3,726	3,762	1,170	950	470	244
Waste	Kt	22,600	9,374	8,997	2,064	1,461	496	209
Ore & waste	Kt	25,710	9,378	9,531	2,819	2,272	1,132	576
Ore	Kt	3,109	4	534	754	812	637	368
Ore	Au g/t	3.42	2.48	3.15	3.48	3.51	3.66	3.04
Ore	Ag g/t	8.71	12.09	15.53	9.87	6.15	6.55	5.73
LG	Kt	2		1	1			
LG	Au g/t	1.22		1.21	1.22			

Mined	Unit	Total	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5
LG	Ag g/t	24.2		26.32	23.03			

Notes:
1. LG is low-grade ore surface stockpiles.
2. Kbcm is kilo bank cubic meters, kt is kilo tonnes, g is grams, t is tonnes.

Source: MCC

The underground mining production schedule is shown in Table 2-6. A total of 3,362,000 t of ore grading 5.83 g/t Au and 9.12 g/t Ag will be extracted over an 8-year period. The total waste rock tonnage is estimated at 710,000 t. The annual underground mine ore production will vary from 328,000 t during the tenth year to 518,000 t on the sixth year.

Table 2-6. Underground mining production schedule

Mined	Unit	Total	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Waste	kbcm	273	46	79	33	16	16	18	28	37
Ore	kbcm	1,293	16	172	198	199	199	196	187	126
Total	kbcm	1,566	63	251	230	215	214	214	214	164
Waste	kt	710	120	206	85	42	41	47	72	97
Ore & waste	kt	4,072	163	653	599	559	558	558	558	426
Ore	kt	3,362	43	447	514	518	516	511	485	328
Ore	Au g/t	5.83	4.13	4.8	5.18	6.06	6.16	6.1	6.2	6.59
Ore	Ag g/t	9.12	5.78	5.25	5.8	8.43	9.94	11.58	12.23	11.38

Source: MCC

Table 2-7 is the combined open pit and underground mining production schedule. The total ore production is placed at 6,471,000 t grading 4.67 g/t Au and 8.92 g/t Ag. The total tonnage of waste rocks is estimated at 23,311,000 t equivalent to 9,308,000 bcm. During the ten years of operation, the annual ore production is expected to range from 328,000 t grading 6.59 g/t Au and 11.38 g/t Ag on the tenth year to 1,084,000 t grading 4.13 g/t Au and 6.01 g/t Ag on the fourth year.

Table 2-7. Combined open pit and underground mining production schedule

Mined	Unit	Total	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Waste	Kbcm	9,308	3,724	3,549	857	657	285	121	16	16	18	28	37
Ore	Kbcm	2,580	2	213	313	355	436	354	199	199	196	187	126
LG	Kbcm	1		0.5	0.5								
Total	Kbcm	11,887	3,726	3,762	1,170	1,012	721	475	215	214	214	214	164
Waste	Kt	23,311	9,374	8,997	2,064	1,581	702	294	42	41	47	72	97
Ore & waste	Kt	29,782	9,378	9,531	2,819	2,435	1,785	1,175	559	558	558	558	426
Ore	Kt	6,471	4	534	754	855	1,084	882	518	516	511	485	328
Ore	Au g/ t	4.67	2.48	3.15	3.48	3.54	4.13	4.29	6.06	6.16	6.1	6.2	6.59

Mined	Unit	Total	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Ore	Ag g/ t	8.92	12.09	15.53	9.87	6.13	6.01	5.77	8.43	9.94	11.58	12.23	11.38
LG	Kt	2		1	1								
LG	Au g/t	1.22		1.21	1.22								
LG	Ag g/ t	24.2		26.32	23.03								

Source: MCC

2.1.6 Process Plant

The standard-design process plant comprises single-stage crushing, SAG milling, gravity concentration and high-intensity cyanidation, leaching, and adsorption, followed by carbon elution and electrowinning to produce combined gold and silver dore (Figure 2-7). The major steps of the process are as follows:

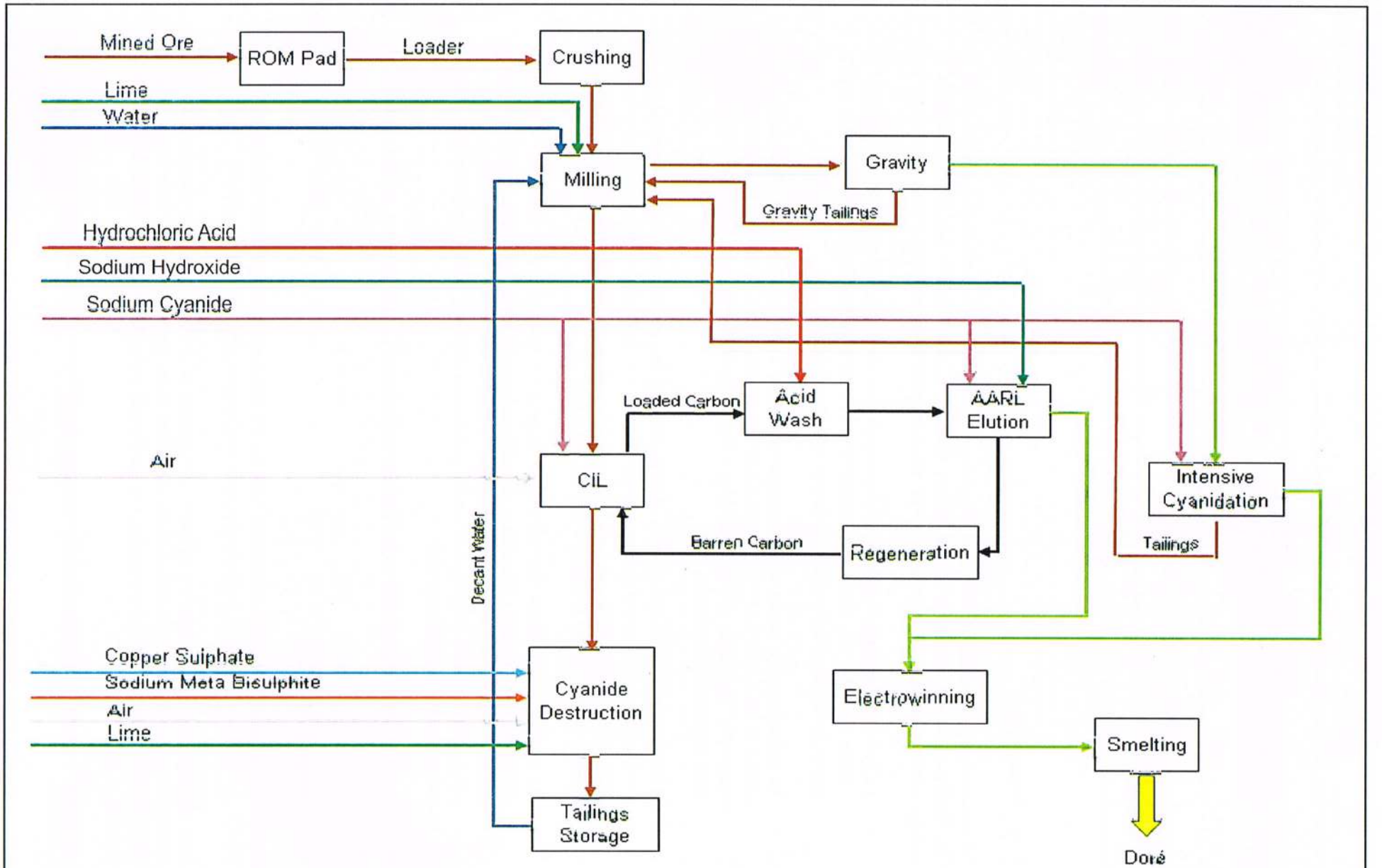
- Ore from the ROM pad is reclaimed by a front-end loader and fed to a 70-t ROM bin. The bin has a grizzly with 700 mm opening and provided with a variable speed apron feeder. From the crusher, the ore goes to the SAG mill and then through a cyclone.
- The cyclone overflow passes through a screen for removal of the coarse particles. Spray water is applied to the screen deck. The screen underflow gravitates to a centrifugal concentrator for recovery of the coarse free gold particles. The concentrator tails and screen overflow are returned to the mill feed chute.
- At the CIL section where cyanide (CN) is introduced, gold and other precious metals from the ore are dissolved, collected, and separated for purification. The cyclone overflow gravitates to one of six agitated CIL tanks. Flow is sequential through the six tanks with the cyanide solution in contact with the counter-current flowing activated carbon stream.
- The carbon, which is called "loaded carbon" because it is laden with gold and silver values, is collected through screens. It is washed with hydrochloric acid (HCl). Then, using diluted sodium hydroxide (NaOH) and CN, the loaded carbon is stripped of its values. The pregnant solution passes through electrowinning cells where the metallic elements adhere as precipitate. The stripped carbon is activated in a kiln.

The process plant design also includes various reagent mixing facilities as well as water, air, and electrical services.

2.1.7 Proposed Mine Life

Based on the current understanding of its ore reserves and the adopted parameters of the Project, the Siana deposit can sustain open pit and underground mining operations for a period of ten years.

Open pit dewatering and development and construction works for the power line and substation, access road and causeway crossing, TSFs and pipelines, waste rock dump, process plant and mine service area, administration building and accommodations, and stormwater and sediment control system will require 1.5 years.



Source : Intermet Engineering

bmp

Gold cyanidation flowsheet

Mine closure activities consisting of decommissioning and rehabilitation works are expected to last for two years. An additional period of eight years is required for maintenance and monitoring works.

2.2 Mineral Resources

2.2.1 Mineral Resource Estimates

Mineral resource estimates were completed for the open pit, surface stockpiles, and underground consistent with the 2004 guidelines of the Australasian Code for Reporting of Exploration Results, Mineral Resources, and Ore Reserves prepared by the Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists, and the Minerals Council of Australia (the JORC Code). The database for the open pit and underground resource estimates totals 88 diamond drill holes for a total length of 37,481 m.

Tables 2-8 and 2-9 present the mineral resource estimates for the Siana deposit by category and area, respectively. Resources have been classified as "indicated" and "inferred" resources. The cut-off grades adopted for the open pit and underground resources are 1.1 g/t Au and 2 g/t Au.

The JORC Code defines "indicated mineral resource" as that "part of a mineral resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings, and drill holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed."

An "inferred mineral resource" is that "part of a mineral resource for which tonnage, grade, and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes which may be limited or of uncertain quality and reliability."

Table 2-8. Mineral resources by category

Category	Tonnes Million	Au g/t	Au 000' oz	Ag g/t	Ag 000' oz
Indicated Resource					
Open Pit	3.07	3.4	336	8.5	839
Stockpiles	0.08	1.3	3	10.7	29
Underground	2.00	6.7	430	10.2	655
Total Indicated Resource	**5.15**	**4.6**	**769**	**9.5**	**1,523**
Inferred Resource					
Open Pit	0.16	2.9	15	13.6	70
Underground	1.38	7.6	338	11.3	503
Total Inferred Resource	**1.54**	**7.1**	**353**	**11.5**	**573**
Total Mineral Resource	**6.69**	**5.2**	**1,122**	**9.7**	**2,095**
Indicated/Total Resource	77 %		69 %		73 %

Source: MCC

Table 2-9. Mineral resources by area

Area	Tonnes Million	Au g/t	Au 000' oz	Ag g/t	Ag 000' oz
Open Pit and Stockpiles					
Indicated	3.15	3.3	339	8.5	868
Inferred	0.16	2.9	15	13.6	70
Total Open Pit and Stockpile Resource	**3.31**	**3.3**	**354**	**8.8**	**937**
Underground					
Indicated	2.00	6.7	430	10.2	655
Inferred	1.38	7.6	338	11.3	503
Total Underground Resource	**3.38**	**7.1**	**768**	**10.7**	**1,158**
Total Mineral Resource	**6.69**	**5.2**	**1,122**	**9.7**	**2,095**
Underground/Total Resource	51%		68 %		55 %

Source: MCC

2.2.2 Ore Reserve Estimates

Ore reserve estimates were derived from the mineral resource estimates consistent with the guidelines of the 2004 JORC Code. Table 2-10 presents the results.

Table 2-10. Probable ore reserve of the Siana deposit

Parameter	Stockpile	Open Pit	Underground	Total
Tonnes	83,000	3,109,000	1,938,000	**5,130,000**
Grade g/t Au	1.33	3.42	5.82	**4.3**
Grade g/t Ag	10.67	8.71	9.08	**8.9**
Ounces Au	3,500	341,400	362,800	**708,000**
Ounces Ag	28,500	870,000	566,000	**1,465,000**

Note: The underground ore reserve estimate is based on the 300,000 TPY road header option.
Source: MCC

The JORC Code defines a "probable ore reserve" as "that economically mineable part of an indicated, and in some circumstances, a measured mineral resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified."

2.2.3 Potential for Additional Resources

Drilling completed after the underground resource estimation, *i.e.*, SMDD134 and SMDD135, intersected high gold grades adjacent to the northern limits of the inferred resource boundaries.

MCC believes that several of the basalt-hosted lodes to the east of porphyry are likely to continue at depth. The resource likewise remains open to the north, south, and at depth below 500 m (Figure 2-8).

MCC further believes that if mineralization extends in a consistent manner, future drilling to approximately 950 m depth has potential to double the Siana resource to approximately 2 million oz of contained gold. This will extend the potential mine life to 15 to 20 years.

2.3 Access and Transportation

2.3.1 Road

Road access to the Project site is via the sealed National Highway that passes the western side of the Project area through the Municipality of Tubod if coming from the City of Surigao in the north and Brgy. Magpayang of Mainit Municipality if coming from the City of Butuan in the south. From the National Highway, access to the Project site is through municipal gravel roads.

2.3.2 Air Access

The Project site may be accessed by plane from Manila either via the Surigao City airport or the Butuan City airport.

The airstrip in Surigao was upgraded in 2004 to accommodate 70-seater airplanes from Manila. Recently, the service was replaced with Dash-8 turbo-prop aircraft operated by PAL Express. Travel time to the Project site from the Surigao City airport is approximately 1 hour.

The Butuan City airport accepts commercial jets from the cities of Manila and Cebu. Travel time to the Project site from the Butuan City airport is roughly 2 hours.

2.3.3 Shipping

Surigao City has two port facilities. Another port is located 20 km southeast of the City at Placer, Surigao del Norte on the eastern provincial coastline. Regular ferry services link Surigao to Cebu, Manila, and other islands.

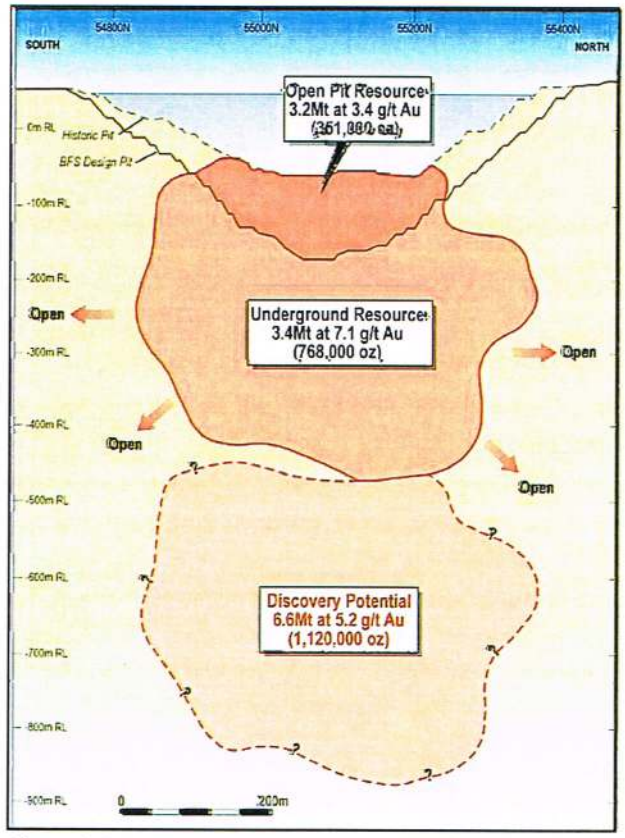


Figure 2-8. Resource extension potential (MCC)

2.4 Power Supply

Power will be supplied to the Project from a SURNECO stepped down 69 kV power line. SURNECO agreed to build a 69 kV substation with landing gantry, 69 kV isolators, CTs, surge diverters, and a 69 kV circuit breaker with the main plant step-down transformer. Cabling from the transformer LV terminals will supply a medium voltage switchboard from where power will be reticulated around the site to the various load centers and plant substations.

Two 750 kVA generator will be installed to provide emergency power for emergency lighting, security system, firewater system, potable water system for safety showers, all slurry agitators, detoxification and tailings pumps, process water pumps, mill inching drive, and accommodations area.

2.5 Water Supply

Primary raw water for the process plant will be sourced initially from the pit dewatering and bores for pumping to the plant feed water dam (Pond A, Figure 2-1). A pump station at the pond will convey the water to a process plant holding tank. Subsequently, tailings supernatant recovered from the TSF will be reused as process water.

For potable water, raw water will be drawn from the pit dewatering bores or pontoon pumps, then treated in the expanded potable water treatment plant. The treated water will be stored in the potable water tank located within the process plant area.

The dewatering bores will be installed outside of the pit perimeter to the east to manage the groundwater inflows and pressures on the pit walls. The groundwater inflows are estimated at 5.9 million m^3 annually. Four bores are sited in the southeast through the karstic limestone, three bores are in the eastern pit wall. The limestone bores are equipped with 50 L/s submersible pump each; the eastern bores with 17 L/s submersible pump each.

2.6 Equipment

2.6.1 Construction Equipment

The contractors are responsible for deploying the equipment needed during construction. The likely composition of the construction equipment fleet is as follows:

- Three 10 – 14-t mobile cranes
- Two 50 -120-t mobile cranes
- Up to fifteen 20-t tipper trucks
- Two backhoes
- Two 30-t excavators
- One front end loader
- Two dozers
- Two graders
- Two roller compactors
- One telescopic handler
- One skid steer loader.

2.6.2 Mining Equipment

2.6.2.1 Open Pit

The open pit dewatering will require four pumps mounted on a floating pontoon to discharge into parallel 450-mm diameter HDPE pipes to be extended as the water level falls. The pumps will have a combined capacity of 800 L/s over a 100 m head. They will be powered by mains power with a standby diesel generator set.

The open pit mine development and operations will require a fleet of earthmoving equipment detailed in Table 2-11.

Table 2-11. Earthmoving and support equipment for the open pit

Item	Make	Model	Total
Excavator	Komatsu	PC1250-7	1
Excavator	Komatsu	PC600-7	1
Truck	Komatsu	HM400-1	10
Dozer	Komatsu	D155A-5	2
Grader	Komatsu	GD555-3A	1
Loader	Komatsu	WA420-6	2
ITC	Komatsu	WA250PT-5	1
Water Cart	Komatsu	Water Cart	1
Service Truck	Plantman	Service Truck	1
Crane	Franna	Franna AT20	1
HIAB Truck	Plantman	HIAB Truck	1
L/C Wagon	Toyota	L/C Wagon	3
L/C Utility	Toyota	L/C Utility	5
Rockbreaker	-	Rockbreaker	1

Source: MCC

Supplementing the earthmoving equipment are four lighting towers, two 50 L/s downhole dewatering pumps, three 17 L/s downhole dewatering pumps, and two static booster slurry pumps.

2.6.2.2 Underground

The equipment for the underground development and operations comprises loader, trucking, breakage, miscellaneous fixed plant, mobile plant, and other equipment. Table 2-12 lists the underground breakage, loading, and trucking equipment.

Table 2-12. Underground breakage, loading, and trucking fleet

Item	Make	Model	Total
Twin boom jumbo	Sandvik	DD320-26	1
Road header	Sandvik	MR620	1
Road header	Sandvik	MR360	2
Loader	Sandvik	LH514	2
Loader	Sandvik	LH510	2
Truck	Sandvik	TH-550+	6

Source: MCC

The other major underground equipment includes:

- Two units of C103 x 7 mono pump + dam
- Three units of portable 103 Mono (55kW) + tank
- 20Kw Flyght + starter
- 8Kw Flyght + starter
- Surface compressor (220Kw/1200cfm)
- Primary surface fans (3 x 180 Kw)
- Underground secondary fans – 180 Kw
- Underground secondary fans – 110Kw
- Portable substation (1.5 MVA)
- Distribution boards
- Leaky feeder system
- 8-man refuge chamber
- Three units of Swellex installation pump
- Paste fill plant
- Underground Managers' wagon
- Two units of underground Ute
- Two units of shift wagon
- Two units of fitter Ute
- Two units of electrical UTE
- Fiber-crete spray and delivery units.

2.6.3 Processing Plant

The processing facility will have the following major equipment:

- Crusher feed – pay loader on ROM pad
- Crushing – single stage crushing plant, spiral set rolls sizer
- Grinding – single stage SAG milling circuit - 5.3 m diameter x 7.8 m EGL, 3,600 kW twin drive
- Gravity recovery – 30 inch diameter centrifugal concentrator
- Leach reactor

- CIL cyanidation and carbon adsorption – six agitated leach tanks, associated pumps and motors
- Cyanide detoxification - one reactor single stage
- Carbon elution - single butyl rubber lined elution column
- Horizontal rotary carbon regeneration kiln, diesel fired
- Gold and silver recovery - four electrowinning cells
- Calcining oven /retort scrubber for removal and recovery of mercury
- Smelting furnace, diesel fired
- Electrical substation
- Emergency diesel generator set
- Reagents mixing and distribution equipment and
- Services (air and water).

2.6.4 Paste Fill Plant

The paste fill plant which will produce paste from tailings for backfill in the underground stopes requires the following equipment:

- Agitator
- Cement bag breaker
- Cake discharge chute
- Cement conveyor
- Cooling tower
- Cyclone cluster
- Screw feeder
- Vacuum disc filter
- Paste hopper
- Cement hopper
- Cyclone feed pump hopper
- Discharge pump hopper
- Overhead crane

- Paste mixer
- Cyclone feed pump
- Discharge pump
- Filter feed pumps
- Cooling tower spray pump
- Filter feed tank
- Vacuum pump.

2.6.5 Others

The offices and accommodations will be provided with computing and domestic equipment. Sewage will be treated with BioMAX wastewater treatment plants and septic tanks.

A total of 18 light vehicles will support various personnel needs. The breakdown is shown in Table 2-13.

Table 2-13. Light vehicles deployment

Unit	Process	Mining	Admin.	Total
Landcruiser Type 4WD			1	1
Dual Cab Ute 4WD	5	6	5	16
Ambulance 4WD			1	1
Sub-total	5	6	7	18

Source: MCC

2.7 Workforce Information

MCC provided workforce information on three different settings, namely pre-production or construction phase, open pit stage, and underground stage.

GRC has an agreement with the Barangay Chairmen of the six impact barangays that 95 % of total employment generated by the Project will come from their constituents. The indirect impact barangays of Magpayang, del Rosario, and Pongtud will provide 10 % each. The direct impact barangays of Dayano, Siana, and Cawilan will get 18 %, 23 %, and 25 % of the total employment, respectively.

2.7.1 Pre-Production Stage

Table 2-14 is the manpower complement of the Project during the pre-production or construction stage. It excludes about 400 managers and workers of contractors.

Table 2-14. Pre-production manpower complement

Division/Position	No.
Administration	
Operations Manager (expat)	1
Manager - Health & Safety	1
Manager - Environment & Community	1
Manager - Human Resources	1
Manager Commercial	1
Accountant	2
Payroll	1
Doctor	1
Dentist	1
Environmental Engineer	1
Nurses	3
Safety Officer	1
Secretary	1
Administration Clerk	2
Community Relations Officer	4
Human Resources Officer	1
Commercial Clerk	3
Tenements Officer	1
Secretary/Typist - Health & Safety	1
Secretary/Typist - Environment & Comm.	1
Secretary/Typist - Commercial	1
Receptionist	1
Procurement Officer	2
Senior Storeperson	1
Officer - Expediter	1
Nursery Laborer	4
Rehabilitation Laborer	4
Stores Laborer	6
Security Guards	40
Laborer - Cleaner	6
TOTAL	**95**

Source: MCC

2.7.2 Open Pit Stage

The Project's manpower complement during the open pit stage is shown in Table 2-15. The total manpower is estimated at 322.

Table 2-15. Open pit stage manpower complement

Administration	No.	Processing	No.	Mining	No.
Operations Manager (expat)	1	Manager Processing	1	Manager – Mining	1
Manager - Health & Safety	1	Superintendent - Process	1	Senior Mine Geologist	1
Manager - Environment & Community	1	Superintendent - Process Maintenance	1	Senior Planning Engineer	1
Manager - Human Resources	1	Senior Metallurgist	1	Mine Foreman	1
Manager Commercial	1	Metallurgist	1	Senior Surveyor	1
Accountant	2	Chemist	1	Drill & Blast Engineer	1
Payroll	1	Supervisor - Plant	4	Geotechnical Engineer	1
Doctor	1	Laboratory Supervisor	1	Mine Geologist	3
Dentist	1	Supervisor - Maintenance	4	Junior Geologists	4
Environmental Engineer	1	Secretary / Receptionist	1	Junior Engineers	4
Nurses	3	Clerk - Processing	1	Surveyor	1
Safety Officer	1	Planner Maintenance	1	Shift Supervisor	3
Secretary	1	Technician - Instrument	1	Pump Crew	10
Administration Clerk	2	Tradesman - Fitter	4	Service Crew	6
Community Relations Officer	4	Tradesman - Electrician	4	Maintenance Tires	4
Human Resources Officer	1	Tradesman - Boilermaker / Welder	3	Excavator Operator	6
Commercial Clerk	3	Loader Operator	4	Truck Operator	36
Tenements Officer	1	Crushing Operator	8	Dozer Operator	6
Secretary/Typist - Health & Safety	1	Milling Operator	8	Grader Operator	3
Secretary/Typist - Environment & Comm.	1	CIL Operator	8	Water Truck Operator	3
Secretary/Typist - Commercial	1	Goldroom Operator	2	Crane Driver	3
Receptionist	1	Reagents Operators	2	General Labor/Timber Pickers	14
Procurement Officer	2	Tailings Operators	4	Secretary	1
Senior Storeperson	1	Shift Relief Operator	4	Data Clerk	2
Officer - Expediter	1	Plant Day Crew	4	Survey Assistants	6
Nursery Laborer	4	Sample Preparers	4	Sampler/Spotter	12
Rehabilitation Laborer	4	Analytical Technicians	8		
Stores Laborer	6	Laborer - Maintenance	4		

Administration	No.	Processing	No.	Mining	No.
Security Guards	40	Laborer - Cleaner	3		
Laborer - Cleaner	6				
TOTAL	**95**	**TOTAL**	**93**	**TOTAL**	**134**

Source: MCC

2.7.3 Underground Stage

Table 2-16 is the Project's manpower complement during the underground stage. The manpower is expected to vary from 255 to 284 personnel.

Table 2-16. Underground stage manpower complement

Administration	No.	Processing	No.	Mining	No.
Manager - Health & Safety	1	Superintendent - Process	1	UG Manager/Foreman	1
Manager - Environment & Community	1	Superintendent - Process Maintenance	1	Senior Mining Engineer	1
Manager - Human Resources	1	Senior Metallurgist	1	Drill and Blast Engineer	1-2
Manager Commercial	1	Metallurgist	1	Geotechnical Engineer	1
Accountant	2	Chemist	1	Senior Mine Geologist	1
Payroll	1	Supervisor - Plant	4	UG Geologists	2-3
Doctor	1	Laboratory Supervisor	1	UG Technicians	2-6
Dentist	1	Supervisor - Maintenance	4	Senior Mine Surveyor	1
Environmental Engineer	1	Secretary / Receptionist	1	Mine Survey Assistant	1-3
Nurses	3	Clerk - Processing	1	Data Clerk	1-2
Safety Officer	1	Planner Maintenance	1	Mine Foreman	1
Secretary	1	Technician - Instrument	1	Shift Supervisor	3
Administration Clerk	2	Tradesman - Fitter	4	Road header (RH) Operator	3-9
Community Relations Officer	3	Tradesman - Electrician	4	Bogger Operator	3-12
Human Resources Officer	1	Tradesman - Boilermaker / Welder	3	Truck Operator	3-18
Commercial Clerk	2	Loader Operator	3	Services/Chargeup	3
Tenements Officer	1	Crushing Operator	6	Shotcrete delivery truck operator	3-6
Secretary/Typist - Health & Safety	1	Milling Operator	6	Nozzleman/service/charge-up	3-6
Secretary/Typist - Environment & Community	1	CIL Operator	8	General Services Crew	3-6
Secretary/Typist - Commercial	1	Goldroom Operator	2	UG Maintenance Foreman (expat)	1
Receptionist	1	Reagents Operators	2	UG Electrical Supervisor (expat)	1

Administration	No.	Processing	No.	Mining	No.
Procurement Officer	2	Tailings Operators	3	UG Electrician	3-6
Senior Storeperson	1	Shift Relief Operator	3	Auto Electrician	1-2
Officer - Expediter	1	Plant Day Crew	4	Boiler Maker	1-2
Nursery Laborer	2	Sample Preparers	3	Shift Fitter	3-6
Rehabilitation Laborer	2	Analytical Technicians	6	Workshop Fitters	3-6
Stores Laborer	6	Laborer - Maintenance	4	Maintenance Planner	1
Security Guards	40	Laborer - Cleaner	3	RH Operator Trainer (contractors, 12 months)	2
Laborer - Cleaner	6				
TOTAL	**89**	**TOTAL**	**83**	**TOTAL**	**53-112**

Source: MCC

2.8 Development Schedule

After the approval by the MGB of the Project's declaration of mining feasibility (DMF) and the finalization of Project financing, MCC will call for tenders from experienced and reputable engineering companies for the development of the Project on an Engineering, Procurement, and Construction Management (EPCM) basis. The Project development, starting from the award of the EPCM contract to the first gold production, is expected to last for roughly 17 months. A Project Team headed by an Owner's Representative will oversee the EPCM contract. The composition of the team will vary as the Project proceeds through the design phase into construction and commissioning.

The Project Development will be undertaken in two phases. Phase 1 will require a total of 5 months; Phase 2, 11 months. Table 2-17 lists the development works and corresponding durations.

Table 2-17. Phase 1 and 2 development works and duration

Sequence	Works	Duration
Phase 1		
1	Connect to the SURNECO power line	Temporary power
	• Temporary power	75 days
	• Permanent power	115 days
	Build access road and Irish crossing	152 days
2	Establish equipment laydown area	14 days
	Erect security fence	60 days
	Build solid waste storage area	30 days
	Establish sewage treatment plants	40 days
	Build accommodations and mess	60 days
3	Construct sanitary landfill	40 days

Sequence	Works	Duration
	Build relocation housing areas at Brgys. Siana and Cawilan	60 days
	Build explosives magazine	40 days
	Relocate households near the toe of TSF3 and CLF	30 days
	Install rock mitigation fence	30 days
Phase 2		
1	Build process plant	300 days
	Build mine equipment maintenance	45 days
2	Dewater open pit	315 days
3	Construct Pond A and Pond B	30 days
	Build emergency spillway of TSF3	15 days
	Build drainage channels	60 days
	Install geotextile tubes	30 days
4	Construct starter ramp to CLF	10 days
	Construct started ramp to WRD	15 days
	Pre-strip mining	271 days
5	Build-up TSF	8 months
6	Plant commissioning works	76 days

Source: MCC

3 ENVIRONMENTAL IMPACTS AND CONTROL

3.1 Land Resources

Physiography

Figure 3-1 is the Landsat Natural Color Image of Northern Mindanao. As shown, the Project site and vicinities have three main physiographic features:

- NNW-SSE trending predominantly andesitic ridge that is parallel and adjacent to the west coast of the Surigao Peninsula. Marked by steep hillsides and narrow valleys, the peak is Mt. Malimono at the north with an elevation of 900 masl. Geomorphologically, the ridge is a structural landform created by massive earth movements due to plate tectonics. The Philippine Fault Zone Surigao Segment marks the eastern edge of the landform.

- Central portion marked by clusters of volcanic peaks and conical hills, some reaching 600 masl at the north, and the Lake Mainit basin down south. The deepest portion of the lake is at 219 mbsl. Geomorpologically, this is another structural landform.

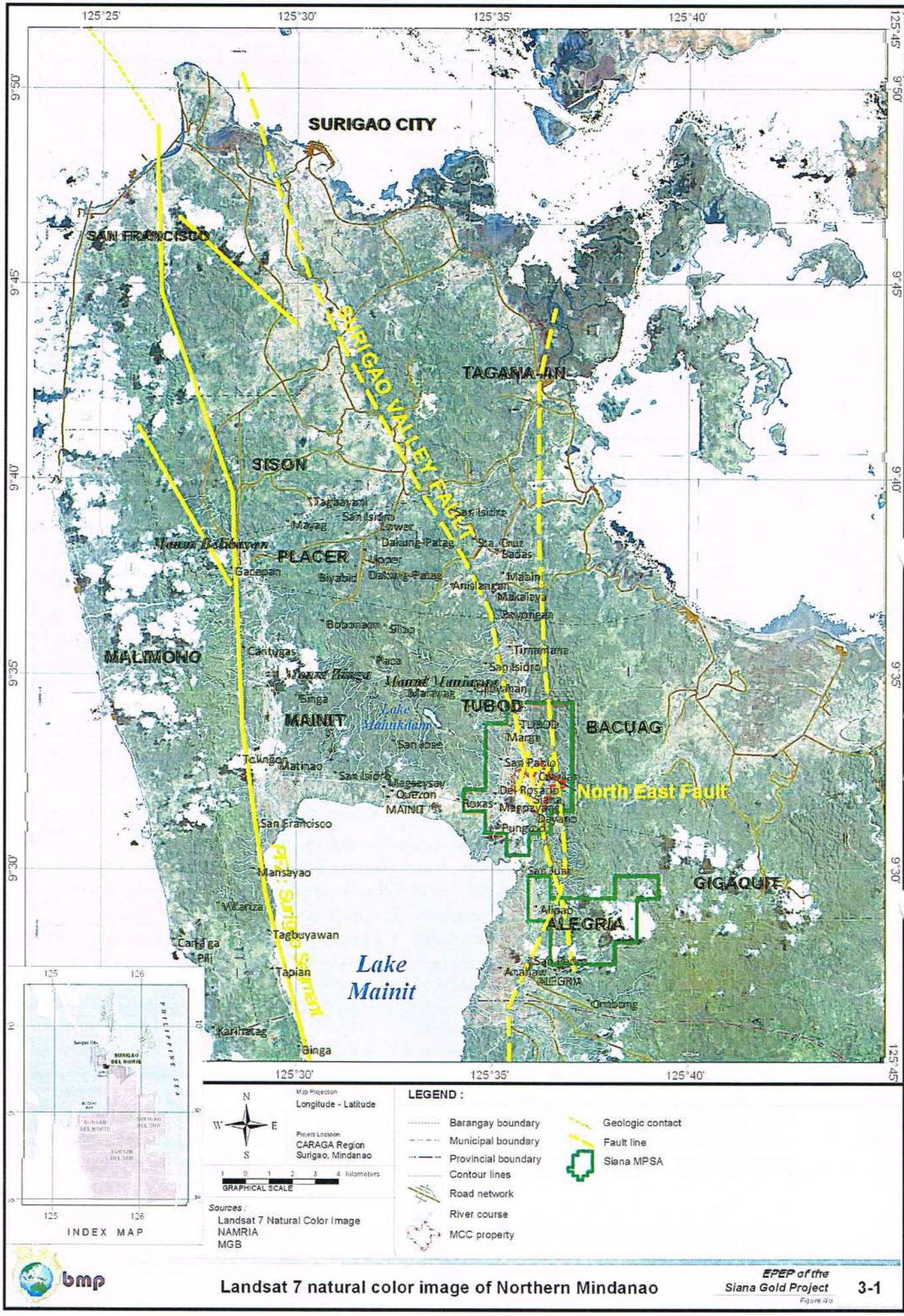
  The Paco area northwest of the Project site, with a 2-km diameter crater-like depression, resembles a large conical volcanic edifice. Three other depressions are discernible, namely, one in Capayahan and two others, which are probably explosion craters previously, are Lake Mahukdam and the small lake of Brgy. Silop. Mt. Binga, a prominent peak adjacent to Brgy. Binga is a volcanic plug with slopes covered by coconut trees. Aligned with this plug in a roughly northwest direction are the Masapelid Hill and Mt. Maragon-ong.

- Eastern portion which forms the northern extremity of the East Mindanao Ridge. The ridge is marked by gentle to moderate slopes on the western peripheries abruptly interrupted on the east by numerous irregular depressions typical of limestone areas. The maximum elevation is about 1600 masl at the south.

The highlands north of the Lake Mainit catchment are separated by two distinct narrow N-S trending lowlands of the Mayag River valley to the west and Magpayang River valley to the east. Both are depositional landforms formed from the placement of surface materials weathered and eroded from the limestone and andesitic ridges. The most productive agricultural lands in the area, they consist of the alluvial floodplains and the transitional upland fringe. The floodplains, which are areas on one or both sides of the stream channel that are inundated by floodwaters at some time, are planted to rice. The transitional upland fringe, a portion of the upland on one or both sides of the floodplain that serves as transitional zone or edge between the floodplain and the surrounding landscape, is planted to coconuts.

Magpayang River Catchment

The Project site is part of the 5,700-ha Magpayang River catchment. As shown in Figure 3-2, the Project site, which occurs southeast of the catchment, is bounded to the north and west by the low river terraces and floodplains of the Magpayang River. The western river terraces have an elevation of 40 to 45 masl and slope of 0 to 3 %. Eastward are the Timamana limestone hills with a local peak elevation of 400 masl and



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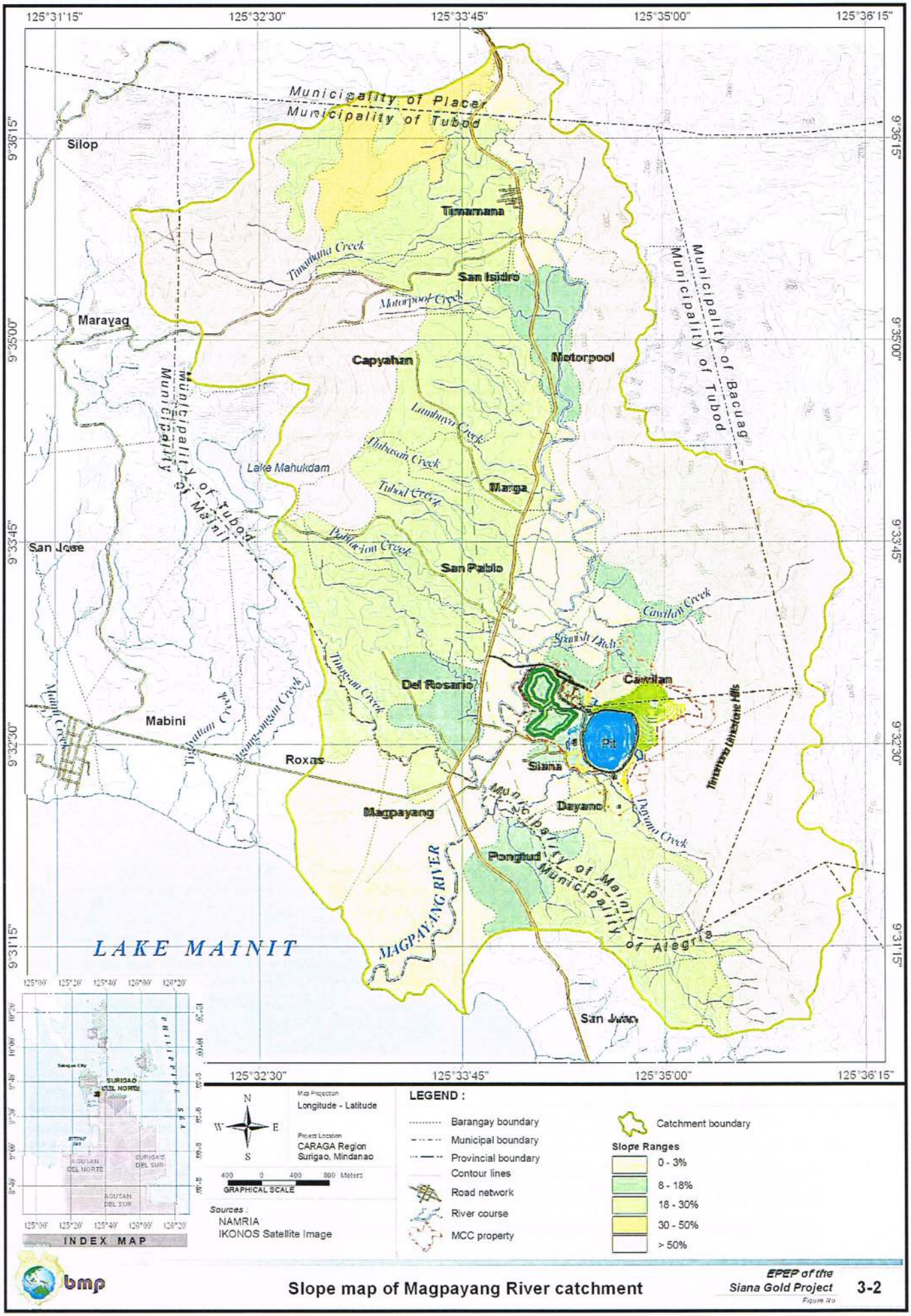
Landsat 7 natural color image of Northern Mindanao

EPEP of the Siana Gold Project 3-1

Figure No



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Slope map of Magpayang River catchment

EPEP of the Siana Gold Project

Figure No. 3-2

slopes in excess of 50 %. South of the site are the alluvial floodplains of the Magpayang River and Dayano Creek. Magpayang River and Dayano Creek are both meandering streams.

Figure 3-3 is the geomorphological map of the Magpayang River catchment. As shown, the Project site is generally part of the transitional upland fringe. It has a mean elevation of 50 masl and slopes of 8 to 18 %. The tailings surface elevation in the former Tailings dam 1 of SURICON varies between 43 to 45 masl. The tailings surface elevations are between 47 and 48 masl at Tailings dam 2 and between 51 and 53 masl at Tailings dam 3. The crest elevation of Tailings dam 1 varies from 47 to 49 masl; for Tailings dam 2, from 48 to 51 masl; and for Tailings dam 3, at roughly 55 masl. The old waste rock dumps adjacent to the open pit have elevations of 55 to 60 masl.

Land Use

The actual land use within the Magpayang River catchment which includes the Project site was inferred from the Ikonos 2005 satellite image. The land use at the Project site and surroundings, roughly 0.5 km from the property line, was verified through a rapid field mapping in April 2008.

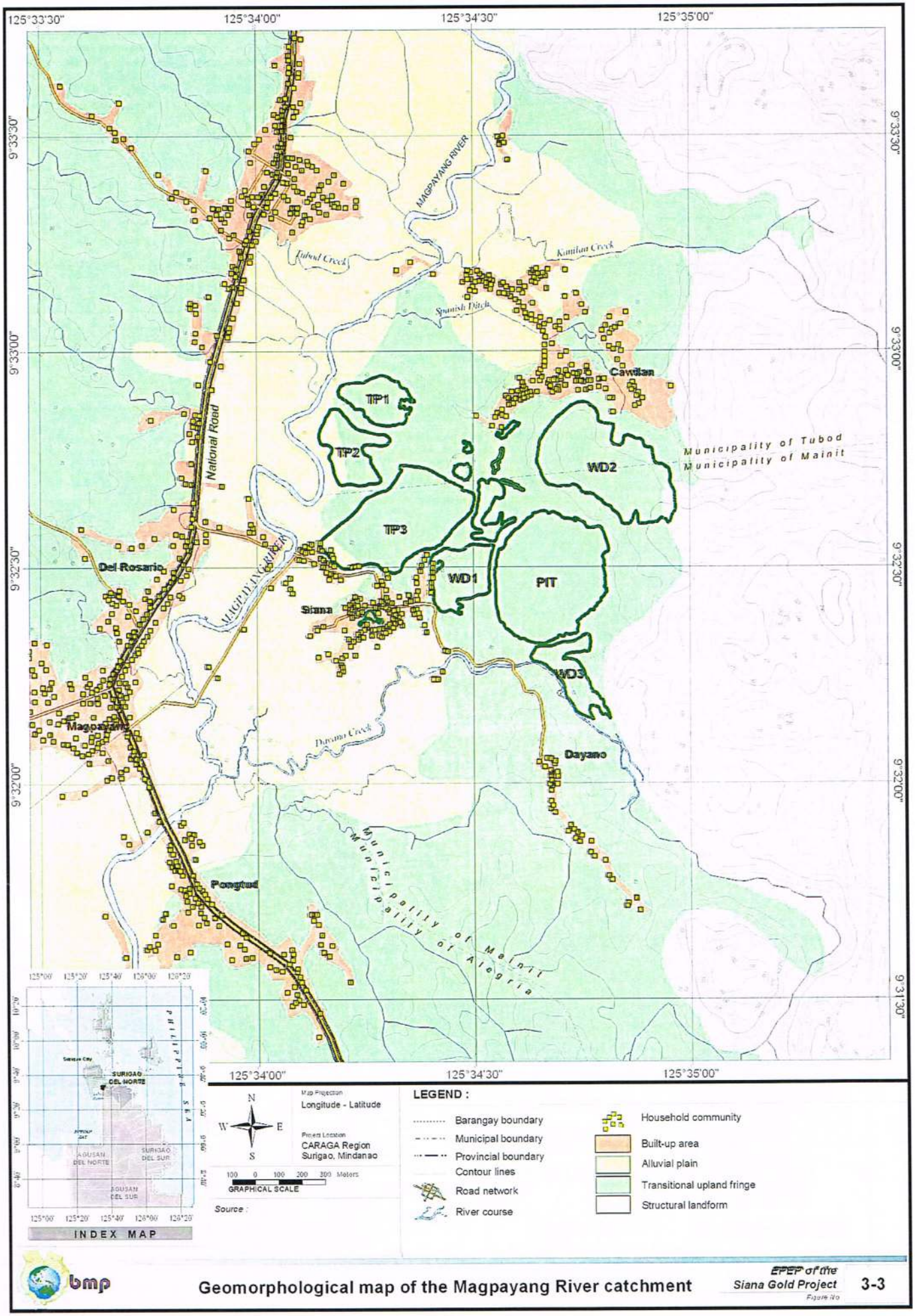
Photo 3-1. Coconuts over grass comprise the dominant land use in the Magpayang River catchment.

Photo 3-2. The alluvial floodplains are planted to rice.

Photo 3-3. Limestone forests with coconut patches east of the flooded Siana pit.

Photo 3-4. Some parts of the limestone forest are burnt preparatory to swidden farming.

Figure 3-4 is the resultant land use map of the Magpayang River catchment. As shown, the catchment is predominantly coconutland. The forests are found in the elevated areas in the northwest and to the east



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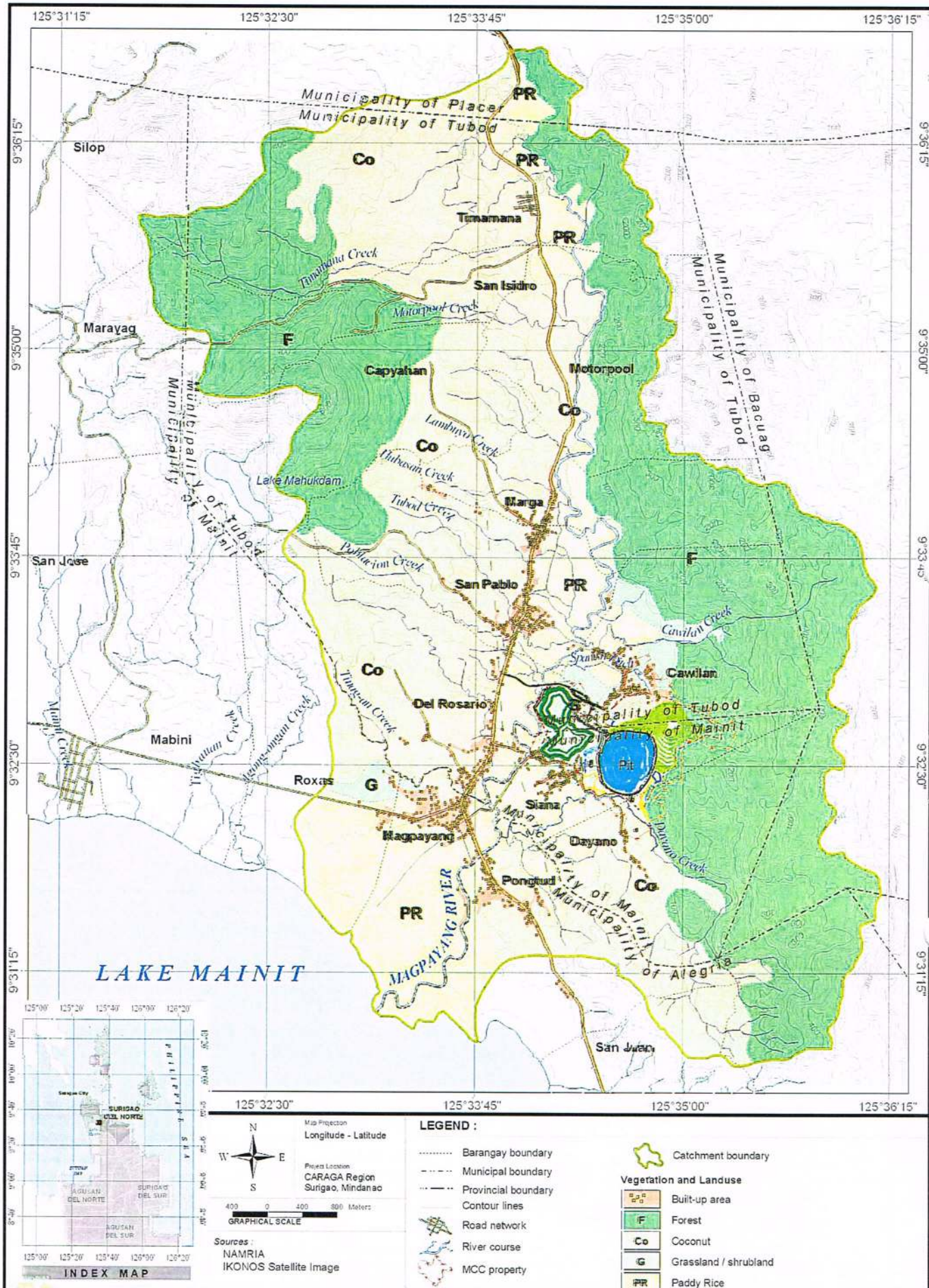
Geomorphological map of the Magpayang River catchment

EPEP of the Siana Gold Project

Figure No 3-3



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Land use map of the Magpayang River catchment

EPEP of the Siana Gold Project 3-4

Figure 4b

of the catchment. The alluvial plains are planted to rice. There are patches of grasslands near Brgy. Magpayang and in Brgy. Cawilan.

The 240-ha Project site is predominantly grassland. The minor exceptions are the rice lands west of the site along the Magpayang River banks, the forests at the Timamana highlands to the east, coconut lands southeast of the property, and the flooded SURICON open pit.

Photo 3-5. The former tailings pond of SURICON is dry and covered with grass.

Photo 3-6. West of SURICON's tailings dam 3 and still part of the 240-ha property are these rice fields.

Photo 3-7. Grass, shrubs, and coconuts cover the former waste dump 2.

Photo 3-8. The flooded Siana pit.

Figure 3-4 shows the households which are concentrated along the National Highway. There are also households occupying the former accommodations facilities of SURICON immediately north of the main waste rock dump. Southwest of the Siana property and at the toe of SURICON's Tailings dam 3 are the households of Brgy. Siana.

Gold small-scale mining without permits is active at the SURICON waste rock dumps and tailings pond areas. The number of miners dramatically increases during the rainy days. Near the southwestern end of Tailings dam 3, a gold CIL plant operates without a permit.

Photo 3-9. Some of the households of Purok Riverside, Brgy. Siana south of Tailings dam 3.

Photo 3-10. One of the many SURICON staff houses located north of Waste dump 2, Purok Bulawanon of Brgy. Cawilan, now occupied by residents.

Photo 3-11. Gold small-scale mining at SURICON's former waste rock dump.

Photo 3-12. The illegal gold CIL plant located southeast of tailings dam 3 (BMP, 2009).

3.1.1 Open Pit

The development works for the open pit include a 6-month dewatering, 9-month pre-strip, and open pit operation that is expected to last for roughly 5 years. When completed, the pit will be deepened by 115 m and its walls pushed back by a maximum of 70 m at the northeast. The final pit surface area is estimated at 32 ha which is an 11-ha increase over the current pit area (Figure 3-5).

As discussed, the pit development plan provides for batter angles of 55.5° to 63° for the east wall and 62.5° to 63.5° for all other walls. The overall angles are 40° for the north wall, 44° for the east wall, 41° for the south wall, and 44° for the west wall. The basic sequence of pit development and mining involves drilling for blast holes, blasting, loading, and hauling.

Diesel hydraulic rigs will drill 5-m deep 89 to 102-mm diameter holes at grids of 4 m by 4 m. Blasting will use ammonium nitrate mixed with fuel oil. For watery holes, waterproof explosives such as emulsion are used. Blasting is in 5-m lifts and excavation is in 2.5-m intervals using hydraulic backhoes.

Diesel hydraulic backhoes with a bucket size of 5.7 lcm will load the waste and ore into articulated trucks. The trucks will bring the ore to the ROM pad beside the process plant and the waste rocks either to the waste rock dump (WRD) or the TSF borrow material stockpile. Soils and clays are deposited at the community livelihood farm (CLF).

3.1.1.1 Impacts

The impacts of pit development and operation to land resources pertain to the following:

- Physical stability is the long-term ability of the final pit slopes and peripheries to withstand erosion and landslide and maintain the configuration.
- Agricultural productivity is the maintenance of soil quality of the adjacent low-lying lands and the recovery of any topsoil within the open pit area. Without physical stability in the open pit, the agricultural lands will be covered with sediment.
- Visual aesthetics refer to the pleasantness of the open pit and its blending with the natural surrounding landscape. The pit development will enlarge the pit area by 11 ha and deepen the pit bottom by 115 m.
- Land use refers to the use of the open pit area prior to and after mine development.
- Human or animal safety requires the prevention of accidents such as falling off or drowning in the pit void.

3.1.1.2 Control Strategy

The control strategies are:

- Comprehensive analyses of geotechnical logs for 60 drillholes within the open pit resource, three-dimensional modeling of rock mass quality data, slope stability modeling, back analysis of the previous wall failure in the northeast of the pit, and design of pit slopes based on the geotechnical assessments (Mining One Pty Ltd, 2007 and RSG Global, 2007).
- Conduct of geotechnical monitoring, mapping and assessment commencing from pit dewatering and continuing throughout the operational phases. The monitoring will employ piezometers sunk in suitable locations around the open pit, computerized prism surveying, extensometers, inclinometers, and crack displacement measurements. It will be done in-house on daily, weekly, and monthly bases and supplemented by external reviews every 3 to 6 months (Mining One Pty Ltd, 2007).
- Recovery of topsoil within the open pit and pit perimeter road areas. The topsoil refers to the "A" horizon of the soil, from 20 cm to 50 cm thick, which is usually darker than the underlying soil because of the accumulation of organic matter. Soils are not to be stripped when they are wet as this can lead to compaction and loss of structure.

  The first option for the recovered topsoil is for use as potting medium in the nursery or as direct placement on an area for rehabilitation as buffer zone. This gives the best results because it prevents or reduces the deterioration of the biological components in the soil during storage. If

stockpiling cannot be avoided, the topsoil is deposited in the CLF which is immediately north of the waste rock dump (Figure 2-1).

- Planting of the pit peripheries that will not be disturbed by mining with Ipil-ipil (*Leucaena leucocephala*) for fuelwood and yemane (*Gmelina arborea*) for timber. Both species have excellent coppicing ability. Hence, after every cutting cycle of 6 to 8 years for ipil-ipil and 8 to 10 years for yemane, there is no need to replant.

- During mine closure, pit dewatering will cease and the pit will accumulate water. To prevent drowning, safety signs and placards will be installed around the pit lake.

3.1.2 Underground Mine

Development works for the underground mine will start on the third year of open pit operations. They entail:

- Driving of a 5 m x 5 m decline from a portal off the northwestern side of the new open pit at -75 m RL using a road header for soft ground (Photo 2-1) and twin boom jumbo for harder ground (Photo 2-2). The underground mine is programmed for development down to the -520 m RL.

- Driving of 4 m x 4 m crosscuts, using a road header or twin boom jumbo at every 40-m vertical distance, from the decline to intersect the ore.

- From the crosscuts, driving of production drifts and stoping by underhand cut and fill using a road header. A loader picks up and loads the broken materials into 50-t trucks for haulage to the surface ROM pad.

- Filling of the mined-out ore panel using tailings paste.

3.1.2.1 Impacts

The impacts of underground mine development to land resources relate to the physical stability of the ground overlying the mine workings. Unstable ground can crack or subside, thereby damaging the supported structures, putting the inhabitants and miners at risk, or making the land unsuitable for use. Mitchell and Roettger (1989) differentiated five undercut failure mechanisms. These are caving, flexural failure, sliding failure, rotational failure, and crushing.

3.1.2.2 Control Strategy

The control strategies include:

- Geotechnical investigations and assessment for the proposed underground mine based on diamond borehole cores, geological and geotechnical logging of holes, core photographs, rock mass classification data, rock mass structural features, laboratory uniaxial compressive strength testing of cores, and laboratory rock specimen deformability determination (Peter O'Bryan & Associates, 2008).

- Based on the assessment, preparation of conceptual design of the decline and access development, stoping method, and development support and reinforcement. Among others, development and stoping works will use a road header for soft ground. A road header is capable of breaking soft ground at rapid rates and low cost without causing damage to the surrounding rocks. Underhand cut and fill which is attractive from the standpoints of worker safety and mining recovery is the preferred stoping method. Paste fill which is a mixture of tailings and cement is the fill material (*Ibid.*).

- Conduct of a paste fill testwork program to evaluate the paste that would be produced from the Siana Project's tailings, to develop the relationship between binder content and strength for the paste fill mixes, and to assess the impacts of desliming the tailings on paste strength.

  Revell Resources (2009) estimated the required paste fill strength for the underground mine at 900 kPa. A similar study by Australian Mining Consultants estimated that a fill strength of 900 to 1,500 kPa would be required depending on the stope width. Testwork by Revell on a deslimed tailings sample showed that a paste fill with strength of 1,760 kPa can be produced using 10 % slag-based cement (Minecem) after 28 days curing time. Mixing the deslimed tailings sample with a 15 % general-purpose cement (Pacemco GP), the resulting paste fill had a measured strength of 1,310 kPa. Further optimization test work will be conducted before underground production commences.

- Finalization of the underground mine design based on the above and the three-dimensional block modeling of the gold resource and geotechnical variability (Cube Consulting Pty Ltd, 2009).

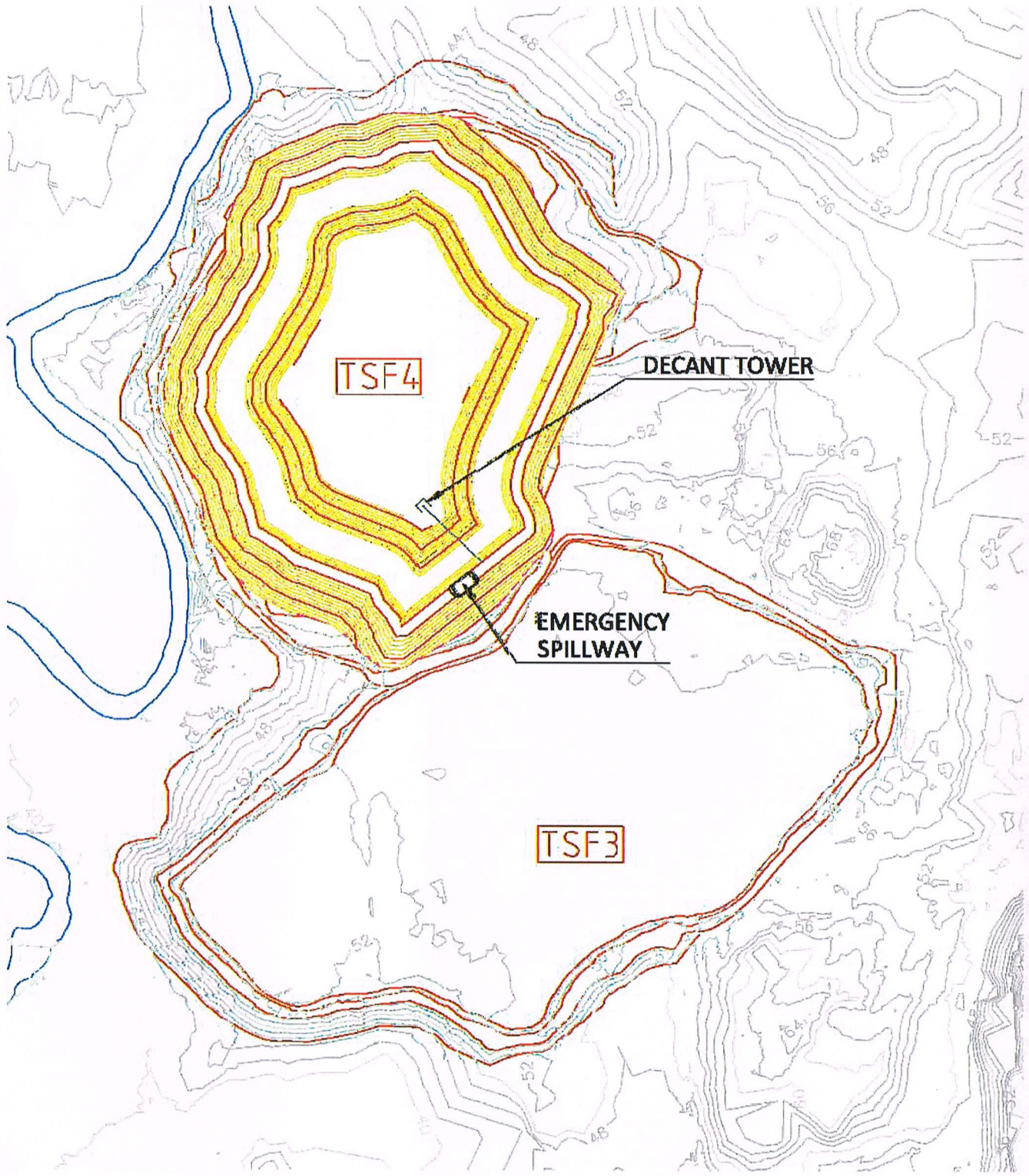
3.1.3 Tailings Storage Facility

Open Pit Mine

A tailings storage facility (TSF) to accommodate 3.08 million t of tailings from the 5-year open pit operation will be built over SURICON's tailings dams 1, 2, and 3. The TSF is paddock-type comprising two separate cells – TSF3 at the southern portion and TSF4 at the northern part (Figure 2-1). To take advantage of the current lower surface elevation of TSF4, TSF4 is constructed prior to TSF3. Table 3-1 is the construction sequence; Figures 3-6, 3-7, 3-8, and 3-9 illustrate this sequence.

Table 3-1. TSF construction sequence

STAGE	Duration (months)	TSF3	TSF4
0		Current embankment crest 54 m RL	Current embankment crests at 50 m RL (Talings dam 1) and 47 m RL (Tailings dam 2)
1			Initial construction to RL 60 m
2	17	Initial construction to 60 m RL	Deposition to maximum beach of 57 m RL
3	9	Deposition to maximum beach of 57 m RL	Raise to 65 m RL
4	6	Raise to 65 m RL	Deposition to maximum beach of 62 m RL
5	9	Deposition to maximum beach of 62 m RL	Raise to 67 m RL
6	3	Raise to 67 m RL	Deposition to maximum beach of 64



STAGE 1 - CONSTRUCTION OF TSF4 TO RL 60m

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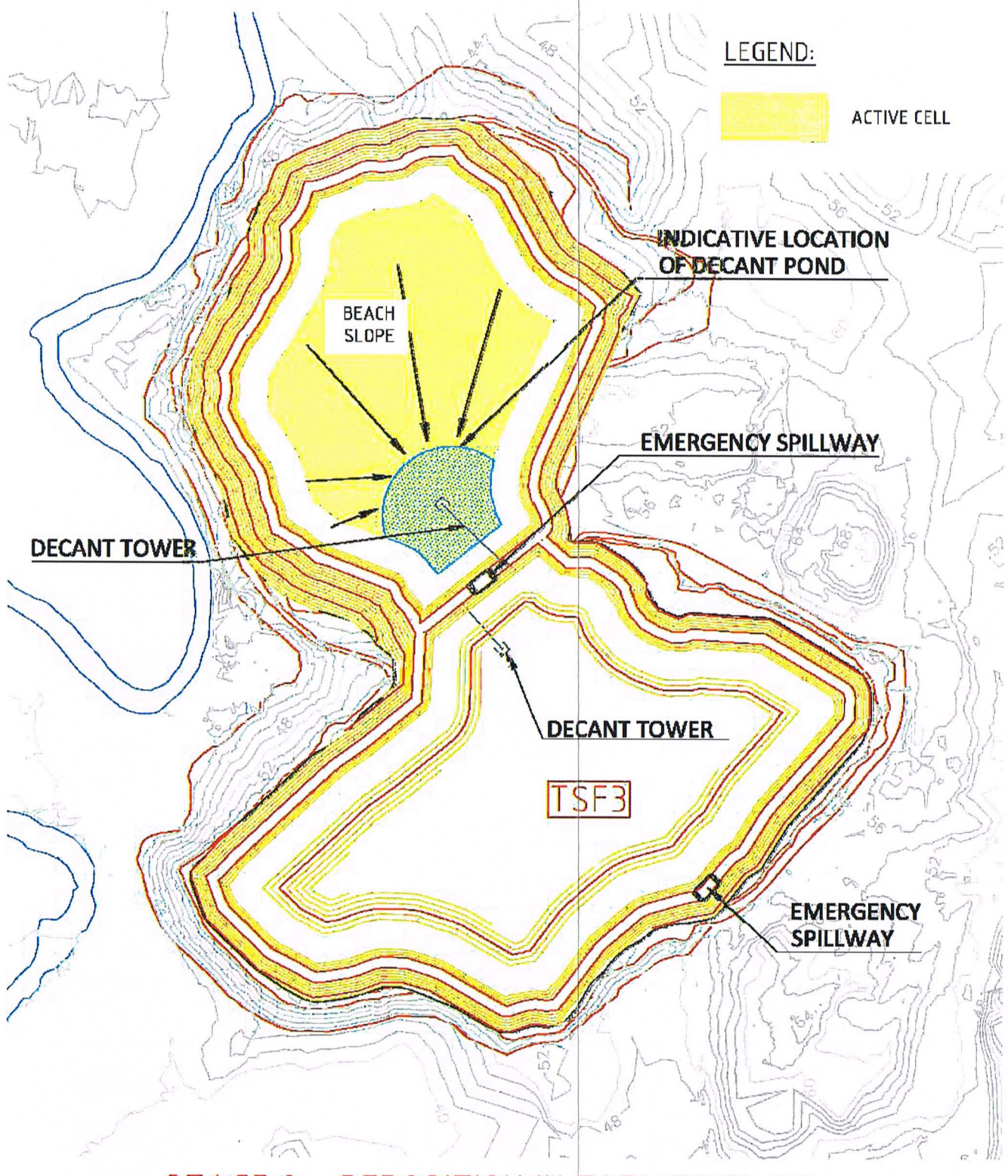

STAGE 2 - DEPOSITION IN TSF4 TO RL 57m, CONSTRUCTION OF TSF 3 TO RL 60m

SCALE 1:5000

PRELIMINARY

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0 50 100 150m
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Approved			
Date			
Scale	1:5000	This Drawing must not be used for Construction unless signed as Approved	

Client: RED 5 LIMITED
Project: SIANA GOLD
Title: Figure 3-6 TSF CONSTRUCTION Stages 1 and 2
Original size: A3
Drawing No: 61-22730-C017
Rev: A

Plot Date: 23 September 2009 - 12:35 AM
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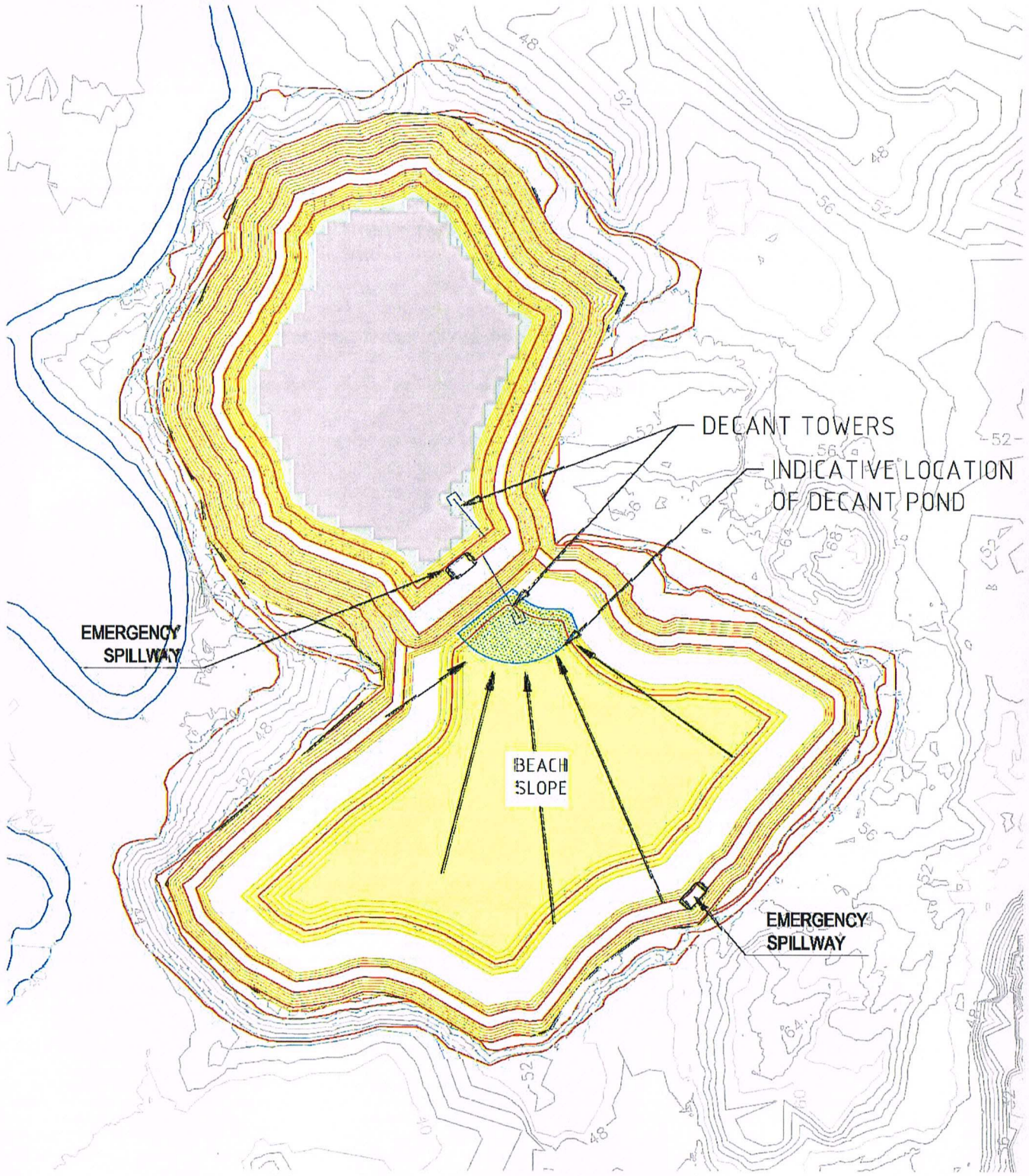

STAGE 3 - DEPOSITION IN TSF3 TO RL 57m,
CONSTRUCTION OF TSF4 TO RL 65m

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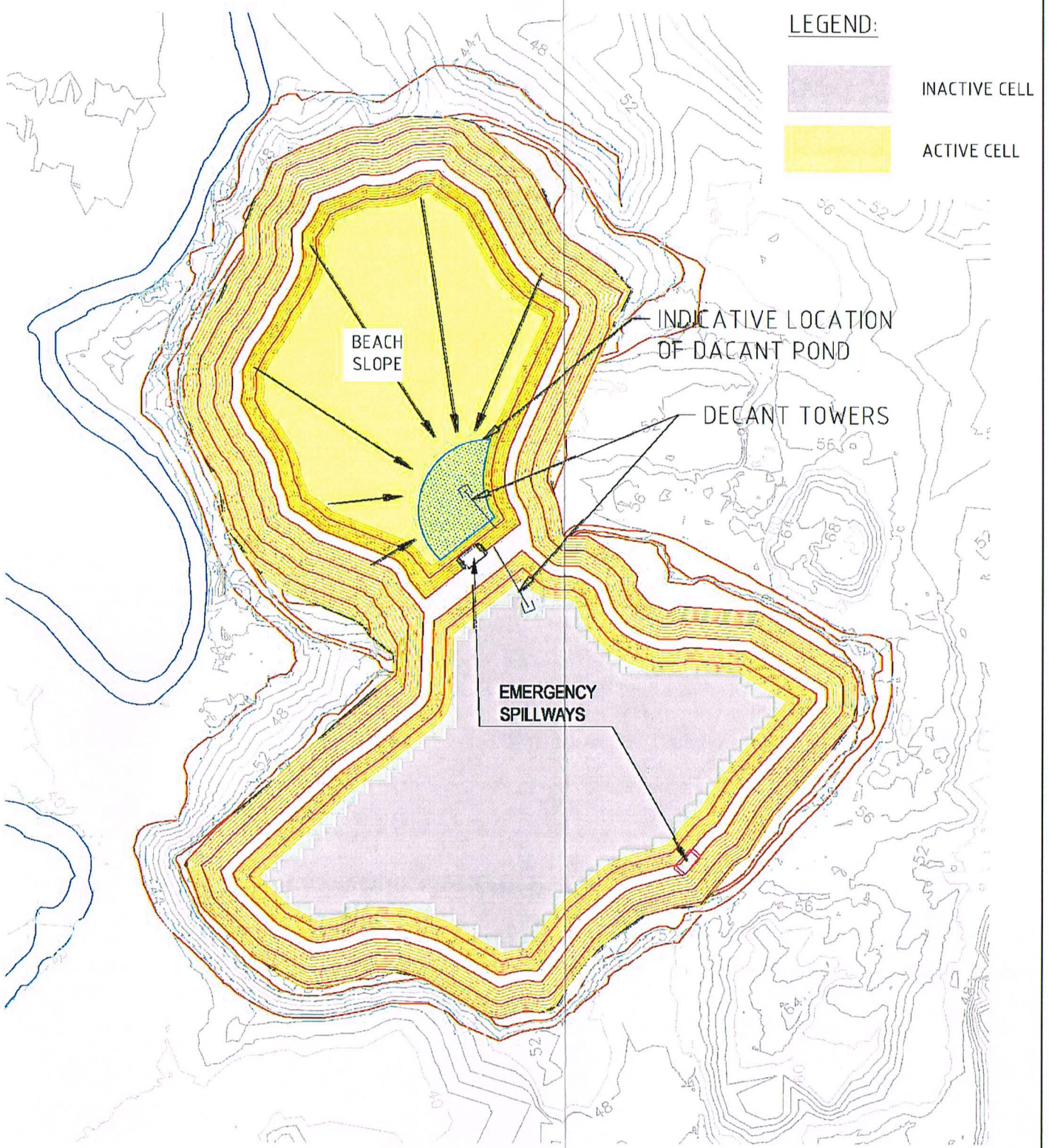

STAGE 4 - DEPOSITION IN TSF4 TO RL 62m,
CONSTRUCTION OF OF TSF3 TO RL 65m

SCALE 1:5000

PRELIMINARY

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SCALE 1:5000 AT ORIGINAL SIZE

GHD CLIENTS | PEOPLE | PERFORMANCE

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Drafting Check		Design Check	
Approved			
Date			
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Client **RED 5 LIMITED**
Project **SIANA GOLD**
Title **Figure 3-7 TSF CONSTRUCTION Stages 3 and 4**
Original Size **A3**
Drawing No: **61-22730-C018**
Rev: **A**

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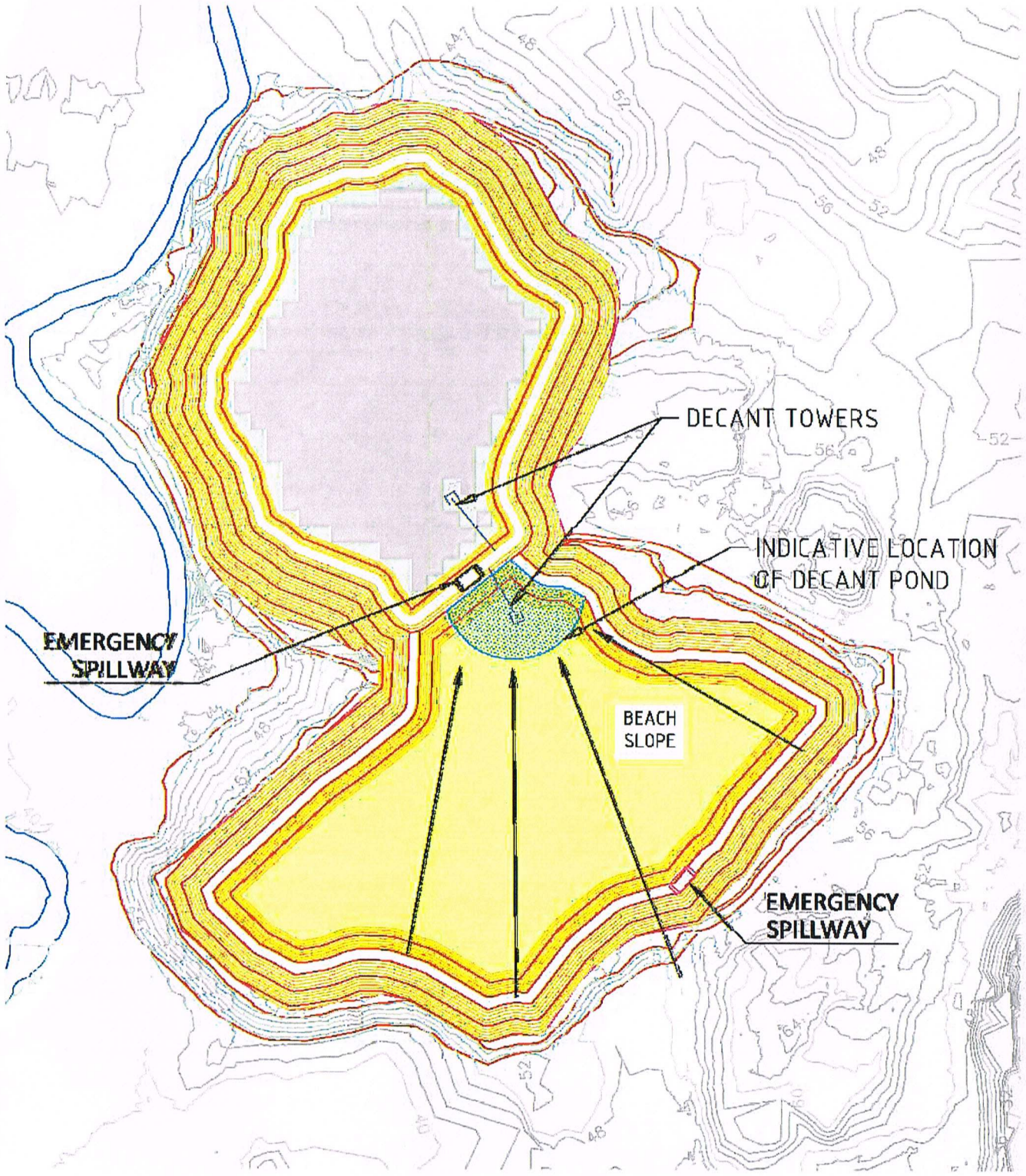

STAGE 5 - DEPOSITION IN TSF3 TO RL 65m
CONSTRUCTION OF TSF4 TO RL 67m

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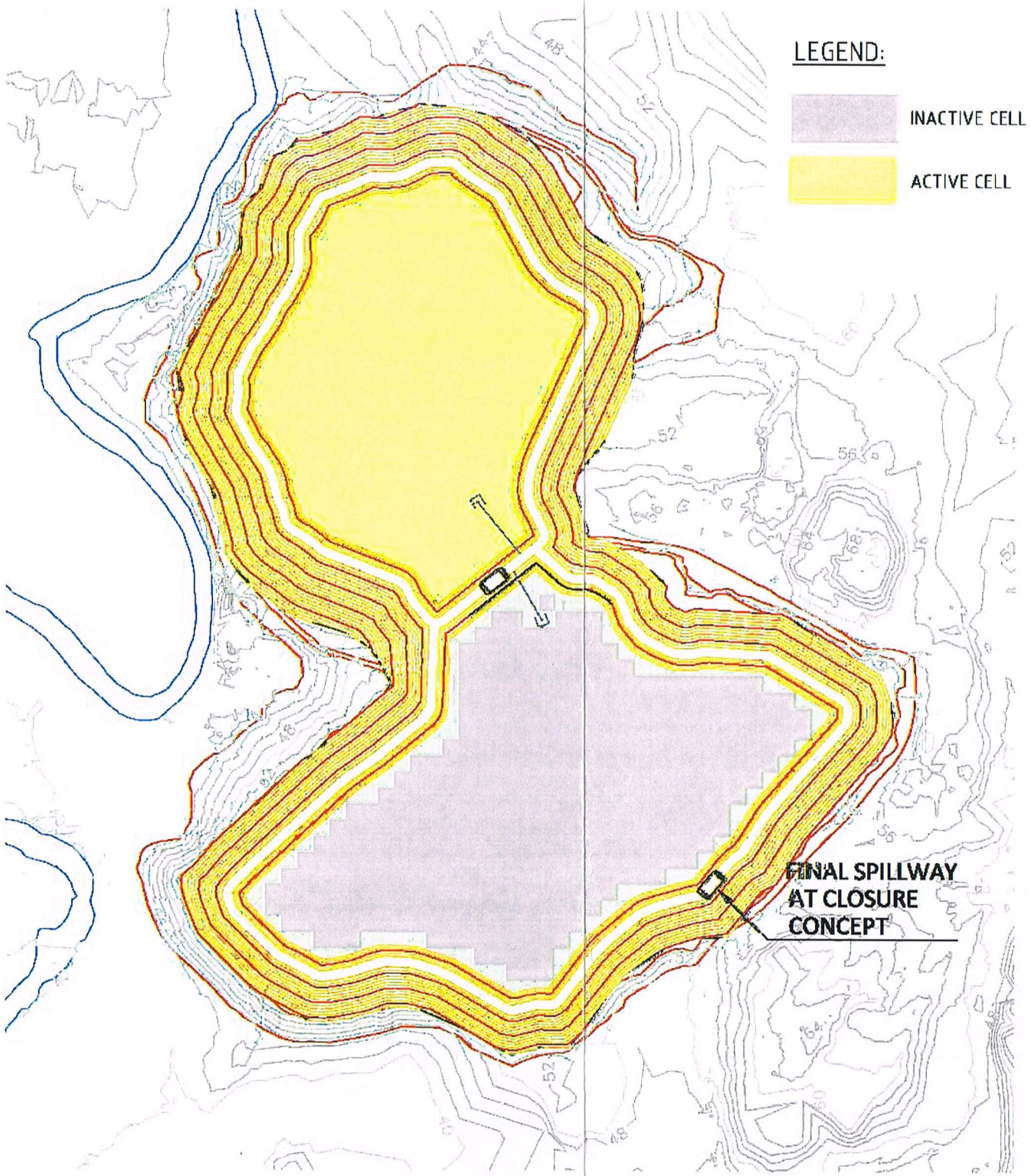

STAGE 6 - DEPOSITION IN TSF4 TO RL 64m
CONSTRUCTION OF TSF3 TO RL 67m

SCALE 1:5000

PRELIMINARY

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0 50 100 150m
SCALE 1:5000 AT ORIGINAL SIZE

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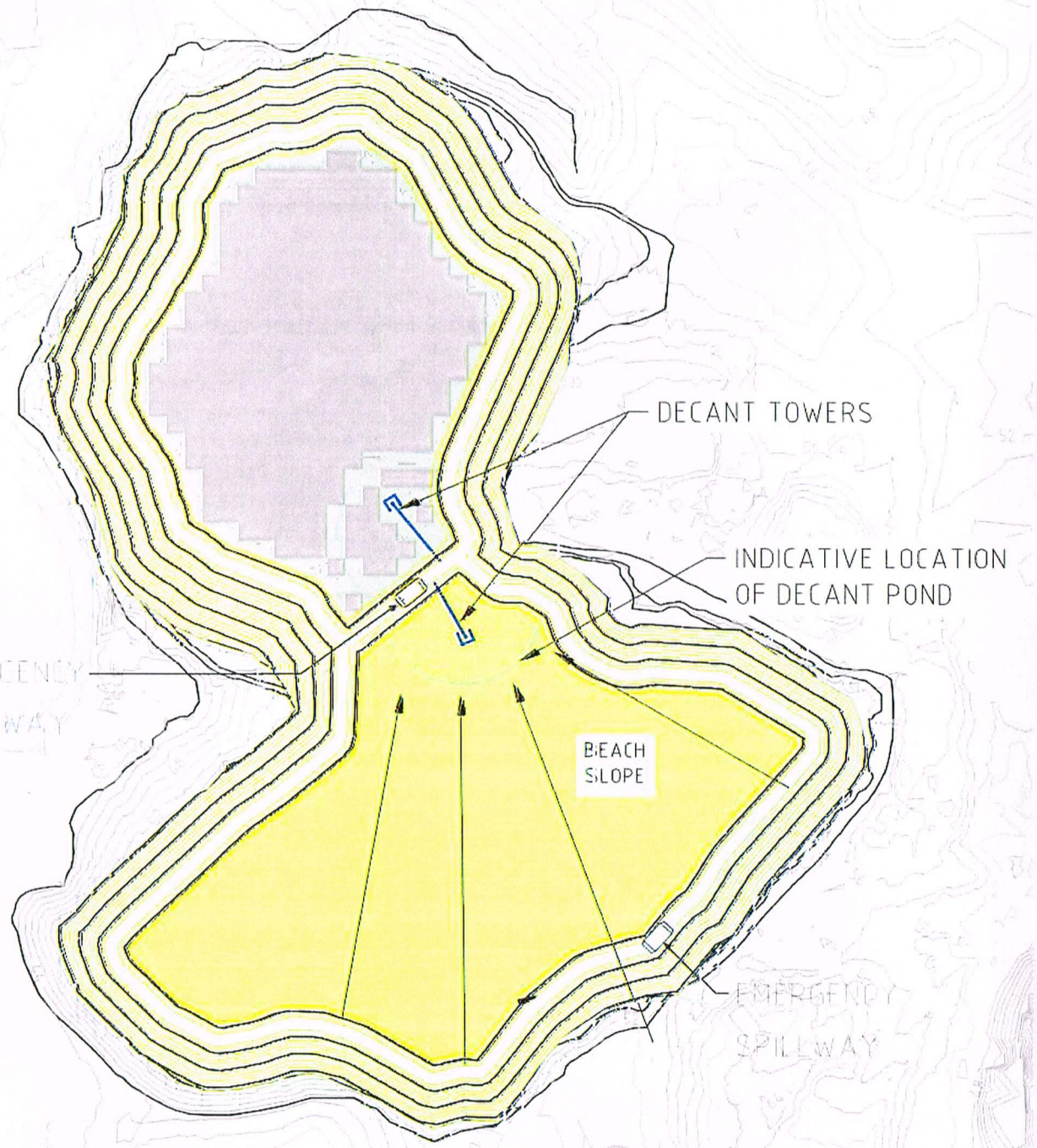
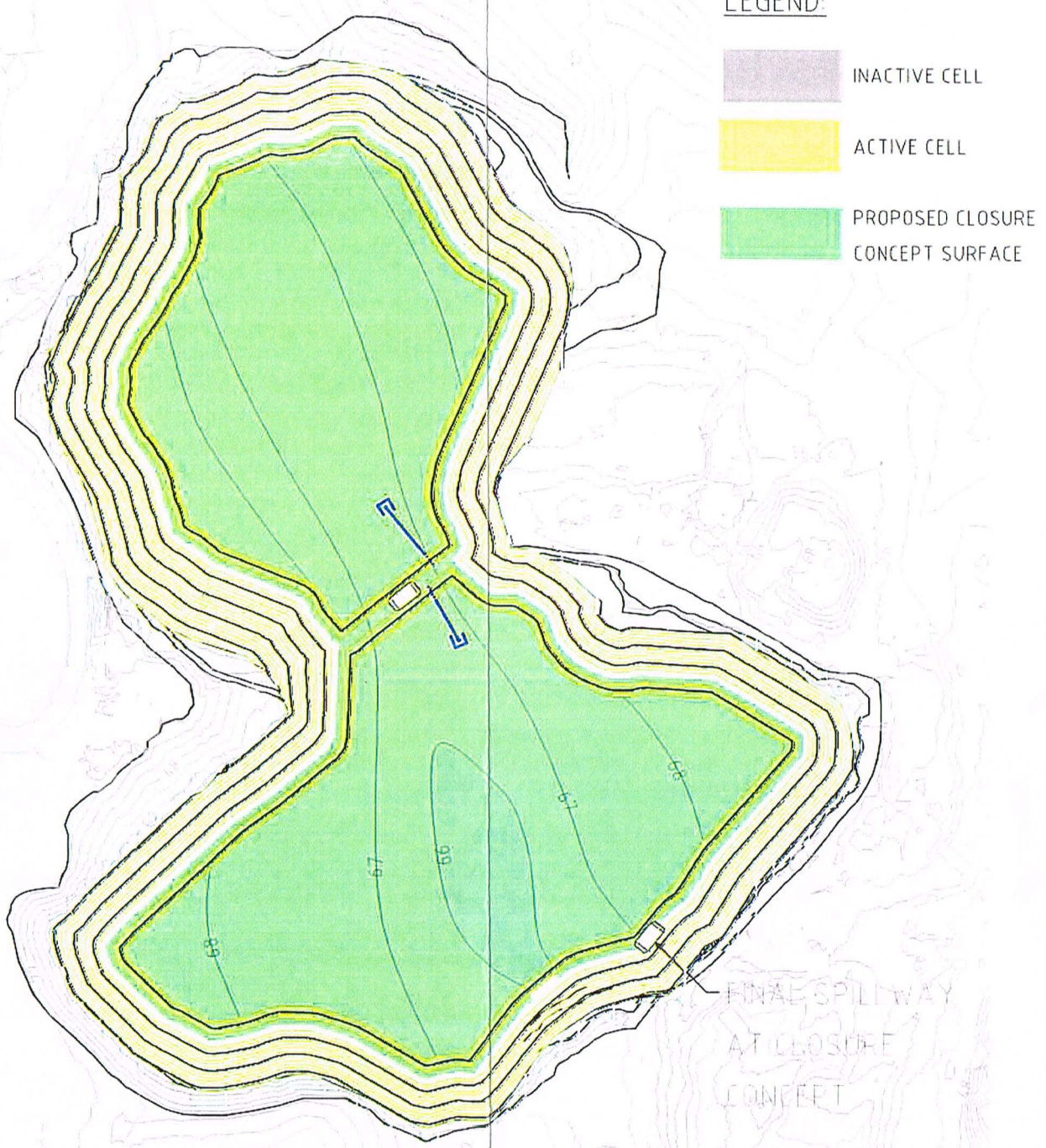
Client: RED 5 LIMITED
Project: SIANA GOLD
Title: Figure 3-8 TSF CONSTRUCTION Stages 5 and 6
Original size: A3
Drawing No: 61-22730-C019
Rev: A

Plot Date: 23 September 2009 - 12:40 AM
Cad File No: P:\Deliverables_PTFS\Figures\Figure 3-8 to 9&6_61-22730-C019.dwg



STAGE 7 - DEPOSITION IN TSF3 TO RL 64m

SCALE 1:5000



STAGE 8 - CLOSURE

SCALE 1:5000

PRELIMINARY

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Client: **RED 5 LIMITED**
Project: **SIANA GOLD**
Title: **Figure 3-9 TSF CONSTRUCTION Stages 7 and 8**

Original Size: **A3** Drawing No: **61-22730-C020** Rev: **A**

STAGE	Duration (months)	TSF3	TSF4
			m RL
7	16	Deposition to maximum beach of 64 m RL	
8		Closure	Closure

Source: GHD, 2009a

Figure 3-10 is a typical section of the proposed TSF embankment. To avoid encroaching into new land and for safety, the TSF embankment is built on top of the existing SURICON embankment, stepped in during Stages 1 to 4 by 10 m. The outer wall has a slope of 1(V):3(H); the inner wall has a slope of 1:2.5. Structural rockfill sourced from the waste rock dump is used to raise the embankment to a Stage 1 height of 60 m RL. To provide a foundation for future raises, an upstream berm is built adjacent to the rockfill embankment to a height of 57 m RL. GHD (2009a) proposes to use the existing tailings – moisture conditioned and compacted – as berm material.

The Stage 3 embankment is placed on top of the Stage 1 and upstream berm to a height of 65 m RL, maintaining the 10-m clearance. Similarly, the Stage 4 embankment will be placed atop the Stage 2 construction. Structural rockfill and a core of low-permeability materials comprise these embankments. The low-permeability core will comprise existing tailings, moisture conditioned and compacted, or stockpiled clay from excavations for the construction of various structures across the minesite.

Finally, the embankment is raised to a height of 67 m RL . The 10-m clearance of the SURICON embankment and the crest of Stage 3 serve as foundation.

A similar construction approach is adopted for the embankment dividing TSF4 and TSF3 (Figure 3-11).

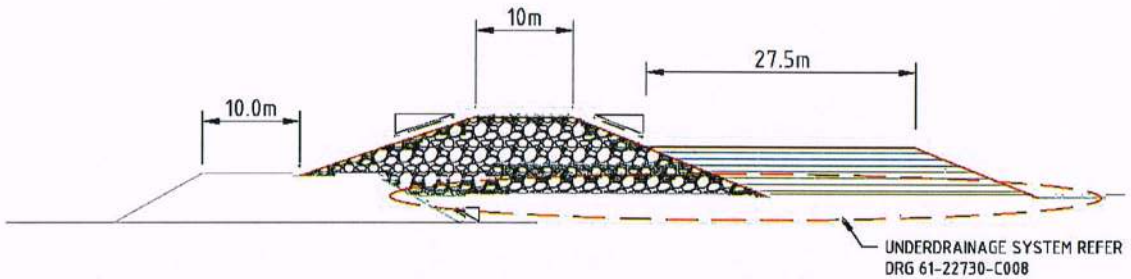
The general design philosophy adopted for construction and raising of the TSF embankments is that no part of the embankments should use recently deposited tailings as a foundation.

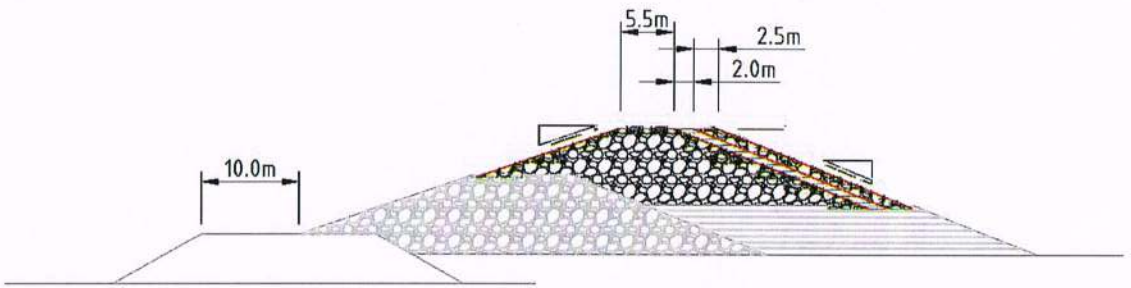
Tailings, with a nominal 32.5 % solids content, will be deposited via spigots spaced at 20 m along the perimeter embankment. Tailings discharge will be controlled through pinch valves or clamps. The supernatant pool for both TSFs is intended to develop adjacent to the dividing embankment.

Underground Mine

From Table 2-5, 3.362 million t of ore, equivalent to 1.293 million m^3, will be extracted from the underground mine over an 8-year period commencing on the third year of open pit operations. This ore will be processed in the same cyanidation plant generating an equal amount of tailings.

Based on a testwork program, Revell Resources (2009) developed a flow diagram for the paste fill plant. As shown in Figure 3-12, tailings from the cyanidation plant at 60 t/hr solids and 32.5 % solids will be fed into the cyclone cluster of the plant. The overflow at 24 t/hr solids and 19.3 % solids goes to a cyclone feed pump hopper and then a discharge pump that leads to the TSF. A provision for a thickener has been made in the BFS. The thickener will allow the density of the cyclone overflow to be increased. The underflow at 36 t/hr solids and 60 % solids goes to a vacuum disc filter and then a paste hopper. The filter increases the % solids to 80 %. The hopper product is mixed with cement to generate the paste fill for the underground stopes.

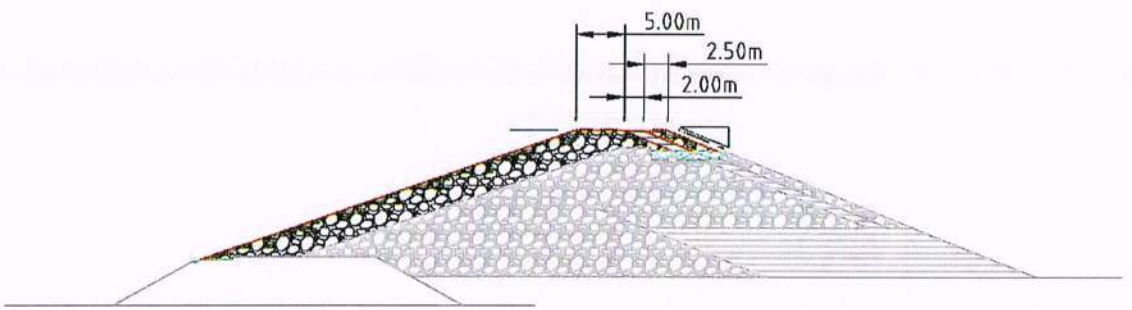




LEGEND

ZONE A (WASTE ROCK)

ZONE B (COMPACTED TAILINGS)



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Client: RED 5 LIMITED
Project: SIANA GOLD
Title: Figure 3-10 TYPICAL EMBANKMENT SECTIONS

Original size: A3
Drawing No: 61-22730-C005
Rev: A

Plot Date: 18 September 2020 - 12:49 AM
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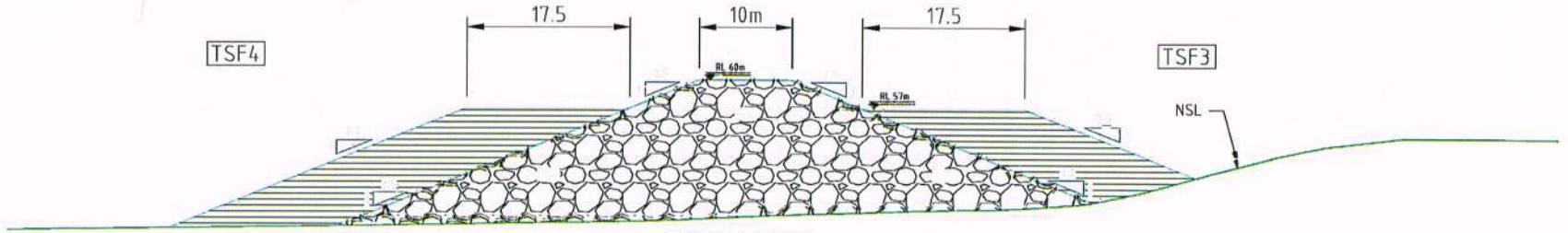
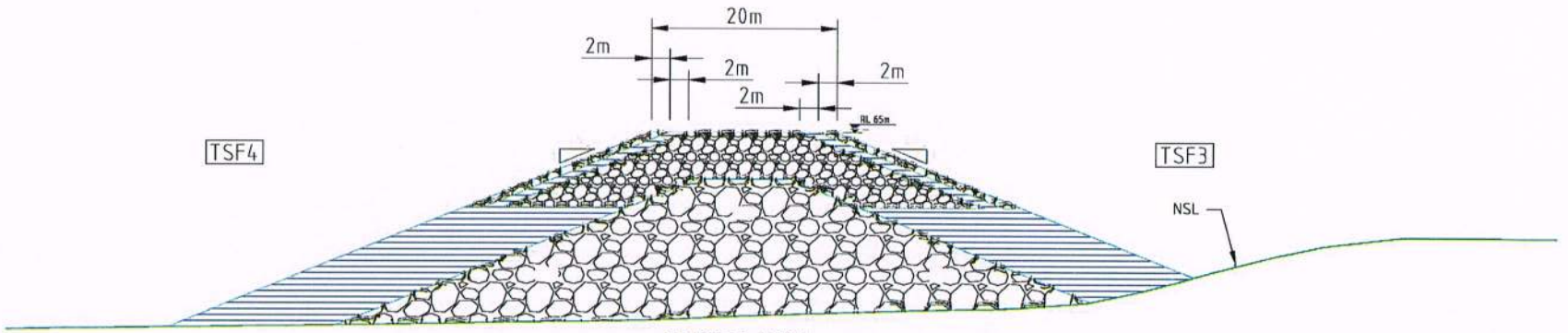
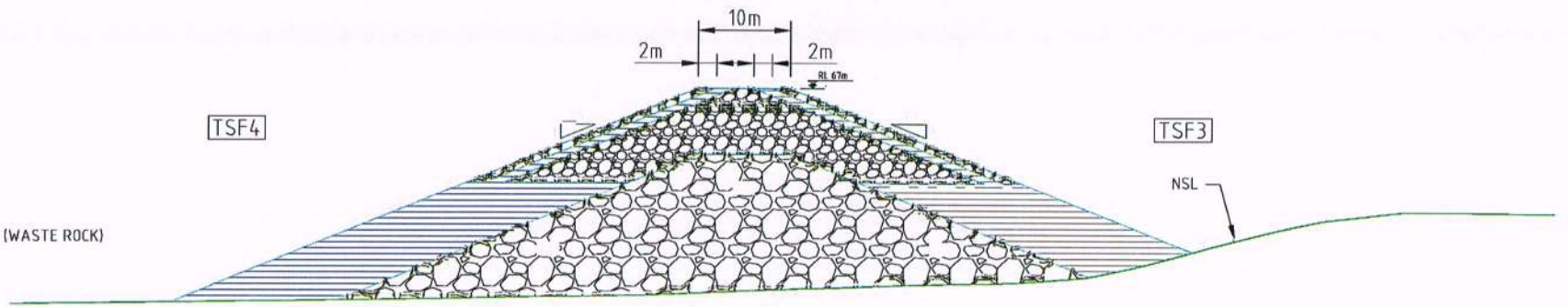


STAGE 1 AND 2



STAGE 3 AND 4



STAGE 5 AND 6

LEGEND

ZONE A (WASTE ROCK)

ZONE B (COMPACTED TAILINGS)

PRELIMINARY

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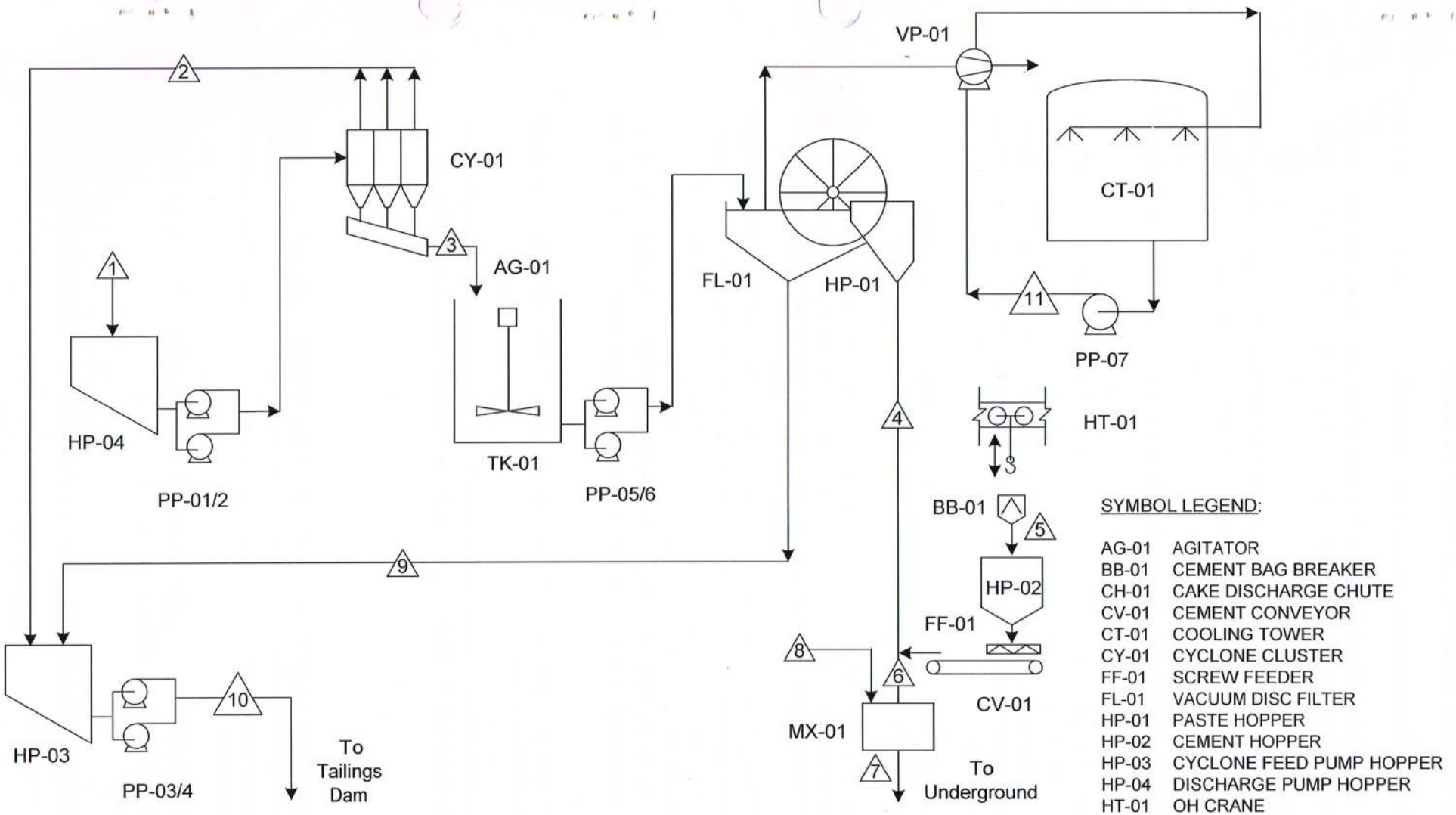
Client: RED 5 LIMITED
Project: SIANA GOLD
Title: Figure 3-11 COMMON WALL (DIVIDING EMBANKMENT) EMBANKMENT DETAILS

Original Size: A3
Drawing No: 61-22730-C006
Rev: A

Plot Date: 23 September 2009 - 12:47 AM
Cad File No: E:\Greenstone_SPS\PS\figures\Figure 3-11 common wall 61-22730-C006.dwg



SYMBOL LEGEND:

AG-01	AGITATOR
BB-01	CEMENT BAG BREAKER
CH-01	CAKE DISCHARGE CHUTE
CV-01	CEMENT CONVEYOR
CT-01	COOLING TOWER
CY-01	CYCLONE CLUSTER
FF-01	SCREW FEEDER
FL-01	VACUUM DISC FILTER
HP-01	PASTE HOPPER
HP-02	CEMENT HOPPER
HP-03	CYCLONE FEED PUMP HOPPER
HP-04	DISCHARGE PUMP HOPPER
HT-01	OH CRANE
MX-01	PASTE MIXER
PP-01/2	CYCLONE FEED PUMP
PP-03/4	DISCHARGE PUMP
PP-05/6	FILTER FEED PUMPS
PP-07	COOLING TOWER SPRAY PUMP
TK-01	FILTER FEED TANK
VP-01	VACUUM PUMP

Stream No.	1	2	3	4	5	6	7	8	9	10	11
Solids, tph	60.0	24.0	36.0	36.0	2.5	38.5	38.5	0.0	0.0	24.0	0.0
% solids	32.5	19.3	60.0	80.0	100.0	81.0	75.0	0.0	0.0	17.2	0.0
Water, tph	124.6	100.6	24.0	9.0	0.0	9.0	12.8	0.0038	15.0	115.6	0.0
Pulp, m3/h	148.6	110.2	37.8	23.4	0.8	24.2	28.2	0.0038	15.0	125.2	11.7

N.T.S.

FLOW DIAGRAM

PASTEFILL PLANT

Figure 3-12 PASTE FILL PLANT DESIGN CRITERIA

Source: Revell Resources

From Figure 3-12, about 40 % of the tailings solids will not go into the paste fill and instead discharge into the TSF. Over the life of the underground mine, this will accumulate to roughly 1.345 million t or 1 million m^3 of tailings.

GHD estimates that at the end of open pit mining operation, TSF3 and TSF4 will have a remaining tailings storage capacity of 280,000 t. This reduces the required storage capacity for underground tailings to 1.065 million t.

GHD briefly explored four options for the disposal of the additional underground tailings in the existing TSF footprint, WRD, or the open pit. These are:

1. Installation of wick drains – Wick drains have been used in TSFs to create a path for the pore water to escape, allowing the tailings to consolidate. For the Siana Project, after the existing tailings are borrowed to form the upstream berm of the TSF embankment, wick drains can be installed at approximately 5-m centers to consolidate the remaining tailings. This will provide room for additional tailings.

2. Co-disposal in the WRD – This involves the placement of tailings "fines" within the pores of the WRD. A review of the WRD stability and environmental impacts would be required.

3. Use of tailings in the TSF embankments – According to GHD, this process has been used successfully in many South African mines. It can be applied to the Siana Project so that the rockfill for use in the embankment can be replaced by cement stabilized paste from the paste fill plant.

   During the day, cement stabilized paste is deposited into a discrete paddock. During the night, thickened tailings are deposited into the center of the TSF along with any excess day production. The next day, deposition is moved to a new paddock and the process repeated. Once the cement stabilized paste has hardened and consolidated sufficiently, it is partially excavated (typically by hand) to raise the next bund wall, where it is compacted. The intention is to provide the cement stabilized paste enough drying time to gain the texture of teacher's chalk or hard cheese before rework.

4. Disposal in open pit – This option will need an assessment of the risks to the underground operations and the environment.

All four options have been used in mines throughout the world. For the purposes of financial analysis, GHD estimated the total capital cost for the third option at P 57.8 million and the operating costs at P 87/t mined.

3.1.3.1 Impacts

The impacts to land resources during the construction and operation of the TSF relate to the containment of the tailings, sourcing of the embankment materials, handling of the cut and fill materials, physical stability of the embankment, and land use after mine decommissioning. For the impacts to be acceptable, the following are paramount:

- The sourcing of rocks and other earth materials for the TSF embankment must not result in unsafe, unstable, or visually unpleasant excavations.

The embankment will require structural rockfill, low-permeability core material, and high-permeability filter and drain materials. It is expected that these materials will come from within the 240-ha Project site without requiring additional ground disturbance. For instance, the structural rockfill and filter and drain materials will be generated from the waste rocks of the open pit; the low-permeability materials from the existing tailings.

- Dam build-up activities must not result in the erosion of sediment into the downstream environment. This would require the proper handling and disposition of the cut and fill materials generated. Rockfalls should also be avoided.

- Tailings containment is the prevention of any movement of tailings solid from the storage area. Water releases from the dam must satisfy the water quality standards of the DENR.

  As discussed previously, additional TSF capacity is needed for the underground tailings. GHD briefly explored four options.

- Seepage from the TSFs is minimized by placement of new tailings above the existing tailings. The old tailings act like a liner across the TSFs.

- Physical stability is the long-term ability of the dam embankments to withstand erosion and failure and to prevent seepages through the embankment or foundation. An underdrainage system has been devised for the TSFs. Modeling by GHD (2009a) using the software package Seep/W indicates that the phreatic surface within the TSFs will decrease after the cessation of deposition. This will increase the strength of tailings due to consolidation and enhance the long-term stability of the TSFs.

- Land use pertains to the feasibility of using the impoundment or the embankment after mine decommissioning.

The impacted areas are the borrow sites, dam embankment sites, and downstream areas.

3.1.3.2 Control Strategy

The land impacts of TSF3 and TSF4 have been minimized by the siting of the structures on the previous tailings dams of SURICON. The control strategies are the following:

- Detailed investigations on volume of tailings for impoundment, type of tailings material, potential borrow materials for the dam embankment, site hydrology and hydrogeology, site seismicity, and site geologic and geotechnical conditions. The investigations have been completed for TSF3 and TSF4 which will impound the tailings of open pit operations. For the underground tailings, several options for their disposal are available. Detailed studies for the selection of the method will be completed before underground mining commences.

- Engineering design of dam embankment and assessment of slope stability under static and pseudo-static (seismic) loading conditions following ICOLD guidelines. The results of the limit equilibrium analysis for TSF3 and TSF4 indicated that the proposed embankments are stable under static conditions, *i.e.*, the factors of safety (FOSs) exceeded 1.5 – the ICOLD threshold for stability. However, under pseudo-static conditions, the estimated FOSs are less than the ICOLD threshold of 1.1.

Since the pseudo-static limit equilibrium is considered very conservative, an FOS of less than 1 does not necessarily mean collapse of the embankment. What it implies is the occurrence of permanent (plastic) deformation. GHD (2009a) conducted further finite element analysis to determine the degree of deformation expected. It found the maximum expected vertical displacements occurring in TSF3. After the worst-case maximum credible earthquake (MCE), the vertical displacement of the crest is estimated to be approximately 1.0 m. Subsequent to the worst-case operating basis earthquake (OBE), the vertical displacement of the crest is estimated to be approximately 0.2 m. GHD noted that the values are less than the allowed subsidence of 1.0 m. The pseudo-static ground acceleration coefficients used in the analyses are 0.66g and 0.39g, respectively.

Engineering design and slope stability assessment will be conducted on the tailings impoundment with the inclusion of the underground tailings when the best alternative is selected.

- Recover the topsoil of areas for clearing.
- Provision of a stormwater and runoff management system for the TSF site and access roads. The system diverts clean water away from the disturbed areas; turbid water is routed safely along channels for temporary impoundment at the existing sedimentation ponds. The TSFs are capable of storing the 1:100 years' 72-hour duration storm on the tailings surface in addition to their normal operating requirement. This should ensure that there is no uncontrolled or unexpected discharge of water from the tailings impoundment area.
- Quality assurance (QA) program for the TSFs during construction, consisting of material testing for strength and density of structural components as well as permeability and density testing of the low-permeability core.
- Safety and stability monitoring program as a component of a comprehensive operating manual that comprises piezometric and survey marker movement monitoring.
- Annual safety and stability audits by a qualified geotechnical or dam engineer.
- To prevent rockfalls during embankment construction, a 10-m clearance from the existing SURICON embankment will be maintained during the initial construction stages. This is complemented by relocation of the households at risk and construction of a rock mitigation fence along the hazardous areas (Figure 3-13).
- Management of tailings disposal to maximize tailings strength gain and consolidation and to ensure the effluent flowpath is adequate to settle the suspended solids. Tailings will be deposited from spigots along the TSF3 and TSF4 embankments excluding the dividing embankment. The tailings beach formed along the embankments will keep tailings water farther away and reduce hydrostatic pressures against the embankments.
- Daily inspection of tailings discharge, pipes and valves, inlet, crest, slopes, toe, and wall freeboard. A clear reporting hierarchy will be provided as part of the operating manual to ensure any actual or potential problems are acted upon quickly.
- Proper handling and disposal of waste materials.

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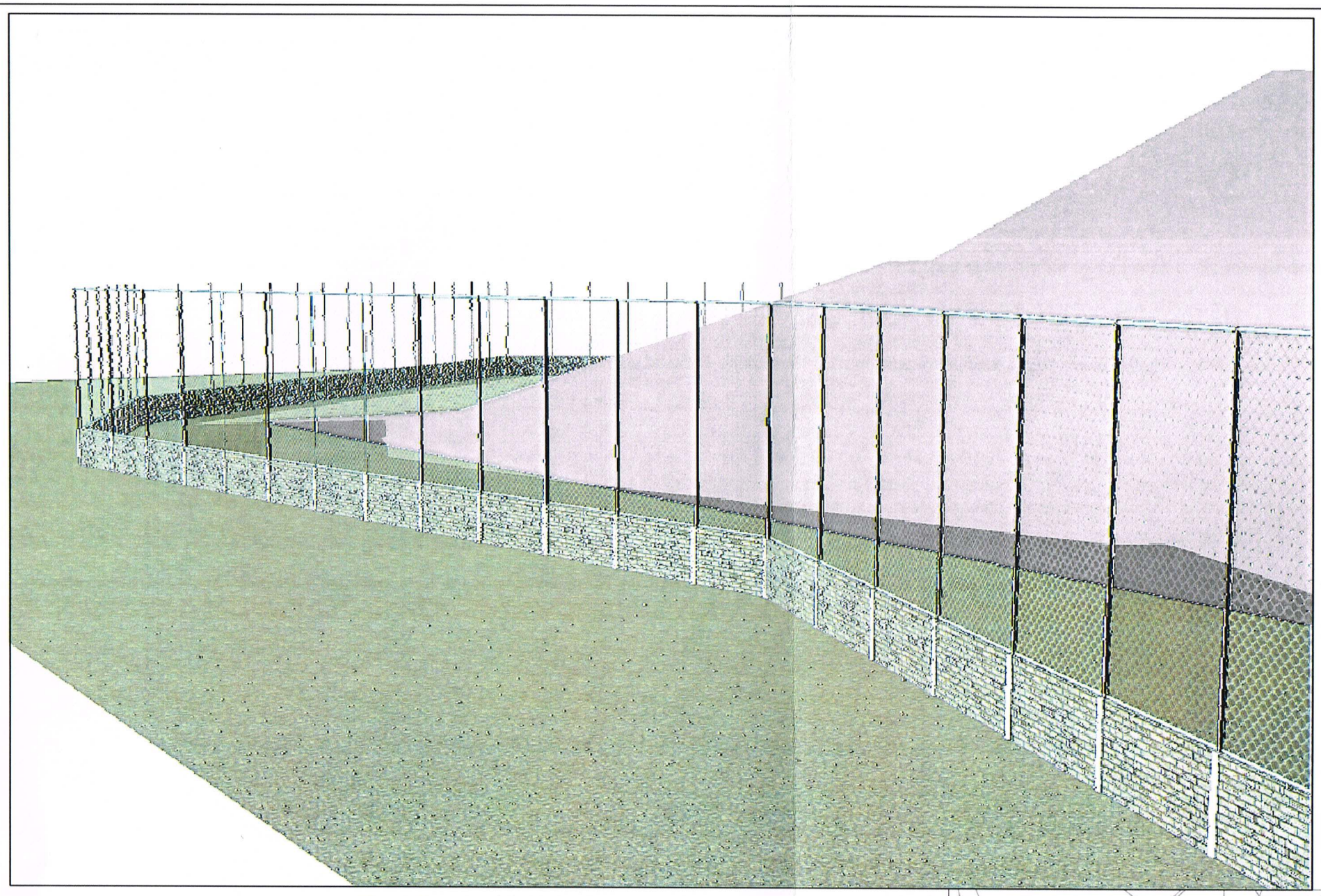

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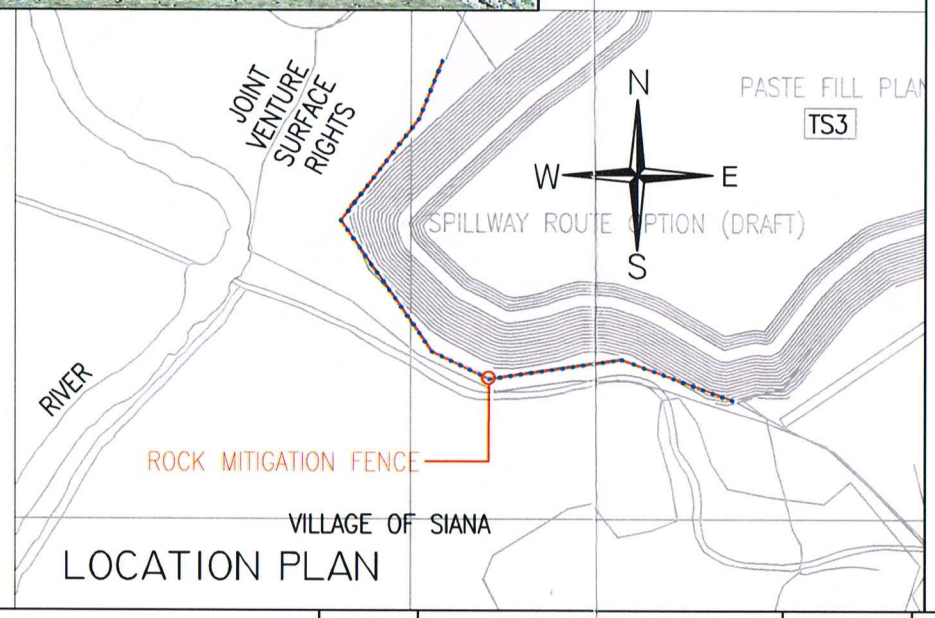


LOCATION PLAN

OWNER:	CHECKED:	PROJECT: SIANA PROJECT INFRASTRUCTURE	DATE	REVISION	APPROVED	SHEET CONTENT	SHEET NO.
GREENSTONE RESOURCES CORPORATION	APPROVED:			I			A161-RMF-A0
	DESIGNED:	TITLE: **Figure 3-13 ROCK MITIGATION FENCE**		II			
ADDRESS:	DRAWN:			III			

- During mine decommissioning, rehabilitation of the TSF3 and TSF4 to ensure the physical stability of the tailings, dam embankment, and drainage channels. The proposed spillway will be converted to a permanent spillway during decommissioning.

3.1.4 Waste Rock Dump

Table 2-4 quantifies the waste rocks, soils, and clays expected to be generated from the open pit operations at 9.034 million bcm which is equivalent to 22.6 million t. Table 2-5 likewise quantifies the waste rocks from the underground mine at 273,000 bcm or 710,000 t. The total waste rocks therefore to be generated from both open pit and underground mines amount to 9.307 million bcm or 23.31 million t.

A portion of the waste rocks, estimated by GRC at 1 million bcm, will go to the TSF embankment construction. To accommodate the bulk of waste rocks that will not be used as borrow materials, GRC provided two waste facilities. One is the waste rock dump (WRD), which is located immediately north, northeast, and east of the open pit on top of SURICON's old Waste dump 2. The other is the community livelihood farm (CLF) which is located immediately northwest of the WRD (Figure 2-1). GRC estimates the total capacities of the WRD and CLF at 7,877,994 bcm and 1,812,841 bcm, respectively or a total capacity of 9,690,834 bcm. This is more than the total volume of waste materials generated from both the open pit and underground mines.

Photo 3-13. The site of the proposed CLF.

Figure 3-14 shows a close-up plan and sections of the WRD. Designed to accommodate mostly waste rocks, the dump will have a height of 85 m, batter angle of 30°, and 10-m to 15-m berms at various vertical distances. The resulting overall slope angles vary by direction. W-E, the slope is around 6°. S-N and NW-SE, the slopes are roughly 24°.

The CLF will accommodate organic soils, subsoils, and clay-rich materials from the open pit. It will have height of 20 m, batter angles of 15°, and overall slope angles of 7° at SW-NE and 14° at NW-SE (Figure 3-14). Because of its flatter slopes and rich soils, the CLF can host the vegetable, crop, and fruit plantations of the community.

3.1.4.1 Impacts

The impacts of the WRD and CLF to land resources include erosion and rockfalls during the deposition of waste rocks, soil, and clay. There is a risk of slope failure during and after operations. So that the impacts are acceptable, the following conditions need to be satisfied by the Project:

- Waste rocks, soil, and clay deposition must not result in erosion or rockfalls. The former adversely affects the plantations downslope; rockfalls can injure or kill workers in the open pit and residents in the adjacent households.
- Physical stability is the long-term ability of the WRD and CLF to withstand erosion and failure.
- Land use pertains to the feasibility of using the dumps after mine decommissioning. This is not a problem for the CLF which is intended to provide plantation sites for vegetables, fruit trees, etc. for Brgy. Cawilan residents chiefly.

3.1.4.2 Control Strategy

The control strategies are:

- Stability assessment of the WRD. Peter O'Bryan & Associates (2008) concluded that:
  1. The location of the proposed dump immediately northeast of the open pit has a negligible effect on pit wall stability.
  2. Under static and dry loading conditions, the proposed waste rock dump will be stable.
  3. Under seismic and dry loading conditions, the dump will essentially remain stable, *i.e.*, some localized movement of near-surface material may occur.
  4. Only a limited saturation of the dump can be tolerated. Water levels exceeding roughly 105 m RL within the dump would be expected to destabilize the slopes. An earthquake of sufficient magnitude or proximity to apply a horizontal acceleration of at least 0.25g coincidental with a water level within the dump of above 104 m RL would cause failure. It is recommended that GRC avoid placing large "continuous" volumes of clay-rich material within the dump.
  5. A worst-case situation in which earthquake-induced vibration coinciding with the presence of a substantial volume of water in the dump would be expected to cause slope instability. Slope movement would occur within the zone roughly 10 m behind or below the slope face. Breakout would occur near the toe of the slope. Consequently, some movement of waste towards the open pit is possible in the northern, northeastern, and eastern sectors. Bunding or the construction of catch fences around the pit edge to contain the material movement was recommended.
- Following the recommendations of the stability assessment, soil, subsoil, and clay-rich materials will not be deposited in the dump but in the CLF. Moreover, piezometers will be installed for the regular monitoring of the phreatic surface within the WRD.

Photo 3-14. *Callopogonium* is common in the Project site.

Photo 3-15. Wild daisy is also good for understory.

- For protection of the WRD and CLF against rain and wind erosion, the slopes will be immediately revegetated as soon as practical with fast growing vines and grasses. The recommended species are *Callopogonium muconoides* and wild daisy (*Wedelia biflora*).
- Bunds consisting of large boulders or catch fences will be placed near the pit edge to protect personnel working in the open pit and underground.
- Houses at risk from slides impacting the WRD will be relocated.
- Temporary stockpiling of topsoil to ensure that it is deposited last on the CLF. After its placement, minor grading and slope stabilization works are foreseen prior to use of the CLF by the residents.

3.1.5 Buildings and Structures

The buildings and structures proposed for the Siana Gold Project are concentrated in a few areas, namely (Figure 2-1):

- Accommodations area – Located northwest of the process plant area and northeast of TSF4, this hosts the Managers' camp, Senior camp, Staff camp, and Dining and recreation building.
- Process plant area – East of TSF4 and north of TSF3, the process plant area comprises the process plant, plant workshop and warehouse, reagents store, secondary containment pond, laboratory, plant office, security office and first aid, and tank farm consisting of process water, raw water, and potable water.
- Main office and Mine service area – Located east of the process plant, this is the site of the Main office, Fuel station, Mine fleet maintenance, ROM pad, and crusher.
- Plant feed water dam (Pond A area) – East of the Mine service area and adjacent to the CLF and WRD, this is the site of Pond A, Silt Trap A, paste fill plant, and drainage channel that connects Pond A to Pond B. Pond A will contain the make-up water and tailings supernatant from the TSF for use in the process plant.

- Explosives magazine area – This stores the ANFO, emulsion, and detonators needed for the open pit and underground blasting. Adjacent to the magazines are the TSF3 spillway and Pond B with overflow channel to Dayano Creek.

  Testworks indicate that the tailings are fine-grained with approximately 30 to 37 % of the sample as clay (finer than 2 µm), 60 to 65 % as silt (2 to 75 µm), and 2 to 5 % sand. Geotextile tubes that will catch the fine materials shall be installed downslope of Pond B.

- Eastern drainage channel area – Silt Trap C will receive surface runoff from the southern half of the WRD and pumped water from the pit. It will discharge into the eastern channel. Geotextile tubes will filter the channel flow before discharge into Dayano Creek.

  West of the eastern drainage channel are the nursery and Silt Trap B that filter runoff along the pit access pond; southward is the sanitary landfill.

3.1.5.1 Impacts

The impacts to land resources of the buildings and structures needed for the Project relate to physical stability, visual aesthetics, and use of the land or buildings during the abandonment of the Project.

- Physical stability is the short and medium-term ability of the structures to withstand earthquakes, typhoons, landslides, and settlement. In the short term during construction, this includes the prevention or mitigation of erosion.

- Visual aesthetics refers to the pleasantness of the buildings and structures or their blending with the natural surrounding landscape.

- Land use pertains to the continued use of the building, structure, or the vacated land after mine decommissioning.

3.1.5.2 Control Strategy

The control strategies are:

- Geotechnical investigations for the building or structure sites to ascertain their foundation conditions. These involve boring works and standard penetration tests. The estimated allowable bearing pressures determine the foundation designs (Mining One Pty Ltd, 2007).

- Reduction of ground clearing works to the minimum needed for construction. This is to minimize erosion and sedimentation of the environment downslope.

- Limiting the exposure of soil to erosion.

- Installation and maintenance of a stormwater and runoff management system for construction and operation. The system diverts clean water away from the working and disturbed areas. Dirty water from the jobsites is routed to a sediment retention structure.

- Proper handling and disposal of waste materials. The materials are kept away from drainage channels and unstable areas.

- Adoption of a QA program for the construction and building works. This will ensure that the structures are built as designed.
- After completion of the building, revegetation of bare areas to minimize erosion.
- During mine decommissioning, determination of the best use of the buildings and structures.

3.1.6 Access Road and Water Crossings

The main access road to the Project site branches out from the National Highway in Brgy. San Pablo, Tubod Municipality, then proceeds easterly through rice fields, a small unnamed creek, and the Magpayang River, finally reaching the site (Figure 2-1). The road also connects to an existing barangay road that leads to Brgy. Cawilan of the same municipality.

The access road is two-lane and two-directional with shoulders. Its total length is 1.7 km, running width is 12 m suitable to accommodate 75 ton, 14 wheel Giga Trucks or similar flat-bed trucks. One-meter walkways shall be provided on both sides of the road making an overall width of 14 m. A 6-m wide lateral road connects the access road to Cawilan Village.

The road pavement surface is all-weather macadam with sub-base coarse acting as foundation. For the road sections subject to flooding, the pavement is Portland cement concreted with headwalls. Designed for a 20-year life, the road can accommodate a traffic volume of about 20 trucks per day with an average gross vehicle load of 25 t per truck.

Figure 3-15 is the layout of the access road. Reinforced concrete pipe culverts will be used for the waterway crossings including the vents of the Irish Crossing across Magpayang River. Side ditches are also provided along road sections near the proposed offices and living quarters. Figure 3-16 is the design of the Irish Crossing.

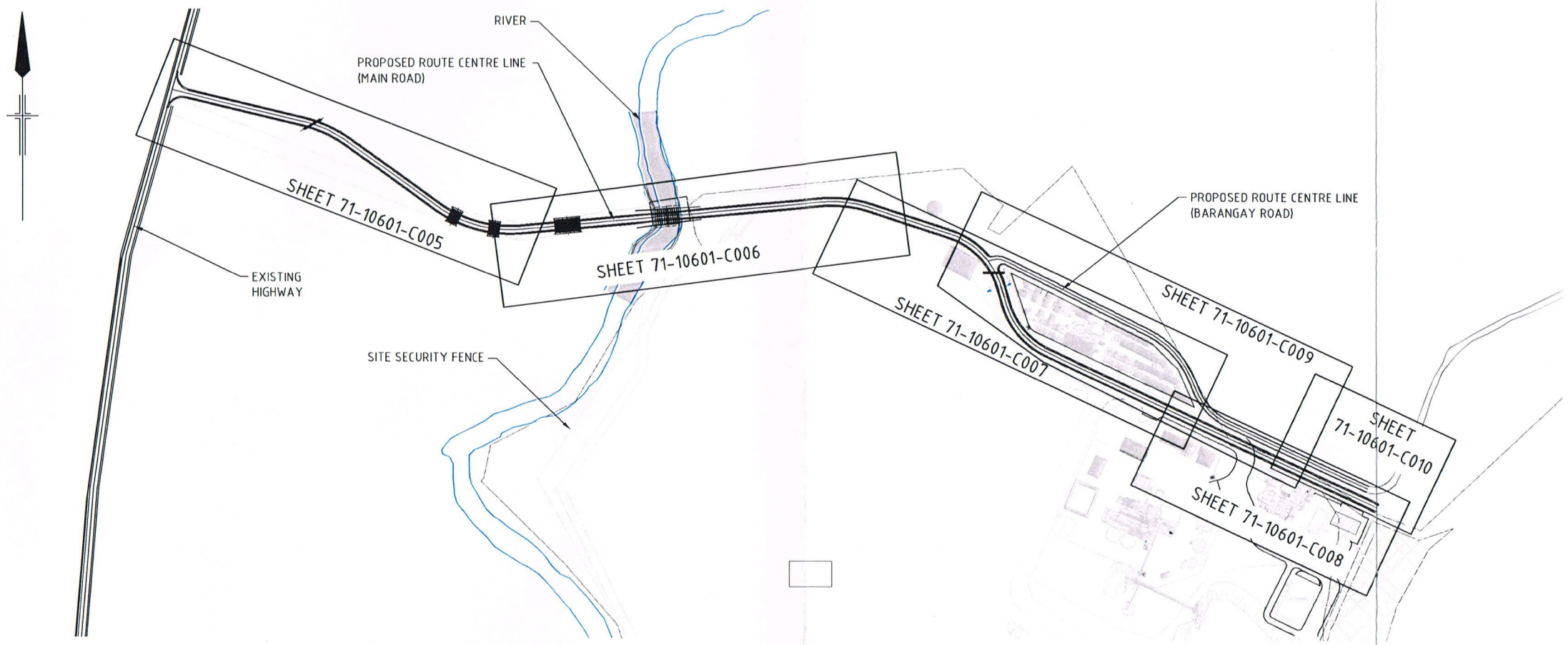
3.1.6.1 Impacts

The impacts of access roads to land resources refer to clearings, visual aesthetics, safety, physical stability, spoils, and land use.

- Clearings are indispensable to road construction. Their extent and the handling of cleared or grubbed vegetation determine whether the impacts are acceptable.
- Visual aesthetics refers to the pleasantness of the road construction or its blending with the natural surrounding landscape.
- Road considerations for safety include vehicle maneuverability, gentle grades, visibility, and guideposts where necessary.
- Physical stability is the stability of the road to withstand erosion, flooding, and landslide.
- Spoils management entails the minimization and proper disposal of spoils away from water bodies in stable piles or dumps.
- Land use pertains to the continued use of the access road after mine decommissioning.

NOTE:

THE CONTOUR AND HORIZONTAL ALIGNMENT USED IN THE DESIGN IS FROM THE CORRECTED PRS DATA AND CORRESPONDING GRC UTM WGS84 AND MINE GRID PROVIDED BY THE CLIENT. GHD WILL NOT BE LIABLE FOR ANY DISCREPANCY BETWEEN THE SURVEY AND ACTUAL SITE CONDITIONS. DISCREPANCIES THAT MAY BE OBSERVED IN THE FIELD DURING CONSTRUCTION SHALL BE RESOLVED BY THE OWNER AND THE CONTRACTOR.



LAYOUT PLAN
SCALE 1:2500

FOR DISCUSSION PURPOSES ONLY

PRELIMINARY

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B	REDESIGN BASED ON NEW SURVEY AND ROAD ALIGNMENT		RGC	RLI*	MSA*	02.03.09
A	ISSUED FOR COMMENTS		NDS	RLI*	MSA*	22.06.08

0 25 50 75 100 125m
SCALE 1:2500 AT ORIGINAL SIZE

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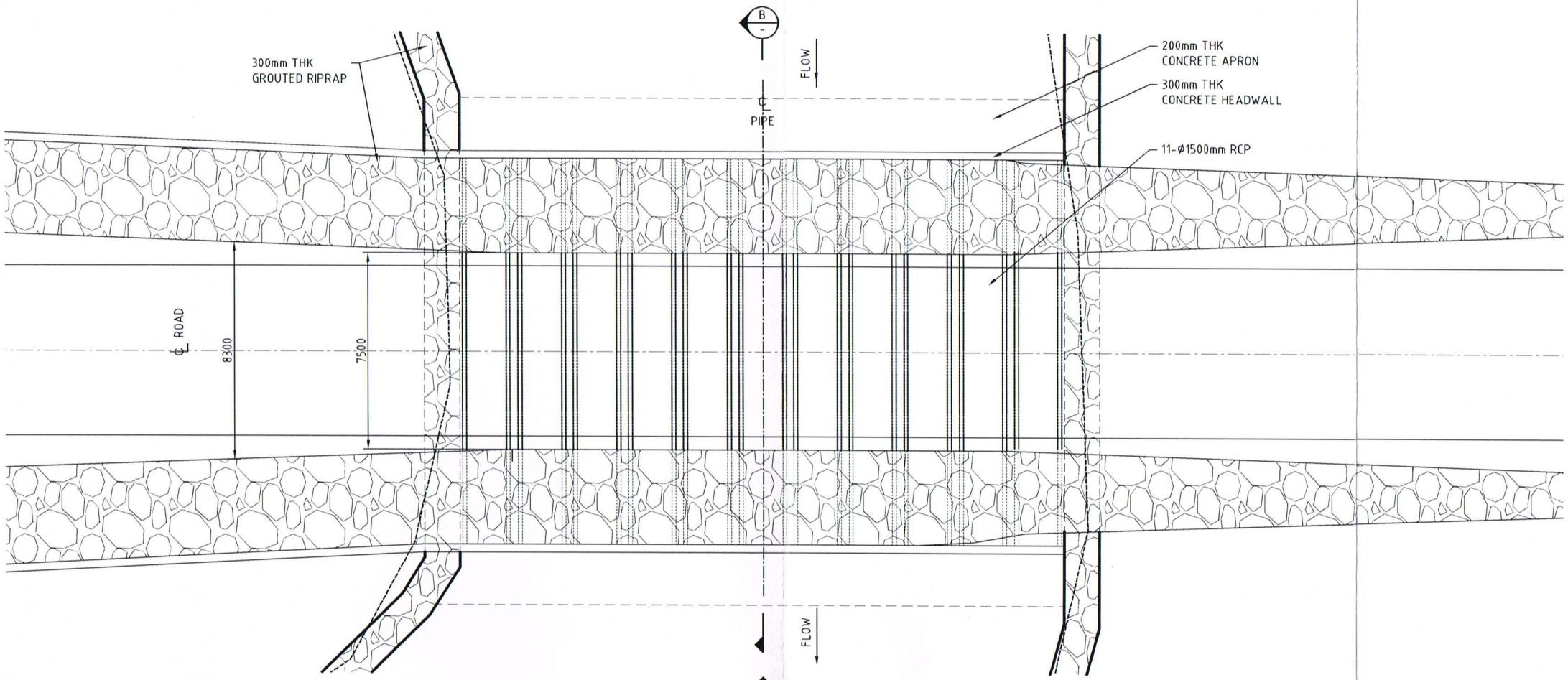
Drawn N. SAUZ		Designed S. TERCEÑO
Drafting Check		Design Check
Approved		
Date		
Scale 1:2500	This Drawing must not be used for Construction unless signed as Approved	

Client GREENSTONE
Project ROAD DESIGN & IRISH CROSSING DESIGN FOR THE SIANA GOLD PROJECT
Title Figure 3-15 ROAD & IRISH CROSSING LAYOUT

Original Size A1 Drawing No: 71-10601-C002 Rev: C

Plot Date: 15 May 2009 - 5:09 PM Cad File No: G:\71\10601\CADD\Drawings\71-10601-C002.dwg



PLAN
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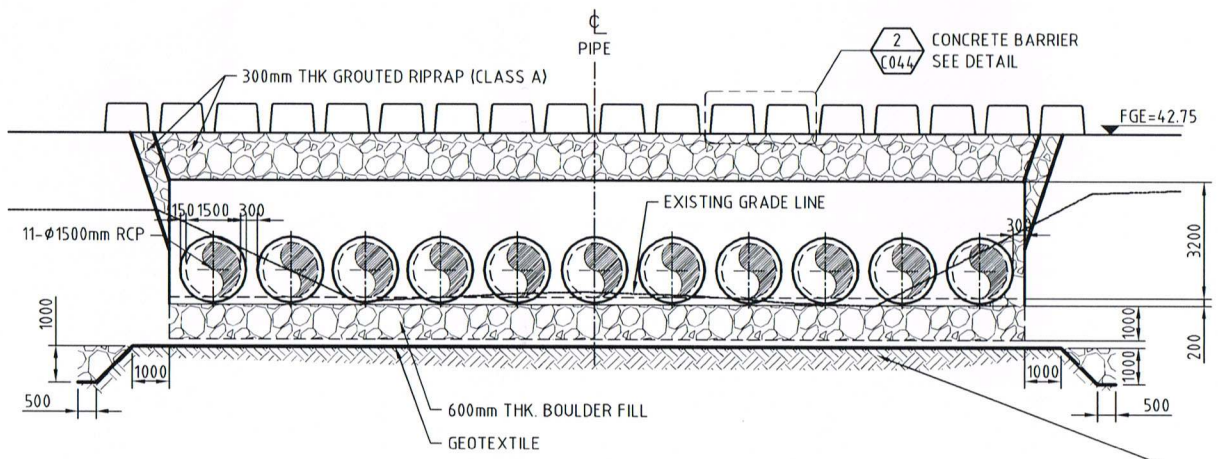
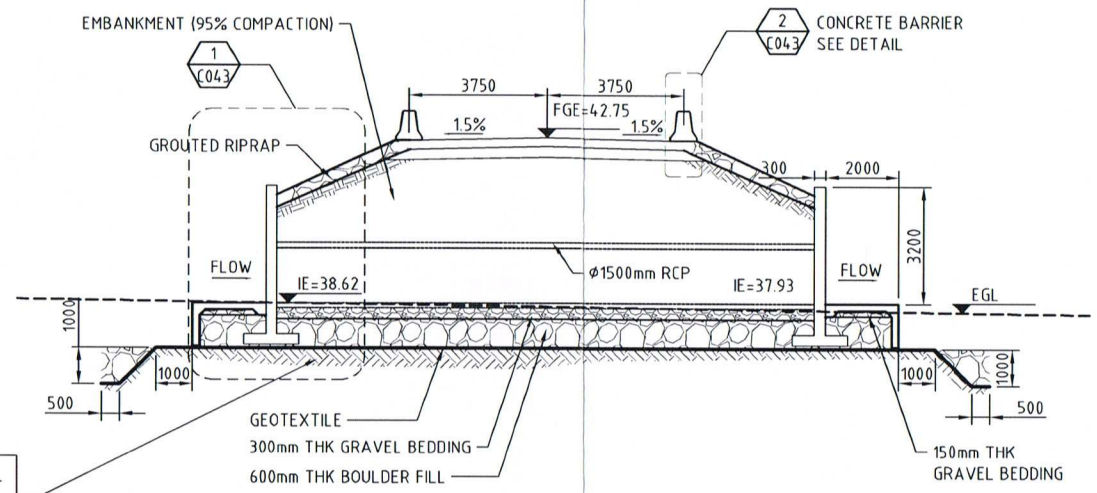


A ELEVATION
SCALE 1:100

REMOVAL OF UNSUITABLE MATERIAL BELOW BOULDER FILL. DEPTH TO BE DETERMINED AT SITE.



B SECTION
SCALE 1:100

IRISH CROSSING (CH. 0+494 TO 0+519)

PRELIMINARY

No	Revision	Drawn	Checked	Approved	Date
C	VARIATION ORDER NO. 1 - FOR CLIENT COMMENTS	RM	RLI*	MSA*	05.06.09
B	REDESIGN BASED ON NEW SURVEY AND ROAD ALIGNMENT	GPR	RLI*	MSA*	02.03.09
A	ISSUED FOR COMMENTS	EP	RLI*	MSA*	25.02.09

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 500 1000 1500 2000 2500mm
SCALE 1:50 AT ORIGINAL SIZE

0 1000 2000 3000 4000 5000mm
SCALE 1:100 AT ORIGINAL SIZE

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Drawn E. PALARCA	Designed A.S. TUMANG	Client	GREENSTONE
Drafting Check	Design Check	Project	ROAD DESIGN & IRISH CROSSING DESIGN FOR THE SIANA GOLD PROJECT
Approved		Title	Figure 3-16 IRISH CROSSING DESIGN
Date			
Scale AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	Original Size A1	Drawing No: 71-10601-C042 Rev: C

Plot Date: 5 June 2009 - 2:41 PM Plotted by: Karl Erik A. Palarca , Melbourne Cad File No: G:\71\10601\CADD\Drawings\71-10601-C042.dwg

3.1.6.2 Control Strategy

The control strategies include:

- Geotechnical investigation to determine the general conditions of the soils along the proposed road alignment. A borehole sunk on a rice paddy field along the eastern bank of the Magpayang River disclosed that the top 0.5-m layer is rice paddy soil. Up to 6.5 m below is fluvial soil which consists of very soft to soft mottled silts and clays. From depths of 7 to 20 m below the ground surface, extremely weathered basalt of very low strength was encountered. Stronger zones of basalt interlayered with very low-strength zones were observed beyond 20 m (Mining One Pty Ltd, 2007).

  GHD (2009b) found the resilient modulus values estimated from the geotechnical investigation "fairly low as compared to typical CBR[1] and resilient modulus values." Consequently, they recommend during the road construction, clearing and grubbing the topmost layer of about 300 mm thickness. Further stripping and removal of unsuitable material is suggested. Before filling, geotextile materials are to be installed. GHD also recommended further geotechnical investigation and soil tests along the alignment during construction.

- GHD (2009b) conducted rainfall intensity analysis, runoff routing modeling, and water level and flood analysis to characterize the flows that would impact the Irish Crossing. Based on this and the hydraulic analysis, the design criteria for the crossing were formulated. The preferred foundation is continuous rock on a prepared subgrade. GHD noted the likelihood of closure of the crossing vents by debris flows, *e.g.*, fallen trees, leaves, and bamboos.

- Reduction of ground clearing to the minimum needed for construction.

- Limiting the exposure of soil to erosion by restricting the clearing and grubbing not to proceed too far ahead of construction.

- Recovery and immediate use if possible of topsoil either as potting medium or direct replacement on another area. Alternatively, the topsoil may be deposited in the CLF.

- Grading and crowning of the road surface to shed water and minimize water ponding. Installation of drainage ditches along the road.

- Proper handling of waste materials and keeping them away from water flow.

- Installation of culverts on water crossings and if required to prevent fill washout during high-flow periods, placement of riprap on the fill slope. The riprap will be supplemented by the plantation of bamboo (*Bambusa blumeana* var. spinosa), kawayang tink, and Narra (*Pterocarpus indicus*) in accordance with condition no. 1b of the ECC (Annex 3). Bamboo and narra will be planted alternatively along rows at 2.5 m x 2.5 m spacing. At this distance, 400 seedlings each of bamboo and narra will be needed per linear kilometer of river bank. The planted seedlings along the banks of the river need regular weeding every 4 months to liberate young seedlings. This is important because vines are prominent competitors for light and they tend to strangle young seedlings to death.

1 CBR is "California bearing ratio". It describes the load-bearing capacity of a soil or soil-binder mixture for road engineering compared with a Californian standard soil with a high bearing capacity.

- Drainage maintenance to include regular inspection, clean out of blocked ditches and culverts, grading to remove ruts, and crowning of the road and pads to shed water.
- During grading operations, loose materials should be brought back to the center of the roadway to prevent the creation of berms that can channel runoff down the road and erode the fill slopes.
- Determination of the best use of the access road at the end of Project life.

3.1.7 Domestic Solid Waste

The Project personnel will generate domestic solid wastes consisting of the following:

1. Canteen wastes comprised of food leftovers, plastic bags and containers, glass bottles, tin cans and cardboards, and cooking wastes
2. Garden wastes such as leaves, twigs, and weeds
3. Human wastes consisting of soiled toilet paper, pads, napkins, cigarette butts, cotton, and plastics.

Previously, the domestic waste storage facility of the Mainit Municipality was eyed as the destination of these wastes. This plan was discarded since the facility is not compliant with Republic Act No. (RA) 9003 and its implementing rules and regulations.

Possible sites for a sanitary landfill within the 240-ha property were evaluated based on the criteria of DENR Administrative Order No. (AO) 34, Series of 2001. These criteria included, among others, at least 75-m distance from a Holocene fault or known recent active fault, not located within a floodplain, and at least 50-m distance from a stream or river. The best site was found south of the open pit and Dayano Creek within Brgy. Dayano (Figure 2-1).

As an estimate of the tonnage and volume of domestic solid waste to be generated, a daily per capita solid waste generation of 0.50 kg/day and a solid waste density of 0.40 t/m^3 were assumed. For the Project personnel, the total number was pegged at 500 during the construction year and at 250 to 300 during the 10 years of open pit and underground operations.

Photo 3-16. The open dump of the Mainit Municipality.

Photo 3-17. The proposed site of the Project's sanitary landfill.

Considering that the landfill plan needs to be consistent with the local government land use plan and that an endorsement is required as per DENR AO 2001-34, the wastes generated by the households of Brgys. Siana and Dayano have been included in the waste estimates. The total number of residents of the two barangays based on the 2007 census is 1,536. Adding the estimated solid wastes generated by the residents to those of Project personnel, the total wastes generated are 372 t for the construction year and 6,521 t for the succeeding 10 years. This tonnage is equivalent to a total waste volume of 17,231 m^3. It should be noted that the estimate disregards the reduction in waste to result from composting and recycling.

The implementing rules of RA 9003 require the placement of a 0.2-m thick soil cover over the wastes. At a waste collection schedule of once every 2 days, the total soil cover required during 11 years of landfill operation is 3,446 m^3. Adding this amount to the solid waste volume, the total capacity needed by the sanitary landfill is 20,677 m^3.

3.1.7.1 Impacts

The impacts of domestic solid wastes to land resources relate to waste containment or physical stability of the landfill, visual aesthetics, and control of nuisance problems such as vermin. For the impacts to be acceptable, the following are required:

- Physical stability is the ability of the sanitary landfill to fully contain the wastes without failure of the enclosing walls.
- Visual aesthetics is the pleasantness and cleanliness of the landfill facility and immediate surroundings. There are no litters or wastes scattered around the facility.
- Control of nuisance problems means that there are no vermins, foul odor, or wind-blown wastes from the facility.

3.1.7.2 Control Strategy

The domestic solid wastes will be placed in a sanitary landfill that features:

- 0.2-m thick soil cover at the end of each workday
- Embankment or cell preparation
- Drainage facility
- Gas venting
- Leachate collection and treatment
- Clay liner at least 0.6 m thick with a permeability of 10^{-6} cm/s and
- Material recovery facility complete with a shredder and staffing.

The overall dimensions of the landfill are 120 m x 70 m x 3 m deep, equivalent to a capacity of 25,200 m^3. The excavated materials net of the soil cover will be brought either to the CLF or WRD. Tailings from SURICON's old tailings dams can be used as clay liner.

3.1.8 Industrial Waste

The industrial solid wastes of the Project are classifiable into non-hazardous and hazardous wastes based on RA 6969 and its implementing rules and regulations. The conditions for the acceptability of their impacts to land resources are similar to those of domestic wastes, for instance, waste containment, visual aesthetics, and control of nuisance problems. The control strategy includes waste classification, waste placement in designated areas, and in-situ waste treatment or waste collection by recyclers or DENR-accredited treaters.

The non-hazardous wastes include:

- Metallic materials such as worn-out tracks, body parts, and frame of equipment, and metal drums - The metal parts will be cut into smaller pieces and deposited inside a metal storage bin. A metals recycler will collect the metal parts regularly. Worn-out tracks, body parts, and frames of equipment which cannot be cut into smaller pieces will be deposited in a lay-down area for retrieval by recyclers. Metal drums will be piled in the designated place for recovery by the supplier for reuse.

- Rubber-based products like worn-out wheels and conveyor belts - These will be placed in a designated spot in the lay-down area for collection by suppliers or recyclers.

- Plastics such as used plastic cans and bulka bags – Just like the rubber-based products, these are collected and placed in a designated storage area for collection by recyclers.

- Wooden pallets and packaging materials – These are collected and stored temporarily for retrieval by recyclers.

The hazardous solid wastes are:

- Used batteries – These are catalogued in the implementing rules and regulations of RA 6969 as lead compounds. Used batteries are collected and stored temporarily in a covered area for recovery by recyclers.

- Oil/grease-contaminated waste rugs – These are collected in metal drums and placed in the temporary storage area. Recyclers collect the metal drums regularly.

- Used oil filters - Used oil filters are collected and drained in drip pans to recover the residual oil. The filters are then mechanically compressed to remove as much oil as possible. The collected oil is stored in used oil drums and the oil filter is placed inside metal drums together with the oil/grease-contaminated waste rugs.

- Used containers of hazardous chemicals such as NaCN, $CuSO_4$, NaOH, HCl, and SMBS – The containers are collected by the suppliers.

3.1.9 Plants and Animal Communities

The Environmental Impact Statement (EIS) of the Project classified the terrestrial flora and fauna assemblages within the Project site and vicinities into four types (Figure 3-17; BMP, 2009):

1. *Remnant agro-forest habitats* - This is represented by Stations 1 (Motorpool) and 3 (Bubudhan) as shown in Figure 3-17. The dominant tree species are Balobo *Diplodiscus paniculatus*, Antipolo *Artocarpus blancoi*, Hagimit *F. minahassae*, Rimas *A. Altilis*, and Tibig *F. nota*. Other associated species include Malugai *Pometia pinnata* and Amamali *L. aculeate*. According to local Mamanwas in the Motorpool Area, the once common species of Molave *Vitex parviflora* and Narra *Pterocarpus indicus*, both classified as premium species by the DENR, are gone due to the requirements of furniture-making.

   In this habitat type, the dominant avian species are the passerines represented by the species Sunbird *Nectaria jugularis,* Starlings *Aplonis panayensis*, and Wood Swallow *Artamus leucorynchus*. The associated forms include White-collared Kingfisher *Halcyon chloris*. Two species are considered migratory, namely, Barn Swallow *Hirundo sp.* and Brown shrike *Lanius cristatus*. The diurnal raptor group Falconiformis is represented by the Brahminy Kite *Haliastus indus*, a resident species of the Family Accipitridae with a wide distribution that extends as far as India and mainland Asia (Rabor, 1975) and the Serpent Eagle *Spilornis holospilus*. Native Mamanwas report the presence of Kulasisi, an indigenous psittaciform of the species *Loriculus* and the Philippine Red Jungle Fowl or Labuyo *Gallus gallus*.

   With respect to mammals, the local informants report the thriving troops of monkeys *Macaca fascicularis*, which local coconut farmers consider as pests; the Palm Civet locally called Milo *Paradoxurus sp.,* a vivirred; giant field rats *Rattus sp.,* representing the murid rodents; the Phil. Musk Shrew *Suncus occultidens*; and the Warty Pigs *Sus philippensis*. The Chiropterans or true flying mammals are represented by species belonging to *Pteropus sp.*

   Among the reptilian forms, secondary data reveal the existence of Bayawak *Varanus salvator* and Sail-fin Lizard *Hydrosaurus palustris*, a varanid and an agamid lizard, respectively, and the Reticulated Python *Python reticulatus* and the Philippine Cobra *Naja naja*. In tribal practices, the above-mentioned mammalian and herpetological species are considered a delicacy.

Photo 3-18. The Station 1 transect runs parallel to Magpayang River which is bordered by limestone karst hills to the west and agricultural fields to the east (BMP, 2009).

2. *Fully developed agricultural habitats* - This type is represented by Station 2 (Cawilan). The farming system is coconut-based. Maximization of land productivity is achieved through rice farming under coconuts where irrigation water is either rainfed or provided through pumping of water from the Cawilan River.

   The tree forms associated with coconuts include Ipil-ipil *Leucaena leucocephala*, a neotropical species introduced into the Philippines by the Spaniards. This species is a good source of fuelwood.

   Faunal forms are limited to those that could adjust to altered habitat conditions – the generalists. For birds, the most common species are Sunbirds, Warblers and Starlings. The mammals are mostly represented by murid rodents. The reptiles are limited to gekkonid and scincoid lizards, although Reticulated Python and the Philippine Cobra are occasionally reported.

Photo 3-19. The Station 2 transect is in the vicinity of Cawilan Creek which supplies irrigation water to the extensive ricefields (BMP, 2009).

3. *Secondary forest habitats (plant succession)* - This is represented by Stations 4 (Edge of Mine Pit) and 6 (Waste Dump No. 2).

   Practically bare during the active years of mining, these sites have been left undisturbed with SURICON's termination of operations in early 1991. In a span of barely 14 years, the mechanisms of natural plant succession, as described by Whitmore (1979), have taken over. The assemblage of vegetative cover has grown past the grass stages and is now dominated by secondary tree species. Pioneer species such as Anabiong *Trema orientalis*, Batino *Alstonia macrophylal*, and Malapapaya *Polyscias nodosa* are discernible. The former is so far the only known non-leguminous tree species that has a symbiotic relationship with the bacteria *Rhizobium*. This bacterium is capable of fixing atmospheric nitrogen into usable nitrates for plant nutrition.

   The associated avifauna are similarly dominated by the passerines. The cuculiforms are represented by the Philippine Coucal *Centropus viridis*. These sites are reported to be within the feeding range of the Brahminy Kite. As manifestation of its fast-tracked natural restoration, Mr. Joel Pacatang, a local resident experienced in hunting as a hobby, reported the presence of the Jungle Fowl, monkeys, and the Palm Civet in the area. Similarly, the Warty Pigs use the sites as feeding grounds and as passageways to natural waterholes.

The facility by which the sites are colonized by faunal forms is explained by their proximity to the remaining natural forests in the headwaters adjacent to and outside the MPSA area.

4. *Wetland habitats* - This is represented by Sampling Areas 5 (Waste Dump 2), 7 (Tailings Pond 1), and 8 (Tailings Pond 2).

   The dominant vegetative covers are those adapted to periodic waterlogged conditions, *i.e.*, members of Family Poacea, Cyperaceae and Typhaceae. Cattail *Typha latifolia* is a gregarious species that thrives up to the Northern hemisphere. The local people use the plant for torch making. They tie the stalks into bundles and soak them with diesel fuel. When ignited, the improvised torch can lighten footpaths and ease movement in paddy fields during moonless nights.

Photo 3-20. Station 4 is at the edge of the flooded open pit (BMP, 2009).

Photo 3-21. The Station 6 transect passes through paddy fields near Dayano Creek (BMP, 2009).

Photo 3-22. The Waste rock dump at Station 5 with its grassland or reed habitat is where the vulnerable Philippine Ducks have been observed by locals to breed (BMP, 2009).

Photo 3-23. Station 7 is a waterlogged area for most part of the year. The tall grass and reed habitat supports a population of waterbirds (BMP, 2009).

The associated avifauna is dominated by wetland species, all belonging to Family Rallidae. Two species of wild ducks, namely, the Philippine Duck *Anas luzonica* and the Wandering Whistling Duck *Dendrocygna arcuata* use the wetlands as alternate sites, adjunct to their feeding and

roosting sites within the flooded Siana open pit. The Painted Snipe *Rostratula benghalensis*, a migratory species was observed to be common during the survey in January 2005.

3.1.9.1 Impacts

The impacts of the Project to the terrestrial plant and animal communities include loss of vegetation and wildlife habitats in the construction and adjacent sites and impaired wildlife movement. Specifically, the impacts are (BMP, 2009):

1. Remnants of forest tree species and wildlife will be affected as the demand for wood materials and other forest-based resources increases because of the economic growth created by the Project.

2. The abandoned waste rock dump and tailings areas which are now in the process of plant adaptation and succession will be affected. The loss of vegetation in these areas will restrict the movement and foraging of wildlife.

3. The wetland habitats of the Philippine Duck, *i.e.*, the flooded pit and wetlands in the tailings ponds and waste rock dump areas, will be lost.

4. Dust, noise, vibration, and airblast from operations will drive the wildlife farther into the uplands.

For the impacts to be acceptable, the following elements are important:

- Clearings and ground disturbance are to be minimized. If they cannot be avoided, phasing of activities and the maintenance of connected habitat patches are the required management measures.

- During clearing and grubbing, vegetation needs to be salvaged for re-planting or for erosion control in other areas.

- Replacement or compensatory vegetation must provide fuel and lumber in order to reduce pressures on the residual forests.

- At the end of mining operations, the disturbed area's potential for vegetative and animal regeneration needs to be enhanced.

3.1.9.2 Control Strategy

The control strategies for the terrestrial plants and animals are apparent from the impacts:

- Maintenance of a forest nursery. GRC presently maintains a forest nursery beside the mess hall north of Tailings dam 3. However, this nursery needs to be relocated to give way to the process plant and mine services areas (Figure 2-1).

  BMP evaluated several sites for a nursery within the 240-ha Project area. The criteria for evaluation included accessibility or central location relative to the planting sites, continuous supply of water for irrigation, freedom from flooding, relatively flat topography with a moderate soil acidity of about 5.5 to 6.0 pH, adequate space to accommodate the needed facilities, and ready availability of soil for nursery beds and filling containers. As regards the penultimate

criterion, the area needed for the nursery, based on the extent of revegetation works, is from 0.5 to 0.75 ha.

Photo 3-24. The present nursery of GRC.

Photo 3-25. GRC's F Bartolay and BMP's Dr. L Florece discussing the seedlings being propagated at the nursery.

The key components of the nursery are:

1. Office shed
2. Workers' potting sheds
3. Germination shed
4. Seedling shed for picking out and allowing the initial growth of seedlings in shade
5. Storage of potting soil
6. Water pump installation
7. Water tank
8. Maturing or hardening beds where seedlings are made to grow unshaded before outplanting.

Table 3-2 lists the requirements of the nursery.

Table 3-2. Nursery supplies, materials, tools, and other requirements

Particulars	Unit Price (PhP)	Quantity/ Size	Total Cost (PhP)
Plastic bags	0.20/pc	750,000	150,000
Potting media/garden soil	300/m^3	60 m^3	180,000
Rubber hose	25/m	500 m	12,500
Plastic sprinkler	150/pc	10 pcs	1,500
Spade	500/pc	10 pcs	5,000
Shovel	500/pc	10 pcs	5,000

Particulars	Unit Price (PhP)	Quantity/ Size	Total Cost (PhP)
Garden fork	500/pc	5 pcs	2,500
Rake	300/pc	5 pcs	1,500
Planting bar	300/pc	20 pcs	6,000
Bolo	250/pc	10 pcs	2,500
Sprayer	2,500/pc	5 pcs	12,500
Garden tools	1,000/set	3 sets	3,000
Wheel Barrow	900/pc	5 pcs	4,500
Multi-purpose shed	2,000/m^2	100 m^2	200,000
Working shed	500/m^2	100 m^2	50,000
Potting shed	500/m^2	75 m^2	37,500
Potted seedlings area (clearing/leveling)	5/m^2	2,000 m^2	10,000
Hardening area	5/m^2	2,000 m^2	10,000
Germination area/shed	50/m^2	30 m^2	1,500
Water system/irrigation			75,000
Total			**770,500**

The most suitable site for nursery was found south of the open pit upstream of the Dayano Creek (Figure 2-1).

- Reduction of clearings and ground disturbance to the minimum required by construction. Phasing of activities will be undertaken for further reduction.

- During clearing or grubbing, important plant species with diameter of at most 10 cm will be balled, transferred, and tended at the nursery to ensure survival when outplanted. Alternatively, these species may be used for enrichment planting.

- The removal of topsoil will be coordinated with the earthworks contractor during clearing and grubbing. The topsoil will be used as potting medium or for immediate placement in areas to be rehabilitated. Any surplus volume of topsoil is placed in the CLF.

- Plantation of fibrous and deeply rooted species along the bare and erosion-prone river banks for stabilization consistent with condition no. 1b of the Project's ECC (Annex 3). The species to be used are bamboo (*Bambusa blumeana* var. spinosa) or kawayang tinik and Narra (*Pterocarpus indicus*).

  Both species will be raised in the nursery. Cuttings of bamboo (at least 2 nodes) should be planted in an appropriately sized plastic bag. As regards narra, they are widespread in the area. Their seeds are readily available and they germinate easily without any seed treatment. Bamboo and narra will be planted alternately along rows at 2.5 m x 2.5 m spacing (Figure 3-18). At this distance, 400 seedlings of bamboo and 400 seedlings of narra will be needed per kilometer of river bank, both sides.

Planted seedlings along the banks of the river need regular weeding, *i.e.*, once every 4 months, to liberate young seedlings. This is needed because along the river, vines are prominent competitors for light and they are known to strangle young seedlings to death. Kawayang tinik produces numerous suckers upon maturity, *i.e.*, more or less 8 years. To maintain a good stand, the removal of matured bamboo is required. Matured culms may be utilized or processed. Bamboo is an excellent source of raw material for light construction, basket making and other finished items that can provide additional income for farmers living along the river. No fertilization will be applied because river banks are relatively fertile due to regular inundation.

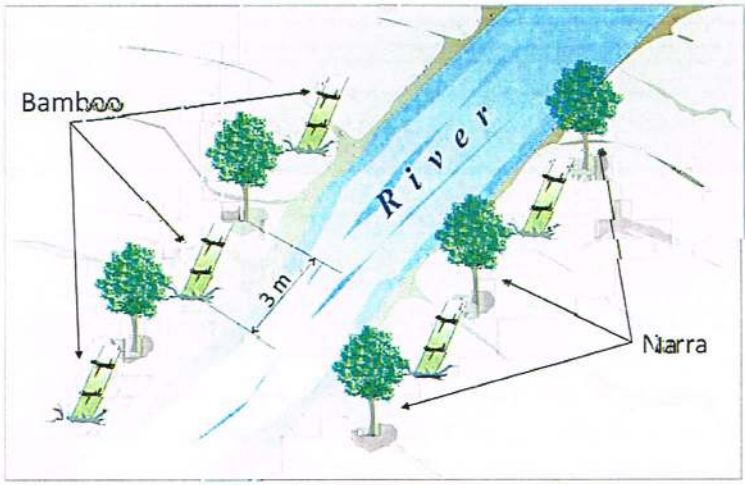


Figure 3-18. River bank stabilization model

- Establishment of a vegetated buffer zone along the perimeter and idle lands of the Project site. The buffer zone will serve as windbreaks, green belts, and corridors for wildlife. It will also enable the production of fuelwood and timber for the community on a sustainable basis and contribute to increasing carbon sink in accordance with condition no. 4 of the ECC (Annex 3).

  The best species observed in the area that can supply fuelwood and timber on a sustainable basis are Ipil-ipil (*Leucaena leucocephala*) and yemane (*Gmelina arborea*), respectively. Both species have excellent coppicing ability; hence for every cutting cycle, *i.e.*, 6 to 8 years for ipil-ipil and 8 to 10 years for yemane, the community need not plant again or start a plantation from seedlings. The technique is that stumps must be high enough, about 0.5 m, and that two vigorous sprouts must be left behind to regenerate for ipil-ipil and one vigorous sprout for Yemane. The rest of the sprouts must be removed to reduce competition in a single stump.

  Ipil-ipil is naturally growing in the area; thus, social acceptability is not a problem. No infestation is so far observed and the tree meets the required calorific value for fuelwood. In fact, naturally growing ipil-ipil in the site is one major source of fuel for cooking among the residents.

  In case of yemane as a source of timber, the species has the fastest growth rate. It needs only about 8 to10 years to mature. It is relatively hard as construction material and yet, it has good workability for furniture making. Unlike other trees, yemane needs no treatment against powder post beetle.

Photo 3-26. Three-year old Yemane (Gmelina arborea) growing vigorously in the Project site

Figure 3-19 is the planting design for idle land and buffer zone areas. Native Ipil-ipil, a slow growing plant, will have a planting distance of 2 m x 2 m. Yemane, a fast growing tree, has a planting distance of 4 m x 4 m. The required seedlings will be raised in the nursery. The estimated number of seedlings per hectare for ipil-ipil at 2 m x 2m is 2,500; for yemane at the planting distance, the requirement is 625. Clearing the plantation sites rather than the whole area is recommended. In this manner, wildlings or regenerants of other species are spared. This technique of site preparation is supportive of the present rehabilitation approach of the DENR known as Assisted Natural Regeneration (ANR). Soil amelioration or site treatment that will be employed is by fertilization using complete fertilizer (basal application twice a year) up to the second year only.

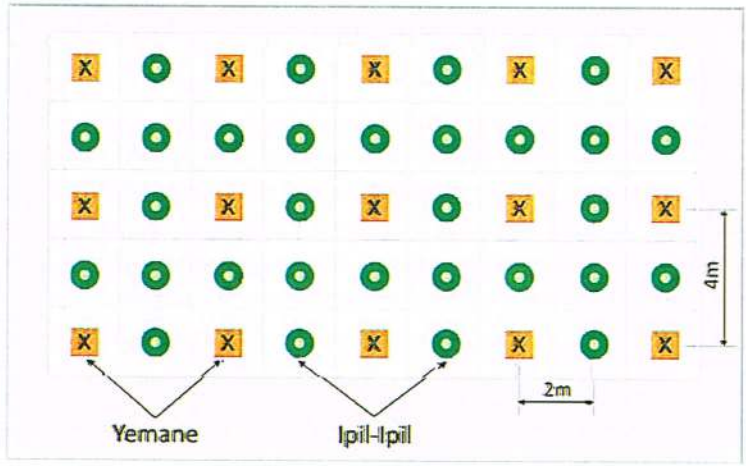


Figure 3-19. Planting design for idle land/buffer zone areas

To maintain and protect the plantation from competition, ring weeding twice a year (*i.e.*, June and December) will be done before fertilizer application. Regular monitoring will be also conducted to

determine if there are injurious insects and pests. At the later stage, sanitation cleaning and pruning of diseased branches will be conducted.

- Instruction to regular and contractual personnel not to harm or capture wildlife and proclamation of the construction or working sites as a wildlife sanctuary.

3.2 Water Resources

Climate Type

The climate at the Project site is classified as Type II under the Modified Coronas Classification (Figure 3-20). This climate type does not have a dry season. A very pronounced maximum rain period occurs from November to February.

Just like other parts of the country, the climate at the Project site is governed by two major climatic controls. These are air streams or masses and tropical cyclones.

The Northeast Monsoon[2], Southwest Monsoon, and the North Pacific Trades are the principal air streams. The Northeast Monsoon generally affects the country in October and gradually weakens in March. The Southwest Monsoon arrives in early May and gradually disappears in October. The North Pacific Trades is dominant in April and early May and over the central and southern Philippines in October. The air stream typically overlies the Northeast Monsoon over the eastern section of the country.

Tropical cyclones are destructive weather disturbances characterized by strong winds and heavy rains. They have a low-pressure center which is called the "eye" of the storm with no clouds and wind. In the northern hemisphere[3], the winds of a tropical cyclone blow around this low-pressure center in a counter clockwise direction with increasing magnitude nearer the center.

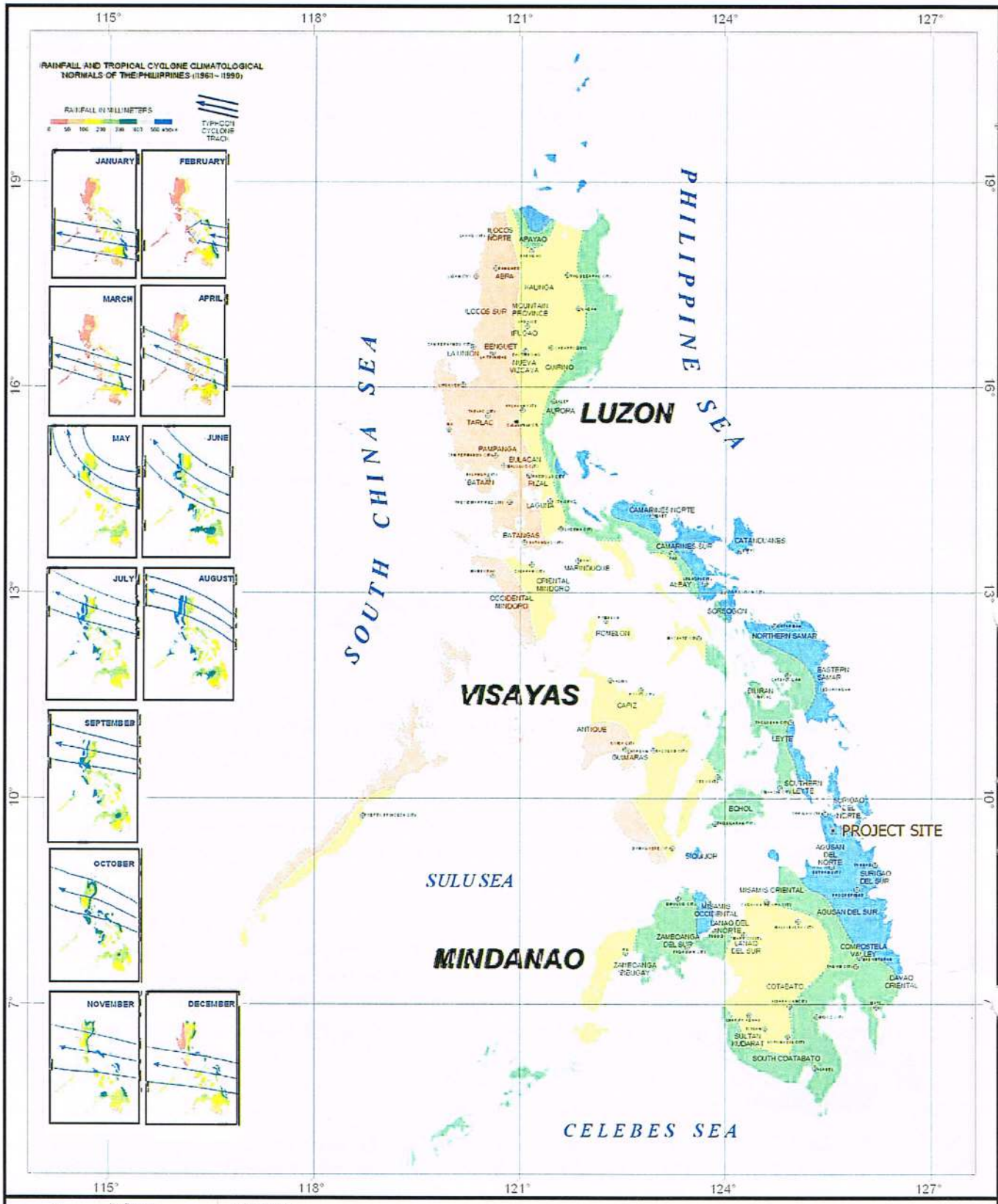
Tropical cyclones are classified in the Philippines according to the accompanying maximum winds. A tropical depression has winds of speed less than 63 km/h; a tropical storm has winds of speed from 63 to 117 km/h; a typhoon has wind speeds of more than 117 km/h.

The typhoon season begins in May and lasts until December. Tropical cyclones may form as early as January to April but these are relatively few in number. Most typhoons occur from July to September. According to the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA), an average of 22 typhoons hit the country each year. Of these, five will be destructive (Gonzales, 1994). The paths of tropical cyclones vary with the season. Figure 3-19 plots the average cyclone tracks for each month.

Rainfall Pattern

The synoptic station closest to the Siana Project site is PAGASA's Station 653 in Surigao City which is 30 km northwest of the site. The succeeding discussions on rainfall pattern are based on data gathered at the Surigao City station.

[2] A monsoon is defined as a seasonal shift in wind direction.
[3] The Philippines is part of the northern hemisphere.



Map Projection
Longitude - Latitude

Project Location
CARAGA Region
Surigao, Mindanao

0 50 100 150 Kilometers
GRAPHICAL SCALE

Source :
PAGASA

LEGEND :

TYPE I	Two pronounced seasons; dry from November to April, wet during the rest of the year.
TYPE II	No dry season with a very pronounced maximum rainfall from November to January
TYPE III	Seasons not very pronounced; relatively dry from November to April and wet during the rest of the year.
TYPE IV	Rainfall more or less evenly distributed throughout the year.

bmp

Climate map of the Philippines

EPEP of the Siana Gold Project

Figure No. 3-20

The climatological normals shown in Annex 4 are based on data compiled from 1971 to 2000. Annex 5 tabulates the climatological extremes based on various periods up to 2003. Annex 6 is the rainfall intensity-duration-frequency data.

Based on Annex 4, Figure 3-21 plots the mean monthly rainfall for Surigao City. The months of May to September are less wet, corresponding to the Southwest Monsoon. During this period, rains coming from the southwest are blocked by various landmasses. October to March, the period when the Northeast Monsoon is operative, are wet months. There is not much landmass, *i.e.*, only Dinagat Island, to block the incoming rains. From Figure 3-19 which plots the average cyclone tracks for each month, the heavy precipitation during the months of November to January is also due to the tropical cyclones. During the said period, the mean cyclone path passes very closely to the Project site. The mean annual rainfall stands at 3,556.4 mm.

Figure 3-21 also plots the greatest daily rainfall recorded for each month as extracted from Annex 5. In some months, *i.e.*, from April to December, the greatest daily rainfall exceeds the average total rainfall for the month.

The average number of rainy days per month is shown in Figure 3-22. The trend closely mimics that of the mean monthly rainfall.

Figure 3-23 is derived from the rainfall intensity-duration-frequency dataset of Annex 6. The two years' 24-hour storm has an estimated precipitation of 204.8 mm. For a hundred years' 24-hour storm, the computed rainfall is 593.6 mm.

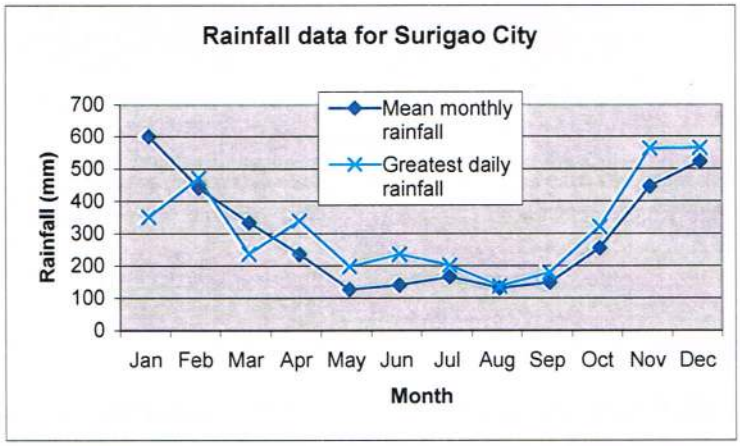


Figure 3-21. Line chart for mean monthly and greatest daily rainfall

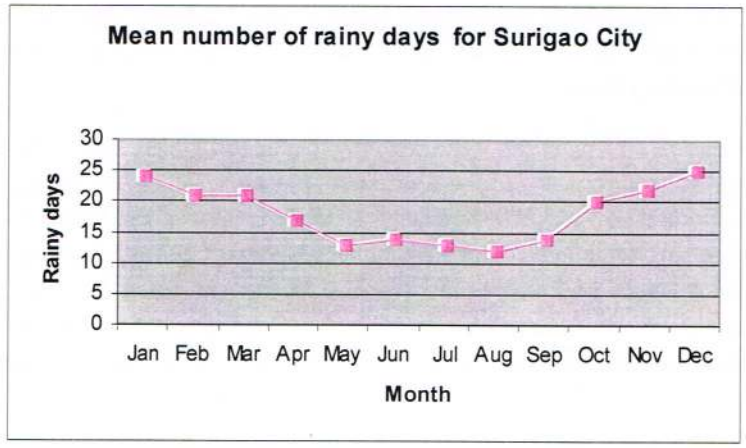


Figure 3-22. Line chart of mean number of rainy days

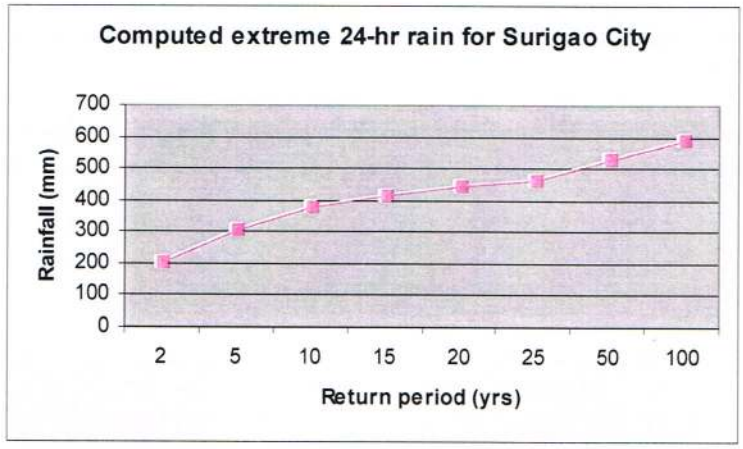


Figure 3-23. Estimated rainfall for 24-hour storms of various return periods

Natural Drainage System

As discussed previously, the 240-ha Project site is inside the 5,700-ha catchment of Magpayang River. The river, together with 27 other rivers and creeks, drains into Lake Mainit. The lake drains towards Bohol Sea.

From Figure 3-2, the Magpayang River catchment extends as far north as Brgy. Timamana, Tubod; Brgy. Magpayang, Mainit and Brgy. Pongtud, Alegria to the south; and Brgy. Candiis, Alegria to the southeast. The easternmost part of the catchment with slopes in excess of 50 % and where the Timamana Limestone occurs is forested. Forest growth is likewise found at the equally steep northwestern andesitic portion up to the vicinity of the access road to Lake Mahukdam. The gentler slopes adjacent to the forests comprising the transitional fringe of the stream corridor are planted to coconuts. At the alluvial plains of Magpayang River are the ricefields. Along the National Highway and secondary roads that lead to the other barangays are the built-up areas for settlements, markets, eateries, government offices, churches, and variety stores.

The dendritic Magpayang River is 15.3-km long. The river is a fourth-order single-thread stream that flows southeasterly from the headwaters in Brgy. Timamana, Tubod. Before reaching Brgy. Motorpool, the flow

becomes southwesterly. At Brgy. Marga, the flow switches again to the southeast. Starting at Brgy. Poblacion, the river generally flows southwesterly ultimately discharging into Lake Mainit. The overall slope or relief ratio of the Magpayang River is 0.51 %.

Table 3-3 lists and provides some details for the tributaries of Magpayang River. The karst topography at the eastern portion of the catchment reduced the surface water flow. This is apparent in the relatively smaller drainage density of the adjacent creeks, particularly the Spanish Ditch which partially drains the northernmost portion of the Project site, or the complete absence of streams.

Photo 3-27. The Timamana Limestone forest mixed with coconuts, grades into grasslands and ricefields in this stretch of Magpayang River at Brgy. Motorpool, Tubod.

Photo 3-28. Brgy. Cawilan residents bathe and wash their clothes at Magpayang River near the bridge (BMP, 2009).

Photo 3-29. The wide river channel of Magpayang River where Harrison Bridge that connected the National Highway to Brgy. Siana used to stand.

Photo 3-30. Access to Brgys. Siana and Dayano is through this dilapidated bridge from Brgy. Magpayang. The river channel is wide in this section.

Photo 3-31. The irrigation dam at Magpayang River for Brgy. Magpayang immediately upslope of the dilapidated bridge (BMP, 2009).

Photo 3-32. The middle reach of Dayano Creek immediately downslope of the pit water discharge.

Photo 3-33. This irrigation dam at Dayano Creek services the rice fields of Brgy. Siana (BMP, 2009).

Photo 3-34. Some fields at Brgy. Siana are irrigated by pumped water from Dayano Creek (BMP, 2009).

Photo 3-35. The confluence of Dayano Creek and Magpayang River.

Photo 3-36. Magpayang River downslope of the Dayano Creek confluence. The channel is wide.

Photo 3-37. The Spanish Ditch that drains the northern portion of the Project site.

Photo 3-38. Fishing at Lake Mainit. The fisherfolks reported declining fish catch over the years due to overfishing and destructive fishing practices.

Table 3-3. Tributaries of Magpayang River

Tributary	Stream Order	Total Length (m)	Subcatchment Area (ha)	Overall Slope	Drainage Density (m/ ha)
Unnamed Creek 1	2	3910	420	2.5 %	9.4
Timamana Creek	2	5660	600	7.2	9.5
Motorpool Creek	2	2655	285	3.7	9.3
Unnamed Creek 2	1	1380	75	4.8	18.6
Unnamed Creek 3	2	2010	190	4.5	10.6
Lambuyo Creek	1	1175	55	5.2	20.6
Hubasan Creek	1	1755	110	5.2	15.7
Unnamed Creek 4	2	2825	155	2.8	18.3
Tubod Creek	1	3515	210	3.1	16.9
Poblacion Creek	2	3555	205	3.6	17.2
Unnamed Creek 5	2	4555	230	2.1	19.8
Tinag-an Creek	2	3295	165	1.4	20.2
Unnamed Creek 6	1	725	35	5.7	20.7
Unnamed Creek 7	1	790	35	2.1	22.6
Cawilan Creek	2	3700	540	7.3	6.8
Spanish Ditch	1	1200	270	5.7	4.4
Dayano Creek	4	7245	915	3.3	7.9

Notes:

1. Stream ordering follows the Strahler System.
2. The overall slope is a weighted average using five sections along the channel.
3. Drainage density is total stream length divided by the subcatchment area.

Source: BMP, 2009

The Spanish Ditch to the north, Magpayang River to the west, and the Dayano Creek to the south drain the Project site.

Availability and Source of Water

Figure 3-24 is the regional geological map covering the Project site and the Magpayang River catchment. The underlying lithologic formations allow groundwater flow in varying degrees. For the highly permeable sand and gravel deposits of the Quaternary Alluvium, the groundwater occurs mainly in unconfined condition. For the Timamana Limestone, the solution cavities and karstic nature are favorable to groundwater flow. The other stratigraphic units such as andesites and basalt allow groundwater flow either through the weathered mantle, solution-enlarged joints and fractures, or bedding planes (MGB, 2003).

At the Project site, three main aquifers are inferred (Meyer Water Environmental Solutions [MWES], 2007):

- Alluvial aquifer which is 6 to 12 m thick and located beneath the near-surface soils. It comprises yellow, orange and brown sands and gravels with inter-layered clays.
- Saprolite aquifer is within the highly weathered bedrock and above the fresh bedrock.
- Bedrock fractured aquifer which includes volcaniclastics, basalts on the eastern side of the pit, and karstic limestone.

The results of GRC-commissioned geotechnical investigation and monitoring of water levels around the tailings dam and proposed process plant site suggest that the groundwater in the deeper aquifers flows towards the Siana open pit from the north and west. Groundwater in the near-surface alluvial aquifer flows towards Magpayang River from the east and northeast and the area of the existing tailings dams.

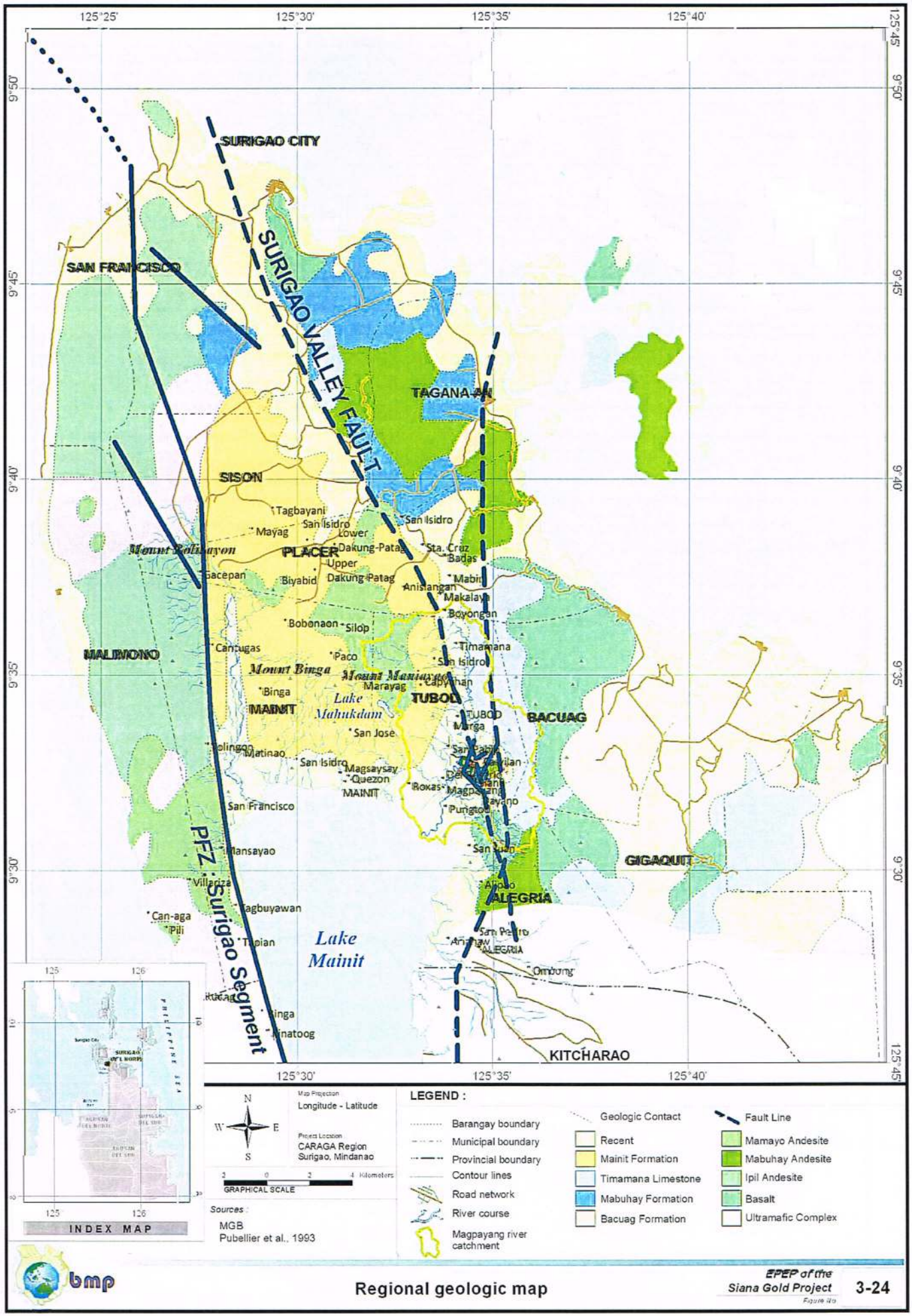
The local residents rely on the Magpayang River for their agricultural needs, washing of clothes, bathing, and care for their animals. The river is also a source of fish.

Water to irrigate the rice fields on the alluvial plains is extracted either by pumping or through irrigation canals (Figure 3-25). At Brgy. Marga, river water is diverted into the irrigation channels of that barangay and Poblacion. Downstream of the discharge point of SURICON's old tailings pond and immediately upstream of the bridge that connects Brgy. Siana to the National Highway is the irrigation intake for the rice fields of Brgy. Magpayang.

The water of Cawilan Creek is also used to irrigate the rice fields. Along Dayano River, downstream of the discharge of the Siana pit, is an irrigation dam for the ricefields of Brgy. Siana. Pumps are also installed at some sections of the river for the fields outside of the irrigation network.

The Siana Pit water is used for washing clothes and bathing by the residents. In 2005, fish cages with fingerlings provided through the DSWD-CIDDS program were observed inside the pit. Currently, the fish cages no longer exist.

Up to 2005, springs and shallow wells are the sources of potable water in Brgys. Cawilan, Siana, and Dayano (Figure 3-25). Songkoy Spring near Lake Mahukdam, which is hosted by diorite and floats of andesite, provides drinking water to Brgys. Marga, Poblacion, San Pablo, Del Rosario, and Cawilan of Tubod and even Brgy. Magpayang of Mainit. A spring in Brgy. Dayano, in an andesite porphyry, provides drinking



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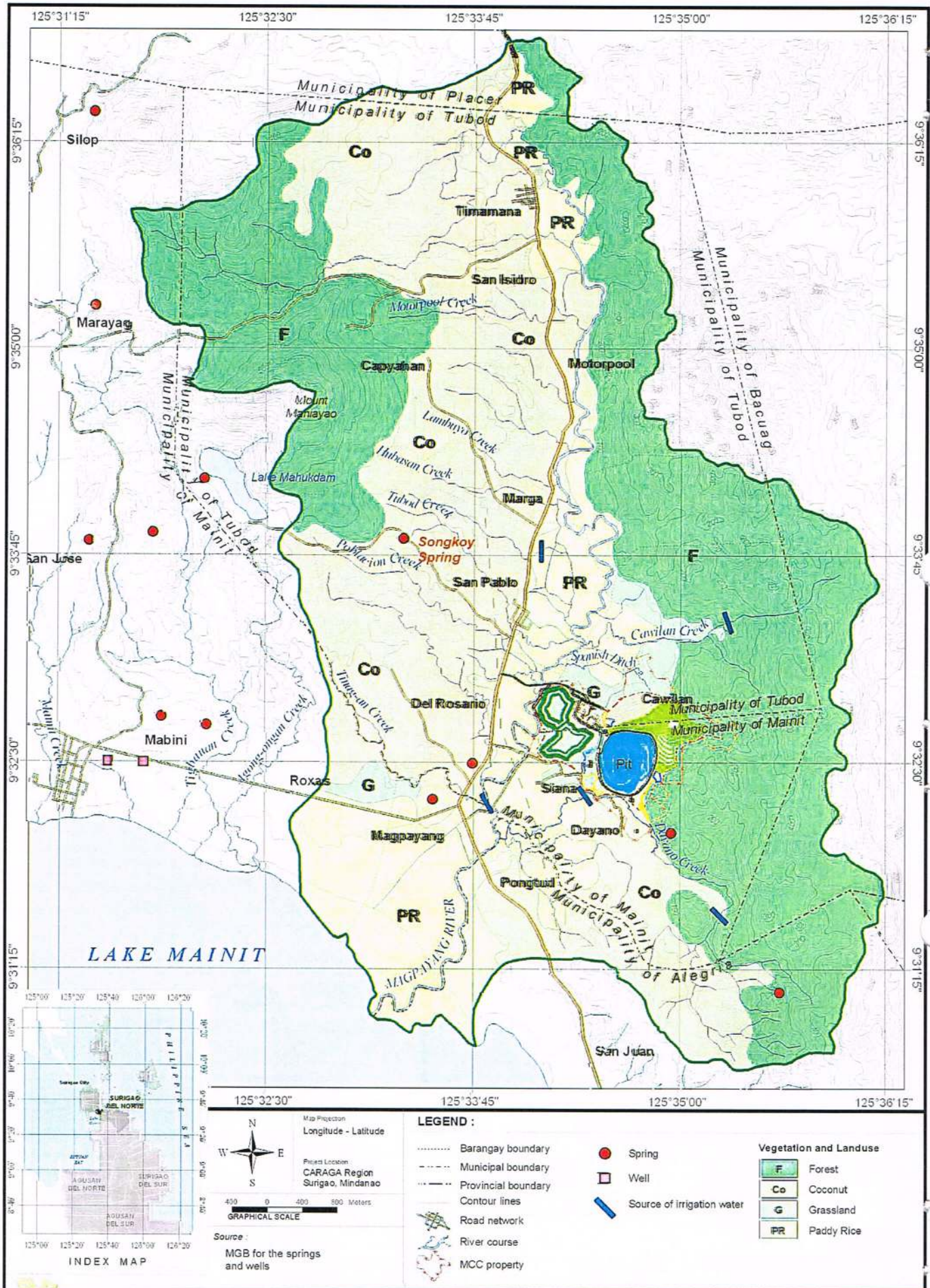
Regional geologic map



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Springs, wells, and irrigation dams

water to that barangay and Brgy. Siana. Brgy. Pongtud residents get their potable water from a spring and shallow well.

In 2005, GRC established a potable water supply and distribution system for the direct impact barangays. The water source is the open pit. Treatment consists of chlorination and filtration.

3.2.1 Pit and Underground Mine Dewatering

Initial Pit Dewatering

The Siana open pit has accumulated about 8.2 million m^3 of water. This water will be continuously pumped out into Dayano Creek at a rate that will maintain at least 20-m clearance between the working bench floor and water level. GRC has programmed the dewatering for 6 months. Taking into account the additional inflow of 0.6 million m^3 of rainfall and 2.8 million m^3 of groundwater during the dewatering period, the required pumping rate is 780 L/s. GRC proposes to use four pumps, each powered by a 375 Kw electric motor governed by variable speed drives with a combined capacity of 800 L/s over a 100 m head. The pumps would be mounted on a floating pontoon and discharge into parallel 450 mm diameter HDPE pipes to be extended as the water level falls. Pipes will discharge into a drainage channel which overflows into Dayano Creek (MWES, 2007).

Slimes, currently estimated at 10 m thickness equivalent to 240,000 m^3, have accumulated at the pit bottom. During pit dewatering as the water level approaches the pit floor, a 10 m long flexible suction hose will be attached to the pump inlet. The suction hose will hang straight down and act like a dredge in sucking up slurry. During this process, the slurry density being discharged will be monitored continuously to prevent blockage. If necessary, clear water will be brought back to the pit. It will take roughly 12 months for mining to reach the level so a large quantity of the slimes can be pumped out. To complete the final clean-up, 12-m deep voids will be blasted on either side of the existing pit floor. Dewatering sumps are excavated and the dewatering pump installed. The swell of the blast is dozed and side cast to mix with the slimes on the pit floor (GRC and Intermet Engineering, 2007).

During the EIA for the Siana Project, conductivity and DO saturation were measured at various water depths of the pit. As expected, conductivity increased at depth, reaching 596 µs/cm at 90.8 m below surface. DO saturation decreased, bottoming out to 35 %.

Another multi-depth sampling followed for pH, Hg, As, Cu, and Pb. The combined sampling results yielded a Class AA classification for the pit water (BMP, 2009).

Open Pit Operations

During pit operation, groundwater inflows into the pit, estimated at 5.9 million m^3 annually, and pressures on the pit walls have to be managed. GRC will install 7 dewatering bores outside of the pit perimeter to the east. Two bores are located in the southeast and southwest through the karstic limestone, three bores are in the eastern pit wall. The limestone bores are equipped with 50 L/s submersible pump each; the eastern bores with 17 L/s individual submersible pumps. Siting of the boreholes was based on the open fractures or cavities inferred from core images, geotechnical logs, and lithology logs (*Ibid.*).

Apart from the groundwater inflows, 1.06 million m^3 of rainfall is expected to flow into the pit annually. Most of the rainfall occurs between November and March. GRC's pit water management plan provides for the pump-out of rainwater over a 3-month period at 0.6 million m^3 monthly which is equivalent to a

minimum of 230 L/s. For the remaining nine months, the pumping rate is a minimum of 115 L/s. GRC will put up a static booster slurry pump at -50 m RL to receive pit water from a pontoon mounted slurry pump. A duplicate system will provide 100 % back-up in case of failure. Sumps will be established in the waste in the pit floor as mining progresses deeper to provide surge capacity. The two pumps in series will be linked telemetrically (*Ibid.*).

Underground Operations

Mine dewatering is likewise needed during underground mining operations. MWES estimates water inflows up to 6,000 m^3/d, equivalent to 70 L/s, from the bores and shafts and up to 3,000 m^3/d, equivalent to 35 L/s, from the development workings. GRC proposes to install two primary pumping systems with a maximum capacity of 120 L/s that will remove water from the underground workings for conveyance to pit-based sump pumps at -140 m RL. The pumping systems, consisting of banks of 7 x WT103 helical rotor pumps with an installed power of 55 kW each, will be located at the –262 m RL and -400 m RL. Water from the working faces will be collected and conveyed by sump pumps to mobile WT103 pump tanks. These pump tanks then convey the water to the primary pump stations.

3.2.1.1 Impacts

The impacts of the pit and underground mine dewatering relate both to water quantity and quality along the receiving water bodies, chiefly the Dayano Creek. In order that the impacts are acceptable, the following must be satisfied:

- Physical stability and geometry of the channels of Dayano Creek must be preserved. This requires the non-exceedance of the creek's drainage capacity and the non-abrupt changes in inflow and sediment load of the creek.
- Maintenance of creek water clarity to sustain the water's utility for washing, bathing, and irrigation.
- Compliance of discharge water with DENR standards on pH, oil and grease and heavy metals. Based on the analyses of waste rocks and tailings solids, the metals of concern are Fe, Mn, Pb, Zn, As, Cd, and Hg. Table 3-4 provides the relevant standards.

Table 3-4. Limits of impact parameters for Project effluents

Parameter	Max. Allowable Value, DENR AO 35	
	Class A	Class C
pH	6.0 – 9.0	6.5 - 9.0
Total Suspended Solids (TSS)	50	70
Total Dissolved Solids (TDS)	1,000	No Standard
Oil and Grease	5.0	5.0
Iron* (as dissolved Fe)	1.0	10.0
Manganese* (as dissolved Mn)	1.0	1.0
Lead (Pb)	0.1	0.3
Zinc*	5.0	5.0
Arsenic (As)	0.1	0.2

Parameter	Max. Allowable Value, DENR AO 35	
	Class A	Class C
Cadmium (Cd)	0.02	0.05
Mercury (Hg)	0.005	0.005

Notes:
1. Except for pH which is unitless, all values are in mg/L.
2. Dayano Creek is classifiable either as Class A or Class C waterbody based on the series of water samplings and the criteria of DENR AO 34, Series of 1990. The final classification will be made by EMB.

Sources: DENR AO 35, Series of 1990, except those with asterisks which were lifted from PD 984, Effluents Regulations of 1982.

- Maintenance of water feed for the potable water system. This system presently draws water from the open pit. The community water system established by GRC for Brgys. Siana, Dayano, and Cawilan will be expanded to accommodate the potable water needs of Project personnel.
- Non-disruption of wells or springs discharges downslope of the Project site.

3.2.1.2 Control Strategy

The control strategies implemented for the water quantity include the following (BMP, 2009):

- Topographic and bathymetric survey of the river banks and channel commencing from the pit discharge into Dayano Creek, along Magpayang River, down to its mouth in Lake Mainit. The survey stations were selected based on changes in river cross-section, tributary occurrence, and bends or changes in flow direction.
- Runoff and flood simulation using the USEPA Storm Water Management Model and 2003 daily rainfall data and rainfall intensity-duration frequency curve for Surigao City. The total rainfall data recorded for that year was 4,073 mm which exceeded the mean annual rainfall of 3,573 mm for the period 1984 to 2004. The simulation used rainfall data for the less rainy months of April to September. The two diversion gates of the irrigation dam along Dayano Creek were assumed fully open. Two cases were investigated: the baseline case without pit dewatering and the pit dewatering case at GRC's planned pit water discharge of 780 L/s.

  For the dewatering case which lasted for 166 days, there were 56 flooding days. This is 6 days more than the 50 days of flooding for the same period without dewatering. The observed extension of the overflow period is from 3 to 6 hours. No significant difference is observed on the overflow depth between the baseline and dewatering cases.

  In view of the favorable simulation results, the pit dewatering at a rate of 780 L/s will be conducted during the period April to September. The water will irrigate the rice fields of Brgys. Siana, Magpayang, and Pongtud.
- The programmed open pit dewatering rates during operation are 151 L/s for the seven bores located east of the pit and 115 to 230 L/s for the pit sumps. These total 266 to 381 L/s.

  For the underground operations, the dewatering rate is 120 L/s. Pit dewatering will continue during underground mining to ensure safety for the workers. Hence, the total dewatering rate is 386 to 501 L/s. This is from 49 % to 64 % of the initial pit dewatering rate.

- Abstracted water from the seven bores will go to the potable water system. Any deficiency will be filled by additional wells to be sunk.

- The current understanding of the groundwater system in the area is that groundwater in the deeper aquifers flows towards the Siana open pit from the north and west. Groundwater in the near-surface alluvial aquifer flows towards Magpayang River from the east and northeast and the area of the existing tailings dams. To ensure that the flow of wells and springs downslope of the Project site is not impacted by the dewatering, their flows will be monitored regularly. If any adverse impact in flow by the Project is confirmed, replacement water will be provided.

For water quality, the control strategies are:

- Sediments are not expected to be a problem during the first months of pit dewatering. However, as the water level recedes and sediments flow out with the water, water filtration will become necessary.

  The settlement of fine silts will be achieved with the use of sediment settling ponds and geotextile tubes. The tubes will capture silts that bypass the ponds which discharge to the Dayano Creek. Geotextile tubes have been successfully applied to the filtration of waste materials with high water content and high percentage of fine particles passing 74 μm. A tube is constructed by sewing one or more layers of permeable but soil-impermeable geotextiles together to form a container that will retain a saturated material. During filling, the geotextile tube is pressurized with the soil-water mixture, allowing discharge of the liquid through the fabric pores but retaining the solid particles. The result is a "soil sausage" with lower water content and high percent solids. The shear strength of the solids will increase with time making them suitable for use as a construction material (Moo-Young *et al.*, undated).

  To evaluate factors affecting the filtration and dewatering capacity of geotextile tubes, Moo-Young *et al.* (undated) conducted pressure filtration tests on five different types of high-water content materials. The test results showed filtration efficiencies in excess of 90 %. Although most of the solid particles in the materials have a grain size much smaller than the apparent opening size of the geotextiles, the geotextiles still retain a very high percentage of the solids. The workers concluded that the mechanism of filtration depended on the porous structure of the geotextile and the formation of a filter cake inside the geotextile. In turn, the latter depended on sludge properties such as porosity, viscosity, and specific gravity; geotextile hydraulic properties; flow condition, and filtration pressure.

Photo 3-39. A typical layout of geotextile tubes in a construction site.

Apart from filtration efficiencies, the other advantages of geotextile tubes are:

- They are not a mechanical device. Hence, they will not break down or malfunction like a centrifuge, belt press, or vacuum or drum filter.
- Tubes can be used for short-term or permanent containment.
- They can be stacked to minimize space requirements and maximize storage capacity.

Geotextile tubes will be installed prior to the Dayano Creek discharge.

- Oil and grease will require the following management measures: training of personnel on proper oil handling, drip trays, oil spills containment, and the collection, containment, and disposition of used oil.
- The heavy metals in the waste rocks and ores are not expected to dissolve in alkaline water. Nonetheless, daily sampling of the pit sumps for pH and occasionally for heavy metals will be undertaken to ensure that the water to be discharged is compliant with DENR standards.

3.2.2 Waste Rock Dump

As discussed in Section 3.1.4, waste rocks, soil, and clays from the open pit and underground mine, which are not needed for TSF construction, will be deposited in the WRD or CLF. In view of the excess storage space, the two facilities can also accommodate the waste rocks and soil from the other Project construction sites. These sites include the access road, sanitary landfill, drainage channels, settling ponds, and other construction sites.

3.2.2.1 Impacts

The impacts to water resources associated with the WRD and CLF include total suspended solids (TSS) or turbidity, pH, oil and grease from the earthmoving equipment, and heavy metals found in the waste rocks.

In order to be acceptable, the surface runoff at the point of discharge to Dayano Creek must be compliant with the relevant DENR effluent water quality standards (Table 3-4).

3.2.2.2 Control Strategy

The control strategies include the following:

- Acid-base accounting of waste rock samples obtained from the waste wall zone of the Siana deposit. Acid-base accounting is a two-part analytical procedure for determining both the acid potential and neutralizing potential of waste rocks. Based on the results, waste rock management measures consisting of waste rock classification and placement to prevent the generation of acid mine drainage (AMD) and dissolution of heavy metals may be formulated.

BMP (2007) undertook the acid-base accounting of waste rock samples. Samples were taken from each of the seven lithodomains of the deposit, which are conveniently classified into Domains 100, 200, 300, 400, 500, 600, and 700. The test results indicate that:

1. Domains 200, 300, and 500, which represent 24 % of the estimated waste rocks, are non-acid-forming (NAF).
2. For Domain 100 which makes up about 33 % of the total waste rocks for extraction, only 13 % of the total 15 samples is potentially acid-forming (PAF).
3. For Domain 400 which is about 27 % of the estimated waste rocks, 15 % of the total 13 samples is PAF.
4. For Domain 600 which is roughly 16 % of the estimated waste rocks, 38 % of the total 8 samples is PAF.

As environmental safeguard, BMP (2009) recommended Net Acid Generation (NAG) pH=4 tests on blasthole cuttings as required of Domain 600 primarily and Domains 100 and 400 secondarily. PAF rocks will be deposited in the WRD in a manner that will prevent AMD.

- Stabilization and revegetation of disturbed areas within 100 m of a water body to prevent erosion and to intercept sediments. The revegetation will use understory species such as *Callopogonium muconoides* and wild daisy; riverbank species like bamboo, kawayang tinik, and Narra; and tree species for fuelwood and timber such as Ipil-ipil and yemane.
- Maintenance of the design batter slope angles, safety berm widths, and overall slope angles for the WRD and CLF.
- As discussed in Section 3.1.4.2, immediate revegetation of WRD and CLF slopes as soon as practical with fast growing vines and grasses. The recommended species are *Callopogonium muconoides* and wild daisy (*Wedelia biflora*).
- Good housekeeping practices for the construction and operations crew to prevent the release of oil and grease and waste materials into the river.
- Stormwater management and sediment control system. Clean surface runoff from the areas east of the Project site will be diverted around the WRD and CLF northward and southward. The northward runoff will go to the Spanish Ditch and exit to Magpayang River upstream of the Cawilan bridge. The southward runoff will report to Dayano Creek.

  There will be no mixing of dirty water from the WRD and CLF with clean water from the eastern highlands. The clean water will be diverted to the Spanish Ditch and the Dayano Creek along channels that will be kept separate from the dirty water channels. The dirty water will pass through silt traps located upslope of the receiving water body.

  CLF surface runoff is split into northern and southern portions. Drainage channels along the perimeter of the CLF bring the runoff to Silt Trap A. The silt trap discharges water to the northern portion of Pond A. The pond overflows into a drainage channel that connects to the TSF3 spillway and then Pond B. Pond B has an overflow channel that discharges to Dayano Creek. Geotextile tubes will do a final filtration of the surface runoff before discharge.

The WRD surface runon is also split into northern and southern portions. The northern portion reports to Silt Trap A. The southern portion is further divided into the southwestern, central, and southeastern splits. The southwestern split reports to Pond A. The central split flows to the perimeter road ending in Silt Trap B. This drainage channel ultimately discharges to the channel that connects Ponds A and B. The southeastern split drains along the eastern side of the WRD discharging into Silt Trap C. The trap also receives the water pumped out of the open pit and underground mine. From the silt trap, the water goes to the eastern drainage channel and then the Dayano Creek after passing through geotextile tubes.

- Regular maintenance of the drainage channels, geotextile-based silt traps, and Ponds A and B. This involves the cleaning of channels, stabilization of eroded channel walls, replacement of geotextile tubes, and unloading of sediment impounded in the ponds to maintain the sediment trapping efficiency. The unloaded sediment is deposited in the WRD, dried, and compacted to prevent re-suspension in the surface runoff.

3.2.3 Process Water

It is estimated that for a monthly ore production of 62,500 t, about 130,000 m^3 of water is needed for slurry production. Adding a 5 % allowance for losses, the total monthly water requirement is roughly 136,500 m^3. Approximately 75 % of this or 104,000 m^3 is expected to be supplied from the release of water during the settlement of tailings in the TSF. The other 25 % or 32,500 m^3 of water will have to be obtained from rainfall accumulation in the TSF or from fresh water makeup sources.

Water balance studies conducted by GHD (2009) for open pit mining operations disclosed that only during the three months of Stage 6 will rainwater be insufficient, thereby requiring make-up water from other sources.

Figure 2-7 is the Project's gold cyanidation flowsheet. The chemicals to be used are lime, HCl, NaOH, NaCN, $CuSO_4$, SMBS, and activated carbon. Of these chemicals, five have significant NFPA hazard ratings in terms of health, flammability, reactivity, and contact. These chemicals are listed in Table 3-5.

Table 3-5. Chemicals with significant hazard ratings

Chemical	NFPA Hazard Ratings			
	Health	Flammability	Reactivity	Contact
$CuSO_4$	2	0	0	---
NaCN	3	0	2	3
NaOH	3	0	1	3
HCl	3	0	2	3
SMBS	2	0	1	3

Notes: NFPA is National Fire Protection Association. A hazard rating of "0" means no hazard; a rating of "4" means extreme hazard.
Sources: MSDS of chemicals.

Of the five chemicals, the most widely used by the Project is NaCN with an annual requirement of 700 t. This is followed by SMBS with an annual requirement of 680 t, $CuSO_4$ at 108 t, HCl at 100 t, and NaOH at 80 t.

The Project will also use diesel to power its standby generator set and the mining fleet and vehicles. Oil will also lubricate the equipment. Apart from its flammability, diesel and oil, when spilled to the environment, can degrade the creeks and rivers and destroy aquatic organisms and habitats.

Apart from the chemicals, the process water, as it goes through the CIL leaching, will be enriched in the heavy metals present in the Siana ore. Based on the average head assays of the metallurgical testworks, the metals of concern are Fe, Mn, Pb, Zn, As, Cd, and Hg (MCC, 2009).

3.2.3.1 Impacts

The chemicals and the process water pose significant risks to the Project personnel, especially those working in the process plant. In fact, based on DENR AO 36, Series of 2004, they are classified as hazardous, *e.g.*, NaCN - cyanide wastes, HCl – acid wastes, NaOH – alkali wastes, and SMBS – oxidizing agents. When released to the environment, the process water can kill organisms including humans, destroy aquatic habitats, and degrade the river environment.

Hg is present in the process plant ore feed at about 0.6 ppm. It can be leached by cyanide, adsorbed by the activated carbon, and then recovered in the elution circuit. Hg poses health risks to Project personnel especially during carbon regeneration.

3.2.3.2 Control Strategy

The control strategies include:

- Conduct of full-blown hazards analysis and environmental risk assessment that focused on chemicals, among others. Based on the release scenarios, risk management measures were formulated. The measures included:

    1. No deliveries of reagents to the Project site during inclement weather.
    2. Sturdy packaging and non-mixing of incompatible reagents during transport.
    3. Restricted access to chemical unloading, storage, and mixing.
    4. Safe vehicle speeds during transport.
    5. Special training, personal protective equipment (PPE), and emergency kit for truck crew and Project handling and emergency personnel.
    6. Sealing, bunding and grading for the collection of spills. The area of the process plant containing the grinding section, leaching circuit, detoxification circuit, process water tank, elution circuit, reagents area, tailings pumps, and process water pumps will be constructed on a concrete pad and bunded. As additional safeguard, a concrete secondary containment pond located west of the process plant will collect rainfall and any bund overflows. All spills contained within the mill bunded area are pumped back to the mill circuit. Tailings containing cyanide (CN) are brought to the detoxification plant prior to pump-out to the

TSF. Water collected at the secondary containment pond is tested for CN and pH and depending on the results of the tests, the water is unloaded daily and brought either into the site drainage system or the detoxification circuit.

7. Sealing, bunding, oil-water separators, and oil collection. The fuel storage and dispensing area located east of the process plant beside the main office will likewise be concreted and bunded to contain any oil spills. Oil-water separators will be installed at the mine workshop and plant workshop areas. A used oil storage will be built within the mine services area.

8. Use of a mercury scrubber at the process plant.

9. CN detoxification of tailings prior to discharge to TSF. GRC evaluated both the Caro's acid and SO_2/Air processes as the CN detoxification method for the Siana tailings. It found the latter more effective and economical. In the worst case, free CN in the process discharge measured 0.03 mg/L which is way below the 0.2 mg/L standard of the DENR.

   Figure 3-26 illustrates the piping and instrumentation diagram of the CN detoxification circuit to be installed in the process plant. The circuit will be two-reactor and single stage. The carbon safety screen underflow, *i.e.*, tailings, will report to the first of two cyanide detoxification reactors. At the reactor, the slurry will react with SMBS and $CuSO_4$ solutions. Air is sparged into the reactor and the slurry pH maintained at 10 with the addition of lime slurry.

10. Availability of eye wash, shower, and emergency kit at the reagent storage, reagent mixing, and process plant area.

11. Pipes are color-coded, protected from foot or equipment movement, and built in sections with emergency shut-off valves.

The "hard" measures will be incorporated into the engineering plant designs by the EPCM contractor.

- QA system during the plant construction.
- Training of operators on the proper handling, emergency procedures, and disposition of chemicals.
- Implementation of a mechanical integrity program with the following elements: identification and categorization of equipment and instrumentation, inspections and tests, testing and inspection frequencies, development of maintenance procedures, training of maintenance personnel, establishment of criteria for acceptable test results, documentation of test and inspection results, and documentation of manufacturer recommendations as to mean time for failure for equipment and instrumentation.

3.2.4 Tailings Storage Facility

The Project's process plant will crush and grind the ore. After the gold is extracted, the ground materials will pass a CN detoxification circuit. The CN-cleansed tailings are then deposited at the TSF.

CIL TAIL
30-SCR-07
161-PI-301

SMBS
50-PMP-17/18

COPPER SULPHATE
50-PMP-14/15

LIME
50-PMP-11/12

XXX-SB-PE6-25-XXX

XXX-CU-PE6-25-XXX

XXX-SL-SC1-25-XXX

XXX-SM-PE6-50-XXX

FE FIT FIC

AV

AALL AAL AIC

AIT

AE pH

REAGENTS 1
161-PI-501

LAH LSH/L

30-PMP-14

PLANT SPILLAGE POND

XXX-SD-PE6-90-XXX

SI

25BA1.XX

LAH LSH/L

30-PMP-13

30-TNK-07
30-AGT-07

30-TNK-08
30-AGT-08

XXX-SD-SR1-300-XXX

XXX-SD-SR1-300-XXX

FV FAL FIC FIT FE

FV FAL FIC FIT FE

LE LIT LAH LIC

FV

XXX-SD-SR1-250-XXX

25BA1.XX

30-PMP-09

XXX-SD-SR1-250-XXX

25BA1.XX

30-PMP-10

XXX-SD-SR1-200-XXX

SI

25BA1.XX

FV

XXX-SD-PE6-200-XXX

TSF

FV

SI

25BA1.XX

XXX-SD-SR1-200-XXX

30-CMP-01

PANEL

30-CMP-02

VENDOR PACKAGE

XXX-AL-SC1-300-XXX

XXX-AL-SC1-300-XXX

FV
15BA1.XX

XXX-AL-SC1-300-XXX

FV
25BA1.XX

XXX-WG-SC1-15-XXX

15CH1.XX

PI
15BA1.XX

SI

FV
25BA1.XX

25X15

XXX-WG-SC1-15-XXX

15CH1.XX

PI
15BA1.XX

SI

GLAND WATER
60-PMP-04/05

XXX-WG-SC1-25-XXX

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CLIENT: RED 5 LIMITED

CONTRACT/ENQUIRY: 161

SUBJECT: SIANA GOLD
Figure 3-26 DETOX
PIPING & INSTRUMENTATION DIAGRAM

SCALE: A1

DRG. No.: 161-PI-302

REV. No.: A

REVISIONS

REV	DESCRIPTION	DRN	CHK	ENG	DATE
A	PRELIMINARY				

REFERENCE DRAWINGS

DRAWING No.	DESCRIPTION
161	

DRAWN	
CHECKED	
DISCIPLINE ENGINEER	
PROJECT MANAGER	
CLIENT	

The tests for engineering properties carried out on the process tailings and remined tailings samples found that about 35 % and 30 % of the remined and process tailings are clay sized, *i.e.*, diameter less than 2 µm. Settling tests established that due to the high clay content, the particles settle at a slow rate. Tailings consolidation is also slow. From these tests, it may be inferred that, without additional treatment, some of the clay and fine silt portions of the tailings solids will remain suspended in the supernatant water and be released into Dayano Creek. Retention ponds and subsequent geotextile tubes will be used to mitigate against the excessive discharge of suspended sediment.

Apart from engineering property tests, geochemical testworks were also undertaken on a metallurgical laboratory prepared sample of process tailings and tailings slurry water. The tests found that the process tailings solid sample is NAF due to the strongly calcareous minerals. The tailings slurry water was found to have concentrations of minor elements, including cyanide-complexing metals and CN forms, which were below or close to the detection limits (Graeme Campbell & Associates Pty Ltd, 2006).

The composition of the tailings solids was analyzed. The solids were found to contain Al at 7.33 %, Ca 8.71 %, Fe 6.4 %, K 2.43 %, Mg 1.11 %, As 131 mg/kg, Cr 197 mg/kg, Cu 272 mg/kg, Mn 4425 mg/kg, Pb 1126 mg/kg, Zn 1629 mg/kg, Cd at 7 mg/kg, and Hg 0.70 mg/kg (*Ibid.*). The heavy metal content of the tailings solids is comparable to that of solid samples taken from SURICON's tailings dams.

For the design of the TSF, GHD (2009a) conducted water balance studies. The studies used the rainfall records of Surigao City from 1961 to 2004, the slurry and settled properties of tailings, process water requirements, evaporation records of the Tagum climate station in Davao, and assumed seepage rates of 1,200 m^3/mo for TSF3 and 900 m^3/mo for TSF4. The study results indicated that excess process water and stormwater need continuous pump-out of the TSF to minimize the volume of supernatant in the facility. The supernatant will initially be pumped to Pond A for reuse in the process. Excess water of Pond A will flow to Pond B. Pond B will discharge water to Dayano Creek through an overflow channel and geotextile tubes B.

Table 3-6 presents the results of water balance studies for TSF3 and TSF4 assuming average rainfall years. Over the life of the open pit mine, the volume of excess water in the TSFs is approximately 2.7 million m^3.

Table 3-6. Combined water balance of TSF3 and TSF4

Stage	TSF3 Excess Water (m^3)	TSF4 Excess Water (m^3)	Net Excess Water (m^3)
1	-	-	-
2	757,000	56,000	813,000
3	317,000	210,000	527,000
4	127,000	-84,000	43,000
5	236,000	236,000	472,000
6	30,000	-68,000	-38,000
7	553,000	299,000	852,000
8	-	-	-
Total	2,020,000	649,000	2,669,000

Source: GHD, 2009a

Future water balance studies will include tailings produced from the milling of ore extracted from the underground operations.

3.2.4.1 Impacts

So that the impacts of tailings and the TSF to water resources are acceptable, the following conditions must be fulfilled:

- The tailings solids must be fully contained within the TSF. Hence, the following pathways for tailings solids release should be avoided:

    1. As an extreme event, an embankment break
    2. Tailings slurry water overtops the TSF
    3. Excessive seepage through the embankment
    4. Infiltration of the groundwater
    5. Leak from the tailings delivery pipe.

    The United Nations Environment Programme (2001) identified the typical causes of tailings dam failures as poor water management, overtopping, drainage failure, piping, erosion, foundation failure, and earthquake.

    Poor water management, *i.e.*, surface runoff routing and water reuse, results in excessive rise in the level of water ponding. One consequence is the rise in phreatic surface within the embankment causing the dam to be unstable.

    The excessive rise in water level within the tailings reservoir can also lead to water overtopping the dam crest particularly in the event of a large and unexpected storm. Without an emergency spillway acting as a preferential flow path, overtopping water will erode the embankment quickly. Failure of the impoundment is likely to follow.

    Drainage failure may involve physical damage to the slurry pipeline. It may also involve failure of the spillway and uncontrolled water flow across the embankment. Both situations result in external scouring of the embankment and potential embankment failure.

    Drainage failure may also be due to pump failure or power supply failure. The consequence of both cases is excessive rise in the level of ponded water.

    Piping occurs if seepage within or beneath the embankment causes internal erosion along the flowpath. Excessive piping may result in local or wide scale embankment failure.

    Erosion has also been discussed as the consequence of slurry pipeline or spillway failure. Erosion of the embankment due to surface runoff may start with rills which later coalesce into larger and deeper channels called gullies. Gullying is a complex and destructive process which, when started, is difficult to stop. Embankment failure eventually ensues.

    Foundation failure is movement of the soil or rock underlying the dam embankment. This happens if the ground is too weak to support the height of the dam. The consequence is partial or complete failure of the dam.

Earthquakes cause ground shaking or rupture. Ground shaking can cause the embankment to fail or the foundations to liquefy. The latter is risky for embankments built on top of mine tailings, or other soft and wet ground.

Based on the record of major tailings dam failures from 1960 compiled by the World Information Service on Energy (WISE) Uranium Project, six occurred in the Philippines (www.wise-uranium.org/mdaf.html). These are:

- Concrete spillway failure of the abandoned tailings dam of Dizon Copper Silver Mines, Inc. in San Marcelino, Zambales in August 2002
- Tailings spill of around 700,000 t from a damaged concrete pipe of Manila Mining Corporation in Placer, Surigao del Norte in April 1999
- Loss of approximately 1,600,000 m^3 of tailings from a storage pit through the old drainage tunnel of Marcopper Mining Corporation in Marinduque in March 1996
- Dam foundation failure that released 50,000 m^3 from the tailings facility of Manila Mining Corporation in Placer, Surigao del Norte in September 1995
- Dam foundation failure that released 80,000,000 t of tailings in Philex Mining Corporation, Padcal, Benguet in January 1992.
- Dam foundation failure that released 28,000,000 t of tailings in Marinduque Mining and Industrial Corporation, Sipalay, Negros Occidental in November 1982.

- Silt- and clay-sized tailings must not flow out of the TSF with the supernatant pump-out or spillway flow.
- The supernatant discharge must be compliant with DENR standards on free CN, pH, TDS, and heavy metals.

3.2.4.2 Control Strategy

Section 3.1.3.2 discussed the detailed geologic and geotechnical investigations which were completed as basis for the engineering design of TSF3 and TSF4. The same section also presented the results of the slope stability assessments under static and pseudo-static (seismic) loading conditions following the guidelines of ICOLD. This will be supplemented by a QA program during construction to ensure that the TSF is built as designed. The investigations, design, stability assessments, and QA program are necessary to rule out a foundation or embankment failure due to ground movement, weak ground, or earthquake shaking.

In addition to the control strategies of Section 3.1.3.2, the following will be implemented to ensure the acceptability of water impacts of the tailings and TSF. Specifically, the strategies address water management, preventing physical damage to the slurry pipeline, and potential pump failure (GHD, 2009a).

- Conventional tailings slurry deposition – Tailings will be pumped to TSF3 and TSF4 through HDPE delivery pipelines. The pipelines will access the TSF embankments from the north, near the process plant. The main valve stations that direct flow to each TSF are installed at this location.

The tailings delivery pipelines will be placed on the perimeter embankment of each facility and not on the dividing embankment. The pipelines are divided into two sections, with each section nominally encompassing half of the perimeter. Valves will be installed at the junctions between embankments to control the tailings flow to each section of the distribution network. Additional isolation valves will be installed at 300-m intervals for maintenance and repairs.

Spigot off-takes will be installed into each of the pipelines at intervals of 25 m. Slotted conductor pipes will be fixed to the internal embankment batters at the location of each spigot off-take. This will allow the tailings to flow without eroding the slopes. The deposition of tailings from the perimeter embankment will create a beach of tailings that will keep the supernatant farther away from the structure.

- Decant and supernatant pool – The supernatant pond for both TSF3 and TSF4 will abut only the dividing embankment. Decant towers with submersible pumps will be built in this area to collect the supernatant for return to the process plant for reuse. In addition to the decant towers, sliding mechanisms will be installed down the slope of the common wall near the decant towers. During emergency events, pumps can be lowered down the slope via the sliding mechanisms. These standby pumps are stored at the crest of the dividing embankment. They will be operated on a quarterly basis to ensure that they remain functional.

- Underdrainage – The underdrainage system will help prevent a potentially unstable build-up of pore pressure in the fine-grained tailings deposits beneath the embankment. The underdrains comprise slotted uPVC pipes wrapped in soil sock, located within a shallow trench backfilled with filter and free-draining materials. Two concentric rings of underdrains are proposed for each TSF. Each underdrainage ring has an outfall at the western edge of the dividing embankment, emptying into a small above ground tank. Any seepage collected in the tank is pumped out either back to the TSF or plant feed water dam.

- Freeboard – Freeboard is defined as the vertical height between the surface of the supernatant pond during storm events and the crest of the embankments. To maintain an adequate buffer against dam overtopping, GHD (2009) proposed a minimum freeboard of 3 m. This comprises a 1-m allowance for design storm storage, 1-m depth of spillway, and 1-m embankment settlement allowance during a major seismic event.

- Spillway – TSF3 and TSF4 will have individual emergency spillways to rout a 6-hour probable maximum flood with a return period of 1 in 10,000,000 years. The estimated total rainfall of this event is 1,160 m.

  Both spillways will be broad-crested weir and lined with Reno Mattress. The TSF4 spillway with a total width of 20 m is located in the dividing embankment. The TSF3 spillway with a width of 12 m is located in the southern perimeter. Water flowing through the spillway will go to a channel that leads to Pond B. Pond B discharges to Dayano Creek and then Magpayang River (Figure 2-1).

- Plant Feed Water Dam (Pond A), Pond B, and geotextile tubes – Based on the water balance studies, the continuous pump-out of tailings supernatant is required in order to ensure the stability of the TSF. The supernatant will be pumped to pond A, where a batter mounted submersible pump is available to send water for re-use in the process plant. If the plant feed water dam is full or if the process plant does not require water, the supernatant water will ultimately go to Pond B via the Pond A-B discharge channel.

Pond A has a proposed dam crest elevation of 54 m RL and a total storage of approximately 12,000 m^3. A division embankment will separate the pond into two parts. When the stored water level reaches 43 m RL, water from the northern section flows into the southern section. The southern section of the pond will have a batter mounted pump to allow the recovery of stored water for plant use. The southern section has an outlet that discharges ultimately to Pond B.

Pond B has dual functions. It serves as an emergency discharge storage for Pond A and a storage facility for flows from the TSF3 emergency spillway. With a dam crest elevation of 48 m RL and total storage of roughly 100,000 m^3, Pond B provides stormwater retention and settling of sediments suspended in the surface runoff. The pond discharges to geotextile tubes which perform a final filtration of the runoff prior to discharge to Dayano Creek.

3.2.5 Infrastructures

3.2.5.1 Impacts

This includes, among others, the Managers' camp, Senior camp, Staff camp, Dining and recreation building, Main office, Mine fleet maintenance, Paste fill plant, Explosives magazines, Nursery, and Sanitary landfill. Their impacts on water resources pertain to increased surface runoff and alteration of the catchment's drainage pattern. TSS and TDS can be additional impacts if the surfaces are not concreted, vegetated, or properly sealed. Oil and grease and solid waste may also be generated. The likely receptors of the increased flows, sediments, oil and grease, and wastes are Magpayang River, Dayano Creek, and finally, Lake Mainit.

3.2.5.2 Control Strategy

The control strategies are:

- Reduction of ground clearing works to the minimum needed for construction. This is to minimize erosion and sedimentation of the environment downslope.
- Limiting the exposure of soil to erosion.
- Installation and maintenance of a stormwater and runoff management system for construction and operation. The system diverts clean water away from the working and disturbed areas. Dirty water from the jobsites is routed to sediment retention structures consisting of settling ponds and geotextile tubes.
- Good housekeeping practices for the construction and operations crew to prevent the release of oil and grease and waste materials into the drainage channels.
- Proper handling and disposal of waste materials. The materials are kept away from drainage channels and unstable areas.
- After completion of the building or structure, revegetation of bare areas to minimize erosion.
- During mine decommissioning, determination of the best use of the buildings and structures.

3.2.6 Domestic Wastewater

3.2.6.1 Impacts

The domestic wastewater comprises the effluent discharges of the kitchens, washrooms, laundry, and toilets of the accommodations and messing area as well as the offices, plants, and workshops. The wastewater consists of organic matter, nutrients, inorganic matter, toxic chemicals, and pathogens. The United Nations Department of Technical Cooperation for Development (UNDTCD, 1985) provides the major constituents of typical domestic wastewater.

Table 3-7. Major constituents of typical domestic wastewater

Parameter	Constituent Concentration (mg/L, unless otherwise indicated)			Effluent Standards (mg/L, unless otherwise indicated)	
	Strong	Medium	Weak	Class A	Class C
TDS	850	500	250	1,000	-
TSS	350	200	100	50	70
Nitrogen as N	85	40	20	-	-
Phosphorus as P	20	10	6	-	-
Cl	100	50	30	-	-
Alkalinity as $CaCO_3$	200	100	50	-	-
Oil and grease	150	100	50	5	5
BOD_5	300	200	100	30	50
Total coliforms	1 billion to over 100 billion/L			3,000	10,000

Notes: The unit of effluent standard for total coliform is MPN/100 mL.

Sources: UNDTCD, 1985 for the wastewater concentrations except total coliforms; BF Environmental Consultants for total coliforms concentrations in MPN/L; DENR AO 35, Series of 1990 for the effluent standards.

Except for TDS, the typical concentrations exceed the applicable maximum allowable effluent standards of DENR AO 35, Series of 1990.

Domestic wastewater contains pathogenic organisms like bacteria, viruses, fungi, etc. with potential risks to cause diseases. The water-borne diseases include typhoid, paratyphoid fevers, dysentery and cholera, polio, and infectious hepatitis. Parasitic infections from Ancylostoma (hookworm) and Ascaris (nematode) have also been reported on people exposed to domestic wastewater.

3.2.6.2 Control Strategy

To manage its sewage, the Project will employ a combination of BioMAX Wastewater Treatment Plant, septic tanks, and portable toilets.

One large unit BioMAX Plant will be installed at the accommodations and messing area. Three smaller units will be provided for the Main office, Process plant, and Mine fleet maintenance.

The Explosives magazines area, Paste fill Plant, Nursery, and Sanitary landfill will be provided with septic tanks. Portable toilets will be installed at the Open pit and Underground areas.

A BioMAX system is preferred over other treatment systems because the recycled water that is produced is clear and odorless. It is also designed to conform to the most stringent health standards in Australia.

A BioMAX system has five principal chambers. These are:

1. Anaerobic chamber where approximately 3- to 50 % of the suspended solids settle out while the wastewater undergoes anaerobic digestion.

2. Aerobic chamber wherein bacteria and other microorganisms in the presence of air convert the dissolved and non-settleable solids into carbon dioxide and a biological floc which, under quiescent conditions, will settle.

3. Clarification chamber which settles the biological floc under quiescent conditions. Settled sludge from the bottom of the chamber and floating materials are returned to the anaerobic chamber. From the clarification chamber, the effluent is drawn off below the surface and flows into the disinfection chamber.

4. Disinfection chamber which provides a minimum of 30 minutes contact time between the effluent and chlorine to achieve bacterial die-off.

5. Pumpout chamber which features a discharge pump operated by a level switch.

The system has two mechanical components – an air compressor and a discharge pump. An alarm is provided to warn of failure in these units.

The septic tank separates the solids from the liquids and it promotes the partial breakdown of contaminants by bacteria. Solids, in the form of sludge, collect on the tank bottom. Scum, which floats on top of the water, remains in the tank and is pumped out periodically.

A connecting pipe brings the septic tank effluent to the absorption field. The absorption field is a subsurface leaching area. As the wastewater seeps into the soil, soil filtering and further bacterial action remove the micro-organisms and harmful materials such as NO_3^-, PO_4^{2-}, and organic compounds. This completes the treatment process.

Portable toilets in the open pit and underground areas will require daily collection of the wastes for treatment into the BioMAX system.

3.3 Noise

Noise is unwanted sound. Its human health effects are hearing loss, sleep loss, stress, high-blood pressure, lost productivity, and distraction. To limit noise within acceptable levels and to protect workers and adjacent households from excessive noise exposure, noise standards have been established for "general" areas and the workplace environment.

Noise Exposure Standards

The memorandum circulars of the former National Pollution Control Commission (NPCC) stipulate the environmental noise standards. These standards are applicable to general areas such as residential, commercial, or industrial. Occupational Health and Safety Standards (OHSS) of the Department of Labor

and Employment (DOLE) define the noise exposure standards. Pertaining to the workplace, these standards are exposure limits that must not be exceeded on a certain period.

Tables 3-8 and 3-9 present the noise standards for general areas and the workplace, respectively.

Table 3-8. Environmental quality standards for noise in general areas

Category	Type	Daytime Morning	Morning/ Evening	Nighttime
AA	Within 100 m from school sites, nursery schools, hospitals, and special home for the aged	50 dBA	45 dBA	40 dBA
A	Residential	55	50	45
B	Commercial	65	60	55
C	Light industrial	70	65	60
D	Heavy industrial	75	70	65
Time		9 a.m. – 6 p.m.	5 – 9 a.m. 6 – 10 p.m.	10 p.m. – 5 a.m.

Source: NPCC

Table 3-9. Permissible noise exposure

Duration per day in hours	Sound levels, dBA, slow response
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25	115

Source: OSHS, DOLE

Wind Effects on Noise

Steady light to moderate winds produce higher noise levels downwind than in still air. Conversely, lower noise levels are produced upwind from a given source.

The wind velocity profile in a vertical plane has a greater effect on noise. It can cause the refraction of sound radiated at small angles above the horizontal. What happens is that some of the upward-directed sound returns to ground level at some distance away. The sound intensity is therefore focused and increased at that location (Hassall and Zaveri, 1979 and Environment Australia, 1998a).

The wind velocity profile in a vertical plane can have an interesting effect on intervening ground topography or artificially created noise barriers. Under still conditions, the intervening topography can significantly attenuate mining noise emissions. However, as wind velocity develops in a vertical plane, the sound rays curve downward and the mitigating effects of the barriers diminish (Hassall and Zaveri, 1979).

Climatological Normals and Baseline Conditions

Based on the climatological normals (Annex 4), the annual mean wind speed measured in the Surigao City synoptic station is 2 m/s. The monthly mean wind direction blows from five directions (Figure 3-27):

- From the east during the months of February to May
- Southwest from June to July
- West-southwest from August to September
- From the west in October
- From the east in November and
- Northeast in December and January.

The highest wind speed of 60 m/s blowing from the east-northeast direction was measured in September (Annex 5).

As part of the EIA of the Siana Project, ambient noise was measured on 6 to 7 January 2005 at four locations, specifically, Marciano A. Dapar Elementary School in Brgy. Cawilan, Brgy. Dayano near the Dayano Elementary School, Brgy. Siana near the Siana Elementary School, and along the National Highway in Brgy. Del Rosario. The weather at the time of sampling was cloudy with scattered rain showers and slight to moderate wind. All noise measurements exceeded the maximum allowable noise levels for areas within 100 m away from the school site and residential areas. The noise sources included the school students, residents, and some animals (BMP, 2009).

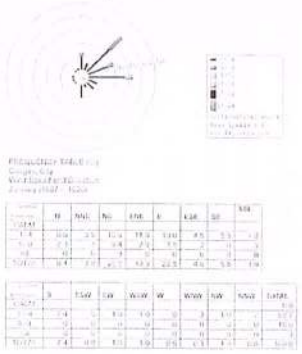
3.3.1 Impacts

The Project will involve the operation of different small and heavy equipment that will generate noise. A noise prediction model, the Roadway Construction Noise Model (RCNM), was employed to determine the combined impact of the expected equipment use (*Ibid.*).

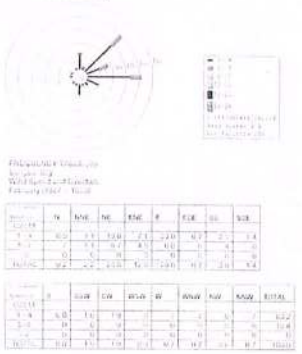
RCNM is the United States Federal Highway Administration's (USFHWA) national model for the prediction of construction noise. It provides a construction noise screening tool to easily predict construction noise levels and to determine compliance with noise limits for a variety of construction projects. The model is based on a spreadsheet tool which was developed in support of the Central Artery/Tunnel Project in Boston, Massachusetts, the largest urban construction project ever implemented in the United States. It allows the estimation of L_{max}, the maximum noise level, and L_{eq}, the equivalent continuous and steady sound level which is equal in energy to the fluctuating level over the interval period, at receptor locations from a maximum of 20 pieces of equipment. The RCNM was applied to the Siana Project since its equipment database includes the same equipment proposed to be used for the Project (*Ibid.*).

The RCNM modeling and results are as follows (*Ibid.*):

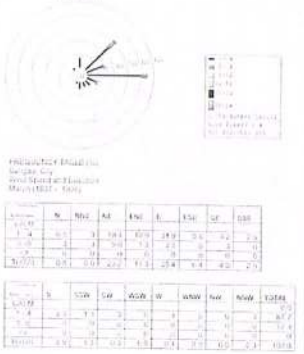
January



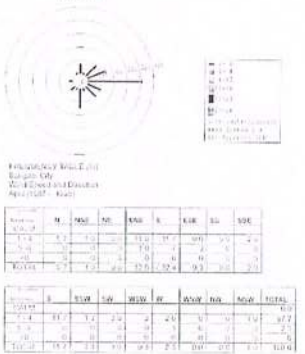
February



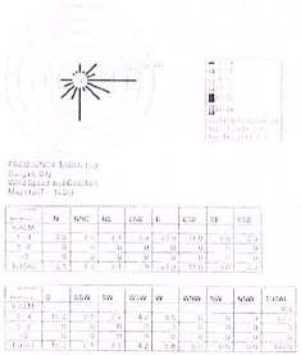
March



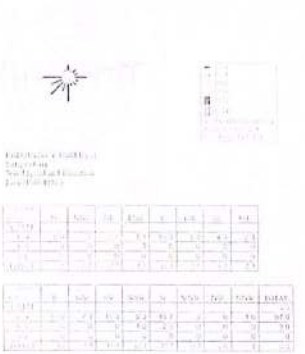
April



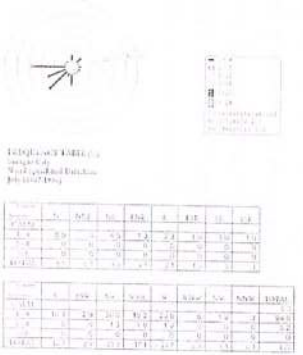
May



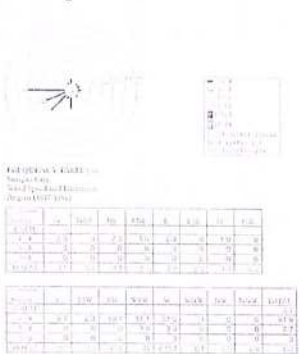
June



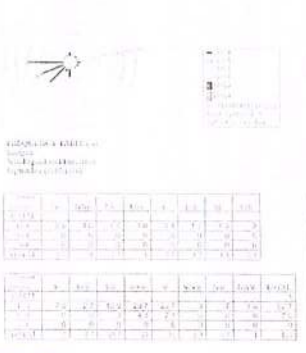
July



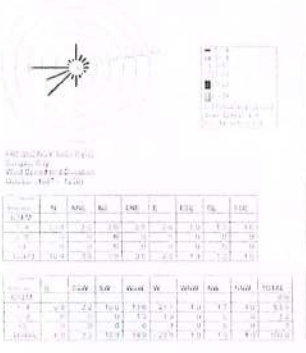
August



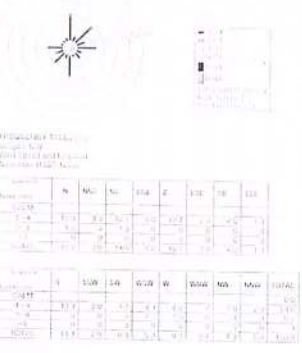
September



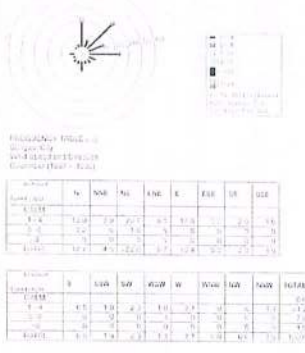
October



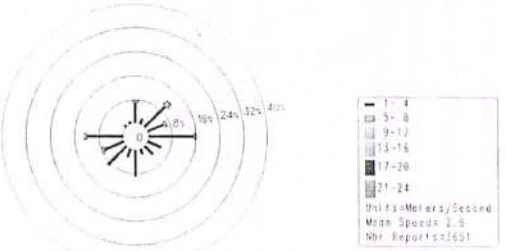
November



December



Annual



FREQUENCY TABLE (%)
Surigao, City
Wind Speed and Direction
ANNUAL (1987 - 1996)

Direction / Speed (mps)	N	NNE	NE	ENE	E	ESE	SE	SSE
CALM								
1 - 4	7.3	1.6	10.1	5.6	14.7	4.5	3.9	1.5
5 -8	.6	.2	2.1	.9	1.2	.1	.1	.0
>8	.1	.0	.1	.0	.0	.0	.0	.0
TOTAL	8.0	1.8	12.3	6.5	15.9	4.6	4.0	1.5

Direction / Speed (mps)	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM									0.0
1 - 4	9.4	2.7	9.5	7.3	12.1	.4	.6	.8	92.1
5 -8	.0	.0	.2	1.2	1.2	.0	.0	.1	7.7
>8	.0	.0	.0	.0	.1	.0	.0	.0	.2
TOTAL	9.4	2.7	9.7	8.5	13.4	0.4	0.6	0.9	100.0

Source: PAGASA

Wind roses

1. For the open pit area, the modeling assumes the simultaneous operation of 13 items of equipment during construction and operation. The equipment items are excavator, dump truck, dozer, grader, two loaders, water cart, crane, rock breaker, pit bores, pumps, and two haulage trucks. At a distance of 5 m from the source, L_{eq} is estimated at 110.1 dBA. At a distance of 100 m, L_{eq} goes down to 84.1 dBA. It should be noted that the predicted L_{eq}s are maximum since the modeling assumes the location of the equipment close to each other. Figure 3-30 shows the contours of the noise level estimates. Because of the pit's confining topography and distance from the residential areas, only the mine workers will be affected.

2. The TSFs and WRD are located adjacent to residential areas. For the TSFs, the modeling assumes the simultaneous operation of a dozer, compactor, and two haulage trucks. At a 10-m distance from the source, L_{eq} is estimated at 95.3 dBA. The L_{eq} is predicted to reduce to 54.9 dBA at a distance of 1,050 m. Figure 3-28 shows the contours of the noise level estimates. Based on the RCNM model predictions, the residents of Brgys. Siana and Purok Malipayon 1 of Brgy. Cawilan will be impacted.

3. For the WRD, the modeling assumes the simultaneous operation of a dozer and two haulage trucks. The estimated L_{eq} is 93.7 dBA at a distance of 10 m. An L_{eq} of 54.6 dBA is achieved only at a distance of 900 m. From Figure 3-30, the residents of Puroks Malipayon 1 and Bulawanon of Brgy. Cawilan will be impacted by the noise.

In the modeling, the noise generators were assumed for simplicity to be adjacent to each other. Thus, the model predictions will overestimate the actual noise levels. Moreover, the RCNM model does not take into account the effects of wind, topography, and temperature gradients which will definitely affect the noise propagation. It is also worth noting that the background noise levels in the area were measured at 60 to 65 dBA. The ambient noise will mask the noise generated by the equipment (*Ibid.*).

The use of explosives or blasting was not included in the RCNM modeling. It was also excluded in the ISC3 modeling for air quality impacts. This is because of the following (*Ibid.*):

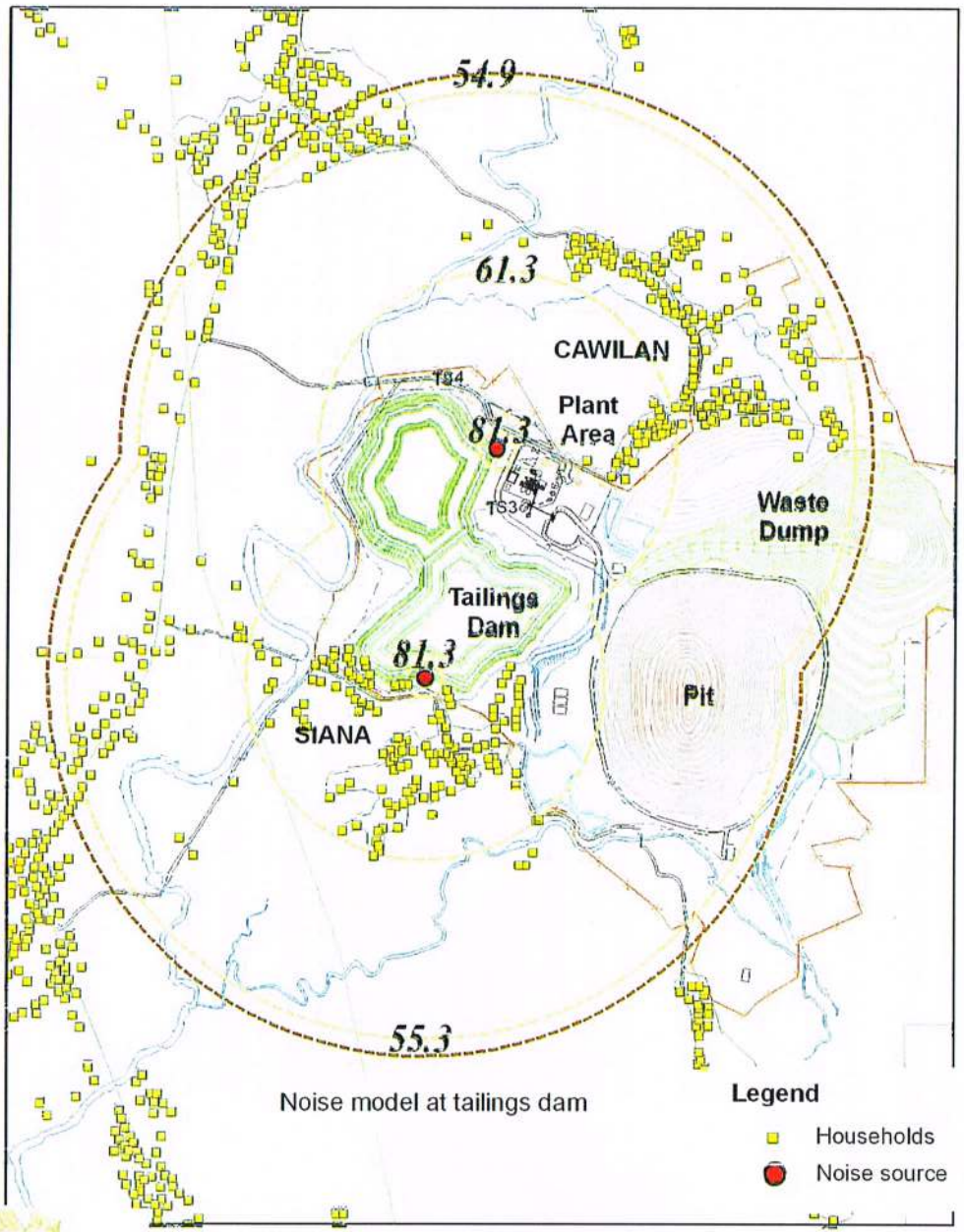
- According to GRC, there will be no blasting within the pit up to a depth of 30 m below the surface. Up to such depth, the rocks are weathered and free-diggable with standard earthmoving equipment. Thus, there is practically a minimum enclosure of 30 m vertical distance for any blast.

  From the depth of 30 m to 60 m below surface, the rock will be 60 % free-diggable on the average. With only 40 % of the material requiring explosives, this would result in a much smaller volume of materials and suspended particulates moved by blasting.

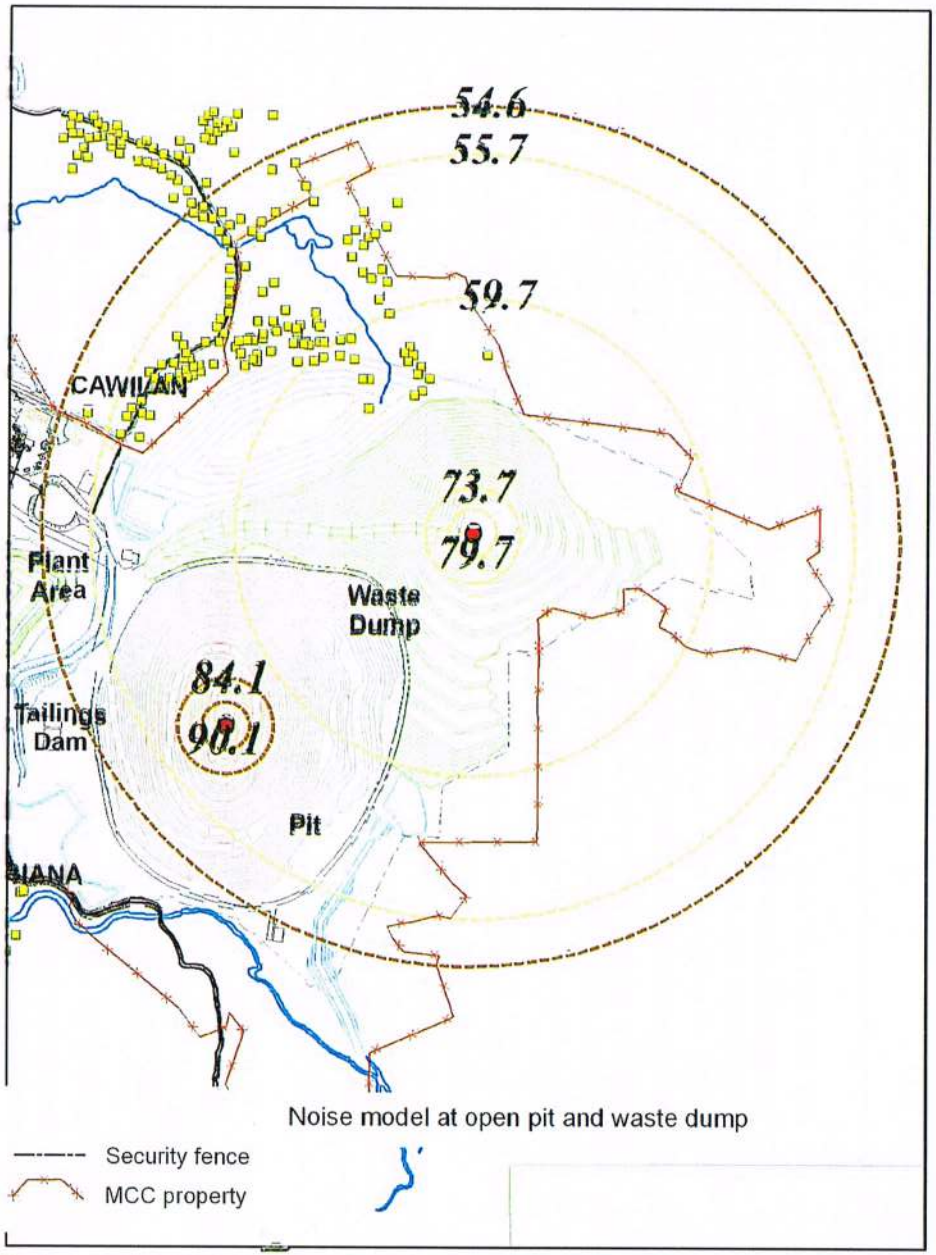
  Full blasting will be employed beyond the 60 m depth. By then, the vertical enclosure will be more than sufficient to contain any dust and noise emission.

- Generally, there will be one blast per day. On occasions when the working areas are separated, two smaller daily blasts may be needed. The number of blast holes per blast will range from 150 to 850. The average powder factor is expected to be 0.30 kg/bcm for dry blasting and 0.35 kg/bcm for wet blasting. These factors are low by industry standards.

- The houses are 450 to 500 m from the edge of the pit. There will be other Project structures to shield the houses from the noise and any dust which can escape the pit enclosure.



Noise model at tailings dam



Noise model at open pit and waste dump

Legend

- Households
- Noise source
- Security fence
- MCC property

bmp

Noise model

EPEP of the Siana Gold Project

Figure No. 3-28

- Finally, the results of the dust monitoring and emission inventory done in the area of Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) in Western Australia are instructive (Environment Australia, 1998b). KCGM manages the large open cut mine commonly known as the Super Pit, adjacent to the city of Kalgoorlie-Boulder in Western Australia. Commercial and residential areas of the city are immediately west of the mining operation. KCGM's operation is large-scale, involving the mining of around 70 million t of ore and waste rock annually. Most of the material requires blasting to enable its removal from the pit. Consequently, blasting is frequent. The dust emission rates of blasting compared to those of truck haulage and truck loading is very minor, about 1/8.

3.3.2 Control Strategy

To safeguard the health of the residents as well as its workers and contractors, GRC will regularly monitor the noise emitted by the Project during construction and operations. The company will implement noise management measures such as:

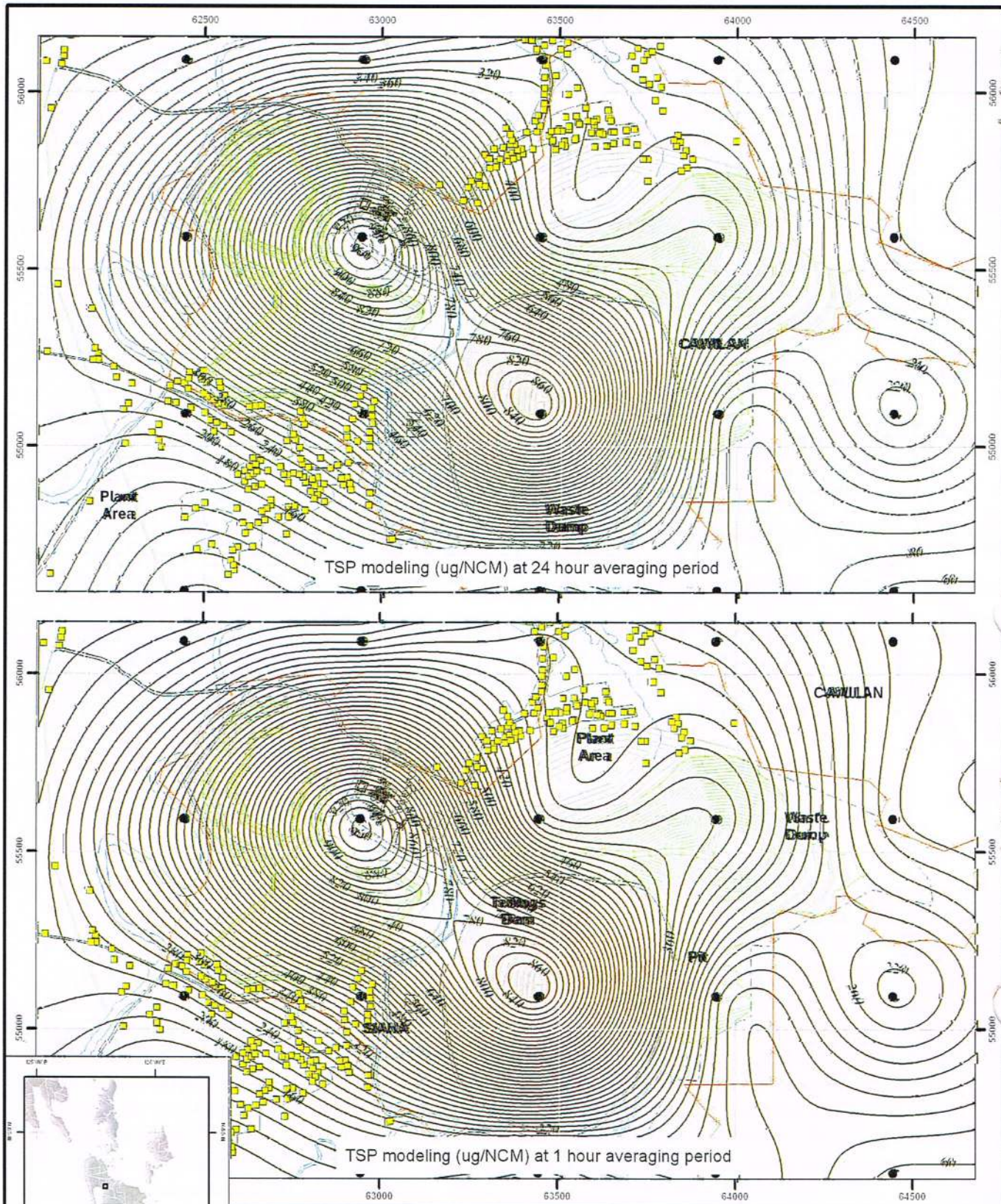
- Use of less noisy and shielded equipment
- Training on equipment use
- Proper equipment maintenance
- Establishment of vegetated buffer zones which will also act as noise barriers
- Provision of noise PPEs to workers.

Considering the noise impacts as well as the dust to be generated during TSF construction and build-up of the WRD and CLF, a buffer or exclusion zone from the TSF and CLF perimeter will be imposed. For safety, some 42 to 56 households in Brgy. Siana and 7 to 13 households in Brgy. Cawilan may be relocated.

3.4 Air Quality

Air Quality Standards

The Philippine Clean Air Act (RA No. 8749), its implementing rules and regulations contained in DENR AO No. 81, Series of 2000, and those prescribed by the DOLE regulate the quantity of air pollutants generated from any source or activity. The AO defines two sets of threshold values, namely, the National Ambient Air Quality Guideline Values (NAAQGVs) and National Ambient Air Quality Standards (NAAQSs). The NAAQGVs are concentrations of air pollutants over specified periods, classified as short-term or long-term, which are intended to serve as goals or objectives for the protection of public health and welfare. They are used for air quality management purposes such as determining time trends and evaluating stages of deterioration or enhancement of the air quality. The NAAQSs are concentrations of air pollutants which, for the protection of public health and welfare, shall not be exceeded at any time. The standards are enforceable and must be complied with by the facility owner. Table 3-10 provides the NAAQGVs and NAAQSs applicable to the Siana Project.



Air Quality Impacts - TSP modeling from all sources

EPEP of the Siana Gold Project

Figure No. 3-29

Table 3-10. Applicable ambient air quality guideline values and standards

Parameter	Ambient Air Quality Threshold	Threshold Type	Averaging Period
Total Suspended Particulates (TSP)	300 µg/Ncm	NAAQS	1 hour
	230 µg/Ncm	NAAQGV	24 hours
Sulfur Dioxide (SO_2)	340 µg/Ncm	NAAQS	1 hour
	180 µg/Ncm	NAAQGV	24 hours
Nitrogen Dioxide (NO_2)	260 µg/Ncm	NAAQS	1 hour
	150 µg/Ncm	NAAQGV	24 hours

Source: DENR AO No. 81, Series of 2000

Baseline Conditions

One-hour ambient air quality sampling complemented the noise samplings at the four stations on 6 to 7 January 2005. The air pollutants evaluated included Particulate Matter 10 microns or less (PM-10), TSP, SO_2, and NO_2.

Compared to the NAAQSs prescribed under the Clean Air Act of 1999, the measured ambient air pollutant concentrations were either minimal or non-detectable. This is understandable considering the state of development of the area and the existence of air pollution sources.

3.4.1 Impacts

There are two primary sources of air pollution during Project construction and operation. These are earth movement and the operation of the standby diesel generator. The use of explosives or blasting was ruled out as an air pollution source in view of the reasons cited earlier.

Air dispersion modeling using ISC3 was performed to estimate the pollutant impacts, *i.e.* TSP, SO_2, and NO_2, from emissions sources of the Siana Project. ISC3 is a steady-state Gaussian plume model. Operating in both long-term and short-term modes, the model can account for settling and dry deposition of particles; downwash; point, area, line, and volume sources; plume rise as a function of downwind distance; separation of point sources; and limited terrain adjustment. ISC3 has two acknowledged limitations. Firstly, its emission factors are derived from a number of samples collected within the United States' western surface coal mining. Secondly, the predicted concentrations are relatively higher than the observed ground level concentrations by a factor as high as 5.

The inputs to the ISC3 modeling included (BMP, 2009):

1. Topography and receptors location data culled from NAMRIA's 1:50,000 topographic map
2. PAGASA Surigao City station's daily weather data for 2003 processed to obtain the hourly values and hourly mixing height using the model of the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO)
3. Pollution sources consisting of earthmoving equipment fleet at the open pit, WRD, CLF, and TSF and the standby diesel generator at the process plant.

The results of the ISC3 modeling are (*Ibid.*):

1. Fugitive dust – For the open pit, exceedance of the NAAQS/NAAQGV at averaging periods of 1 hour and 24 hours, respectively will occur only at selected portions of Puroks Bulawanon and Malipayon 1, Brgy. Cawilan, immediately adjacent to the waste rock dump.

   For the TSF and waste rock dump, the NAAQS/NAAQGV at averaging periods of 1 hour and 24 hours, respectively have not been exceeded at the residential areas of Brgys. Cawilan and Siana.

   The 750-kVA standby generator is expected to have negligible impacts with respect to TSP for both 1-hour and 24-hour averaging periods.

   Figure 3-29 shows the aggregate TSP contours from the earthworks and generator operation at 1-hour and 24-hour averaging periods. For Brgy. Cawilan, Purok Malipayon 1 and a portion of Purok Bulawanon are expected to have ambient TSP in excess of the NAAQS, *i.e.*, 1-hour averaging. For the 24-hour averaging, Puroks Malipayon 1 and Bulawanon will have ambient TSP in excess of the NAAQGV. For Brgy. Siana, the NAAQS, *i.e.*, 1-hour averaging threshold, is predicted to be exceeded in Purok Riverside. The NAAQGV, *i.e.*, 24-hour averaging threshold, is expected to be exceeded in Puroks Riverside and Hilltop.

   As discussed previously, the ISC3 model predictions are limited by the use of western United States' surface coal mining data and by overestimation which can be five times the actual ground level concentration. Thus, during construction and operation, regular air quality monitoring is indispensable to validating the ISC3 predictions.

2. Generator emission – Generally, the operation of the standby generator will not cause exceedance of the DENR standards for SO_2 and NO_2 (Figures 3-30 and 3-31). Based on the results of the dispersion modeling, there is only one occasion that the 1-hour NAAQS for NO_2 will be exceeded at a location close to the generator stack, *i.e.*, at 267 µg/Ncm.

3.4.2 Control Strategy

The control strategy has three key components: dust prevention, dust suppression, and control of diesel emissions.

Dust prevention has at least four aspects:

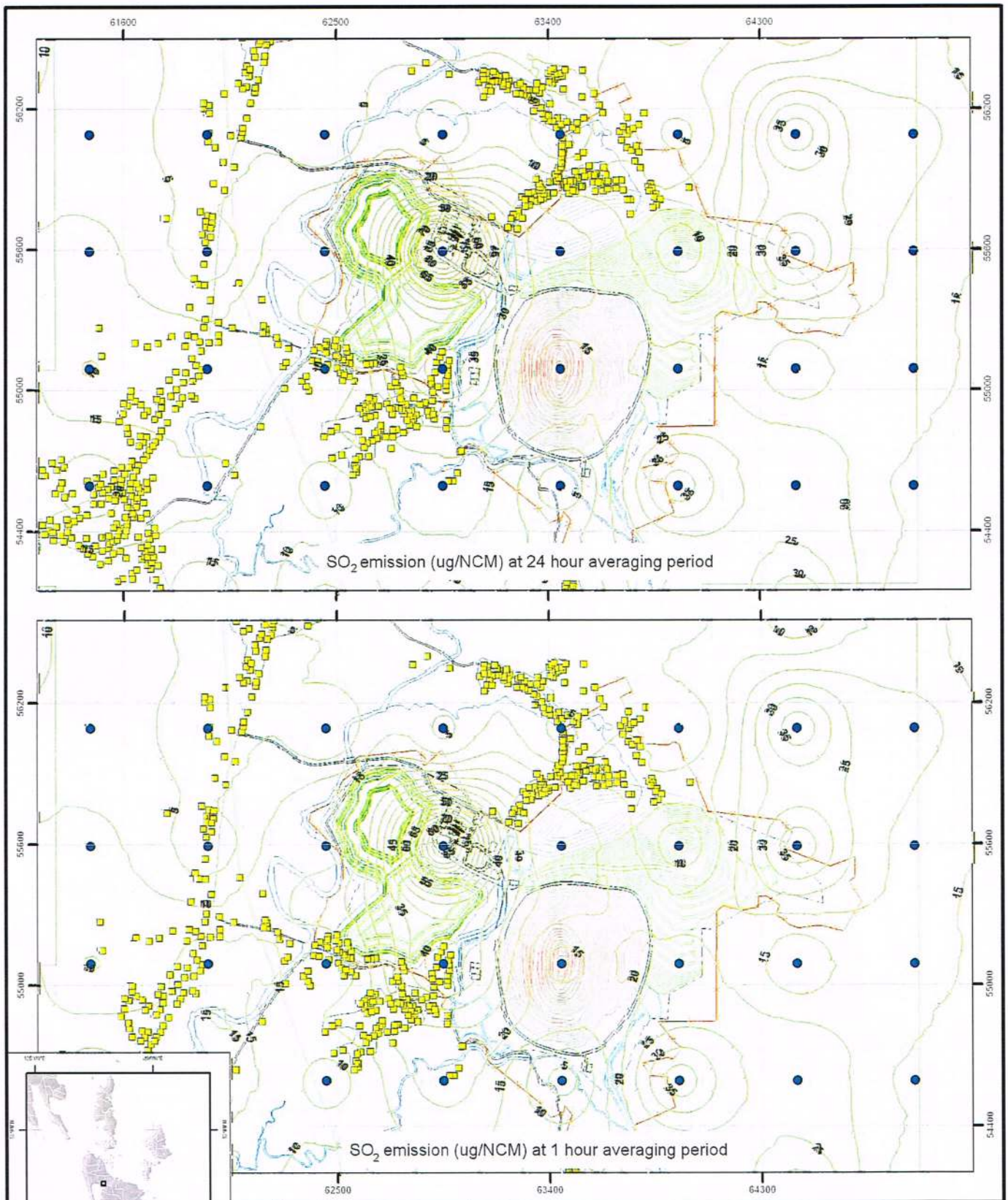
1. A thorough appreciation of the climate, wind conditions, and related factors so that activities may be undertaken at the "best season" or if possible at the "best site";

2. Knowledge of the potential dust sources and incorporation of details and potential control measures in planning;

3. Workforce awareness so that dust-prone activities are either prevented or corrected, and

4. Minimization of disturbed areas including the delay of the opening up of new areas.

Dust suppression involves the integration of remedial measures into the work practices or dust control device or enclosure into the dust-prone facility. Its application includes the following:



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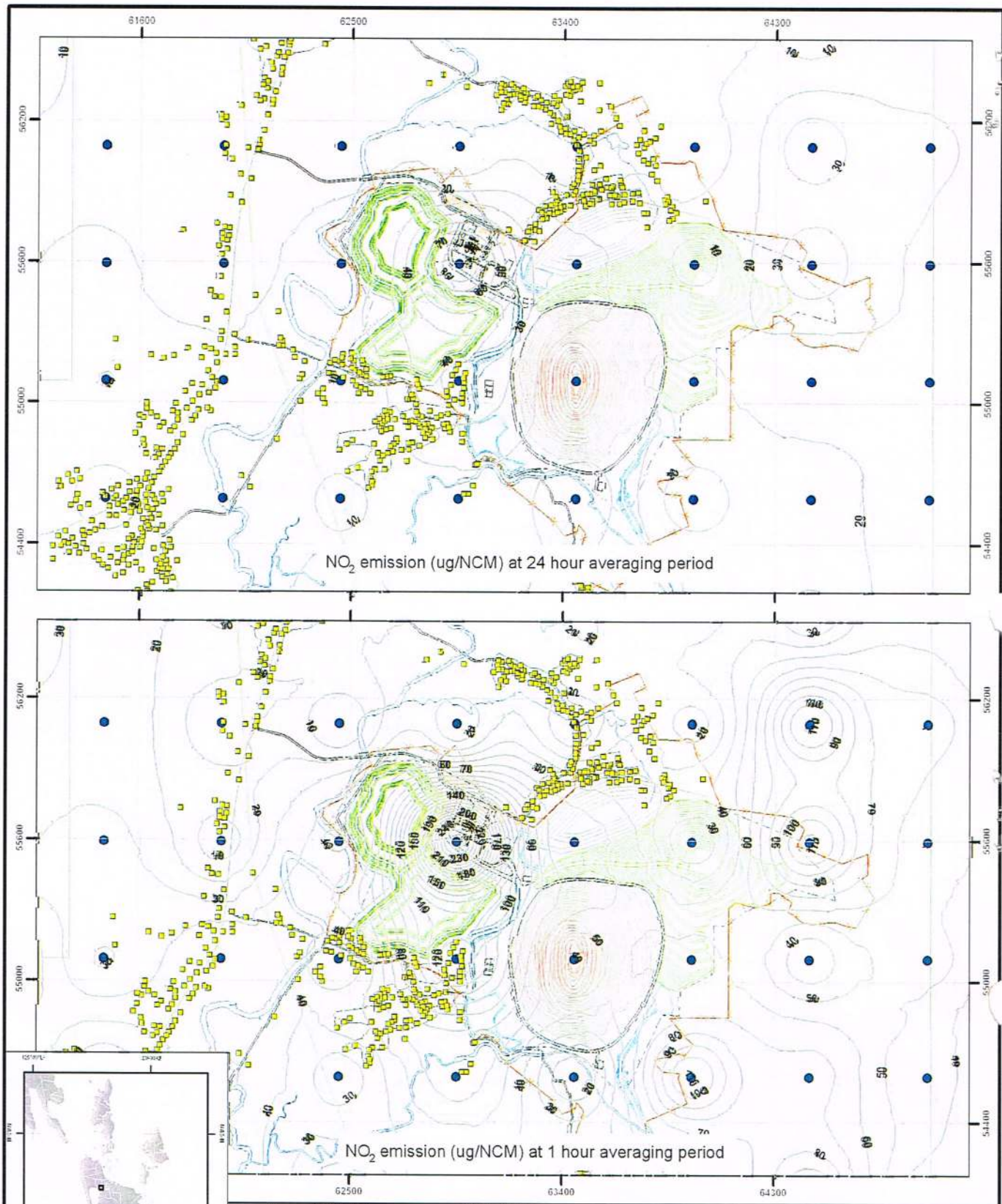
Air Quality Impacts - SO_2 modeling from generator

EPEP of the Siana Gold project

Figure No. 3-30



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Air Quality Impacts - NO_2 modeling from generator

EPEP of the Siana Gold Project

Figure No. 3-31

- During land clearing, topsoil removal, and transport of ore or borrow materials, the dust control option is the spraying of water or a mixture of water and chemical dust suppressant.
- Dust from blasting may be controlled by watering the blast area after charging of blast holes with explosives and the delay of blasting under unfavorable wind and atmospheric conditions.
- Windbreaks – The vegetated buffer zones to be established around the Project features serve as windbreaks.
- For conveyors, the installation of side wind guards and covers, belt cleaning, dust collection systems, clean-up program, and maintenance of enclosures.

A well-planned inspection and preventive maintenance program will be implemented for the diesel engines of the vehicles, earthmoving equipment, and generator. The program will cover the air intake system, exhaust system, engine, and fuel system. Undiluted exhaust tests will be conducted regularly.

The safe and proper use of diesel equipment shall also be encouraged. This entails understanding and strict compliance by personnel with the operator's and engine manuals, use of low-sulfur fuel, correct lubrication, and avoidance of bad practices such as extended engine idling, lugging, and overpowering.

3.5 Conservation Values

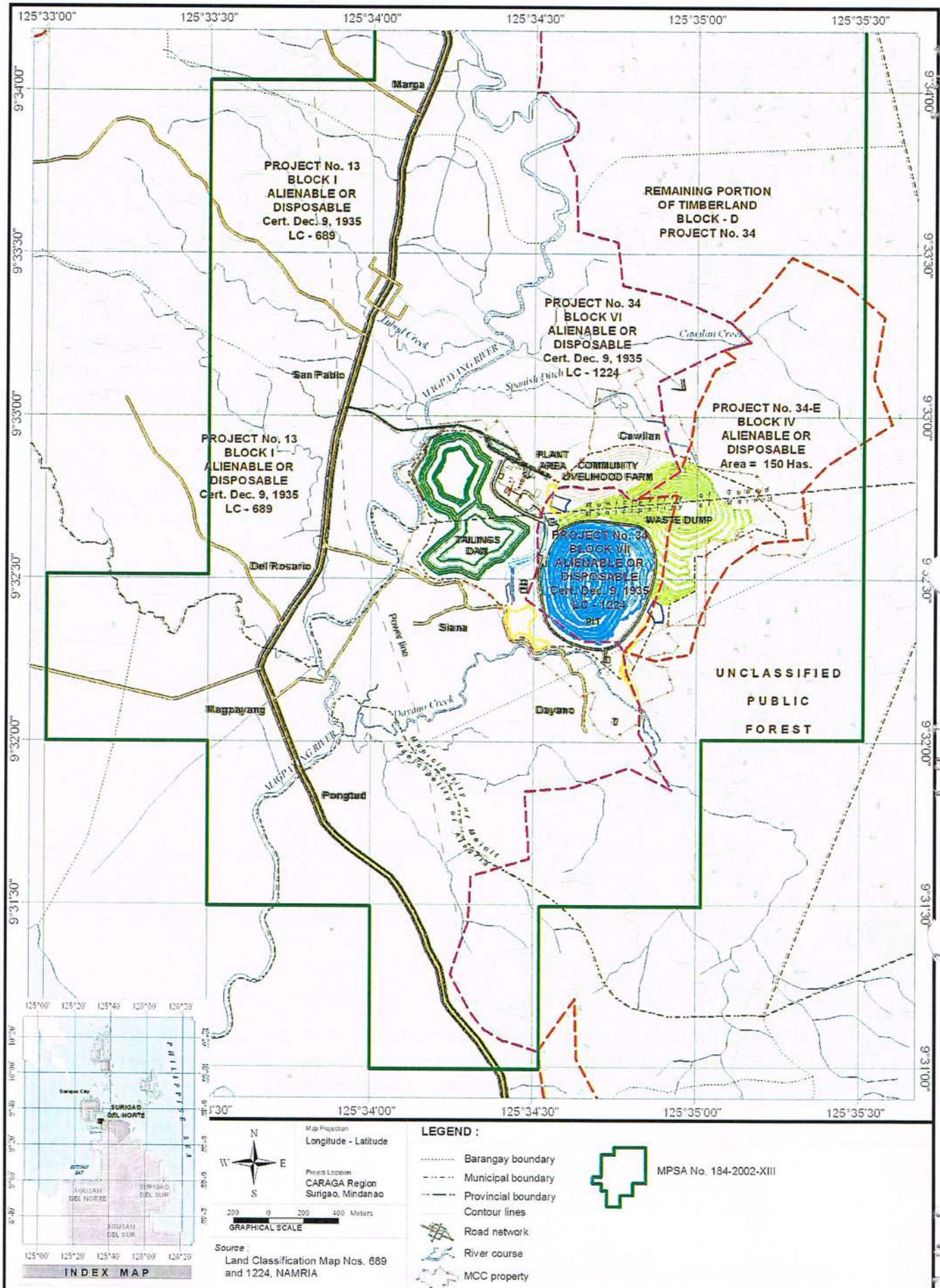
Figure 3-32 is the land classification of the Siana Project site and vicinities based on NAMRIA's Land Classification Map Nos. 689 and 1224. Also shown are the proposed facilities of the Project. The 240-ha Project site together with the adjoining lands to the west is classified as alienable and disposable (A&D). Lands far north of the Project are classified as part of Timberland Block D. Lands far south and to the southeast are "Unclassified Public Forest". Presidential Decree No. 705 provides that no private claims for surface ownership may be made over timberlands and public forests.

The Project site and surroundings are inside the 2,024-ha northern block of MPSA No, 184-2002-XIII which has been transferred to MCC.

The Project site is disturbed land that hosted the former underground and open pit mining operations of SURICON. There are no protected areas or sites of ecological, aesthetic, and recreational significance within the Project site and vicinities. About 6 km downslope is Lake Mainit. The Lake is not a protected area.

3.6 Heritage and Cultural Values

There are no heritage values within the disturbed and built-up 240-ha Project site. Based on the records of the National Commission on Indigenous Peoples (NCIP), there is no approved Certificate of Ancestral Domain Claim or Ancestral Domain Claim over the Project site and vicinities.



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Land classification map

EPEP of the Siana Gold Project 3-32

Figure No.

Photo 3-40. The Mamanwa households near the Marciano A. Dapar Elementary School in Brgy. Cawilan.

Photo 3-41. An extended Mamanwa family with Joel Pacatang (in hardhat), the local guide (BMP, 2009).

Some 21 Mamanwa households reside in Purok Bulawanon, Brgy. Cawilan. The Mamanwas are the indigenous peoples of Northeastern Mindanao. They have a distinct ethnic identity due to their phenotypic difference from the rest of the peoples of Mindanao and their unique culture. Based on genetic frequencies, they belong to the Negritoid stock. The average height is 1.42 m, they are prognathous, with broad flat noses, and their skin color ranges from reddish to dark brown (Winick, 1970).

Previously, the Mamanwas primarily subsisted on shifting cultivation supplemented by hunting, fishing, and foraging activities. Presently, the Mamanwas of Cawilan mostly rely on wage labor. The males have been employed by GRC on a work rotation basis as security guards and utility men. They plant bananas, sweet potatoes, and other rootcrops on backyard plots. Other income sources include wood gathering and gold panning at the dried tailings and waste rock dumps of SURICON. Housewives make baskets from rattan and other vines when there are orders for these products.

The Project will impact the Mamanwas in various ways (BMP, 2009):

- Employment and livelihood – During construction and operation, more jobs will become available to the Mamanwas of the impact barangays. The jobs include equipment operators, security guards, carpenters, mechanics, aides, and utility men. At mine closure, labor for the dismantling of equipment, clean-up works, and mine rehabilitation will be available.

  Employee training programs specifically targeting the Mamanwas are needed well ahead of the Project requirement. A Social Development and Management Program (SDMP) to cater to the non-employable Mamanwas is also required. The livelihood projects suitable to the Mamanwas are cash crop production, handicrafts, agroforestry, aquaculture, and animal dispersal.

- Inter-ethnic relations – The Project is likely to hire personnel who are not familiar with the Mamanwa culture. To prevent conflicts and promote harmonious relationships among employees of different ethnicity, a cultural sensitivity program will be administered to both Mamanwa and non-Mamanwa employees and contractors.

- Housing, settlement pattern, and social services – Work regularity will contribute to a more sedentary lifestyle for the Mamanwas. Hence, there is a need for improved social services in the

Mamanwa community. These include access to education, electricity, tap water, and sanitary toilets.

- Lifestyle and standard of living – More disposable income for the Mamanwas will most likely accelerate the acculturation. Social preparation and culturally sensitive values formation programs should be implemented. A cultural awareness program implemented by anthropologists and social workers will help the Mamanwas preserve their culture and face the changes to their lives that the Project will bring.

3.7 Social Issues

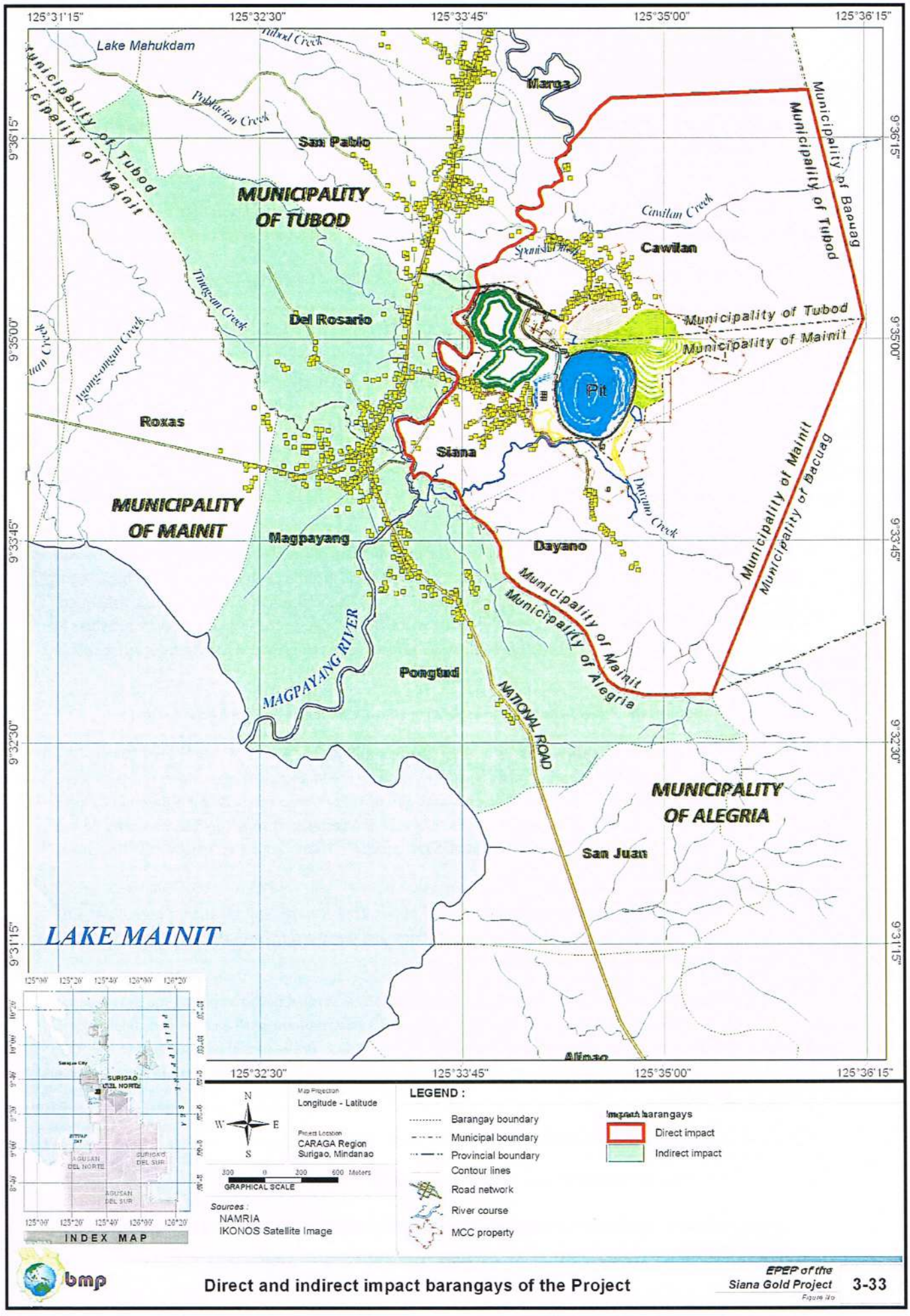
Figure 3-33 shows the impact barangays of the Siana Gold Project. The barangays are classified into direct impact barangays and indirect impact barangays.

In a direct impact barangay, the direct or primary effects of the Project occur at the same time and place. The direct effects include physical or economic displacement, landslides or flyrocks, flooding, contamination of land and water, reduced flow or discharge of well or spring, dust, noise, acculturation, employment and livelihood, habitation space for non-resident Project personnel, increased cost of living, community development programs, taxes and fees. The direct impact barangays of the Project are Brgy. Cawilan of Tubod Municipality and Brgys. Siana and Dayano of Mainit Municipality. In 2007, the populations of the three barangays are 1,290; 872; and 402, respectively.

In an indirect impact barangay, the effects are indirect or secondary and occurring at a different time or place. The indirect effects are in-migration; displacement at the host resettlement sites for Project-displaced persons (if the site is not within the direct impact area); reduced flow or discharge of stream, well or spring that replaces the water source impacted by the Project; dust, noise, and increased traffic along roads used to transport personnel, goods, supplies, and equipment; improved economic conditions, and taxes and fees. The indirect impact barangays are Brgy. Del Rosario, Tubod; Brgy. Magpayang, Mainit; and Brgy. Pongtud, Alegria Municipality. The populations of these barangays are 1,249; 1,498; and 1,216, respectively.

A participatory rural appraisal conducted in 2005 indicated a general decline in agriculture and fishery productivity over the last 25 years. The decline was attributed to:

- Soil erosion in the upland due to deforestation
- Soil erosion from SURICON operations
- Sedimentation and flooding of rice fields
- Sedimentation of rivers and Lake Mainit
- Water pollution from SURICON tailings and gold panning
- Backflow of Lake waters
- Pests infestation and
- Illegal fishing methods.



bmp

Direct and indirect impact barangays of the Project

The participants reported monthly incomes based on average cash receipts of P 1,000 to P 11,000. Brgy. Cawilan had the least number of households engaged in agriculture at 3 %; Brgys. Siana and Dayano had 40 %. Brgy. Cawilan also had the least number of households engaged in fishing at 1 %; Brgy. Siana had 2 %; Brgys. Dayano and Pongtud had 3 % (BMP, 2009).

A household socio-economic and perception survey was administered on the impact barangays in April to May 2005 as part of the EIA of the Siana Gold Project. The major findings are as follows (*Ibid.*):

- With a median age of 19, the sample population is young.
- For household members aged 5 years and above, the bulk of 31 % reached only the elementary school level.
- Only 11 % and 6 % finished high school and college, respectively.
- The median income is P 4,456. Approximately 70 % of the samples earn less than the Annual Per Capita Poverty Threshold Level estimated by the National Statistical Coordination Board.
- The occupational profile is reflective of the educational attainment. Majority of the jobs involve manual labor with farming as the predominant occupation.

Problem assessment conducted with the key leaders and members of the six impact barangays in 2005 and 2009 surfaced four major ones. These are the lack of income and income opportunities, lack of basic social services, lack of basic infrastructures, and lack of technical and financial support to the farmers, fishermen, and other vulnerable groups. All four problem groups are attributable to the lack of economic activities in the area that would spur demand and have multiplier effects such as increase in consumption attributable to an increase in income.

The social impacts of the Project and the corresponding control strategies are the following (*Ibid.*):

1. Relocation of 7 to 13 households in Brgy. Cawilan and 42 to 56 households in Brgy. Siana - The figures are still tentative and efforts will be made to minimize the displacement. The affected Siana residents live adjacent to the proposed site of TSF3. Those that will be displaced in Cawilan live close to the CLF. The families to be relocated are technically squatters because they do not have title to the houses and land that they occupy. Those from Cawilan live in the former SURICON Duplex-type Staff Houses.

   There are two proposed resettlement sites – one in Brgy. Cawilan and another in Brgy. Siana. The location will be finalized based on consultations and negotiations with those affected as well as those adjacent to the host resettlement site.

   A Resettlement Action Plan (RAP) shall be prepared in accordance with International Best Practice in particular, IFC Performance Standard No. 5. The resettlement shall also be coordinated with the Local Government to comply with Executive No. 708. The essential components of the RAP, as recommended by IFC in its Handbook for Preparing a Resettlement Action Plan, are the following:

   - Identification of project impacts and affected populations
   - Legal framework for land acquisition and compensation

- Compensation framework
- Description of resettlement assistance and restoration of livelihood activities
- Detailed budget
- Implementation schedule
- Description of organizational responsibilities
- Framework for public consultation, participation and development planning
- Description of provisions for redress of grievances and
- Framework for monitoring, evaluation and reporting.

2. Displacement of seasonal gold small-scale miners – Some 20 small-scale miner family groups operate seasonally and freely within the mine site. GRC has allowed them to carry out their mining activities in the meantime that the company is not yet operating. The miners have a standing arrangement with the company to voluntarily vacate the area when advised to do so.

   The displacement has positive impacts, namely, cessation of sedimentation and contamination of soil and water with cyanide and other chemicals used by the small-scale miners, elimination of health and safety issues related to small-scale mining such as exposure to cyanide and physical danger to the miners, and reduction of water usage.

   The RAP will also cover the small-scale miners as they are also economically-displaced. Mitigating measures will include the hiring of those who may be qualified for applicable positions. Livelihood opportunities will be provided to those who could not be employed.

3. Flooding along Dayano Creek and the adjacent rice fields - Farmlands and other properties might be inundated during the dewatering of the pit. However, if done properly, *i.e.,* at a rate of 780 L/s within the less rainy months of April to September and with the irrigation dam doors wide open, the farmers will benefit from the steady release of clean water from the pit.

4. Chemicals, especially CN – The residents are afraid that the fish kills and animal deaths suffered during the SURICON days may recur with the redevelopment of the Siana property. GRC commits to put up physical systems that will fully contain any chemical spills such bunds, sumps, and secondary containment ponds in the process area. The company will also train personnel on chemicals and their management, implement management systems and procedures for chemicals handling, and operate a CN detoxification plant that will bring down the CN in the tailings to safe levels before discharge to the TSF.

5. Sedimentation and turbidity – Another recollection of the residents is the "labod" or sediments from the SURICON mine. The Project proponent's commitment is minimized ground clearing and disturbances, scheduling of construction during the less wet months, surface runoff diversion from the disturbed areas, recovery and use of topsoil, spoils management, grading and sloping of work areas and channels, and use of settling ponds and geotextile tubes.

6. Employment and livelihood opportunities – The company will implement its agreement with the Brgy. Chairmen on unskilled employment. To add to the employment opportunities, the company

will inventory local skills and enterprises vis-a-vis the company requirements. Training programs will be implemented to address the skills gaps. Local residents and suppliers will be assisted to provide the goods and services needed by the Project.

7. In-migration – Employment and livelihood opportunities created by the Project will attract people from other adjoining areas to flock to the Project site. This will create pressures on the existing social services, disturb the peace, and possibly lead to a breakdown of peace and order. The agreement with the Brgy. Chairmen of the impact barangays on giving priority to local residents in employment will discourage in-migration.

8. Increased cost of living in the impact barangays – The increased disposable income of households with members working on the Project will lead to a rise in the cost of living in the area. This can be addressed by the Social Development and Management Program (SDMP) which the Project is required to fund and implement based on DENR AO 40, Series of 1996 as revised. The projects under the SDMP include livelihood and the provision of basic services and utilities.

9. Management of vector-borne diseases – GRC will observe stringent health standards in the hiring of employees and contractors. Regular medical examinations of employees and contractors will be undertaken to prevent any outbreak of diseases in the community. The company will coordinate with the Department of Health for the implementation of programs for vector-borne diseases.

10. Vehicular accidents and other physical impacts such as landsliding, flyrocks, etc. – The company will enforce a combination of no-access to the public in certain areas and designated pedestrian walkways and vehicular access at certain times of the day. Company vehicles will be required to observe speed limits and forced stops at certain points of the road. To prevent physical impacts, households at risk will be relocated.

11. Dust, noise, AMD, and heavy metals – GRC will implement the environmental management measures designed for the stressors.

12. Increased frequency of STD, drug use, alcoholism, spread of other communicable diseases, and human trafficking – GRC will administer awareness and preventive education programs for the workers, communities, and spontaneous settlers.

4 ENVIRONMENTAL MONITORING PROGRAM

The Project will implement an Environmental Monitoring Program (EMoP) that tracks the Project's effluents and air emissions as well as the changes in the land, water, noise, air, biological, and social environments. The changes that are due to the Project will indicate the efficacy of the Project's Environmental Management Program (EMP). Any required improvements are introduced into the EMP.

Five types of impact are monitored under the EMoP. These are:

- Water impacts
- Noise impacts
- Air impacts
- Biological impacts and
- Social impacts.

The monitoring results are recorded. Any sampling parameter in excess of the acceptable impacts or thresholds triggers a non-conformance report (NCR). In this report, the investigation of the causes of the non-conformance and any corrective measures to be undertaken is documented. Pending the correction of the exceedance which is established in a subsequent sampling, further emission or release to the environment by the Project is stopped or contained. The NCR is closed only after it is confirmed by sampling that the problem has been rectified.

Table 4-1 is the EMoP for the Siana Gold Project. For clarity, the Project is divided into the major phases and the key environmental aspects *e.g.*, construction and pit dewatering. The potential impacts of each phase and aspect are then grouped into land, water, air, and people and then the specific environmental sector, *e.g.*, hydrology and flooding. Based on the specific impact, the parameters for monitoring are selected, *e.g.*, water level along Dayano Creek and Magpayang River. Subsequently, the sampling and measurement plan in terms of method, frequency, and location is specified.

Figure 4-1 plots the locations of the sampling stations for the Project.

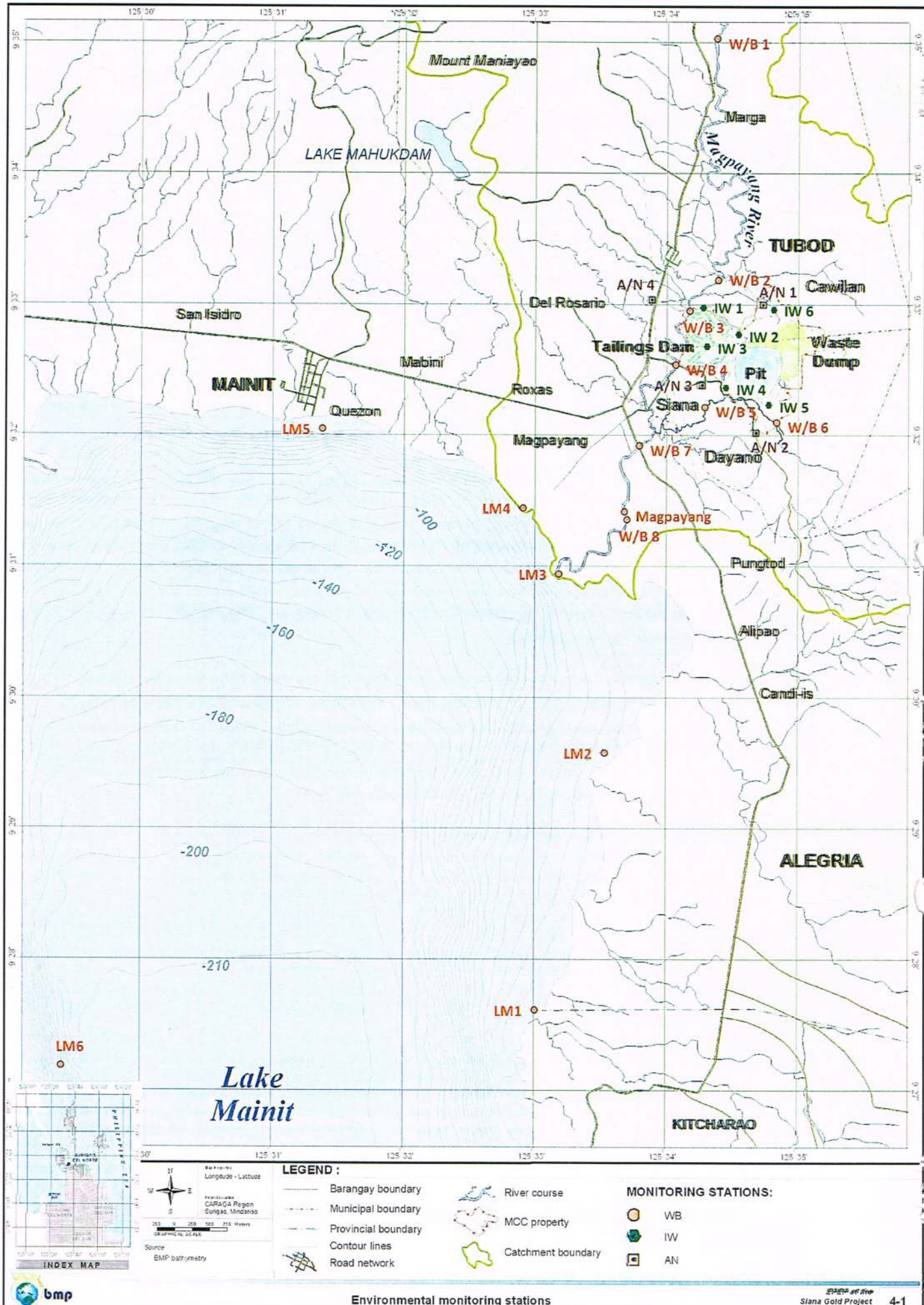

W/B 1
Mount Maniayao
Marga
LAKE MAHUKDAM
Magpayang River
TUBOD
W/B 2
A/N 4
A/N 1
Cawilan
Del Rosario
IW 1
IW 6
San Isidro
W/B 3
IW 2
Tailings Dam
IW 3
Waste Dump
Mabini
W/B 4
Pit
MAINIT
A/N 3
IW 4
Roxas
Siana
W/B 5
IW 5
Quezon
LM5
W/B 6
Magpayang
W/B 7
A/N 2
Dayano
LM4
Magpayang
W/B 8
-100
-120
-140
-160
LM3
Pungtod
Alipao
Candi-is
-180
LM2
-200
ALEGRIA
-210
LM1
LM6
Lake Mainit
KITCHARAO
INDEX MAP
LEGEND :
Barangay boundary
Municipal boundary
Provincial boundary
Contour lines
Road network
River course
MCC property
Catchment boundary
MONITORING STATIONS:
WB
IW
AN
Environmental monitoring stations
Siana Gold Project
4-1

Table 4-1. Environmental monitoring program of the Siana Gold Project

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
All Project Phases	Land				
	• Visual aesthetics – solid waste	• Daily volume of solid waste dumped in the landfill • Weekly volume of compost generated	Volume measurement	Daily and weekly	Project area
	Water quality				
	• Turbidity	TSS (mg/L)	Gravimetric method	Quarterly	W/B 1 to 8
			Turbidity meter	Daily	IW 1 to 6
	• Oil and grease	Oil and grease (mg/L)	Gravimetric (petroleum ether extraction)	Quarterly	W/B 1 to 8
				Daily - visual	IW 1 to 6
	• Sewage	BOD_5 (mg/L)	Azide modification (Dilution technique)	Quarterly	W/B 1 to 8
				Quarterly	IW1
		Total coliform (MPN/ 100mL)	Multiple-tube fermentation	Quarterly	W/B 1 to 8
				Quarterly	IW1
	Freshwater biology	Composition and structure of stream macroinverte-brates	Comparative measures of biological community composition	Quarterly	W/B 1 to 8
		Fish assemblage and structure	Participatory fish stock assessment	Quarterly	LM 1 to 6
	People				

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
	• Socio- economics – employment taxes, community program	• Percentage of population below poverty/subsistence line • Employment, industries, and income – Project and non-Project-related • Proportion of 6-12 yrs old not in elementary school • Proportion of 13-16 years old not in secondary school • Proportion of households with make-shift houses	FGDs and household survey	Annual	Direct and indirect impact barangays

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
		Complaints on • Water quality • Fish catch • Employment • SDMP • Dust • Noise • Foul smell • Community water supply • Flooding • Erosion • Ground subsidence	Review of complaints register and interviews	Weekly and as needed	Direct and indirect impact barangays

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
	• Culture – Mamanwa acculturation and discrimination	• Proportion of Mamanwas directly employed to total Mamanwas in the impact barangays • Number of skills and training activities • Trainees actually employed • Number of cultural awareness programs and participants • Changes in material culture			
	• Occupational health and safety – excessive exposure to elements, musculo-skeletal stress, physical injuries, loss of hearing, respiratory diseases, exposure to hazardous reagents	• Safety and health program • Monthly safety reports • Safety meetings, trainings, and inspections • PPEs • Accident statistics and reports • Medical records	Review of records	Semestral	GRC and contractors

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
	• Public health – vector and water-borne diseases, traffic hazards, respiratory diseases, spread of diseases by migrant workers, heavy metals, AMD	Metals and general health conditions	Blood chemistry, hepatitis test, basic blood chemistry, CBC and blood analysis, urinalysis, fecalysis of selected samples	Annual	Direct and indirect impact barangays
Construction					
Surface earthworks and civil works	Land				
	• Terrestrial biology – loss of grassland habitats	Areas cleared or disturbed	Area measurement	Weekly	Project Area
	Air – Dust and noise	TSP (mg/ Ncm)	Gravimetry	Quarterly and as needed	A/N 1 to 4
		Noise (dBA)	Direct readout soundmeter	Quarterly and as needed	A/N 1 to 4
Pit dewatering	Land				
	• Terrestrial biology – loss of wetland habitat	• Ban on wildlife hunting and eggs gathering enforced • Flora and fauna protection programs in SDMP implemented	Site assessment and reports	Monthly	Project area and direct impact barangays
	Water				
	• Hydrology	Flooding - Water level along Dayano Creek and Magpayang River (m)	Site measurement	Weekly and during heavy rains	Along Dayano Creek and Magpayang River

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
		Discharge of wells and springs downslope of the Project site	Flow measurement	Weekly	Brgys. Magpayang and Pongtud
	• Water quality • Freshwater biology	Dissolved solids (mg/L)	TDS meter	Daily	IW5, W/B 5
		pH	pH meter	Daily	IW5, W/B 5
		Streamflow (L/s)	Water level and current measurement	Weekly and during heavy rains	W/B 5
Pit development and build-up of TSF and waste rock dump	Land				
	• Geomorphology – Physical instability	• Tension cracks • Scarps • Settling • Erosion • Seepage • Phreatic surface	Visual, topographic survey, and reading of piezometer	Weekly	TSF, waste rock dump, pit walls
	• Geochemistry – acid generation	Net acid generation (NAG) pH=4	Blasthole cuttings sampling	During blasthole drilling	Open pit area
	Water				
	• Hydrology	Flooding and dam overtopping - Water level (m)	Measurement and documentation	During heavy rains	W/B 2, W/B 4 to 5, W/B 7, IW 1 to 6, TSF, open pit, waste rock dump
		Discharge of wells and springs downslope of the Project site	Flow measurement	Weekly	Brgys. Magpayang and Pongtud

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
	• Water quality • Freshwater biology	• As (mg/L) • Cd (mg/L) • Cu (mg/L) • Fe (mg/L) • Hg (mg/L) • Mn (mg/L) • Pb (mg/L) • Zn (mg/L)	AAS	Quarterly	W/B 1 to 8, IW 1 to 6
		pH	pH meter	Quarterly	W/B 1 to 8
				Daily	IW 1 to 6, pit sumps
	Air				
	Air – Dust and noise	TSP (mg/ Ncm)	Gravimetry	Quarterly and as needed	A/N 1 to 4
		Noise (dBA)	Direct readout soundmeter	Quarterly and as needed	A/N 1 to 4
	• Vibration	Airblast and flyrocks	Airblast measurement	Initially and as needed	Open pit area
Gold cyanidation plant commissioning	Water				
	• Water quality • Freshwater biology	NaOH, $CuSO_4$, HCl, Diesel	Visual	Daily	Reagent storage and mixing area, process plant area
		NaCN (mg/L)	Distillation – titremetry or CN meter	Daily	IW2 to 3
		Water level (m) of secondary containment pond	Measurement of water level	Every shift	Process plant area

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
Underground development works	Land				
	• Geomorphology	Ground subsidence – cracks and other signs of surficial failure	Visual	Weekly	Within 500 m from pit edges
	Water				
	• Hydrology	Water level (m)	Measurement of water level	During heavy downpours	Underground works
		Discharge of wells and springs downslope of the Project site	Flow measurement	Weekly	Brgys. Magpayang and Pongtud
	• Water quality • Freshwater biology	pH	Meter reading	Daily	Underground sumps
Operations					
Open pit, TSF, and waste rock dump operations	Land				
	• Terrestrial biology – revegetation of idle lands and buffer zone	Area revegetated	Area measurement	Quarterly	Project area
	• Geomorphology – physical instability	Tension cracks, scarps, settling, erosion, seepage, phreatic surface	Visual, topographic survey, and reading of piezometer	Weekly	TSF, waste rock dump, pit walls
	• Geochemistry – acid generation	Net acid generation (NAG) pH=4	Blasthole cuttings sampling	During blasthole drilling	Open pit area
	Water				

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
	• Hydrology	Flooding, erosion, and dam overtop - Water level (m)	Measurement of water level	During heavy rains	W/B 2, W/B 4 to 5, W/B 7
					IW 1 to 6, TSF, open pit and underground works
		Discharge of wells and springs downslope of the Project site	Flow measurement	Weekly	Brgys. Magpayang and Pongtud
	• Water quality • Freshwater biology	• As (mg/L) • Cd (mg/L) • Cu (mg/L) • Fe (mg/L) • Hg (mg/L) • Mn (mg/L) • Pb (mg/L) • Zn (mg/L)	AAS	Quarterly	W/B 1 to 8, IW 1 to 6
		pH	Meter reading	Quarterly	W/B 1 to 8
				Daily	IW 1 to 6, pit sumps
	Air				
	Air – Dust and noise	TSP (mg/ Ncm)	Gravimetry	Quarterly and as needed	A/N 1 to 4
		Noise (dBA)	Direct readout soundmeter	Quarterly and as needed	A/N 1 to 4
	• Vibration, air blast	Airblast and flyrocks	Airblast measurement	Initially and as needed	Open pit area

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
Gold cyanidation plant operations	Water • Water quality • Freshwater biology				
		NaOH, $CuSO_4$, HCl, Diesel	Visual	Daily	Reagent storage and mixing area, process plant area
		NaCN (mg/L)	Distillation – titremetry or CN meter	Daily	IW2 to 3
		Water level (m) of secondary containment pond	Measurement of water level	Every shift	Process plant area
Underground operations	Land				
	• Geomorphology	Ground subsidence – cracks and other signs of surficial failure	Visual	Weekly	Within 500 m from pit edges
	Water				
	• Hydrology	Water level (m)	Measurement of water level	During heavy downpours	Underground works
		Discharge of wells and springs downslope of the Project site	Flow measurement	Weekly	Brgys. Magpayang and Pongtud
		pH	Meter reading	Daily	Underground sumps

Key Environmental Aspects per Project Phase	Potential Impacts Per Environmental Sector	Parameter for Monitoring	Sampling and Measurement Plan		
			Method	Frequency	Location
	• Water quality • Freshwater biology	• As (mg/L) • Cd (mg/L) • Cu (mg/L) • Fe (mg/L) • Hg (mg/L) • Mn (mg/L) • Pb (mg/L) • Zn (mg/L)	AAS	Quarterly	W/B 1 to 8, IW 1 to 6

5 RESEARCH PROPOSAL

One major control strategy of the Siana Gold Project is the use of geotextile tubes. As discussed in Section 3.2.1.2, said tubes were used successfully in the filtration of materials with high water content and high percentage of fines passing 74 µm. The applications included:

1. Mining operations
2. Waterway dredging
3. Wastewater treatment facilities
4. Paper mills
5. Construction sites
6. Agricultural sites
7. Other industrial sites.

Photos 5-1 and 5-2 show three methods of filling geotextile tubes, either through a sump pump, a jet or submersible pump, or gravity method. Interestingly, all three filling methods may be used by the Siana Project.

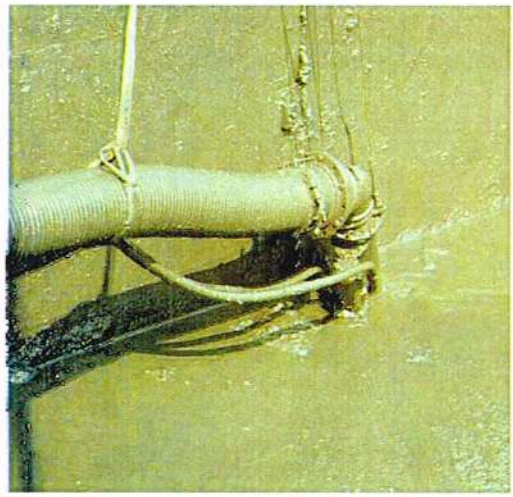


Photo 5-1. A sump pump feeds the dirty water to the geotextile tubes (J.R. Wynn).

Photo 5-2. The geotextile tubes are fed water by a submersible pump (J.R. Wynn).

Photo 5-3. Filling of tubes by gravity method (J.R. Wynn).

Photo 5-4 illustrates one possible lay-out of geotextile tubes. Photo 5-5 shows the filtered clean and clear water that comes out after filtration by the tube.

Photo 5-4. A geotextile tube farm (J.R. Wynn).

Photo 5-5. Clean and clear water drips out of a geotextile tube (J.R.Wynn).

After filling, a dry filter cake of mine waste is contained inside the tube (Photo 5-6). This material can be used to pave roads.

Prior to their effective and efficient use in the site, the suitability of sediment- and tailings-laden surface runoff from the Project site to geotextile tube filtration needs to be evaluated. This is the objective of the proposed research.

The research entails a series of dewatering, water recycling, erosion and scour trials at the site. Prior to the trials, soil mechanics and mine stream data such as specific gravities, flow-rates, TSS, hydrometer test results, and composition will be assessed.

The trials would be in two stages (J.R. Wynn, pers. comm.):

Photo 5-6. After filling, a dry filter cake of mine waste remains (J.R. Wynn).

1. The first is a preliminary ASTM hanging bag trial to assess the different geotextile fabrics and tube fabrication types.

2. The second is a mini-tube trial with mine slurries and runoff pumped into the geotextile tubes.

The trials will require geotextile hanging bags, mini-tubes, and in-situ geotechnical testing equipment such as mud balance and shear vane.

After the two tests, laboratory testing for soils and water will follow. Based on the test results, the work scope for the geotextile tube implementation will be formulated.

6 TOTAL COST OF EPEP

6.1 Summary of Impacts and Mitigating Measures

Table 6-1 summarizes the potential environmental impacts and corresponding mitigating measures for each major Project feature and major activity of the Siana Gold Project.

As presented, the Project features have been segmented into:

- All Project features
- Open pit, TSF, WRD, and CLF
- Process plant and
- Underground mine

The activities have been broken down into:

All Project features

- Generation of domestic and liquid waste
- Earthworks
- Operation and maintenance of equipment
- Manning of offices, plant, workshop, equipment, and work stations
- All activities of the Project

Open pit, TSF, WRD, and CLF

- Pit dewatering during construction and operations
- Pit development and build-up of TSF, WRD, and CLF
- Operation

Process plant

- Commissioning and operations

Underground mine

- Construction and operations

The environmental impacts and corresponding mitigating measures have been categorized into Land Resources, Water Resources, Air Quality and Noise, and People.

The areas affected by each activity of the Project features are also indicated.

Table 6-1. Environmental impacts and control strategy for the Siana Gold Project

Project Feature/Activity	Affected Areas	Potential Impacts	Mitigating Measures
All Project features			
Generation of domestic solid and liquid waste	Project area and immediate vicinities – Brgys. Cawilan, Siana, and Dayano	<u>Land Resources</u> • Degraded visual aesthetics • Litter and vermin • Inability to use the waste dump <u>Water Resources</u> Elevated levels in the water of: • Cl, Na, K, NH_4, and N • pH, BOD_5, COD, SO_4, Ca, Mg, Fe, and some metals when conditions are acidic • Total coliforms <u>Air Quality</u> • Foul odor	• Segregation of waste into biodegradable and non-biodegradable • Composting or disposal of wastes to recyclers • Dumping of non-biodegradable and non-hazardous waste in the sanitary landfill
	Dayano Creek and Magpayang River ultimately discharging to Lake Mainit	<u>Water Resources</u> Elevated levels in the water of • Nutrients – N, P, K • Toxic chemicals – heavy metals • Pathogens – total coliforms • Organic matter – BOD_5 • Oil and grease, surfactants Degraded visual aesthetics Reduced or lost utility of creek water	• BioMAX Wastewater Treatment Plants at the accommodations and messing area, main office, process plant, and mine fleet maintenance • Septic tanks at the explosives magazines area, paste fill plant, nursery, and sanitary landfill • Portable toilets at the open pit and underground areas

Project Feature/Activity	Affected Areas	Potential Impacts	Mitigating Measures
Earthworks	• Dayano Creek, Spanish Ditch, and Magpayang River ultimately discharging to Lake Mainit • Rice fields along the riverbanks	Land Resources • Sedimentation of rice fields • Reduced or lost utility of the land Water Resources • Turbidity and TSS • Shoaling of creek and river channels • Reduced or lost utility of stream water	• Minimized ground clearings and disturbances • Scheduling of construction during less wet months • Surface runoff diversion from disturbed areas • Recovery and use of topsoil • Spoils management • Grading and sloping of work areas and channels • Use and regular maintenance of drainage channels, settling ponds, and geotextile tubes.
	Direct impact barangays of Cawilan, Siana, and Dayano	Air quality • Dust • Noise	• Training of operators on proper equipment use • Water sprays • Enclosures, barriers, and vegetated buffer zones • Use of less noisy and shielded equipment • Proper maintenance of equipment • Restricted vehicle speed in populated areas
Operation and maintenance of equipment	• Dayano Creek, Spanish Ditch, and Magpayang River ultimately discharging to Lake Mainit • Project area	Land Resources • Degraded visual aesthetics • Reduced utility of the land Water Resources • Oil and grease • Reduced or lost utility of stream water	• Training on proper oil handling • Oil spills containment through bunds and drip trays • Collection and containment of used oil

Project Feature/Activity	Affected Areas	Potential Impacts	Mitigating Measures
Manning of offices, plant, workshop, equipment, and work stations	Direct and indirect impact barangays of Cawilan, Siana, Dayano, Del Rosario, Magpayang, and Pongtud	People • Direct and indirect employment • In-migration • Increased cost of living in the impact barangays	• Inventory of skills and local suppliers and contractors and identification of gaps based on Project requirements • Training programs for local residents • Implementation of employment policy agreed upon by the Chairmen of direct and indirect impact barangays • Preference to qualified local suppliers and contractors • Transparent consultative mechanisms for the identification and prioritization of SDMP projects
	Mamanwas in the impact barangays	People • Mamanwa acculturation • Mamanwa discrimination	• Inclusion of qualified Mamanwas in priority hiring • Improvement of social services for the Mamanwa community • Education of non-Mamanwa workers on Mamanwa culture and need for ethnic tolerance • Cultural revival activities
	Project employees and contractors	Occupational Safety and Health • Exposure to elements • Musculo-skeletal stress • Physical injuries • Loss of hearing • Respiratory diseases • Exposure to hazardous reagents	• Stringent policies and programs of the Project on occupational safety and health • General employee induction and regular safety training • Safety inspection and toolbox meetings • Regular medical examinations • PPEs • Bunds at the waste dump areas • First –aid and mine rescue training

Project Feature/Activity	Affected Areas	Potential Impacts	Mitigating Measures
All activities of the Project	Direct and indirect impact barangays	People • Vector and water-borne diseases • Traffic hazards • Respiratory diseases • Spread of diseases by migrant workers • Heavy metals • AMD • Hazardous reagents • Landslide and rockfall	• Coordination with the DOH for the implementation of programs for vector-borne diseases • Continuation of GRC's community water treatment and distribution system • Vehicle speed limits, safety signages, pedestrian walkways and restriction from mine access and haul roads • Observation of buffer or exclusion zone from the TSF and waste rock dump perimeter • Rockfall mitgation fence south of TSF 3 • Management measures for dust, noise, AMD, and reagents • Hiring and regular medical check-up of all employees and contractuals and selected samples from the impact barangays
Open Pit, TSF, WRD, and CLF			
Pit dewatering during construction and operations	• Project area • Direct impact barangays of Siana, Magpayang, and Pongtud • Dayano Creek and Magpayang River	Water Resources • Loss of wetland habitat of Philippine Duck	• Establishment of a vegetated buffer zone along the perimeter and idle lands of the Project site • Ban on wildlife hunting and gathering of duck eggs within the property • Inclusion of flora and fauna protection in the SDMP
		Water Resources • Change in creek and river channel geometry • Flooding along Dayano Creek and Magpayang River	• Monitoring and control of initial pit dewatering flow rates during high-rainfall periods • Opening of the diversion structures of the irrigation dam to divert water to the ricefields
		Water Resources • Total suspended and dissolved solids • Increased flow	• Monitoring and control of pit dewatering flow rates during high-rainfall periods • Discharge of pumped out pit water into geotextile tubes prior to discharge to Dayano Creek • Regular monitoring of pit water quality at the drainage channel prior to discharge
		People Loss of community water supply	• Installation of 7 dewatering bores near the eastern edge of the pit • Use of water pumped out from the bores to feed the existing community water supply • Replacement of water impacted by the Project

Project Feature/Activity	Affected Areas	Potential Impacts	Mitigating Measures
Pit development and build-up of TSF, WRD, and CLF	Project area	Land Resources Physical instability of: • Open pit • TSF • WRD and CLF	• Geotechnical site investigations and engineering design of structures • Design implementation with strict quality control (QC) • Use of dewatering bores, pumps, and ground support where required at the open pit • Regular stability inspections and monitoring including phreatic surface of the TSF embankments and WRD • Observance of buffer or exclusion zone from the edge of TSF embankment, WRD, and CLF • Non-placement of large continuous volumes of clay-rich material within the WRD • Construction of safety bunds or catch fences around the pit edge • Emergency planning and testing
		Land and Water Resources • Flooding of open pit • Overtopping of TSF embankment • Flooding and erosion at waste rock dump area	• Hydrological and hydrogeological studies to determine pit and TSF water balances • Installation of pit perimeter drainage, dewatering bores, pit sumps and pumps • Installation of TSF decant, spillway, underdrainage, freeboard, and ponds. At the TSF, the pool of supernatant will be minimized to abut the dividing embankment only. • Use of diversion channels, drainage channels, settling ponds and geotextile tubes • Flood monitoring during heavy rains • Emergency planning and testing
	Dayano Creek and Magpayang River	Water Resources • Heavy metals • AMD	• Geochemical testworks of waste rocks • NAG pH=4 tests as required on blasthole cuttings of Domain 600 primarily and Domains 100 and 400, secondarily; classification of waste rocks from the open pit into PAF and NAF materials; and placement of materials in a manner to prevent acid generation • Collection of surface runoff including pumped pit water into a sump or settling pond • Regular monitoring of sump, pond, or drainage channel water quality prior to discharge • pH treatment at the sump or pond if required

Project Feature/Activity	Affected Areas	Potential Impacts	Mitigating Measures
	GRC employees and contractors	Air quality (workers) • Dust and noise • Air blast and flyrocks	• Training on proper equipment use • Water sprays • Enclosures, barriers, and vegetated buffer zones • Proper maintenance of equipment • Use of less noisy and shielded equipment • Dust and noise PPEs to workers • Use of delays, reduced hole diameter and deck loading to reduce the maximum instantaneous charge in blastholes • Complete isolation of the area prior to blasting; a siren is sounded 5 minutes before the blast for warning
Operation	Project area	Land Resources Physical instability of: • Open pit • TSF • WRD and CLF	• Construction with strict QC • Use of dewatering bores, pumps, and ground support where required at the open pit • Regular stability inspections and monitoring, including phreatic surface of the TSF embankments and waste rock dump • Observance of buffer or exclusion zone from the edge of TSF embankment, WRD, and CLF • Non-placement of large continuous volumes of clay-rich materials at the waste rock dump • Emergency planning and testing
	Dayano Creek and Magpayang River	Water Resources • Turbidity • NaCN • Heavy metals • Tailings and • AMD	• Classification of waste rocks into PAF and NAF and placement of materials in a manner to prevent acid generation • Stormwater drainage to keep clean water away from dirty water • Collection of surface runoff and pumped out pit water into a sump or settling pond • Regular monitoring of sump, pond, or drainage channel water quality prior to discharge • pH treatment at the sump or pond if required • CN detoxification of tailings prior to discharge to the TSF • Reuse of tailings water for processing • Use of drainage channels, settling ponds, and geotextile tubes

Project Feature/Activity	Affected Areas	Potential Impacts	Mitigating Measures
		Air quality (workers) • Dust and noise • Airblast and flyrocks	• Training on proper equipment use • Water sprays • Enclosures, barriers, and vegetated buffer zones • Proper maintenance of equipment • Use of less noisy and shielded equipment • Dust and noise PPEs to workers • Use of delays, reduced hole diameter and deck loading to reduce the maximum instantaneous charge in blastholes • Complete isolation of the area prior to blasting; a siren is sounded 5 minutes before the blast for warning
Process plant			
Commissioning and operation of process plant	Dayano Creek and Magpayang River	Water Resources • pH • NaOH, $CuSO_4$, HCl, diesel • NaCN • Heavy metals	• Full-blown hazards analysis and environmental risk assessment that focused on chemicals, among others • Physical systems to fully contain chemicals, *e.g.*, concrete pad, sumps, bunds, pumps, and secondary containment pond • CN detoxification prior to discharge of tailings to TSF • Use of a mercury scrubber at the process plant • Personnel training on chemicals and their management • Management system and procedures for chemicals handling • Implementation of a mechanical integrity program
		Occupational Safety and Health • CN and wastes • Acid and wastes • Alkali and wastes • Oxidizing agent and wastes • Heavy metals especially Hg	• Personnel training on chemicals and their management • Use of a mercury scrubber at the process plant • Availability of eye wash, shower, and emergency kit at the reagent storage, reagent mixing, and process plant area • Chemical PPEs to workers
Underground Mine			

Project Feature/Activity	Affected Areas	Potential Impacts	Mitigating Measures
Construction and operations	Project area	Land Resources Ground subsidence	• Geotechnical investigations and assessment • Preparation of conceptual design of the decline and access development, stoping method, and development support and reinforcement. Development and stoping works will use a road header for soft ground. Underhand cut and fill using paste fill is the mining method. • Conduct of a paste fill testwork program
	Project area and downslope barangays of Magpayang and Pongtud	Water Resources • Drying of rivers and wells	• Geotechnical investigation and assessment • Use of road header for soft ground, thus minimizing breakage of rocks • Use of paste fill to seal underground workings • Replacement of community water impacted by the Project
		• Flooding of underground workings	• Hydrological and hydrogeological studies • Installation of pit perimeter drainage and dewatering bores • Installation of primary pumping systems that will remove water from the underground workings • Emergency planning and testing
	Dayano Creek and Magpayang River	Water Resources • Turbidity • NaCN • Heavy metals • Tailings and • AMD	• Classification of waste rocks into PAF and NAF and placement of materials in a manner to prevent acid generation • Stormwater drainage to keep clean water away from dirty water • Collection of surface runoff and pumped out underground mine water into a sump or settling pond • Regular monitoring of sump, pond, or drainage channel water quality prior to discharge • pH treatment at the sump or pond if required • CN detoxification of tailings prior to discharge to the TSF • Reuse of tailings water for processing • Use of drainage channels, settling ponds, and geotextile tubes • Use of tailings as paste fill for the sealing of underground workings

6.2 Compliance with ECC Conditions

Annex 3 reproduces the ECC of the Siana Gold Project. The ECC has three major parts:

1. Conditions which are further broken down into environmental management and general conditions
2. Restrictions and
3. Project assessment planning tool which consists of regulatory conditions and environmental planning recommendations for the proponent.

Table 6-2 presents these conditions, restrictions, and recommendations and their status of compliance by the Project and references to this EPEP.

Table 6-2. ECC conditions and recommendations and status of Project's compliance

ECC Conditions or Recommendations	Status of Project's Compliance	Reference to this EPEP
Conditions		
Environmental management		
All commitments, mitigating measures and monitoring requirements, especially those contained in the EMP in the EIS, including all their modifications and additional information as approved by the EMB, shall be instituted to minimize any adverse impact of the project to the environment throughout its implementation, including the following:	For compliance during the Project construction and operating stages.	The mitigating measures which are consistent with the final EIS are summarized in Table 6-1. Table 4-1 is the Project's environmental monitoring plan.
1. Observance of good vegetative practices, proper land use, and sound soil management throughout the project implementation such as:	For compliance.	• The control strategy for plants and animal communities is discussed in Section 3.1.9.2 (Figure 2-1). • All structures and buildings of the Project are confined within the 240-ha disturbed Siana property. • Soil management is part of the control strategy for plants and animal communities.
a. Properly stockpiling and disposal of materials generated from the mining site, silt materials scooped out from the sediment ponds, and other solid waste in permanent, stabilized areas to avoid pollution of any water body and drainage systems, and maintaining them in safe and non-polluting conditions;	For compliance.	• Soil, subsoil, and waste rocks excavated by the Project will either go to the TSF embankment construction or be deposited in the WRD or CLF (Section 3.1.4). • Sediment unloaded from the drainage channels, settling ponds, and geotextile tubes will be placed, dried, and compacted at the WRD (Section 3.2.2.2).
b. Strictly effecting stabilization and erosion control of the affected side slopes of roads and nearby gullies, creeks, rivers, and	There are no gullies in the Project area. The roads are not cut and there are no high	• The Project will stabilize and revegetate disturbed areas within 100 m of a water body for erosion and sediment control

ECC Conditions or Recommendations	Status of Project's Compliance	Reference to this EPEP
sediment ponds within the project site;	side slopes. The stabilization of erodible river banks for compliance.	(Section 3.2.2.2). • Bare and erosion-prone sections of the river banks will be planted with fibrous and deeply-rooted bamboo and narra (Section 3.1.9.2).
c. Using the recovered topsoil for re-soiling, as soil cover on waste dumps, for landscaping or stockpiling on designated suitable areas, maintained at not more than 3 m high and stabilized by temporary vegetation to protect it from erosion;	For compliance.	The topsoil on the construction and work sites shall be recovered and used as potting medium or for immediate placement in areas for rehabilitation. Any surplus volume of topsoil will be placed in the CLF (Section 3.1.9.2).
d. Limiting the clearing of vegetation within the planned areas to be mined and planting idle land areas in the site with appropriate species;	For compliance.	The control strategy for plants and animal communities includes the minimization of clearings and ground disturbance and the establishment of a vegetated buffer zone along the perimeter and idle lands of the Project site. Fuelwood and timber species will be planted (Section 3.1.9.2).
2. Conduct of an effective IEC campaign to inform and educate all stakeholders, especially its local residents on the project's mitigating measures embodied in the EIS, the conditions stipulated in the ECC and measures in surface mining and processing for greater awareness, understanding and sustained acceptance of the project. The proponent shall implement an annual detailed IEC campaign in coordination with the MGB Regional Office No. XIII and EMB Regional Office No. XIII. The proponent shall also conduct a Knowledge, Attitude, Practice evaluation to determine the effectiveness of the IEC campaign, copy of such evaluation provided to the MGB and EMB regional offices;	For compliance.	• The IEC campaign and budget are provided in the Project's SDMP. Upon approval of the SDMP by MGB Region XIII, the IEC campaign will be implemented. • The KAP evaluation will be undertaken at the end of each construction or operating year of the Project.
3. Design and construction of roads with minimal land and ecological disturbance and with adequate drainage. It shall continuously maintain access roads and other public/private roads within the project site to offset impact of heavy vehicle traffic and nuisances or damages to the people and properties, as well as conduct regular water spraying and require vehicles to maintain low speed in dusty road;	For compliance.	• For safety and to avoid inconveniences to local residents, a new main access road will be built west of the Project site. A 6-m wide lateral road will connect the access road to Brgy. Cawilan. Local residents can use the main access road (Section 3.1.6). • Water sprays and regulated speeds of vehicles in populated areas are part of the control strategy for air quality (Section 3.4.2).
4. Establishment of a reforestation and carbon sink program to mitigate greenhouse gas (GHG) emissions of the project in line with the DENR's thrust for GHG emission reduction programs. The program shall be submitted to EMB prior to project implementation;	For compliance.	The reforestation and carbon sink program is one component of the control strategy for plants and animal communities (Section 3.1.9.2).

ECC Conditions or Recommendations	Status of Project's Compliance	Reference to this EPEP
5. Protect the headwaters and natural springs/wells within the project site that are being utilized as sources of potable water by the community. Should the development activities affect the headwaters and natural springs/wells, the proponent shall immediately provide alternative sources of potable water to the affected community;	For compliance.	• GRC established a potable water supply and distribution system for the direct impact barangays. The water source is the open pit. After pit dewatering, the seven bores sunk east of the open pit to depressurize the pit walls will be the source of the potable water system (Section 3.2.1.2). • The indirect impact barangays of Magpayang and Pongtud use springs and wells for their water requirements. The weekly measurement of the flows of these springs and wells to detect any impacts from the Project is part of the EMoP (Table 4-1).
General conditions		
6. The mining and milling operations shall conform with the provisions of RA No. 6969, RA No. 9003, RA No. 9275, and RA No. 8749.	For compliance.	The requirements are subsequent to the approval of this EPEP.
7. The proponent shall comply with the environmental management and protection requirements of the Philippine Mining Act of 1995 as well as the pertinent provisions of the MOA between the EMB and MGB executed on 16 April 1998 such as, but not limited, to the following:	For compliance	This EPEP complies with the environmental requirements of RA No. 7942 and the MOA between EMB and MGB.
a. Submission of EPEP with the FMRDP integrated thereto, to the MGB, for approval;	For compliance.	This EPEP complies partially with the condition. In accordance with the requirements of the MGB, the FRMDP will be submitted separately.
b. Setting up of a Contingent Liability and Rehabilitation Fund (CLRF) and Environmental Trust Fund (ETF);	For compliance.	The condition is subsequent to the approval of this EPEP.
c. Setting up of a Mine Environmental Protection and Enhancement Office (MEPEO) to competently handle the environment-related aspect of the project. In addition to the monitoring requirements as specified in the EMP, the MEPEO shall also monitor the actual project impacts vis-à-vis the predicted impacts and management measures in the EIS;	For compliance.	The condition is subsequent to the approval of this EPEP.
d. Establishment of Mine Rehabilitation Fund Committee (MRFC) and Multipartite Monitoring Team (MMT). A local DOH representative shall be included as member in the MMT;	For compliance.	The condition is subsequent to the approval of this EPEP.
e. Submission of an SDMP within 30 days from receipt of this ECC to the MGB Regional Office No. XIII for approval. The EMB shall	Complied with.	

ECC Conditions or Recommendations	Status of Project's Compliance	Reference to this EPEP
be furnished with the SDMP within 30 days from its approval and		
f. Designation of a Community Relations Officer;	Complied with.	
8. The proponent shall ensure that its contractors and subcontractors properly comply with the relevant conditions of this Certificate;	For compliance.	The condition is subsequent to the approval of this EPEP.
9. The proponent shall conduct detailed geotechnical and hydrogeological studies to predict the hydrological impacts of underground mining and submit the results of the studies to EMB-XIII and MGB-XIII prior to project operation.	For compliance.	Geotechnical studies commissioned by GRC for the underground mine have been completed. These include the reports of Peter O'Bryan & Associates (2008), Red Rock Engineering Pty Ltd (2009), and Revell Resources Pty Ltd (2009). Hydrogeological studies will still be commissioned.
Restrictions		
10. The gold deposit shall be mined by open pit method to an approximate depth of 200 m below the surface from the existing floor depth of about 90 m, then by underground method over an approximately 200 m vertical interval and shall be processed by cyanidation and flotation, and	For compliance.	The mining plan and methods discussed in Section 2.1.4 comply with this restriction.
11. Transfer of ownership of this project carries these same conditions and restrictions for which written notification must be made by herein grantee to EMB within 15 days from such transfer	For compliance.	
Project assessment planning tool		
Regulatory conditions		
1. Compliance with the Sanitation Code of the Philippines	For compliance.	The condition is subsequent to the approval of this EPEP.
2. Compliance with the Labor Code of the Philippines, including occupational health and safety standards	For compliance.	The condition is subsequent to the approval of this EPEP.
3. Compliance with the Building Code of the Philippines	For compliance.	The condition is subsequent to the approval of this EPEP.
4. Provision of proper storm drainage canal, concrete culverts, and other flood control measures to adequately receive and channel the silt-laden runoff from nearby receiving bodies of water	For compliance.	The major features and design criteria of the Project's stormwater and sediment control system are discussed in Sections 3.1.6 (access road), 3.2.2.2 (WRD), and 3.2.4.2 (TSF).
5. Coordination and consideration of the NWRB conditions or requirements in the allocation of water supply	For compliance.	The condition is subsequent to the approval of this EPEP.
6. Presentation of the EIA findings for consideration in the approval by FMB-DENR of its Tree Cutting Permit	For compliance.	The condition is subsequent to the approval of this EPEP.

ECC Conditions or Recommendations	Status of Project's Compliance	Reference to this EPEP
7. Coordination with the LGUs concerned on the implementation of the Solid Waste Management System	For compliance.	The major features and design criteria of the Project's sanitary landfill are discussed in Section 3.1.7.
Environmental planning recommendations for the proponent		
8. The Emergency Response Plan (ERP) shall be prepared to include an off-site emergency plan based on APELL (Awareness and Preparedness for Emergency at the Local Level)	For compliance.	The condition is subsequent to the approval of this EPEP.
9. Priority of employment shall be given to qualified local residents. Adequate public information for jobs shall be made available to local residents in the affected areas.	For compliance.	GRC has a MOA with the Chairmen of the six impact barangays for the hiring of local residents.
10. The proponent needs to implement a Risk Management Program to address environmental risks including contingency measures in case of accidents, equipment/machine malfunctions/failures, and other emergencies	For compliance.	The condition is subsequent to the approval of this EPEP.
11. An independent third party shall be commissioned to undertake an environmental audit, including a continuing study on the effects of the project on the health of the workers and affected residents, particularly women and children. The result of the third party audit, including the auditing of risks and hazards of the project, shall be submitted to EMB and MGB, while the result of the continuing health study shall be submitted, every 2 years to the DOH for evaluation.	For compliance.	The condition is subsequent to the approval of this EPEP.

6.3 Capital and Operating Costs

Table 6-3 presents the EPEP's estimated capital cost. The cost items have been broken down into Pollution control facilities, rock mitigation fence, environmental review, environment and community, and relocation housing.

Table 6-3. Capital cost of the EPEP

ITEM	US $	PhP
Pollution control facilities		
Tailings storage facility	4,260,849	205,159,879
Additional thickener for underground tailings	1,200,000	57,780,000
CN detoxification	401,998	19,356,204
Paste fill plant	4,359,005	209,886,091
Mercury scrubber	153,619	7,396,755

ITEM	US $	PhP
Stormwater drainage and settling ponds	375,514	18,080,999
Sewage treatment plant	74,766	3,600,000
Oil-water separators	70,000	3,370,500
Process spillage pumps	25,212	1,213,958
Bunds (plant area)	198,976	9,580,694
Rock mitigation fence	20,768	1,000,000
Environmental review	80,000	3,852,000
Environment and community	269,948	12,997,996
Relocation housing	620,286	29,866,771
Total Environmental CAPEX	12,110,941	583,141,847
Total Project CAPEX	103,825,785	4,999,222,225
% of Environmental to Total CAPEX	11.7	11.7

Note: Capital cost does not include additional capital required for the storage of tailings from underground operations.

Source: MCC

The pollution control facilities include the TSF, additional thickener for underground tailings, CN detoxification circuit, paste fill plant, mercury scrubber, stormwater drainage and settling ponds, sewage treatment plant, oil-water separators, process spillage sumps, and bunds in the plant area.

Capital costs for additional equipment and works for the underground tailings will be determined after a full technical and financial evaluation of the alternatives presented in Section 3.1.3.

Table 6-3 presents the EPEP operating costs commencing from Year -1 and ending on Year 10. The major cost items are:

- Maintenance of WRD and CLF
- TSF operation and maintenance
- CN detoxification

Table 6-4. Operating costs of the EPEP

EPEP Cost Item		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	TOTAL
Maintenance of WRD and CLF	PhP	26,655,241	25,583,231	5,869,044	4,495,619	1,996,157	835,998	119,428	116,585	133,646	204,734	275,822	66,285,505
	US$	553,588	531,324	121,891	93,367	41,457	17,362	2,480	2,421	2,776	4,252	5,728	1,376,646
TSF operation and maintenance	PhP		16,260,592	21,680,789	25,375,271	60,430,773	66,234,283	66,544,648	66,441,078	65,934,405	63,736,194	50,148,591	502,786,624
	US$		337,707	450,276	527,005	1,255,052	1,375,582	1,382,028	1,379,877	1,369,354	1,323,701	1,041,508	10,442,090
CN detoxification	PhP		91,053,627	127,610,474	144,704,185	183,461,212	149,273,791	87,668,734	87,330,245	86,484,022	82,083,660	55,512,249	1,095,182,199
	US$		1,891,041	2,650,269	3,005,279	3,810,202	3,100,183	1,820,742	1,813,712	1,796,138	1,704,749	1,152,902	22,745,217
Mercury scrubber operation and maintenance	PhP		73,968	73,968	73,968	73,968	73,968	73,968	73,968	73,968	73,968	73,968	739,680
	US$		1,536	1,536	1,536	1,536	1,536	1,536	1,536	1,536	1,536	1,536	15,362
Paste fill plant operation and maintenance	PhP				17,867,984	185,743,922	213,584,733	215,246,871	214,415,802	212,338,130	201,534,233	136,295,316	1,397,026,991
	US$				371,090	3,857,610	4,435,820	4,470,340	4,453,080	4,409,930	4,185,550	2,830,640	29,014,060
Process spillage pumps	PhP		1,648,497	2,310,347	2,619,824	3,321,508	2,702,555	1,587,215	1,581,087	1,565,766	1,486,099	1,005,032	19,827,930
	US$		34,237	47,982	54,410	68,983	56,128	32,964	32,837	32,519	30,864	20,873	411,795
Stormwater drainage and ponds and geotextile tubes maintenance	PhP		449,240	449,240	449,240	449,240	449,240	449,240	449,240	449,240	449,240	449,240	4,492,400
	US$		9,330	9,330	9,330	9,330	9,330	9,330	9,330	9,330	9,330	9,330	93,300
Installation and maintenance of Geotextile tubes	PhP	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	16,500,000
	US$	31,153	31,153	31,153	31,153	31,153	31,153	31,153	31,153	31,153	31,153	31,153	342,679
STP operation and maintenance	PhP	65,792	394,753	394,753	394,753	394,753	394,753	394,753	394,753	394,753	394,753	394,753	4,013,322
	US$	1,366	8,198	8,198	8,198	8,198	8,198	8,198	8,198	8,198	8,198	8,198	83,350
Oil-water separators	PhP	1,124	6,741	6,741	6,741	6,741	6,741	6,741	6,741	6,741	6,741	6,741	68,534
	US$	23	140	140	140	140	140	140	140	140	140	140	1,423
Bunds	PhP	15,569	93,411	93,411	93,411	93,411	93,411	93,411	93,411	93,411	93,411	93,411	949,679
	US$	323	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	1,940	19,723
Road sprinkling	PhP	85,000	510,000	510,000	510,000	510,000	510,000	510,000	510,000	510,000	510,000	510,000	5,185,000

EPEP Cost Item		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	TOTAL
	US$	1,765	10,592	10,592	10,592	10,592	10,592	10,592	10,592	10,592	10,592	10,592	107,684
Landfill operation and maintenance	PhP	541,753	3,250,520	3,250,520	3,250,520	3,250,520	3,250,520	3,250,520	3,250,520	3,250,520	3,250,520	3,250,520	33,046,953
	US$	11,251	67,508	67,508	67,508	67,508	67,508	67,508	67,508	67,508	67,508	67,508	686,333
Revegetation of idle lands and slope stabilization as required by the ECC	PhP	1,052,958	253,195	571,960	480,447	384,627	288,807	192,985	2,689				3,227,669
	US$	21,868	5,258	11,879	9,978	7,988	5,998	4,008	56				67,034
Water quality monitoring	PhP		121,400	121,400	121,400	121,400	121,400	121,400	121,400	121,400	121,400	121,400	1,214,000
	US$		2,521	2,521	2,521	2,521	2,521	2,521	2,521	2,521	2,521	2,521	25,213
Air quality monitoring	PhP		30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	300,000
	US$		623	623	623	623	623	623	623	623	623	623	6,231
MMT Monitoring	PhP		120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	120,000	1,200,000
	US$		2,492	2,492	2,492	2,492	2,492	2,492	2,492	2,492	2,492	2,492	24,922
Research on geotextile tubes	PhP	850,000											850,000
	US$	17,653											17,653
Operation of the MEPEO	PhP	1,261,547	7,569,280	7,569,280	7,569,280	7,569,280	7,569,280	6,734,937	6,734,937	6,734,937	6,734,937	6,734,937	72,782,632
	US$	26,200	157,202	157,202	157,202	157,202	157,202	139,874	139,874	139,874	139,874	139,874	1,511,581
TOTAL	PhP	32,028,984	148,918,455	172,161,927	209,662,643	449,457,512	447,039,480	384,644,851	383,172,456	379,740,939	362,329,890	256,521,980	3,225,679,118
	US$	665,192	3,092,803	3,575,533	4,354,364	9,334,528	9,284,309	7,988,470	7,957,891	7,886,624	7,525,024	5,327,559	66,992,297

Note: The operating costs indicated for the TSF operation and maintenance include an additional US $ 1.80/t of underground ore milled.
Sources: All cost estimates were prepared by GRC except for installation and maintenance of geotextile tubes, road sprinkling, landfill operation and maintenance, revegetation of idle lands and slope stabilization as required by the ECC, water quality monitoring, air quality monitoring, MMT monitoring, and research on geotextile tubes which were done by BMP.

- Mercury scrubber operation and maintenance
- Paste fill plant operation and maintenance
- Process spillage pumps
- Stormwater drainage, ponds, and geotextile tubes maintenance
- STP operation and maintenance
- Oil-water separators
- Bunds
- Road sprinkling
- Landfill operation and maintenance
- Revegetation of idle lands and slope stabilization as required by the ECC
- Water quality monitoring
- Air quality monitoring
- MMT monitoring
- Research on geotextile tubes and
- Operation of the MEPEO.

The revegetation program for idle lands and river bank stabilization is spread over a period of 8 years. The cost details are shown in Table 6-5.

Table 6-5. Cost details of revegetation program

Project Component	2010	2011	2012	2013	2014	2015	2016	2017	Total
Nursery establishment	770,500								770,500
Idle lands									
Nursery operations	282,458								282,458
Plantation establishment		246,601							246,601
Plantation maintenance and protection			566,857	472,381	377,905	283,429	188,952		1,889,525
Sub-total	282,458	246,601	566,857	472,381	377,905	283,429	188,952		2,418,583
Slope stabilization of river banks									
Nursery operations		6,594							6,594
Plantation establishment			5,103						5,103
Plantation maintenance and protection				8,066	6,722	5,378	4,033	2,689	26,888

Project Component	2010	2011	2012	2013	2014	2015	2016	2017	Total
Sub-total		6,594	5,103	8,066	6,722	5,378	4,033	2,689	38,585
Grand total	1,052,958	253,195	571,960	480,447	384,627	288,807	192,985	2,689	3,227,669

Notes:

1. Costs are in Philippine Pesos.
2. Idle lands refer to lands within the Siana property which will not be utilized by the Project.

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8 ANNEXES

Annex 1. MPSA No. 184-2002-XIII

Annex 2. Approval of transfer of MPSA No. 184-2002-XIII from JCG Resources Corporation to Merrill Crowe Corporation

Annex 3. Environmental compliance certificate of the Siana Gold Project

Annex 4. Climatological normals at PAGASA's Surigao City Synoptic Station

Annex 5. Climatological extremes at PAGASA's Surigao City Synoptic Station

Annex 6. Rainfall intensity-duration-frequency data of PAGASA's Surigao City Synoptic Station

Annex 1. MPSA No. 184-2002-XIII

PHO59

MINERAL PRODUCTION SHARING AGREEMENT

No. MPSA No. 184-2002-XIII

This **MINERAL PRODUCTION SHARING AGREEMENT** ("Agreement") is made and entered into in Quezon City, Philippines, this _____ day of DEC 11 2002 by and between:

THE REPUBLIC OF THE PHILIPPINES, herein referred to as the **GOVERNMENT**, represented in this act by the Secretary of the Department of Environment and Natural Resources, with offices at the Department of Environment and Natural Resources Building, Visayas Avenue, Diliman, Quezon City

and

J.C.G. RESOURCES CORPORATION, a corporation duly organized and existing under the laws of the Republic of the Philippines, herein referred to as the CONTRACTOR, with office at 11th Flr., Gotesco Corporate Centre, Bilibid Viejo corner Gil Puyat Streets, Quiapo, Manila and represented in this act by its President, **Joel T. Go**, as authorized by its Board of Directors (please refer to ANNEX "A")

WITNESSETH :

WHEREAS, the 1987 Constitution of the Republic of the Philippines provides in Article XII, Section 2 thereof that all lands of the public domain, waters, minerals, coal, petroleum, and other natural resources are owned by the State and that their exploration, development and utilization shall be under the full control and supervision of the State;

WHEREAS, the Constitution further provides that the State may directly undertake such activities, or it may enter into a Co-Production, Joint Venture, or Mineral Production Sharing Agreement with Filipino citizens, or cooperatives, partnerships, corporations or associations at least sixty per centum of whose capitalization is owned by such citizens;

WHEREAS, pursuant to Republic Act No. 7942, otherwise known as "The Philippine Mining Act of 1995", which took effect on 09 April 1995, the Secretary of the Department of Environment and Natural Resources is authorized to enter into Mineral Production Sharing Agreements in furtherance of the objectives of the Government and the Constitution to bolster the national economy through sustainable and systematic development and utilization of mineral lands;

For the Exploration Work Program:

1st Contract Year	:	PhP 2,600,000.00
2nd Contract Year	:	PhP 4,400,000.00
Total	:	PhP 7,000,000.00

For the Environmental Work Program : PhP 700,000.00

In the event of renewal of the Exploration Period, the amount to be spent every year shall first be agreed upon by the parties.

In the event of termination of this Agreement, the Contractor shall only be obliged to expend the pro-rata amount for the period of such Contract Year prior to termination. If during any Contract Year, the Contractor should expend more than the amount to be expended as provided above, the excess may be subtracted from the amount required to be expended by the Contractor during the succeeding Contract Years, and should the Contractor, due to unforeseen circumstances or with the consent of the Government, expend less during a year, then the deficiency shall be applied to the amount to be expended during the succeeding Contract Years.

5.3 Relinquishment of Total/Portion of the Contract Area - During the Exploration Period, the Contractor may relinquish totally or partially the original Contract Area. After the Exploration Period and prior to or upon approval of a Declaration of Mining Project Feasibility, the Contractor shall finally relinquish any portion of the Contract Area not necessary for mining operations and not covered by any Declaration of Mining Project Feasibility.

5.4 Final Mining Area - The final Mining Area shall not be more than five thousand hectares (5,000 has.) for metallic minerals. The Director may allow the Contractor to hold more than one (1) final Mining Area subject to the maximum limits set under the implementing rules and regulations of the Act: Provided, That each final Mining Area shall be covered by a Declaration of Mining Project Feasibility supported by a Mining Project Feasibility Study, Development/Utilization Work Program and application for survey.

5.5 Survey of the Contract Area - The Contractor shall cause the survey of the perimeter of the Contract Area through an application for survey, complete with requirements, filed with the concerned Regional Office simultaneous with the submission of the Declaration of Mining Project Feasibility. Survey returns shall be submitted to the concerned Regional Director for approval within one (1) year from receipt of the Order of Survey complete with the mandatory requirements stated in the implementing rules and regulations of the Act.

5.6 Declaration of Mining Project Feasibility - During the Exploration Period, the Contractor shall submit to the Director through the concerned Regional Director, a Declaration of Mining Project Feasibility together with a Mining Project Feasibility Study, a Three (3)-Year Development and Construction or

WHEREAS, the Government desires to avail itself of the financial resources, technical competence and skill which the Contractor is capable of applying to the mining operations of the project contemplated herein;

WHEREAS, the Contractor desires to join and assist the Government in the sustainable development and utilization for commercial purposes of certain **gold, copper, silver** and other associated mineral deposits existing in the Contract Area (as herein defined);

WHEREAS, the Contractor has access to all the financing, technical competence, technology and environmental management skills required to promptly and effectively carry out the objectives of this Agreement.

NOW, THEREFORE, for and in consideration of the foregoing premises, the mutual covenants, terms and conditions hereinafter set forth, it is hereby stipulated and agreed as follows:

SECTION I

SCOPE

1.1 This Agreement is a Mineral Production Sharing Agreement entered into pursuant to the provisions of the Act and its implementing rules and regulations. The primary purpose of this Agreement is to provide for the rational exploration, development and commercial utilization of certain **gold, copper, silver** and other associated mineral deposits existing within the Contract Area, with all necessary services, technology and financing to be furnished or arranged by the Contractor in accordance with the provisions of this Agreement. The Contractor shall not, by virtue of this Agreement, acquire any title over the Contract/Mining Area without prejudice to the acquisition by the Contractor of the land/surface rights through any mode of acquisition provided for by law.

1.2 The Contractor shall undertake and execute, for and on behalf of the Government, sustainable mining operations in accordance with the provisions of this Agreement, and is hereby constituted and appointed, for the purpose of this Agreement, as the exclusive entity to conduct mining operations in the Contract Area.

1.3 The Contractor shall assume all the exploration risk such that if no minerals in commercial quantity are developed and produced, it will not be entitled to reimbursement.

1.4 During the term of this Agreement, the total value of production and sale of minerals derived from the mining operations contemplated herein shall be accounted for and divided between the Government and the Contractor in accordance with Section VIII hereof.

SECTION II

DEFINITIONS

As used in this Agreement, the following words and terms, whether singular or plural, shall have the following respective meaning :

2.1 "Act" refers to Republic Act No. 7942, otherwise known as the "Philippine Mining Act of 1995".

2.2 Agreement means this Mineral Production Sharing Agreement.

2.3 Associated Minerals mean other ores/minerals which occur together with the principal ore/mineral.

2.4 Bangko Sentral means Bangko Sentral ng Pilipinas.

2.5 Budget means an estimate of expenditures to be made by Contractor in mining operations contemplated hereunder to accomplish the Work Program for each particular period.

2.6 Calendar Year or Year means a period of twelve (12) consecutive months starting with the first day of January and ending on December 31, while "Calendar Quarter" means a period of three consecutive months with the first calendar quarter starting with the first day of January.

2.7 Commercial Production means the production of sufficient quantity of minerals to sustain economic viability of mining operations reckoned from the date of commercial operation as declared by the Contractor or as stated in the feasibility study, whichever comes first.

2.8 Constitution or Philippine Constitution means the 1987 Constitution of the Republic of the Philippines adopted by the Constitutional Convention of 1986 on October 15, 1986 and ratified by the People of the Republic of the Philippines on February 2, 1987.

2.9 Contract Area means the area onshore or offshore delineated under the Mineral Production Sharing Agreement subject to the relinquishment obligations of the Contractor and properly defined by latitude and longitude or bearing and distance.

2.10 Contract Year means a period of twelve (12) consecutive months counted from the Effective Date of this Agreement or from the anniversary of such Effective Date.

2.11 Contractor means **J.C.G. RESOURCES CORPORATION** or its assignee or assignees of interest under this Agreement. Provided, That the assignment of any of such interest is accomplished pursuant to the pertinent provisions of the implementing rules and regulations of the Act.

2.12 Declaration of Mining Feasibility means a document proclaiming the presence of minerals in a specific site that are recoverable by socially acceptable, environmentally safe and economically sound methods specified in the Mine Development Plan.

2.13 Department or DENR means the Department of Environment and Natural Resources.

2.14 Director means the Director of Mines and Geosciences Bureau.

2.15 Effective Date means the date of execution of this Agreement by the Contractor and by the Secretary on behalf of the Government. In case an Exploration Permit/Temporary Exploration Permit had been availed of by the Contractor, the Effective Date of this Agreement shall be the date of issuance of said Exploration Permit/Temporary Exploration Permit.

2.16 Environment means all facets of man's surroundings: physical, ecological, aesthetic, cultural, economic, historic, institutional and social.

2.17 Exploration means searching or prospecting for mineral resources by geological, geophysical and geochemical surveys, remote sensing, test pitting, trenching, drilling, shaft sinking, tunneling, or any other means for the purpose of determining the existence, extent, quality, and quantity of mineral resources and the feasibility of mining them for profit.

2.18 Exploration Period shall mean the time period from the Effective Date of this Agreement which shall be for two (2) years, renewable for like periods but not to exceed a total term of eight (8) years subject to the pertinent provisions of the implementing rules and regulations of the Act.

2.19 Force Majeure means acts or circumstances beyond the reasonable control of the Contractor including, but not limited to war, rebellion, insurrection, riots, civil disturbances, blockade, sabotage, embargo, strike, lockout, any dispute with surface owners and other labor disputes, epidemics, earthquake, storm, flood, or other adverse weather conditions, explosion, fire, adverse action by the Government or by any of its instrumentality or subdivision thereof, act of God or any public enemy and any cause as herein described over which the affected party has no reasonable control.

2.20 Foreign Exchange means any currency other than the currency of the Republic of the Philippines acceptable to the Government and the Contractor.

2.21 Government means the Government of the Republic of the Philippines or any of its agencies and instrumentalities.

2.22 Gross Output means the actual market value of the minerals or mineral products from each mine or mineral land operated as a separate entity, without any deduction for mining, processing, refining, transporting, handling, marketing, or any other expenses: Provided, That if the minerals or mineral products are sold or consigned abroad by the Contractor under C.I.F. terms, the actual cost of ocean freight and insurance shall be deducted: Provided

further, That in the case of mineral concentrates which are not traded in commodity exchanges in the Philippines or abroad such as copper concentrate, the actual market value shall be the world price quotation of the refined mineral products contained thereof prevailing in the said commodity exchanges, after deducting the smelting ,refining, treatment, insurance, transportation and other charges incurred in the process of converting mineral concentrates into refined metal traded in those commodity exchanges.

2.23 Mine Development refers to work undertaken to prepare an ore body or a mineral deposit for mining, including the construction of necessary infrastructure and related facilities.

2.24 Minerals mean all naturally occurring inorganic substances in solid, liquid, gas or any intermediate state excluding energy materials such as coal, petroleum, natural gas, radioactive materials and geothermal energy.

2.25 Mineral Products mean materials derived from mineral ores/rocks and prepared into marketable state by metallurgical processes which include beneficiation, cyanidation, leaching, smelting, calcination and other similar processes.

2.26 Mining Area means that portion of the Contract Area identified by the Contractor as defined and delineated in a Survey Plan duly approved by the Director/concerned Regional Director for purposes of development and/or utilization and sites for support facilities.

2.27 Mining Operations means mining activities involving exploration, feasibility study, environmental impact assessment, development, utilization, mineral processing, and mine rehabilitation.

2.28 Notice means notice in writing, telex or telecopy (authenticated by answer back or confirmation received) addressed or sent as provided in Section 16.2 of this Agreement.

2.29 Ore means naturally occurring substance or material from which a mineral or element can be mined and/or processed for profit.

2.30 Pollution means any alteration of the physical, chemical and/or biological properties of any water, air and/or land resources of the Philippines, or any discharge thereto of any liquid, gaseous or solid wastes or any production of unnecessary noise or any emission of objectionable odor, as will or is likely to create or render such water, air, and land resources harmful, detrimental or injurious to public health, safety or welfare or which will adversely affect their utilization for domestic, commercial, industrial, agricultural, recreational or other legitimate purposes.

2.31 Secretary means the Secretary of the Department of Environment and Natural Resources.

2.32 State means the Republic of the Philippines.

2.33 Work Program means a document which presents the plan of major mining operations and the corresponding expenditures of the Contractor in its Contract Area during a given period of time, including the plan and expenditures for development of host and neighboring communities and of local geoscience and mining technology, as submitted and approved in accordance with the implementing rules and regulations of the Act.

SECTION III

TERM OF AGREEMENT

3.1 This Agreement shall have a term of twenty-five (25) years from Effective Date, and may be renewed thereafter for another term not exceeding twenty five (25) years. The renewal of this Agreement, as well as the changes in the terms and conditions thereof, shall be upon mutual consent by the parties. In the event the Government decides to allow mining operations thereafter by other Contractor, this must be through competitive public bidding. After due publication of notice, the Contractor shall have the right to equal the highest bid upon reimbursement of all reasonable expenses of the highest bidder.

SECTION IV

CONTRACT AREA

4.1 Size, Shape, and Location of Contract Area. This Agreement covers a total area of Three Thousand two hundred eighty eight and 7,676/10,000 hectares (3,288.7676 has.), situated in the Municipalities of Alegria, Mainit, Tubod and Bacuag, Province of Surigao Del Norte, bounded by the following geographical coordinates (please refer to ANNEX "B" - 1:50,000 scale Location Map/Sketch Plan):

BLOCK I – 1,265.0309 Hectares

CORNER	LATITUDE	LONGITUDE
1	9°28'30"	125°35'00"
2	9°29'30"	125°35'00"
3	9°29'30"	125°34'30"
4	9°30'30"	125°34'30"
5	9°30'30"	125°35'00"
6	9°30'00"	125°35'00"
7	9°30'00"	125°36'30"
8	9°30'30"	125°36'30"
9	9°30'30"	125°37'30"
10	9°30'00"	125°37'30"
11	9°30'00"	125°37'00"
12	9°29'00"	125°37'00"
13	9°29'00"	125°36'30"
14	9°28'30"	125°36'30"

BLOCK II – 2,023.7367 Hectares

CORNER	LATITUDE	LONGITUDE
1	9°31'00"	125°34'00"
2	9°31'30"	125°34'00"
3	9°31'30"	125°33'30"
4	9°32'00"	125°33'30"
5	9°32'00"	125°33'00"
6	9°32'30"	125°33'00"
7	9°32'30"	125°33'30"
8	9°34'00"	125°33'30"
9	9°34'00"	125°34'00"
10	9°34'30"	125°34'00"
11	9°34'30"	125°35'30"
12	9°32'00"	125°35'30"
13	9°32'00"	125°35'00"
14	9°31'30"	125°35'00"
15	9°31'30"	125°34'30"
16	9°31'00"	125°34'30"

SECTION V

EXPLORATION PERIOD

5.1 Timetable for Exploration - The Contractor shall commence Exploration activities not later than three (3) months after the Effective Date for a period of two (2) years, renewable for like periods but not to exceed a total term of six (8) years, subject to annual review and approval by the Director to evaluate compliance with the terms and conditions of this Agreement: Provided, That further renewal may be granted by the Secretary under circumstances as defined in the implementing rules and regulations of the Act.

In case where a Temporary Exploration Permit was issued, the Period of such Temporary Exploration Permit shall be included as part of the Exploration Period of this Agreement.

5.2 Work Programs and Budgets - The Contractor shall strictly comply with the approved Exploration and Environmental Work Programs together with their corresponding Budgets (please refer to ANNEXES "C" and "D")

The amount to be spent by the Contractor in conducting Exploration activities under the terms of this Agreement during the Exploration Period shall be in the aggregate of not less than that specified for each of the Contract Years, as follows:

Commercial Operation Work Program, a complete geologic report of the area and an Environmental Compliance Certificate. The Mining Project Feasibility Study and Work Program are subject to approval by the Director. Failure of the Contractor to submit a Declaration of Mining Project Feasibility during the Exploration Period shall be considered a substantial breach of this Agreement.

5.7 Reporting

a) Periodic Reports - During the Exploration Period, the Contractor shall submit to the Director through the concerned Regional Director, quarterly and annual accomplishment reports under oath on all activities conducted in the Contract Area from the Effective Date of this Agreement. The quarterly report shall be submitted not later than fifteen (15) days at the end of each Calendar Quarter while the annual accomplishment report shall be submitted not later than thirty (30) days from the end of each Calendar Year. Such information shall include detailed financial expenditures, raw and processed geological, geochemical, geophysical and radiometric data plotted on a map at a minimum 1:50,000 scale, copies of originals of assay results, duplicated samples, field data, copies of originals from drilling reports, maps, environmental work program implementation and detailed expenditures showing discrepancies/deviations with approved exploration and environmental plans and budgets as well as all other information of any kind collected during the exploration activities. All information submitted to the Bureau shall be subject to the confidentiality clause of this Agreement.

b) Final Report - The Contractor shall submit to the Director through the concerned Regional Director, a final report under oath upon the expiration of the Exploration Period which shall be in the form and substance comparable to published professional reports of respectable international institutions and shall incorporate all the findings in the Contract Area including location of samples, assays, chemical analysis, and assessment of mineral potentials together with a geologic map of 1:50,000 scale at the minimum showing the results of the exploration. Such report shall also include detailed expenditures incurred during the Exploration Period. In case of diamond drilling, the Contractor shall, upon request of the Director/concerned Regional Director, submit to the Regional Office a quarter of the core samples which shall be deposited in the Regional Office Core Library for safekeeping and reference.

c) Relinquishment Report - The Contractor shall submit a separate relinquishment report with a detailed geologic report of the relinquished area accompanied by maps at a scale of 1:50,000 and results of analyses and detailed expenditures, among others.

SECTION VI

DEVELOPMENT AND CONSTRUCTION PERIOD

6.1 Timetable - The Contractor shall complete the development of the mine including the construction of production facilities within thirty six (36) months from the submission of the Declaration of Mining Project Feasibility, subject to such extension based on justifiable reasons as the Director may approve, upon recommendation of the concerned Regional Director.

6.2 Reporting

a) Annual - The Contractor shall submit, within sixty (60) days after December 31 of each year, to the Director through the concerned Regional Director, an annual report which states the major activities, achievements and detailed expenditures during the year covered, including maps, assays, rock and mineral analyses and geological and environmental progress reports during the Development and Construction Period.

b) Final Report - Within six (6) months from the completion of the development and construction activities, the Contractor shall submit a final report to the Director through the concerned Regional Director. Such report shall integrate all information in maps of appropriate scale and quality, as well as in monographs or reports in accordance with international standards.

SECTION VII

OPERATING PERIOD

7.1 Timetable - The Contractor shall submit, within thirty (30) days before completion of mine development and construction of production facilities, to the Director through the concerned Regional Director, a Three-Year Commercial Operation Work Program. The Contractor shall commence commercial utilization immediately upon approval of the aforesaid Work Program. Failure of the Contractor to commence Commercial Production within the period shall be considered a substantial breach of the Agreement.

7.2 Commercial Operation Work Program and Budget - During the Operating Period, the Contractor shall submit to the Director through the concerned Regional Director, Work Programs and Budgets covering a period of three (3) years each, which shall be submitted not later than thirty (30) days before the expiration of the period covered by the previous Work Program.

The Contractor shall conduct Mining Operations and other activities for the duration of the Operating Period in accordance with the duly approved Work Programs and corresponding Budgets and any modification thereof shall be subject to approval by the Director.

7.3 Expansion and Modification of Facilities - The Contractor may make expansions, modifications, improvements, and replacements of the mining facilities and may add new facilities as the Contractor may consider necessary for the operations: Provided, That such plans shall be embodied in an appropriate Work Program approved by the Director.

7.4 Reporting

a) Quarterly Reports - Beginning with the first Calendar Quarter following the commencement of the Operating Period, the Contractor shall submit, within thirty (30) days after the end of each Calendar Quarter, to the Director through the concerned Regional Director, a Quarterly Report stating the tonnage of production in terms of ores, concentrates, and their corresponding grades and other types of products; value, destination of sales or exports and to whom sold; terms of sales and expenditures.

b) Annual Reports - During the Operating Period, the Contractor shall submit within sixty (60) days from the end of each Calendar Year, to the Director through the concerned Regional Director, an Annual Report indicating in sufficient detail:

b.1) The total tonnage of ore reserves, whether proven, probable, or inferred, the total tonnage of ores, kind by kind, broken down between tonnage mined, tonnages transported from the minesite and their corresponding destination, tonnages stockpiled in the mine and elsewhere in the Philippines, tonnages sold or committed for export (whether actually shipped from the Philippines or not), tonnages actually shipped from the Philippines (with full details as to purchaser, destination and terms of sale), and if known to the Contractor, tonnages refined, processed or manufactured in the Philippines with full specifications as to the intermediate products, by-products or final products and of the terms at which they were disposed;

b.2) Work accomplished and work in progress at the end of the year in question with respect to all the installations and facilities related to the utilization program, including the investment actually made or committed;

b.3) Profile of work force, including management and staff, stating particularly their nationalities, and for Filipinos, their place of origin (i.e., barangay, town, province, region); and

b.4) Ownership of the Contractor, particularly with respect to nationality.

The Contractor shall also comply with other reporting requirements provided for in the implementing rules and regulations of the Act.

SECTION VIII

FISCAL REGIME

8.1 General Principle - The fiscal regime of this Agreement shall be governed by the principle according to which the Government expects a reasonable return in economic value for the utilization of non-renewable mineral resources under its national sovereignty while the Contractor expects a reasonable return on its investment with special account to be taken for the high risk of exploration, the terms and conditions prevailing elsewhere in the industry and any special efficiency to be gained by a particularly good performance of the Contractor.

8.2 Registration Fees - Within fifteen (15) days upon receipt of the notice of approval of the Agreement from the concerned Regional Office, the Contractor shall cause the registration of this Agreement with the said Regional Office and pay the registration fee at the rate provided in the existing rules and regulations. Failure of the Contractor to cause the registration of this Agreement within the prescribed period shall be sufficient ground for cancellation of the same.

8.3 Occupation Fees - Prior to registration of this Agreement and at the same date every year thereafter, the Contractor shall pay to the concerned Municipal/City Treasurer an occupation fee over the Contract Area at the annual rate provided in the existing rules and regulations. If the fee is not paid on the date specified, the Contractor shall pay a surcharge of twenty five percentum (25%) of the amount due in addition to the occupation fees.

8.4 Share of the Government - The Government Share shall be the excise tax on mineral products at the time of removal and at the rate provided for in Republic Act No. 7729 amending Section 151 (a) of the National Internal Revenue Code, as amended, as well as other taxes, duties, and fees levied by existing laws.

For purposes of determining the amount of the herein Government Share, the Contractor shall strictly comply with the auditing and accounting requirements prescribed under existing laws and regulations.

The Government Share shall be allocated in accordance with Sections 290 and 292 of Republic Act No. 7160, otherwise known as "The Local Government Code of 1991".

8.5 Pricing of Sales - The Contractor shall endeavor to obtain the best achievable price for its production and pay the lowest achievable marketing commissions and related fees. The Contractor shall seek to strike a balance between long-term sales comparable to policies followed by independent producers in the international mining industry.

The Contractor shall likewise seek a balanced distribution among consumers. Insofar as sales to Contractor's affiliates are concerned, prices shall be at arm's length standard and competing offers for large scale and long-term

contracts shall be procured. The Bureau shall be furnished a copy of the said Sales Agreement subject to confidentiality between the Bureau and the Contractor.

8.6 Associated Minerals - If minerals other than **gold, copper, silver** and other associated deposits are discovered in commercial quantities in the Contract Area, the value thereof shall be added to the value of the principal mineral in computing the Government share.

SECTION IX

WORK PROGRAMS

9.1 Submission to Government - Within the periods stated herein, the Contractor shall prepare and submit to the Director through the concerned Regional Director, a Work Program and corresponding Budget for the Contract Area stating the Mining Operations and expenditures which the Contractor proposes to carry out during the period covered with the details and particulars set forth elsewhere in this Agreement or in the supporting documents.

9.2 Government's Examination and Revision of Work Program - Should the Government wish to propose a revision to a certain specific feature in the Work Program or Budget, it shall, within thirty (30) days after receipt thereof, provide a Notice to the Contractor specifying in reasonable detail its reasons therefore. Promptly thereafter, the Government and Contractor will meet and endeavor to agree on the revision proposed by the Government. In any event, the revision of any portion of said Work Program or Budget in which the Government shall fail to notify the Contractor of the proposed revision shall, insofar as possible, be carried out as prescribed herein. If the Government should fail within sixty (60) days from receipt thereof to notify Contractor of the proposed revisions, the Work Program and Budget proposed by the Contractor shall be deemed to be approved.

9.3 Contractor's Changes to Work Program - It is recognized by the Government and the Contractor that the details of any Work Program may require changes in the light of changing circumstances. The Contractor may make such changes: Provided, That it shall not change the general objective of the Work Program: Provided further, That changes which entail a variance of at least twenty percentum (20%) shall be subject to the approval of the Director.

9.4 The Government's approval of a proposed Work Program and Budget will not be unreasonably withheld.

SECTION X

ENVIRONMENTAL PROTECTION AND MINE SAFETY AND HEALTH

10.1 The Contractor shall manage its Mining Operations in a technically, financially, socially, culturally and environmentally responsible manner to achieve the sustainable development objectives and responsibilities as provided for under the implementing rules and regulations of the Act;

10.2 The Contractor shall prepare a plan of mining so that its damage to the environment will be minimal. To the extent possible, control of pollution and the transformation of the mined-out areas or materials into economically and socially productive forms must be done simultaneously with mining;

10.3 The Contractor shall submit an Environmental Work Program during the Exploration Period as prescribed in the implementing rules and regulations of the Act;

10.4 An Environmental Compliance Certificate (ECC) shall be secured first by the Contractor prior to the conduct of any development works, construction of production facilities and/or mine production activities in the Contract Area;

10.5 The Contractor shall submit within thirty (30) Calendar days after the issuance and receipt of the ECC, an Environmental Protection and Enhancement Program (EPEP) using MGB Form No. 16-2 covering all areas to be affected by development, utilization and processing activities under this Agreement. The Contractor shall allocate for its initial environment-related capital expenditures approximately ten percent (10%) of the total project cost or in such amount depending on the environmental/geological condition, nature and scale of operations and technology to be employed in the Contract Area;

10.6 The Contractor shall submit, within thirty (30) days prior to the beginning of every calendar year, an Annual Environmental Protection and Enhancement Program (AEPEP), using MGB Form 16-3, which shall be based on the approved EPEP. The AEPEP shall be implemented during the year for which it was submitted. To implement its AEPEP, the Contractor shall allocate annually three to five percent (3%-5%) of its direct mining and milling costs depending on the environmental/geologic condition, nature and scale of operations and technology employed in the Contract Area;

10.7 The Contractor shall establish a Mine Rehabilitation Fund (MRF) based on the financial requirements of the approved EPEP as a reasonable environmental deposit to ensure satisfactory compliance with the commitments/strategies of the EPEP/AEPEP and availability of funds for the performance of the EPEP/AEPEP during the specific project phase. The MRF shall be deposited as Trust Fund in a government depository bank and shall be used for physical and social rehabilitation of areas affected by mining activities and for research on the social, technical and preventive aspects of rehabilitation;

10.8 The Contractor shall set up mitigating measures such as mine waste and mill tailings disposal system, mine rehabilitation or plan, water quality monitoring, etc. to minimize land degradation, air and water pollution, acid rock drainage and changes in hydrogeology;

10.9 The Contractor shall set up an Environmental and Safety Office at its minesite manned by qualified personnel to plan, implement and monitor its approved EPEP;

10.10 The Contractor shall be responsible in the monitoring of environmental, safety and health conditions in the Contract Area and shall strictly comply with all the rules and regulations embodied under DAO No. 2000-98, otherwise known as the "Mine Safety and Health Standards;"

10.11 The Contractor shall be responsible for the submission of a final mine rehabilitation and/or decommissioning plans including its financial requirements and incorporating the details and particulars set forth in the implementing rules and regulations of the Act.

SECTION XI

RIGHTS AND OBLIGATIONS OF THE PARTIES

11.1 Obligations of the Contractor:

a) To exclusively conduct sustainable Mining Operations within the Contract Area in accordance with the provisions of the Act and its implementing rules and regulations;

b) To construct and operate any facilities specified under the Mineral Agreement or approved Work Program;

c) To determine the exploration, mining and treatment process to be utilized in the Mining Operations;

d) To extract, remove, use and dispose of any tailings as authorized by an approved Work Program;

e) To secure all permits necessary or desirable for the purpose of Mining Operations;

f) To keep accurate technical records about the mining operations as well as financial and marketing accounts and make them available to Government representatives authorized by the Director for the purpose of assessing the performance and compliance of the Contractor with the terms of this Agreement. Authorized representatives of other Government Agencies may also have access to such accounts in accordance with existing laws, rules and regulations;

g) To furnish the Bureau all the data and information gathered from the Contract Area and that all the books of accounts and records shall be open for inspection;

g) To allow access to Government during reasonable hours in inspecting the Contract Area and examining pertinent records for purposes of monitoring compliance with the terms of this Agreement;

i) To hold the Government free and harmless from all claims and accounts of all kinds, as well as demands and actions arising out of the accidents or injuries to persons or properties caused by Mining Operations of the Contractor and indemnify the Government for any expenses or costs incurred by the Government by reason of any such claims, accounts, demands or actions;

j) In the development of the community:

j.1) To recognize and respect the rights, customs and traditions of indigenous cultural communities over their ancestral lands and to allocate royalty payment of not less than one percent (1%) of the value of the gross output of minerals sold;

j.2) To coordinate with proper authorities in the development of the mining community and for those living in the host and neighboring communities through social infrastructure, livelihood programs, education, water, electricity and medical services. Where traditional self-sustaining income and the community activities are identified to be present, the Contractor shall assist in the preservation and/or enhancement of such activities;

j.3) To allot annually a minimum of one percent (1%) of the direct mining and milling costs necessary to implement the activities undertaken in the development of the host and neighboring communities. Expenses for community development may be charged against the royalty payment of at least one percent (1%) of the gross output intended for the concerned indigenous cultural community;

j.4) To give preference to Filipino citizens who have established domicile in the neighboring communities, in the hiring of personnel for its mining operations. If necessary skills and expertise are currently not available, the Contractor must immediately prepare and undertake a training and recruitment program at its expense;

j.5) To incorporate in the Mining Project Feasibility Study the planned expenditures necessary to implement (j.1) to (j.3) of this Section;

k) In the development of Mining Technology and Geosciences:

k.1) In the course of its operations, to produce geological, geophysical, geochemical and other types of maps and reports that are

appropriate in scale and in format and substance which are consistent with the internationally accepted standards and practices. Such maps shall be made available to the scientific community in the most convenient and cost effective forms, subject to the condition that the Contractor may delay release of said information for a reasonable period of time which shall not exceed three (3) years;

k.2) To systematically keep the data generated from the Contract/Mining Area such as cores, assays and other related information, including economic and financial data and make them accessible to students, researchers and other persons responsible for developing mining, geoscience and processing technology subject to the condition that the Contractor may delay release of data to the science and technology community within a reasonable period of time which shall not exceed three (3) years;

k.3) To transfer to the Government or local mining company the appropriate technology it may adapt in the exploration, development and commercial utilization of the minerals in the Contract Area;

k.4) To allocate research and development budget for the advancement of mining technology and geosciences in coordination with the Bureau, research institutions, academe, etc.;

k.5) To replicate data, maps and reports cited in (k.1) and (k.2) and furnish the Bureau for archiving and systematic safekeeping which shall be made available to the science and technology community for conducting research and undertaking other activities which contribute to the development of mining, geoscience and processing technology and the corresponding national pool of manpower talents: Provided, however, that the release of data, maps and the like shall be similarly constrained in accordance with (k.1) and (k.2) above;

l) To incorporate in the Mining Project Feasibility Study the planned expenditures necessary to implement all the plans and programs set forth in this Agreement; and

m) To pay all other taxes and fees mandated by existing laws, rules and regulations.

11.2 Rights of the Contractor

The Contractor shall have the right:

a) To conduct Mining Operations within the confines of its Contract/Mining Area in accordance with the terms and conditions hereof and that it shall not interfere with the rights of other Contractors/Lessees/Operators/ Permittees;

b) Of possession of the Contract Area, with full right of ingress and egress and the right to occupy the same, subject to surface and easement rights;

c) To use and have access to all declassified geological, geophysical, drilling, production and other data relevant to the mining operations;

d) To sell, assign, transfer, convey or otherwise dispose of all its rights, interests and obligations under the Agreement subject to the approval of the Government;

e) To employ or bring into the Philippines foreign technical and specialized personnel, including the immediate members of their families as may be required in the operations of the Contractor, subject to applicable laws and regulations: Provided, That if the employment connection of such foreign persons with the Contractor ceases, the applicable laws and regulations on immigration shall apply to them. Everytime foreign technologies are utilized and where alien executives are employed, an effective program of training understudies shall be undertaken. The alien employment shall be limited to technologies requiring highly specialized training and experience subject to the required approval under existing laws, rules and regulations;

f) To enjoy easement rights and use of timber, water and other natural resources in the Contract Area subject to pertinent laws, rules and regulations and the rights of third parties;

g) Of repatriation of capital and remittance of profits, dividends and interest on loans, subject to existing laws and Bangko Sentral rules and regulations; and

h) To import when necessary all equipment, spare parts and raw materials required in the operations in accordance with existing laws and regulations.

11.3 Obligation of the Government

The Government shall:

a) Ensure that the Contractor has the Government's full cooperation in the exercise of the rights granted to it under this Agreement;

b) Use its best efforts to ensure the timely issuance of necessary permits and similar authorizing documents for use of the surface of the Contract Area; and

c) To cooperate with the Contractor in its efforts to obtain financing contemplated herein from banks or other financial institutions: Provided, That such financing arrangements will in no event reduce the Contractor's obligation on Government rights hereunder.

SECTION XII

ASSETS AND EQUIPMENT

12.1 The Contractor shall acquire for the Mining Operations only such assets that are reasonably estimated to be required in carrying out such Mining Operations.

12.2 All materials, equipment, plant and other installations erected or placed on the Contract Area of a movable nature by the Contractor shall remain the property of the Contractor. The Contractor shall have the right to remove and re-export such materials and equipment, plant and other installations from the Philippines, subject to existing rules and regulations. In case of cessation of Mining Operations on public lands occasioned by its voluntary abandonment or withdrawal, the Contractor shall have a period of one (1) year from the time of cessation within which to remove its improvements; otherwise, all social infrastructures and facilities shall be turned over or donated tax free to the proper government authorities, national or local, to ensure that said infrastructures and facilities are continuously maintained and utilized by the host and neighboring communities.

SECTION XIII

EMPLOYMENT AND TRAINING OF PHILIPPINE PERSONNEL

13.1 The Contractor agrees to employ, to the extent possible, qualified Filipino personnel in all types of mining operations for which they are qualified; and after Commercial Production commences shall, in consultation and with consent of the Government, prepare and undertake an extensive training programme suitable to Filipino nationals in all levels of employment. The objective of said programme shall be to reach within the timetable set forth below the following targets of "Filipinization":

	Unskilled (%)	Skilled (%)	Clerical (%)	Professional (%)	Management (%)
Year 1	100	100	100	75	75
Year 3	100	100	100	80	80
Year 5	100	100	100	90	90
Year 7	100	100	100	95	95
Year 10	100	100	100	95	95
Year 15	100	100	100	95	95

13.2 Cost and expenses of training such Filipino personnel and the Contractor's own employees shall be included in the Operating Expenses.

13.3 The Contractor shall not discriminate on the basis of gender and shall respect the right of women workers to participate in policy and decision-making processes affecting their rights and benefits.

SECTION XIV

ARBITRATION

14.1 The Government and the Contractor shall consult with each other in good faith and shall exhaust all available remedies to settle any and all disputes or disagreements arising out of or relating to the validity, interpretations, enforceability, or performance of this Agreement before resorting to arbitration as provided for in Section 14.2 below.

14.2 Any disagreement or dispute which can not be settled amicably within a period of one (1) year from the time the issue was raised by a Party shall be settled by a tribunal of three (3) arbitrators. This tribunal shall be constituted as follows: one to be appointed by the Contractor and another to be appointed by the Secretary. The first two appointed arbitrators shall consider names of qualified persons until agreement on a mutually acceptable Chairman of the tribunal is selected. Such arbitration shall be initiated and conducted pursuant to Republic Act No. 876, otherwise known as the "Arbitration Act".

In any event, the arbitration shall be conducted applying the substantive laws of the Republic of the Philippines.

14.3 Each party shall pay fifty per centum (50%) of the fees and expenses of the Arbitrators and the costs of arbitration. Each party shall pay its own costs and attorney's fee.

SECTION XV

SUSPENSION OR TERMINATION OF CONTRACT, TAX INCENTIVES AND CREDITS

15.1 This Agreement may be suspended for failure of the Contractor: (a) to comply with any provision or requirement of the Act and/or its implementing rules and regulations; (b) to pay taxes, fees and/or other charges demandable and due the Government.

15.2 This Agreement terminates or may be terminated for the following causes: (a) expiration of its term, whether original or renewal; (b) withdrawal from the Agreement by the Contractor; (c) violation by the Contractor of the Agreement's terms and conditions; (d) failure to pay taxes, fees/or charges or financial obligations for two (2) consecutive years; (e) false statement or omission of facts by the Contractor; and (f) any other cause or reason provided under the Act and its implementing rules and regulations, or any other relevant laws and regulations.

15.3 All statements made in this Agreement shall be considered as conditions and essential parts hereof, and any falsehood in said statements or omission of facts which may alter, change or affect substantially the fact set forth in said statements shall be a ground for its revocation and termination.

15.4 The Contractor may, by giving due notice at any time during the term of this Agreement, apply for its cancellation due to causes which, in the opinion of the Contractor, render continued mining operation no longer feasible or viable. In this case, the Secretary shall decide on the application within thirty (30) days from notice: Provided, That the Contractor has met all the financial, fiscal and legal obligations.

15.5 No delay or omissions or course of dealing by the Government shall impair any of its rights under this Agreement, except in the case of a written waiver. The Government's right to seek recourse and relief by all other means shall not be construed as a waiver of any succeeding or other default unless the contrary intention is reduced in writing and signed by the party authorized to exercise the waiver.

15.6 In case of termination, the Contractor shall pay all the fees and other liabilities due up to the end of the year in which the termination becomes effective. The Contractor shall immediately carry out the restoration of the Contract Area in accordance with good mining industry practice.

15.7 The withdrawal by the Contractor from the Mineral Agreement shall not release it from any and all financial, environmental, legal and fiscal obligations under this Agreement;

15.8 The following acts or omission, *inter alia* shall constitute breach of contract upon which the Government may exercise its right to terminate the Agreement:

a) Failure of the Contractor without valid reason to commence Commercial Production within the period prescribed; and

b) Failure of the Contractor to conduct mining operations and other activities in accordance with the approved Work Programs and/or any modification thereof as approved by the Director.

15.9 The Government may suspend and cancel tax incentives and credits if the Contractor fails to abide by the terms and conditions of said incentives and credits.

SECTION XVI

OTHER PROVISIONS

16.1 Any terms and conditions resulting from repeal or amendment of any existing laws or regulation or from the enactment of a law, regulation or administrative order shall be considered a part of this Agreement.

16.2 Notice

All notices, demands and other communications required or permitted hereunder shall be made in writing, telex or telecopy and shall be deemed to

have been duly given notice, in the case of telex or telecopy, if answered back or confirmation received, or if delivered by hand, upon receipt or ten days after being deposited in the mail, airmail postage prepaid and addressed as follows:

If to the Government:

THE SECRETARY
Department of Environment and Natural Resources
DENR Building , Visayas Avenue
Diliman, Quezon City

If to the Contractor:

THE PRESIDENT
J.C.G. Resources Corporation
11th Flr., Gotesco Corporate Centre
Bilibid Viejo corner Gil Puyat Streets
Quipo, Manila

Either party may substitute or change such address on notice thereof to the other party

16.3 Governing Law

This Agreement and the relation between the parties hereto shall be governed by and construed in accordance with the laws of the Republic of the Philippines. The Contractor hereby agrees and obliges itself to comply with the provisions of the Act, its implementing rules and regulations and other relevant laws and regulations.

16.4 Suspension of Obligation

a) Any failure or delay on the part of any party in the performance of its obligation or duties hereunder shall be excused to the extent attributable to *Force Majeure* as defined in the Act.

b) If Mining Operations are delayed, curtailed or prevented by such *Force Majeure* causes, then the time for enjoying the rights and carrying out the obligations thereby affected, the term of this Agreement and all rights and obligations hereunder shall be extended for a period equal to the period involved.

c) The Party, whose ability to perform its obligations is affected by such *Force Majeure* causes, shall promptly give Notice to the other in writing of any such delay or failure of performance, the expected duration thereof and its anticipated effect and shall use its efforts to remedy such

delay, except that neither Party shall be under any obligation to settle a labor dispute.

16.5 Amendments

This Agreement shall not be annulled, amended or modified in any respect except by mutual consent in writing of the herein parties.

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement, as of the day and year first above written

THE REPUBLIC OF THE PHILIPPINES

BY :

DEC 11 2002

HEHERSON T. ALVAREZ
Secretary
Department of Environment and
Natural Resources

J.C.G. RESOURCES CORPORATION
TIN _____

BY:

JOEL T. GO
President

SIGNED IN THE PRESENCE OF :

GREGORY C. EDWARDS
(Signature over Printed Name)

(Signature over Printed Name)

ACKNOWLEDGMENT

Republic of the Philippines)
Quezon City) s s

Before me, a Notary Public for and in the City of Quezon, personally appeared **HEHERSON T. ALVAREZ**, with Community Tax Certificate No. 06496785 issued on January 7, 2011 at Manila, in his capacity as Secretary of the Department of Environment and Natural Resources, and **JOEL T. GO**, with Community Tax Certificate No. 15898780 issued on February 5, 2011 at Manila, in his capacity as President of J.C.G. Resources Corporation, both known to me and to me known to be the same persons who executed the foregoing instrument consisting of twenty four (24) pages, including this acknowledgment page, and acknowledged to me that the same is their voluntary acts and deeds.

IN WITNESS WHEREOF, I have hereunto set my hand and affix my notarial seal, this 12th day of December 2011.

ANSELMO C. ABUNGAN
NOTARY PUBLIC
Notary Public
UNTIL DECEMBER 31, 2011
PTR NO. 2106443 1/4/11 QC

Doc. No. 610
Page No. 124
Book No. IV
Series of 2011

C2/proforma/jcg.doc/mpsa

Annex 2. Approval of transfer of MPSA No. 184-2002-XIII from JCG Resources Corporation to Merrill Crowe Corporation

Republic of the Philippines
Department of Environment and Natural Resources
Visayas Avenue, Diliman, Quezon City
Tel Nos. (632) 929-66-26 to 29 • (632) 929-62-52
929-66-20 • 929-66-33 to 35
929-70-41 to 43

IN RE: Deed of Assignment Executed By and Between J.C.G. Resources Corporation (Contractor/Assignor) and Merrill Crowe Corporation (Assignee) Involving Mineral Production Sharing Agreement No. 184-2002-XIII

x----------x

ORDER

WHEREAS, on December 11, 2002, the Philippine Government represented by the Secretary of the Department of Environment and Natural Resources (DENR) and J.C.G. Resources Corporation (JCG) entered into the Mineral Production Sharing Agreement (MPSA) No. 184-2002-XIII covering an area of 3,288.7676 hectares located in the Municipalities of Alegria, Mainit, Tubod and Bacuag, Province of Surigao del Norte;

WHEREAS, on August 15, 2005, the Deed of Assignment (Deed) was executed, wherein JCG assigned to Merrill Crowe Corporation (Merrill Crowe) its rights in MPSA No. 184-2002-XIII;

WHEREAS, the Deed was duly registered in the Mines and Geosciences Bureau (MGB) Regional Office (RO) No. XIII on February 23, 2006;

WHEREAS, MGB RO No. XIII, thru its Memorandum dated October 26, 2007, forwarded to MGB Central Office the subject Deed for further evaluation;

WHEREAS, the MGB Director has recommended the approval of the assignment of MPSA No. 184-2002-XIII from JCG to Merrill Crowe pursuant to the Deed thru the Memorandum dated January 30, 2008;

WHEREAS, the verification of pertinent records showed that:

1. The Deed includes the required proviso that the Assignee shall assume all the Assignors' obligations under the MPSA;

2. JCG has complied with the terms and conditions of MPSA No. 184-2002-XIII;

3. Merrill Crowe is a Filipino corporation duly organized and existing under and by virtue of the laws of the Republic of the Philippines, and

CERTIFIED TRUE COPY
02Apr08
LEO L. JASARENO
Director II and
Chief, Mining Tenements Management Division
Mines and Geosciences Bureau

registered with the Securities and Exchange Commission on May 19, 2005; and

4. Merrill Crowe meets the eligibility requirements as Assignee of the MPSA pursuant to the pertinent provisions of DENR Administrative Order No. 96-40, as amended;

WHEREAS, the execution of the Deed and the subsequent endorsement thereof by the MGB are in accordance with the provisions of Section 46 of DENR Administrative Order No. 96-40, as amended, and other applicable provisions of Republic Act No. 7942, the Philippine Mining Act of 1995;

WHEREFORE, the foregoing premises considered, the assignment by J.C.G Resources Corporation of the Mineral Production Sharing Agreement No. 184-2002-XIII to Merrill Crowe Corporation pursuant to the Deed of Assignment of August 15, 2005 is hereby **APPROVED.** Accordingly, the said Mineral Production Sharing Agreement shall now be recorded in the name of **Merrill Crowe Corporation.**

SO ORDERED.

Quezon City, Philippines, MAR 1 1 2008.

JOSE L. ATIENZA, JR.
Secretary

Republic of the Philippines
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
IN REPLYING, PLS CITE:
SENR-014840

CERTIFIED TRUE COPY

LEO L. JASARENO
Director
Chief, Mining Tenements Management Division
Mines and Geosciences Bureau

ACCOUNTABLE FORM NO. 51-C
Revised January, 1992 (ORIGINAL)

Official Receipt of the Republic of the Philippines

No 4003099 L

Date March 31, 2005

Agency MINES & GEO-SCIENCES BUREAU | Fund

Payor Quentore Corporation

Nature of Collection	Account Code	Amount
Certified true copy + photocopy fee		₱ 50.-
TOTAL		₱ 50.-

Amount in Words Fifty Pesos

	Drawee Bank	Number	Date
☑ Cash			
☐ Check			
☐ Money Order			

Received the amount stated above.

for: applied
EVELYN ANDROMEDA-VIDAD
Collecting Officer/Section

NOTE: Write the number and date of this receipt on the back of check or money order received.

MINES & GEO-SCIENCES BUREAU

FINFORM CODE No. 2

Republic of the Philippines
Department of Environment and Natural Resources
MINES AND GEOSCIENCES BUREAU
Quezon City

ORDER OF PAYMENT

No. _____
Date: March 31, 2008

The Collecting Officer
Cash Unit

Please issue Official Receipt in favor of

Greenstone Corporation
(Name)

440 Agoncillo Street, Ayala Alabang Village, Muntinlupa City
(Address/Office)

in the amount of Fifty Pesos, (PhP 50.00) in cash, as payment for certified true copy and photocopying fees per the Letter dated March 24, 2008 of Greenstone Corporation pursuant to Section 1.8 of DENR Administrative Order No. 2005-08.

(Purpose)

By Authority of the Director :

LEO L. JASARENO
Chief, Mining Tenements Management Division

per Official Receipt No. 4033099
dated 3/31/08

Please deposit the collections under Bank Account/s:

No.	Name of Bank	Amount
_____	_____	PhP_____
_____	_____	_____
	TOTAL	**PhP**_____

Republic of the Philippines
Department of Environment and Natural Resources
MINES AND GEOSCIENCES BUREAU
North Avenue, Diliman, Quezon City, Philippines
Tel. No. (+63 2) 928-8642 / 928-8937 Fax No. (+63 2) 920-1635 E-mail: central@mgb.gov.ph

March 25, 2008

IN RE : DEED OF ASSIGNMENT EXECUTED BY AND BETWEEN J.C.G. RESOURCES CORPORATION (CONTRACTOR/ASSIGNOR) AND MERRILL CROWE CORPORATION (ASSIGNEE) INVOLVING MINERAL PRODUCTION SHARING AGREEMENT NO. 184-2002

x----------x

NOTICE OF ISSUANCE OF AN ORDER

MR. JOEL T. GO **Registered Mail**
President
JCG Resources Corporation
12th Floor, Ever Gotesco Corporate Centre
1962 CM Recto Ave., Manila

MS. WILMA C. CRISOSTOMO **Registered Mail**
President
Merrill Crowe Corporation
2003 The Peak Tower
107 LP Leviste St., Salcedo Village
Makati City

MR. ALILO C. ENSOMO, JR. **Registered Mail**
Regional Director
Mines and Geosciences Bureau
Regional Office No. XIII
Km. 2, National Highway
Surigao City

Please be notified that an Order was issued by the Secretary of the Department of Environment and Natural Resources on March 11, 2008 on the subject, a copy of which is attached.

HORACIO C. RAMOS
Director

Annex 3. Environmental compliance certificate of the Siana Gold Project

Republic of the Philippines
Department of Environment and Natural Resources
Visayas Avenue, Diliman, Quezon City 1110
Tel. Nos.: (632) 929-66-26 to 29 • (632) 929-65-52
929-66-20 • 929-66-33 to 35
929-70-41 to 43

APR 2 1 2009

ECC Ref. Code: 0811-030-1010

Mr. Gregory C. Edwards
Managing Director
GREENSTONE RESOURCES CORPORATION
Level 2, NOL Tower, Commerce Avenue cor. Acacia Avenue
Madrigal Business Park
Ayala Alabang, Muntinlupa City

SUBJECT : ENVIRONMENTAL COMPLIANCE CERTIFICATE

Dear Mr. Edwards:

This refers to your submitted Environmental Impact Statement (EIS) in connection with your application for an Environmental Compliance Certificate (ECC) for your proposed **SIANA GOLD PROJECT** to be located at Barangay Cawilan, Municipality of Tubod, and Barangays Siana and Dayano, Municipality of Mainit, all in the Province of Surigao del Norte.

After satisfying the requirements in the said application and upon recommendation of the Environmental Management Bureau (EMB), this Department has decided to grant an ECC to the above-mentioned project.

With the issuance of this ECC, you are expected to implement the measures presented in the EIS intended to protect and mitigate the project's adverse impacts on community health, welfare and the environment. Environmental considerations shall be incorporated in all phases and aspects of the project. You may proceed with the project implementation after securing all the necessary permits from other pertinent Government agencies. This Office will be monitoring the project periodically to ensure your compliance with stipulations cited in the attached ECC.

Please be guided accordingly.

Very truly yours,

Republic of the Philippines
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
SENR-020053

JOSE L. ATIENZA, JR.
Secretary

cc: EMB Regional Office No. XIII
MGB Central Office
MGB Regional Office No. XIII
LGU – Province of Surigao del Norte
LGU – Municipality of Tubod
LGU – Municipality of Mainit
LGU – Barangay Cawilan
LGU – Barangay Siana
LGU – Barangay Dayano

Republic of the Philippines
Department of Environment and Natural Resources
Visayas Avenue, Diliman, Quezon City 1110
Tel. Nos.: (632) 929-66-26 to 29 • (632) 929-65-52
929-66-20 • 929-66-33 to 35
929-70-41 to 43

ENVIRONMENTAL COMPLIANCE CERTIFICATE

(Issued under Presidential Decree No. 1586)

ECC Reference Code: 0811-030-1010

THIS IS TO CERTIFY THAT THE PROPONENT, **GREENSTONE RESOURCES CORPORATION (GRC)**, as represented by its Managing Director, **Mr. Gregory C. Edwards**, is granted this Environmental Compliance Certificate (ECC), for its proposed ***SIANA GOLD PROJECT*** to be located at **Barangay Cawilan, Municipality of Tubod, and Barangays Siana and Dayano, Municipality of Mainit, all in the Province of Surigao del Norte** by the Department of Environment and Natural Resources (DENR) through the Environmental Management Bureau (EMB).

SUBJECT to the conditions and restrictions set out herein labeled as Attachments A and B, this Certificate is issued for the proposed **Siana Gold Project** with the following details:

PROJECT DESCRIPTION

This Certificate shall cover the Siana Gold Project of Greenstone Resources Corporation (GRC) within the 240-hectare Siana property covered by a Mineral Production Sharing Agreement (MPSA No. 184-2002-XIII) located at Barangay Cawilan, Municipality of Tubod, and Barangays Siana and Dayano, Municipality of Mainit, all in the Province of Surigao del Norte, granted on 12 December 2002, and bounded by the following geographical coordinates:

Corner	Latitude	Longitude
1	9°33'10"	125°33'55"
2	9°33'10"	125°35'25"
3	9°32'00"	125°35'25"
4	9°32'00"	125°33'55"

Note: Based on the Luzon (Philippines) datum.

The Project has the following components:

1. Dewatering of the open pit with current approximate depth of 90 m;
2. Mining of the gold deposit by open pit method to an approximate depth of 200 m below the surface from the existing floor depth of about 90 m, then by underground method over an approximately 200 m vertical interval;
3. Construction and operation of a 750,000 tons per year (TPY), expandable to one million TPY, cyanidation and flotation plant;
4. Construction and operation of mine tailings ponds and waste rock dumps;
5. Development and use of a mine camp, workshop, administration office, and 750-KVA standby generator;
6. Construction and use of a 1-km all-weather access road and a 65-ton causeway crossing; and
7. Mine rehabilitation and decommissioning.

This Certificate is issued pursuant to the provisions of Presidential Decree No. 1586, in accordance to DENR Administrative Order (D.A.O.) No. 2003-30. Non-compliance with any of the provisions of this Certificate shall be a sufficient cause for the cancellation of this Certificate and/or imposition of a fine in an amount not to exceed Fifty Thousand Pesos (₱50,000.00) for every violation thereof. The EMB, however, is not precluded from reevaluating, adding, removing, and/or correcting any deficiencies or errors that may be found after issuance of this Certificate.

Issued at DENR, Quezon City, Philippines, this APR 21 2009.

Recommending Approval:

JULIAN D. AMADOR
Director, EMB

Approved by:

JOSE L. ATIENZA, JR.
Secretary

Republic of the Philippines
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
IN REPLYING, PLS CITE:
SENR-020054

SWORN ACCOUNTABILITY STATEMENT

I, **Mr. Gregory C. Edwards**, as the proponent of this Siana Gold Project located at *Barangay Cawilan, Municipality of Tubod, and Barangays Siana and Dayano, Municipality of Maimit, all in the Province of Surigao del Norte*, take full responsibility in complying with all conditions contained in this Environmental Compliance Certificate (ECC).

Signature

TIN E3074609

ASR- E204464

QUEZON CITY

Subscribed and sworn to before me in this ____ day of APR 21 2009 2008, the above-named affiant taking oath presenting his Community Tax Certificate (CTC) No. _____ issued on _____ 2008 at _____.

ATTY. FELIXBERTO F. ABAD
NOTARY PUBLIC
Until [illegible]
Signature of Administering Officer
PTR NO. [illegible]-8-09-QC 2009
ATTORNEY'S ROLL NO. 24242
IBP NO. [illegible] Q. C./1-8-09
OFFICE OF THE CITY ATTY. Q.C.

DOC NO. 341
BOOK NO. 74
SERIES OF 2009

ATTACHMENT A

I. CONDITIONS

ENVIRONMENTAL MANAGEMENT

All commitments, mitigating measures and monitoring requirements, especially those contained in the Environmental Management Plan (EMP) in the Environmental Impact Statement (EIS), including all their modifications and additional information as approved by the EMB, shall be instituted to minimize any adverse impact of the project to the environment throughout its implementation, including the following:

1. Observance of good vegetative practices, proper land use, and sound soil management throughout the project implementation such as:

    a. Properly stockpiling and disposal of the materials generated from the mining site, silt materials scooped-out from the sediment/silt ponds, and other solid waste in permanent, stabilized areas to avoid pollution of any water body and drainage systems, and maintaining them in safe and non-polluting conditions;
    b. Strictly effecting stabilization and erosion control of the affected side slopes of the roads and nearby gullies, creeks, rivers and sediment/silt ponds within the project site;
    c. Using the recovered topsoil for i.e. re-soiling, as soil cover on waste dumps, for landscaping or stockpiling on designated suitable areas, maintained at not more than three (3) meters high and stabilized by temporary vegetation to protect it from erosion;
    d. Limiting the clearing of vegetation within the planned areas to be mined and planting idle land areas in the site with appropriate species;

2. Conduct of an effective Information, Education and Communication (IEC) Campaign to inform and educate all stakeholders, especially its local residents, on the project's mitigating measures embodied in its EIS, the conditions stipulated in this Certificate and measures in surface mining and processing for greater awareness, understanding and sustained acceptance of the project. The proponent shall implement an annual detailed IEC campaign in coordination with the Mines and Geosciences Bureau (MGB) Regional Office No. XIII and EMB Regional Office No. XIII. The proponent shall also conduct a Knowledge, Attitude, Practice (KAP) Evaluation to determine the effectiveness of the IEC Campaign, copy of such evaluation provided to the MGB and EMB Regional Offices;

3. Design and construction of roads with minimal land and ecological disturbance and with adequate drainage. It shall continuously maintain access roads and other public/private roads within the project site to offset impact of heavy vehicle traffic and nuisances/damages to the people and properties, as well as conduct regular water spraying and require vehicles to maintain low speed in dusty roads;

4. Establishment of a reforestation and carbon sink program to mitigate greenhouse gas (GHG) emissions of the project in line with the DENR's

thrust for GHG emission reduction programs. The program shall be submitted to EMB prior to the project implementation;

5. Protect the headwaters and natural springs/wells within the project site that are being utilized as sources of potable water by the community. Should the development activities affect the headwaters and natural springs/wells, the proponent shall immediately provide alternative source of potable water to the affected community;

GENERAL CONDITIONS

6. The mining and milling/processing operations shall conform with the provisions of R.A. No. 6969 (*Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990*), R.A. No. 9003 (*Ecological Solid Waste Management Act of 2000*), R.A. No. 9275 (*Philippine Clean Water Act of 2004*), and R.A. No. 8749 (*Philippine Clean Air Act of 1999*);

7. The proponent shall comply with the environmental management and protection requirements of the pertinent provisions of the Philippine Mining Act of 1995 (R.A. No. 7942 and its Revised Implementing Rules and Regulations (D.A.O. No. 96-40, as amended), as well as the pertinent provisions of the Memorandum of Agreement (MOA) between the EMB and MGB executed on 16 April 1998, such as, but not limited to, the following:

   a. Submission of Environmental Protection and Enhancement Program (EPEP), with the Final Mine Rehabilitation and/or Decommissioning Plan (FMR/DP) integrated thereto, to the MGB, for approval;
   b. Setting up of a Contingent Liability and Rehabilitation Fund (CLRF) and Environmental Trust Fund (ETF);
   c. Setting up of a Mine Environmental Protection and Enhancement Office (MEPEO) to competently handle the environment-related aspect of the project. In addition to the monitoring requirements as specified in the EMP, the MEPEO shall also monitor the actual project impacts vis-à-vis the predicted impacts and management measures in the EIS;
   d. Establishment of Mine Rehabilitation Fund Committee (MRFC) and Multipartite Monitoring Team (MMT). A local DOH representative shall be included as member in the MMT;
   e. Submission of a Social Development and Management Program (SDMP), within thirty (30) days from receipt of this Certificate, to the MGB Regional Office No. XIII, for approval. The EMB shall be furnished with the SDMP within thirty (30) days from its approval; and
   f. Designation of a Community Relations Officer (CRO);

8. The proponent shall ensure that its contractors and subcontractors properly comply with the relevant conditions of this Certificate;

9. The proponent shall conduct detailed geotechnical and hydrogeological studies to predict the hydrological impacts of underground mining and submit the results of the studies to EMB-XIII and MGB-XIII prior to project operation.

II. RESTRICTIONS

10. The gold deposit shall be mined by open pit method to an approximate depth of 200 m below the surface from the existing floor depth of about 90 m, then by underground method over an approximately 200 m vertical interval and shall be processed by cyanidation and flotation; and

11. Transfer of ownership of this project carries these same conditions and restrictions for which written notification must be made by herein grantee to EMB within fifteen (15) days from such transfer.

O.R. No. : 6833359
Date : 03 November 2008
Processing Fee : ₱6,000.00

Attachment B

PROJECT ASSESSMENT PLANNING TOOL

For the assistance of the Proponent and the Government agencies concerned in the management of the project and for better coordination in mitigation on the impact of the project on its surrounding areas and to the environment, and by way of recommendation, the following have been taken notice of by the EIA Review Committee and are forwarding these recommendations to the parties and authorities concerned for proper appreciation and action.

REGULATORY CONDITIONS	Government Agencies/Institutions Concerned
1. Compliance with the Sanitation Code of the Philippines	DOH
2. Compliance with the Labor Code of the Philippines including occupational health and safety standards	DOLE-Bureau of Working Condition/MGB
3. Compliance with the Building Code of the Philippines	LGU-MPDO
4. Provision of proper storm drainage canal, concrete culverts, and other flood control measures to adequately receive and channel the silt-laden runoff from nearby receiving bodies of water	Provincial/Municipal Engineering Office
5. Coordination and consideration of the NWRB conditions or requirements in the allocation of water supply	NWRB
6. Presentation of the EIA findings for consideration in the approval by FMB-DENR of its Tree Cutting Permit	DENR - FMB
7. Coordination with the LGUs concerned on the implementation of the Solid Waste Management System	LGU
ENVIRONMENTAL PLANNING RECOMMENDATIONS FOR THE PROPONENT	
8. The Emergency Response Plan (ERP) shall be prepared to include an off-site emergency plan based on APELL (Awareness and Preparedness for Emergency at the Local Level)	
9. Priority of employment shall be given to qualified local residents. Adequate public information for jobs shall be made available to local residents in the affected areas.	
10. The Proponent need to implement a Risk Management Program to address environmental risks including contingency measures in case of accidents, equipment/machine malfunctions/failures, and other emergencies;	
11. An independent third party shall be commissioned to undertake an environmental audit, including a continuing study on the effects of the project on the health of the workers and affected residents, particularly women and children. The result of the third party environmental audit, including the auditing of risks and hazards of the project, shall be submitted to EMB and the MGB, while the result of the continuing health study shall be submitted, every two (2) years, to the Department of Health (DOH), for evaluation.	

DR. DAISY J. SERRANO
EIARC Chair

CESAR S. SIADOR, JR.
OIC, EIAM Division

JULIAN D. AMADOR
Director

Annex 4. Climatological normals at PAGASA's Surigao City Synoptic Station

Annex 4. Climatological normals at PAGASA's Surigao City Synoptic Station

STATION :653 - SURIGAO, SURIGAO DE NORTE
LATITUDE :09° 48' N LONGITUDE :125° 30' E ELEVATION : 39.0 m
PERIOD :1971 - 2000

	RAIN-	NO	-----TEMPERATURE DEG. C------								--WIND--				
	FALL	OF				DRY	WET	DEW	VP	RH	MSLP		SPD	CLD	DAYS WITH
MONTH	MM	RD	MAX.	MIN.	MEAN	BULB	BULB	PT.	MBS.	%	MBS.	DIR	MPS	OKT	TSTM LTNG
JAN.	600.8	24	29.3	22.7	26.0	25.8	24.2	23.6	29.1	88	1010.7	NE	3	6	2 1
FEB.	443.2	21	29.6	22.7	26.2	25.9	24.2	23.6	29.0	87	1011.0	E	3	6	1 0
MAR.	334.6	21	30.4	23.1	26.8	26.5	24.6	23.9	29.6	86	1011.0	E	3	5	1 1
APR.	236.3	17	31.6	23.7	27.7	27.5	25.3	24.5	30.7	84	1010.0	E	2	5	4 3
MAY	127.2	13	32.7	24.2	28.4	28.3	25.8	25.0	31.5	82	1009.1	E	2	5	7 11
JUNE	140.3	14	32.5	24.1	28.3	28.1	25.7	24.9	31.4	82	1009.1	SW	2	6	7 12
JULY	165.9	13	32.2	24.1	28.1	28.0	25.4	24.5	30.6	81	1008.8	SW	2	6	7 15
AUG.	131.4	12	32.6	24.2	28.4	28.2	25.5	24.6	30.8	80	1009.0	WSW	2	6	6 15
SEPT	149.0	14	32.6	24.1	28.4	28.2	25.5	24.6	30.8	80	1009.4	WSW	2	6	8 15
OCT.	255.6	20	31.9	23.8	27.8	27.6	25.4	24.6	30.9	84	1009.2	W	2	6	9 14
NOV.	447.2	22	30.6	23.5	27.1	26.9	25.0	24.3	30.4	86	1009.4	E	2	6	7 8
DEC.	524.9	25	29.8	23.3	26.6	26.3	24.7	24.1	30.0	88	1010.2	NE	2	6	3 3
ANNUAL	3556.4	216	31.3	23.6	27.5	27.3	25.1	24.3	30.4	84	1009.7	E	2	6	62 98

PREPARED BY: PAGASA/CAB/CDS

Annex 5. Climatological extremes at PAGASA's Surigao City Synoptic Station

Annex 5. Climatological extremes at PAGASA's Surigao City Synoptic Station

YEAR - AS OF 2003

	TEMPERATURE, DEG C				GREATEST DLY RAINFALL, MM		HIGHEST WIND, MPS			SEA LEVEL PRESSURE, MBS			
MONTH	HIGH	DATE	LOW	DATE	AMOUNT	DATE	SPD	DIR	DATE	HIGH	DATE	LOW	DATE
JAN.	33.7	15-16	18.6	02-78	351.8	24-63	25/	N	24-75	1019.5	29-98	984.9	24-75
FEB.	33.3	02-06	18.2	24-05	472.9	12-74	20/	NE	21-97	1019.1	02-98	1002.5	29-96
MAR.	35.0	31-39	18.8	01-49	237.5	19-59	29/	NW	03-67	1019.3	12-64	999.8	04-89
APR.	35.2	19-87	18.9	05-63	339.0	05-86	35/	WSW	04-94	1018.3	14-93	990.5	05-94
MAY	36.3	22-87	20.8	18-72	198.1	16-62	36/	SSE	07-54	1015.9	09-57	986.1	06-54
JUNE	37.5	15-87	20.7	13-65	235.3	29-70	22/	SSW	30-70	1015.5	08-97	1000.7	30-70
JULY	36.2	31-16	20.0	06-61	201.9	01-52	31/	WNW	02-52	1015.6	04-89	995.2	02-52
AUG.	37.0	19-16	20.0	22-93	137.4	15-40	25/	WSW	17-86	1016.4	11-97	1000.2	15-74
SEP.	37.2	16-87	20.6	01-66	179.4	01-84	60/	ENE	01-84	1016.5	10-93	1000.8	11-00
OCT.	35.6	11-05	20.5	16-06	320.6	13-19	30/	W	23-88	1016.5	03-97	981.8	27-91
NOV.	36.2	02-75	19.7	12-11	564.7	18-68	46/	WSW	18-68	1018.3	23-92	977.3	12-90
DEC.	34.6	18-05	19.1	21-25	566.4	18-03	56/	E	21-86	1017.4	12- 2	977.5	21-86
ANNUAL	37.5	6-15	18.2	2-24	566.4	12-18	60/	ENE	9-01	1019.5	1-29	977.3	11-12
		1987		1905		2003			1984		1998		1990
PERIOD OF RECORD	1903 - 2003				1902 - 2003		1950 - 2003			1949 - 2003			

NOTE : 1. EQUAL SIGN(=) MEANS YEAR 1800
2. NO RECORD FOR THE PERIOD 1941-1945

Annex 6. Rainfall intensity-duration-frequency data of PAGASA's Surigao City Synoptic Station

Annex 6. Rainfall intensity-duration-frequency data of PAGASA's Surigao City Synoptic Station

Based on **36 years** of record

COMPUTED EXTREME VALUES (in mm) of PRECIPITATION

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	16.3	24.7	31.8	37.8	47.5	57.4	64.2	74.5	83.8	90.8	100.1	108.6	143.5	177.9	204.8
5	24.5	37.2	48.2	56.9	71.1	85.4	95.2	111.0	125.5	136.8	151.5	164.6	216.8	269.1	308.9
10	29.9	45.5	59.0	69.6	86.8	104.0	115.8	135.2	153.1	167.3	185.6	201.7	265.4	329.4	377.8
15	32.9	50.2	65.1	76.7	95.6	114.5	127.3	148.8	168.6	184.5	204.8	222.6	292.8	363.5	416.7
20	35.0	53.5	69.4	81.7	101.8	121.8	135.5	158.3	179.5	196.5	218.2	237.2	311.9	387.3	443.9
25	36.7	56.0	72.7	85.6	106.5	127.5	141.7	165.7	187.9	205.8	228.6	248.5	326.7	405.7	464.9
50	41.8	63.8	82.8	97.4	121.2	144.9	161.0	188.4	213.8	234.3	260.5	283.2	372.2	462.3	529.5
100	46.8	71.6	92.9	109.2	135.8	162.1	180.1	210.8	239.5	262.6	292.2	317.7	417.4	518.4	593.6

EQUIVALENT AVERAGE INTENSITY (in mm/hr) OF COMPUTED EXTREME VALUES

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	195.6	148.2	127.2	113.4	95.0	76.5	64.2	55.9	50.3	45.4	40.0	36.2	23.9	14.8	8.5
5	294.0	223.2	192.8	170.7	142.2	113.9	95.2	83.3	75.3	68.4	60.6	54.9	36.1	22.4	12.9
10	358.8	273.0	236.0	208.8	173.6	138.7	115.8	101.4	91.9	83.7	74.2	67.2	44.2	27.4	15.7
15	394.8	301.2	260.4	230.1	191.2	152.7	127.3	111.6	101.2	92.3	81.9	74.2	48.8	30.3	17.4

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
20	420.0	321.0	277.6	245.1	203.6	162.4	135.5	118.7	107.7	98.3	87.3	79.1	52.0	32.3	18.5
25	440.4	336.0	290.8	256.8	213.0	170.0	141.7	124.3	112.7	102.9	91.4	82.8	54.5	33.8	19.4
50	501.6	382.8	331.2	292.2	242.4	193.2	161.0	141.3	128.3	117.2	104.2	94.4	62.0	38.5	22.1
100	561.6	429.6	371.6	327.6	271.6	216.1	180.1	158.1	143.7	131.3	116.9	105.9	69.6	43.2	24.7

prepared by:

the HYDROMETEOROLOGICAL INVESTIGATIONS and SPECIAL STUDIES SECTION

Flood Forecasting branch, PAGASA